



**HYDROGEOLOGICAL INVESTIGATION REPORT**

**for**

**REPLACEMENT OF UNDERPASS AT HIGHWAY 401 AND  
CONCESSION ROAD 7**

**HIGHWAY 401, SITE NO. 35-351, STATION 21+042**

**PUSLINCH TOWNSHIP, COUNTY OF WELLINGTON**

**LATITUDE: 43.44977; LONGITUDE: -80.15391**

**ASSIGNMENT NO. 3014-E-0014**

**GWP 3224-15-00**

PETO MacCALLUM LTD.  
165 CARTWRIGHT AVENUE  
TORONTO, ONTARIO  
M6A 1V5  
Phone: (416) 785-5110  
Fax: (416) 785-5120  
Email: toronto@petomaccallum.com

**Distribution:**

- 1 cc: AECOM for distribution to MTO  
Project Manager + One (1) Digital Copy (PDF)
- 1 cc: AECOM for distribution to MTO  
Foundations Section + One (1) Digital Copy (PDF)
- 1 cc: AECOM + One (1) Digital Copy (PDF)
- 1 cc: PML Toronto

PML Ref.: 17TF006C  
Index No.: 034FHR  
GEOCREs No.: 40P8-255  
November 26, 2018



## TABLE OF CONTENTS

1. INTRODUCTION .....	1
2. SITE DESCRIPTION .....	3
3. FIELD INVESTIGATION PROCEDURES .....	3
3.1 Borehole Locating and Drilling Program.....	3
3.2 Ground Water Conditions .....	5
3.3 Borehole Permeability Testing.....	5
4. LABORATORY TEST PROCEDURES .....	6
4.1 Soil Samples .....	6
4.1.1 Testing Program .....	6
4.1.2 Soil Particle Size Distribution Analyses and Hydraulic Conductivity Estimate.....	7
4.2 Ground Water Samples .....	8
5. SITE HYDROGEOLOGY AND SUBSURFACE CONDITIONS .....	8
5.1 Site Physiographic, Geologic and Hydrogeologic Settings .....	8
5.2 Review of MOECC Water Well Records .....	9
5.3 Soil Stratigraphy .....	10
5.3.1 Topsoil.....	11
5.3.2 Silty Sand, With Gravel (Pavement Structure).....	11
5.3.3 Silty Sand, With Gravel (Fill).....	11
5.3.4 Silty Sand, With Gravel.....	11
5.3.5 Dolostone Bedrock .....	12
5.4 Groundwater Conditions .....	12
5.5 Estimated Hydraulic Conductivity .....	13
5.6 Ground Water Sample Test Results.....	13
6. CONSTRUCTION DEWATERING REQUIREMENTS AND IMPACT ASSESSMENT .....	15
6.1 Hydrogeological Conceptual Site Model .....	15
6.2 Construction Dewatering Requirements.....	15
6.3 Water Taking Permit .....	16
6.4 Construction Dewatering Impact Assessment .....	16
7. CLOSURE .....	17



Table 1 – Ground Water Level Readings in Monitoring Wells

Table 2 – Estimated Hydraulic Conductivity K Values from Soil Sample Grain Size Distribution and Borehole Permeability Test Results

Figure 1 – 2017 Aerial Photo

Figure 2 – Physiographic Regions and Landforms

Figure 3 – Surficial and Bedrock Geology

Figures 351-GS-1 through 351-GS-2C – Grain Size Distribution Charts

Drawing 35-351-1 – Borehole Location and Soil Strata

Explanation of Terms Used in Report

Log of Borehole Sheets 35-351-01 to 35-351-08

Appendix A – Site GIS Map

Appendix B – Borehole Permeability Testing Plots

Appendix C – Water Sample Laboratory Certificates of Analyses

Appendix D – MOECC Recorded Water Well Location Map and MOECC Records

**HYDROGEOLOGICAL INVESTIGATION REPORT**

for

Replacement of Underpass at Highway 401 and Concession Road 7  
Highway 401, Site No. 35-351, Station 21+042  
Puslinch Township, County of Wellington, Ontario  
Latitude: 43.44977; Longitude: -80.15391  
Assignment No. 3014-E-0014, GWP 3224-15-00

---

**1. INTRODUCTION**

Ministry of Transportation Ontario (MTO) has retained AECOM Canada Ltd. (AECOM) as the Prime Consultant to provide Owner's Engineer services for the re-alignment, improvement and replacement of existing structures on Highway 6 from Hamilton to Guelph. The assignment includes the following project to be delivered by the Design-Bid-Build model:

- GWP 3224-15-00; Replacement of Underpass, Highway 401 and Concession Road 7, Bridge #11, Puslinch Township

AECOM has retained Peto MacCallum Ltd. (PML) on behalf of the MTO to provide geotechnical engineering and hydrogeological services for this assignment.

The hydrogeological investigation work reported herein is part of the assignment under GWP 3224-15-00 to report the factual hydrogeological findings for the proposed replacement of the existing underpass located at the crossing of Highway 401 and Concession Road 7, approximate Sta. 21+042 (assumed by AECOM), in the Township of Puslinch, County of Wellington, Ontario. The hydrogeological investigation was conducted concurrently with the geotechnical investigation, also under Assignment No. GWP 3224-15-00, with the reference:

- Foundation Investigation and Design Report for Replacement of Underpass at Highway 401 and Concession Road 7, Highway 401, Site No. 35-351, Station 21+042, Puslinch Township, County of Wellington, Latitude: 43.44977; Longitude: -80.15391, Assignment No. 3014-E-0014, GWP 3224-15-00

The above report is abbreviated as "FIDR (35-351)" herein.

The purpose of the investigation was to provide hydrogeological findings to aid the design of the replacement bridge and selection of the suitable type of foundation to support the replacement structure.

This hydrogeological investigation report is in accordance with the MOECC's "Environmental Assessment Act, Section 9, Notice of Approval to Proceed with the Undertaking, Re: An Environmental Assessment for Highway 6: Freelon Northerly 16.9 kilometres to Guelph", dated 2009. A summary of





the report's compliance with Section 7.3, "Hydrogeological Studies Required", with references, follows in Table 1, below.

**Table 1 – Summary of Compliance with Relevant EA Conditions of Approval, Section 7.3**

ABSTRACT OF MOECC CONDITIONS	REPORT REFERENCE
a) One hydrogeological cross-section along the entire length of the recommended route, and shorter cross-sections placed perpendicular to the recommended route at sensitive areas (e.g. recharge/discharge zones). The cross-sections should show depth to bedrock, stratification within the overburden, water table and/or potentiometric surface, and referenced wells;	A hydrogeological cross-section is provided on drawing 35-351-1.
b) On the basis of a pre-construction well owner field survey, a map identifying the location of the wells within 300 metres (m) of the highway right of way will be prepared. Based on the owner survey and a review of the MOECC Water Well Record database information wells should be categorized as overburden or bedrock wells, and the owners and status of the wells should be identified;	A well record review is provided in Section 5.2, along with a map and summary table in Appendix D. The private well survey is to be provided in the AECOM Groundwater Report (AECOM GR).
c) After having completed the studies described in Conditions 7.3 (a) and (b), the proponent shall assess the potential impact of road salt and other contaminants on the identified wells and identify possible mitigation measure that could be implemented in the event that those impacts occur;	The AECOM GR is to provide an assessment of salt and contaminant impacts.
d) A pre-construction survey of all potable water wells with 300 m of the highway right of way, to serve as a baseline for comparison to future monitoring data;	The AECOM GR is to document a pre-construction survey of the wells within 300 m of the ROW.
e) An assessment of seasonal variation of water level. Boreholes should be drilled at proposed stormwater management facilities to determine the site-specific stratigraphy to the bedrock. Alternative best management practices should be considered if a direct hydraulic connection to bedrock aquifer is identified upon drilling; f) An explanation of the expected temporary and long-term implications of deep road cuts defined in this project as from 75 m north of Crieff Road northerly for 350 m and from 350 m south of Calfass Road, northerly for 1 kilometre, to 250 m north of the Connection Road at Morriston on surface water and groundwater interaction; g) A map identifying the location of the deep road cuts described in Condition 7.3(f); h) An identification of mitigation options for the impacts of the deep road cuts described in Condition 7.3(f);	These items are not applicable to the Concession Road 7 bridge replacement.



**Table 1 – Summary of Compliance with Relevant EA Conditions of Approval, Section 7.3**

ABSTRACT OF MOECC CONDITIONS	REPORT REFERENCE
i) An assessment of the dewatering impacts of the preferred alternative;	An assessment of dewatering impacts is provided in Section 6.2.
j) Achieve the treatment levels for soluble pollutants required as per current Ministry of Natural Resources and MOECC policy and practice, using methods advocated by the MOECC and Ministry of Transportation in their respective manuals on hydrogeology;	Potential treatment of dewatering discharge is discussed in Section 5.6.
k) An assessment of the potential groundwater impacts on lands having existing development rights, and which are located adjacent to the highway project.	The AECOM GR Report is to provide an assessment of potential groundwater impacts on lands having existing development rights.

## **2. SITE DESCRIPTION**

The topography of the project area is generally flat, except for the highway embankments. For aerial photography and GIS mapping of the Site and surroundings, see Figure 1 and Appendix A, respectively. Generally, the site surrounding the bridge is covered with bushes and grass. The area along the highway on both north and south sides is moderately vegetated with grass, trees and shrubs. The Highway 401 in this area passes through several shallow depressions, which are damp or swampy. The land use adjacent to the project site comprises industrial, agricultural, residential and undeveloped lands.

## **3. FIELD INVESTIGATION PROCEDURES**

### **3.1 Borehole Locating and Drilling Program**

PML staff visited the site on October 25, 2017 to mark out the borehole locations. The underground services at the borehole locations were cleared by the respective utility companies. Public and private utility authorities were informed and all the utility clearance documents were obtained before the commencement of drilling work.

The fieldwork was carried out between October 31, 2017 and January 17, 2018 and the location of boreholes in the field was established by PML staff using a portable GPS device. Subsequently, J.D. Barnes Limited, Ontario, under contract to PML, carried out the survey of the borehole locations and elevations and provided the co-ordinates for locations in MTM NAD 83 northing and easting.



PML used the survey data provided by J.D. Barnes Limited for preparation of this report. All elevations reported in this report are referred to Geodetic datum and expressed in meters.

The drilling equipment from three different contractors were used for the field investigation. The equipment used were owned and operated by Landshark Drilling, Aardvark Drilling Inc., and Altech Canada who are specialist drilling contractors. The fieldwork was carried out under the full-time supervision of PML field supervisors.

The investigation included drilling eight (8) boreholes numbered 35-351-01 to 35-351-08, as listed in Table 3.1, below. These boreholes were drilled to depths ranging from 9.8 to 29.4 m below ground surface (bgs) using hollow stem augers powered by a CME 850 track-mounted drill rig and C 57 truck-mounted drill rig. Rock coring was carried out in Boreholes 35-351-03 and 35-351-05 using a NQ size double core barrel to confirm the presence of bedrock. The location of the boreholes is shown on the attached Drawing 35-351-1.

**Table 3.1 - Borehole Information**

BOREHOLE NO.	BOREHOLE LOCATION	MTM NAD 83 COORDINATES		GROUND SURFACE ELEVATION (m)	BOREHOLE DEPTH (m)
		NORTHING	EASTING		
35-351-01	North Embankment	4812484.9	251867.3	317.0	14.3
35-351-02	North Abutment	4812456.1	251897.2	318.4	29.1
35-351-03		4812456.0	251866.4	311.1	26.1
35-351-04	Pier	4812414.8	251875.3	311.8	25.0
35-351-05		4812420.2	251860.7	311.8	29.4
35-351-06	South Abutment	4812382.6	251872.3	310.2	20.1
35-351-07		4812376.5	251875.3	311.3	27.5
35-351-08	South Embankment	4812359.4	251877.6	313.1	9.8

Representative soil samples were recovered from the boreholes at 0.75 m intervals to a depth of 5.0 m bgs, using a conventional 51 mm O.D split spoon sampler in accordance with the Standard Penetration Test (SPT) procedure. The frequency of sampling was increased to 1.5 m intervals below the depth of 5.0 m bgs. Standard penetration tests and cone penetration tests were conducted with the sampling operation to assess the strength characteristics of the substrata.



Boreholes 35-351-02, 35-351-04 and 35-351-06 were advanced below the sampling depths by conducting Dynamic Cone Penetration (DCP) test to refusal.

Upon completion of drilling, the boreholes were backfilled with bentonite/cement grout in accordance with the MTO guidelines and MOECC Regulation 903 for borehole abandonment procedures.

The recovered soil samples were returned to our laboratory for detail visual examination, and index tests.

### **3.2 Ground Water Conditions**

The ground water conditions at the borehole locations were observed during the drilling process by visual examination of the soil samples, sampler and drill rods as the samples were retrieved. In addition, water level measurements were taken in the open boreholes upon completion of drilling.

To supplement the ground water information, monitoring wells were installed in Boreholes 35-351-03 and 35-351-07 in order to facilitate monitoring of the ground water level at these locations and allow for in-situ hydraulic conductivity testing and ground water sampling. The monitoring wells consisted of solid 50 mm diameter PVC pipes with slotted screens at the bottom. The annular space of the borehole around the screen was backfilled with clean filter sand (up to 0.5 m above the top of the well screen) and filled to the surface with bentonite. Additional monitoring well details are presented in the specific Record of Borehole Log sheets.

The wells were developed by removing an equivalent of 3 to 10 times the well volume prior to borehole permeability testing.

The ground water level in the monitoring wells was measured using a Solinst™ flat tape water level reader which was cleaned between uses at each monitoring well location. Ground water levels are indicated on the borehole log sheets.

The ground water condition findings are described in Section 5.4 and Table 1, attached.

### **3.3 Borehole Permeability Testing**

In order to estimate the hydraulic conductivity (K) of the soils screened in the monitoring wells, borehole permeability testing was conducted in the monitoring wells in Boreholes 35-351-03 and 35-351-07. The field permeability testing was conducted using a slug test, which was carried out after well development and after the ground water level was stabilized to a relatively hydrostatic state.



In the test, a volume of water (the 'slug') was rapidly removed from the monitoring well using a bailer, and periodic water level measurements were recorded manually and with an electronic transducer (a Solinst Levellogger), as the water level recovered inside the well.

Using the Hvorslev method (Hvorslev, 1951), the data was plotted on a semi-logarithmic scale to estimate the basic time lag  $T_0$ , which, combined with the geometric configuration of the well screens, resulted in an estimation of hydraulic conductivity (K value) for the soils in the vicinity of the well screen. The plots of normalized head versus elapsed time and the estimation of the basic time lags ( $T_0$  values) are included in Appendix B for each crossing.  $T_0$  was estimated by fitting an exponential trend line to the data and calculating  $T_0$  from the inverse of the slope of the fit line. A plot exhibiting concave-upward curvature reflects compressibility of the formation indicating that a storage effect may exist.

The K values (in cm/s) were estimated using the following equation:

$$K = \frac{r^2}{2LT_0} \ln\left(\frac{L}{R}\right)$$

where: K = hydraulic conductivity (cm/s)  
L = the length of the screen (cm)  
R = the radius of the borehole (cm)  
r = the radius of the well casing (cm)  
 $T_0$  = the basic time lag in seconds (-1/slope of line fitted to data, see Appendix B for each crossing).

#### **4. LABORATORY TEST PROCEDURES**

##### **4.1 Soil Samples**

###### **4.1.1 Testing Program**

Laboratory tests on representative SPT samples recovered during the fieldwork were carried out by the certified laboratory owned by PML, located in Toronto. The laboratory testing program included the following:

- Natural moisture content determinations (106)
- Grain size distribution analyses (25)



The laboratory tests to determine the index properties were performed in accordance with the MTO test procedures, which follow American Society for Testing Materials (ASTM) test procedures, with the exception of hydrometer test (LS-702). The results of the grain size distribution analyses are presented on Figures 351-GS-1, 351-GS-2A, 351-GS-2B and 351-GS-2C. All of the test results are summarized on the attached Record of Borehole sheets.

#### 4.1.2 Soil Particle Size Distribution Analyses and Hydraulic Conductivity Estimate

In addition to in-situ testing, the hydraulic conductivity of selected soil samples from boreholes 35-351-03 and 35-351-07 was estimated using the grain size distribution and an established empirical formula for cohesionless soils, as described below.

The hydraulic conductivity of the silty sand was estimated using the following equation (Vukovic and Soro, 1992):

$$K = C f(n) d_e^2 \frac{g}{\nu}$$

where:

- Hydraulic conductivity K has units of m/s
- Constant C =  $8.3 \times 10^{-3}$ ,  $2.4 \times 10^{-3}$ , or  $0.7 \times 10^{-3}$  for coarse, medium, or fine grained sand, respectively.
- Porosity function  $f(n) = \frac{n^3}{(1-n)^2}$
- Porosity  $n = 0.255 (1 + 0.83^{C_u})$
- Uniformity coefficient,  $C_u = \frac{d_{60}}{d_{10}}$
- Grain diameter  $d_x$  = grain diameter, in mm, for which x% of the sample is finer based on the grain size distribution curve.
- Effective grain size diameter  $d_e = f\left(\frac{d_{30}}{d_5}\right)$  (see below)

The soil uniformity,  $d_{30}/d_5$ , and an empirical relationship (Figure 3 of Vukovic and Soro, 1992) are applied to the soil's grain size distribution curve to estimate the effective grain size diameter  $d_e$ .

- Gravitational constant  $g = 9.81 \text{ m/s}^2$
- Ground water kinematic viscosity  $\nu = 1.3 \times 10^{-6} \text{ m}^2/\text{s}$  (assumed 10°C)



The results are shown on Table 2, attached, and are discussed in Section 5.5.

#### **4.2 Ground Water Samples**

On January 19, 2018, ground water samples were obtained from borehole 35-351-03 for chemical analyses and assessment of the water quality as described in the following section. The ground water samples were taken after well development, which consisted of removing an equivalent of about 3 to 10 times the well volume. Both unfiltered and field-filtered samples were collected and analyzed as described below. The ground water samples were kept cool with ice in a cooler until delivery to the laboratory for analysis.

To address the potential in-construction ground water dewatering discharge quality issues, the ground water samples collected were delivered to the laboratories at SGS Canada (SGA) for chemical analyses. SGS is accredited by The Standards Council of Canada (SCC) and The Canadian Association for Laboratory Accreditation (CALA).

The ground water samples were analyzed for the parameters of the City of Guelph Sewer Bylaw for storm water sewers and a suite of metals and fecal coliform count for comparison to Provincial Water Quality Objectives (PWQO). The unfiltered sample was analyzed to assess the raw ground water quality for compliance with the potential discharge options, while the filtered sample was analyzed to evaluate the potential effectiveness of sedimentation or filtration treatment on the metal content of the ground water.

The Chain-of-Custody Record and the laboratory certificates of analyses are included in Appendix C.

### **5. SITE HYDROGEOLOGY AND SUBSURFACE CONDITIONS**

#### **5.1 Site Physiographic, Geologic and Hydrogeologic Settings**

The Ontario Base Map (OBM) and GIS mapping (see Appendix A) for the area of the Site indicates the ground surface elevation varies from about 310 to 315 m above mean sea level (amsl).

According to Chapman and Putnam (Physiography of Southern Ontario, Ministry of Natural Resources, 1984), the Site is in the physiographic region known as the Horseshoe Moraines and the physiographic landform in the area is defined as Spillways. The area where the site is located is marked by the old spillways containing flat sand and gravel terraces and some linear, undrained



swampy areas. The dominant soil deposit of the area is a coarse, open, stony till composed largely of dolomite with traces of red shale. The selected maps from OGSEarth showing the physiographic region and landform are included in Figure 2. OGSEarth is a collection of Ontario Geological Survey geoscientific maps and data hosted by the Ontario Ministry of Northern Development and Mines which can be viewed using programs such as Google Earth.

The OGSEarth map of Surficial Geology of Southern Ontario (Ontario Geological Survey, 2010), shown in Figure 3 (left), indicates that the Site lies in a region of glaciofluvial outwash deposits of gravel and sand.

The OGSEarth map of Paleozoic Geology of Southern Ontario (Armstrong and Dodge, 2007), shown in Figure 3 (right), indicates that the bedrock geology at the Site comprises dolostone of the Guelph Formation.

The bedrock underlying the Site was encountered in the boreholes at elevations of 285.7 and 288.5 (depths of 26.1 and 22.6 m bgs).

The Site is located within the Grand River watershed, and Mill Creek, a tributary of the Grand River, is located about 800 m to the west of the Site.

## **5.2 Review of MOECC Water Well Records**

The water wells recorded by the Ministry of Environment and Climate Change (MOECC) in the vicinity of the Site are shown on Figure D-1 in Appendix D along with a listing of the records obtained from the MOECC's water well records database, which include all recorded wells regardless of their current status. The wells within a 500 m radius are numbered to tie-in with the records listed.

The ground water strike ("water found" in the records) depth varied widely at the private wells, with depths ranging from 1.2 to 61 m bgs and the hydrostatic ground water level depth varied from 1.2 to 8.8 m bgs with an average of about 5.5 m bgs.

Only eleven (11) recorded wells or well clusters were located within the 500 m radius study area. Two of the wells were used as monitoring wells, two for industrial purposes (one since abandoned), one for commercial purposes, and six for domestic use. Four of the wells appear to be screened in the bedrock.





A private water well survey is to be conducted by others and is expected to determine further details, including which wells are currently in use and could be impacted by potential dewatering operations. It is noted that some of the well records are quite old (e.g. six are more than 40 years old) and, if municipal water supply systems have been constructed in the meantime, may not need to be assessed for impact.

### **5.3 Soil Stratigraphy**

The FIDR(35-351) takes precedence on matters related to soil stratigraphy; however, for convenience, the information is reproduced in the following section.

The subsurface conditions encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole Sheets attached to the report. The borehole locations plan and a stratigraphic profile section are shown on Drawing 35-351-1. The boundaries between soil strata have been established at the borehole locations only. The boundaries of soil strata between and beyond the boreholes are assumed and may vary from location to location.

In general, the subsurface conditions immediately below the existing ground level consist of 800 mm to 1.5 m thick pavement structure in the paved areas and 200 mm to 300 mm thick topsoil in boreholes that were advanced near the toe of the embankment. The topsoil and pavement structure are underlain by compact to very dense silty sand with gravel to a maximum depth of elevation 283.5 and the silty sand is underlain by dolostone bedrock of the Guelph Formation, encountered at two locations at elevations of 285.7 and 288.5.

The soil classification system used in this investigation was based on the Unified Soil Classification System (USCS). Accordingly, the use of the term “silty” refers to samples with greater than 12% fines (silts and clays). It is of note that the majority of the samples of the overburden explored had less than 20% fines and would be expected to be highly permeable.

For classification purposes, the soils encountered at this site can be divided into five distinct zones:

- a) Topsoil
- b) Silty Sand, With Gravel (Pavement Structure)
- c) Silty Sand, With Gravel (Fill)
- d) Silty Sand, With Gravel
- e) Dolostone Bedrock



#### 5.3.1 Topsoil

Topsoil was encountered in Boreholes 35-351-03, 35-351-06, 35-351-07 and 35-351-08 at the existing ground surface at the borehole locations. The thickness of the topsoil was observed to vary from 200 to 300 mm.

#### 5.3.2 Silty Sand, With Gravel (Pavement Structure)

The pavement structure was encountered at the existing ground surface in Boreholes 35-351-01, 35-351-02, 35-351-04 and 35-351-05. The pavement structure includes 100 to 180 mm of asphalt over 620 to 900 mm of silty sand, with gravel.

The moisture content of samples tested from the pavement base vary from 2.5% to 7.0% with an average value of 4.0%.

#### 5.3.3 Silty Sand, With Gravel (Fill)

The pavement structure in Boreholes 35-351-01 and 35-351-02 are underlain by compact to very dense silty sand, with gravel fill. The fill layer ranges in thickness from 3.6 to 5.1 m and extends to a maximum depth of 6.1 m bgs (elevation 310.9). The SPT values in the fill layer vary from 16 blows to 57 blows, indicating that it is compact to very dense. Occasional cobbles were encountered in the fill at elevation 312.4 in Borehole 35-351-01 and at elevation 316.1 in Borehole 35-351-02.

The moisture content of samples tested from the fill vary from 3.0 to 6.8% with an average value of 4.8%. The results of the sieve analysis test performed on one representative sample from the fill is provided on Figure 351-GS-1. The test result indicates that the fill consists of 44% gravel, 37% sand, 15% silt and 4% clay sized particles.

#### 5.3.4 Silty Sand, With Gravel

The fill and topsoil layers are underlain by a silty sand with gravel deposit, which extends to a maximum depth of 29.1 m bgs (elevation 283.8). The SPT values in this layer vary widely from 11 blows/30 cm to refusal (100 blows/3 cm penetration), indicating it is compact to very dense. Boreholes 35-351-02, 35-351-04 and 35-351-06 were advanced below the sampling depths ranging from 12.8 to 13.7 m bgs (elevation 298.1 to 305.6) by conducting dynamic cone penetration (DCP) tests and terminated at the depths of refusal to dynamic cone penetration. The termination depths



range from 20.1 to 29.1 m bgs (elevation 289.3 to 290.1). Occasional cobbles were encountered in the deposit below elevations ranging from 310.9 to 294.4.

The moisture content of samples tested from the deposit vary widely from 2.1 to 28.5% with an average value of 11.9%. The results of the sieve analysis tests performed on 23 representative samples from this deposit are provided on Figures 351-GS-2A, 351-GS-2B and 351-GS-2C. The test results indicate that this deposit consists of 3 to 70% gravel, 27 to 89% sand, 3 to 29% silt and 1 to 8% clay sized particles.

#### **5.3.5 Dolostone Bedrock**

The presence of bedrock was proven by coring in Boreholes 35-351-03 and 35-351-05 and obtaining rock cores with lengths of 3.55 and 3.05 m, respectively. The rock coring was terminated at a depth of 26.1 m bgs (elevation 285.0) in Borehole 35-351-03 and 29.4 m bgs (elevation 282.4) in Borehole 35-351-05.

The measured recovery of the rock cores range between 78 and 100% and the RQD measured from the rock cores retrieved range between 75 and 97%, with the exception of Sample 18 in Borehole 35-351-03. Based on the RQD values, the bedrock below about elevation 288.0 may be described as good to excellent quality. For complete descriptions of the bedrock, refer to the rock core description logs provided in Appendix A of the FIDR(35-351).

#### **5.4 Groundwater Conditions**

Ground water observations were made during and upon completion of augering of each borehole in the field. The observed first water strike during augering (the ground water strike) was encountered in Boreholes 35-352-01 to 35-351-04, 35-351-06 and 35-351-07 at elevations ranging from 304.8 to 306.7. The ground water strike was located in the silty sand with gravel which is acting as an aquifer.

At completion of drilling, boreholes 35-351-01 and 35-351-02 had free water at elevations 305.1 and 309.2, respectively. The remaining boreholes were found dry upon completion of drilling or rotary mud drilling was used, preventing the measuring of a meaningful ground water level.

The measured depth to the hydrostatic ground water level in the monitoring wells of boreholes 35-351-03 and 35-351-07 were measured on six occasions between November 2017 and April 3 2018. Over the five month period the hydrostatic ground water levels have been



relatively steady at Borehole 35-351-03 with the levels ranging from 306.4 to 306.6 (4.5 to 4.7 m bgs) and the levels have risen gradually at Borehole 35-351-07, with the levels ranging from 305.6 to 306.2 (5.7 to 5.1 m bgs).

The hydrostatic ground water level readings are listed on Table 1; and the estimated K values for the soils surrounding the monitoring well screens are listed on Table 2. The ground water strike and the hydrostatic ground water level measured on November 14, 2017 are depicted in the profile on Drawing 35-351-1.

The ground water level is subject to seasonal fluctuations and variations due to precipitation and climate change.

#### **5.5 Estimated Hydraulic Conductivity**

The hydraulic conductivity K values of the soils surrounding the monitoring well screens in boreholes 35-351-03 and 35-351-07 were estimated using borehole permeability tests (slug tests) as well as from the grain size distribution charts (based on sieve and hydrometer tests) of selected soil samples using an established empirical formula. The estimation methods were described in Sections 3.3 and 4.1, above, respectively. The slug test ground water level measurements, plots of the normalized head versus elapsed time, and the estimation of the basic time lags ( $T_0$  values) are included in Appendix B.

The results of the slug tests as well as the estimated K values from grain size distribution test results are listed on Table 2.

The analysis of the slug test results for boreholes 35-351-03 and 35-351-07, which are screened in gravelly sand and sandy gravel, indicated K values of  $6.0 \times 10^{-2}$  and  $2.0 \times 10^{-2}$  cm/s, respectively.

Based on the grain size distribution test results carried out on two selected samples of soil, the K values were  $4.0 \times 10^{-2}$  and  $5.0 \times 10^{-2}$  cm/s for the soil at the depth of the well screen.

#### **5.6 Ground Water Sample Test Results**

The laboratory certificate of chemical analyses carried out by SGS on unfiltered and filtered ground water samples from monitoring well 351-3 in accordance with the chain-of-custody records and the protocols described above (Section 4.2) are included in Appendix C.



The concentrations of the parameters of the City of Guelph Storm Sewer Use By-Law, in the unfiltered sample, complied with the respective criteria with the exceptions listed on Table 5.6(a) below:

**Table 5.6(a) - Elevated Ground Water Sample Concentrations For The Parameters of the City of Guelph Storm Sewer Use By-Law Criteria**

PARAMETER	CONCENTRATION (mg/L)	CONCENTRATION LIMIT (mg/L)
Total Copper	0.0169	0.01
Total Lead	0.0674	0.05
Total Zinc	0.473	0.05
Total Suspended Solids	342	15

In addition, the concentrations of selected metals, in the unfiltered sample, complied with the PWQO criteria with the exceptions listed on Table 5.6(b) below:

**Table 5.6(b) - Elevated Ground Water Sample Concentrations for Selected Parameters of PWQO**

PARAMETER	CONCENTRATION (mg/L)	CONCENTRATION LIMIT (mg/L)
Total Aluminum	1.36	0.015
Total Cadmium	0.000727	0.0001
Total Chromium	0.00253	0.001
Total Cobalt	0.00202	0.0009
Total Copper	0.0169	0.001
Total Iron	3.57	0.3
Total Lead	0.0674	0.001
Total Phosphorous	0.196	0.01
Total Zinc	0.473	0.02

The unfiltered ground water sample findings indicate that the discharge water, if untreated, is expected to be prohibited from discharge to a municipal storm sewer, ditch, or natural watercourse. However, the filtered ground water sample complied with both criteria, and thus it is expected that



the concentrations of the non-compliant parameters will be reduced significantly by treatment with a sedimentation tank or filtration bags prior to discharge. If construction dewatering is required, a discharge water quality monitoring program is recommended.

## **6. CONSTRUCTION DEWATERING REQUIREMENTS AND IMPACT ASSESSMENT**

### **6.1 Hydrogeological Conceptual Site Model**

A simplified hydrogeological conceptual site model (HCSM) of the Site area was developed based on the field and laboratory data compiled to date.

The relevant assumptions for the HCSM are summarized in Table 6.1, below.

**Table 6.1 - Hydrogeological Conceptual Site Model Summary**

FEATURE	ELEVATIONS
Existing Ground Surface	311.5
Bottom of Fill / Top of Silty Sand (Silty Sand $K = 1 \times 10^{-3}$ m/s)	311.0
Ground water strike and hydrostatic ground water level	306.7
Bottom of Silty Sand / Top of Bedrock	287.0

### **6.2 Construction Dewatering Requirements**

The recommended option for founding the new bridge, as described in Section 8 of the FIDR(35-351) consists of using driven steel H-piles at both abutments and a shallow foundation (strip footing) to support the centre pier. Alternatively, caissons socketed into the bedrock may be used for the centre pier foundation.

Based on the HCSM and the recommendations above, the requirements for construction dewatering are as follows:

- Steel H-Piles Driven to Bedrock – No ground water dewatering is required for the installation of piles.



- Shallow Foundation, Strip Footings – Since the footings are expected to be constructed at or just below elevation 310.0, and this is above the expected ground water strike level (elevation 306.7), no significant dewatering is anticipated.
- Caissons Into Bedrock – Dewatering is not anticipated for the caisson installation.

Thus, it is not expected that significant dewatering will be required for the construction of the bridge, besides potential minor sump pumping of intruding surface waters, if any.

### **6.3 Water Taking Permit**

In-construction and post-construction dewatering, like other water takings in Ontario, is governed by the Ontario Water Resources Act (OWRA) and the Water Taking and Transfer Regulation 387/04, a regulation under the OWRA.

In accordance with the above-noted regulatory requirements, an application for a Permit-To-Take-Water (PTTW) should be filed with the MOECC for any construction dewatering if the construction dewatering discharge will be greater than 400,000 L/day or about 4.6 L/s. If the dewatering discharge will be greater than 50,000 L/day and less than 400,000 L/day then the water taking will not require the MOECC PTTW approval process and can instead be registered with the Environmental Activity and Sector Registry (EASR). Water taking at a rate less than 50,000 L/day does not require MOECC approval.

Since the discharge rate for the construction dewatering at the subject Site is expected to be less than 50,000 L/day, neither a PTTW nor an EASR is required for this Site.

### **6.4 Construction Dewatering Impact Assessment**

As described above, based on the currently proposed foundation options and ground water levels, no significant construction dewatering is anticipated. Since there is to be no dewatering, no impacts (such as settlement, movement of contaminant plumes, and reduction in ground water flow to streams and water supply wells) are expected in the vicinity of the Site due to dewatering.



## 7. CLOSURE

Mr. S. Aziz and Mr. M. Fall carried out the field investigations under the supervision of Mr. L. Yimam, Ph.D., P. Eng., Senior Engineer and Mr. C. M. P. Nascimento, P.Eng., Project Manager. Landshark Drilling, Aardvark Drilling Inc., and Altech Canada Drilling Ltd. supplied the drilling equipment for the subsurface exploration. The laboratory testing of the selected samples was carried out in the PML laboratory in Toronto. Chemical tests on ground water samples were performed by SGS Canada.

This report was prepared by Mr. Andrew Cooke, PhD, P. Eng., Senior Engineer, and reviewed by Mr. Shamsul Tarafder, MSc., PhD, P.Geo. Mr. Carlos Nascimento, P.Eng., Project Manager and MTO Designated Principal Contact, conducted an independent review of the report.

Sincerely

Peto MacCallum Ltd.



Andrew Cooke, PhD, P.Eng.  
Senior Engineer  
Geoenvironmental and  
Hydrogeological Services



Shamsul A. Tarafder, MSc., PhD, P.Geo  
Senior Geoscientist  
Geoenvironmental and  
Hydrogeological Services



Carlos M. P. Nascimento, P.Eng.  
Project Manager and  
MTO Designated Principal Contact





**TABLE 1**  
**GROUND WATER LEVEL READINGS IN MONITORING WELLS**

MONITORING WELL (MW) No. <sup>(2)</sup>	GROUND SURFACE ELEVATION <sup>(3)</sup>	MID-SCREEN ELEVATION (DEPTH (m)) <sup>(2)</sup>	DRILLING COMPLETION DATE	HYDROSTATIC GROUND WATER LEVEL ELEVATION (DEPTH (m)) <sup>(1)</sup>					
				November 2017	December 2017	January 2018		February 2018	April 2018
35-351-3	311.1	304.2 (6.9)	07/11/2017	14/11/2017 306.4 (4.7)	01/12/2017 306.5 (4.6)	09/01/2018 306.4 (4.7)	17/01/2018 306.5 (4.6)	15/02/2018 306.5 (4.6)	03/04/2018 306.6 (4.5)
35-351-7	311.3	297.6 (13.7)	31/10/2017	14/11/2017 305.7 (5.6)	01/12/2017 305.6 (5.7)	09/01/2018 305.7 (5.6)	17/01/2018 305.9 (5.4)	14/02/2018 306.1 (5.2)	03/04/2018 306.2 (5.1)

**Notes:**

- (1) Water level measured from ground surface using a Solinst flat tape water level reader.  
 (2) See Drawing 35-351-1 for monitoring well location plan and Record of Borehole Log Sheets for details of monitoring well installation.  
 (3) Ground surface elevations were surveyed and are geodetic.



**TABLE 2**  
 ESTIMATED HYDRAULIC CONDUCTIVITY K-VALUES FROM  
 SOIL SAMPLE GRAIN SIZE DISTRIBUTION AND BOREHOLE PERMEABILITY TEST RESULTS

BOREHOLE (BH) NO.	MONITORING WELL (MW) MID-SCREEN ELEVATION (DEPTH, m)	SOIL TYPE <sup>(1)</sup> (SAMPLE NO, TYPE, DEPTH) AND / OR MONITORING WELL (MW) SCREEN SOIL TYPE	% CLAY <sup>(2)</sup>	ESTIMATED K-VALUES FROM GRAIN SIZE DISTRIBUTION TEST RESULTS (cm/sec) <sup>(3)</sup>	ESTIMATED K-VALUES FROM BOREHOLE PERMEABILITY TESTING (cm/sec) <sup>(4)</sup>
35-351-03	304.2 (6.9)	Log: SILTY SAND, with gravel (Sample SS 8, gravelly SAND, 6.1 to 6.7 m)	< 4%	$4 \times 10^{-2}$ (V&S)	$6.0 \times 10^{-2}$
35-351-07	297.6 (13.7)	Log: SILTY SAND, some gravel (Sample SS 13, sandy GRAVEL, 12.2 to 12.8 m)	1%	$5 \times 10^{-2}$ (V&S)	$2.0 \times 10^{-2}$

**Notes:**

- (1) See Log of Borehole Sheets for soil sample description.
- (2) % Clay is percentage of the total soil sample weight finer than 0.002 mm.
- (3) K-value determined using particle size distribution method by Vukovic and Soro (1992) (V&S). For particle size distribution charts, see Figures 351-GS-2A and 351-GS-2C.
- (4) K-value estimated using Hvorslev's Method.



**HYDROGEOLOGICAL INVESTIGATION REPORT FOR  
REPLACEMENT OF UNDERPASS AT  
HIGHWAY 401 & CONCESSION ROAD 7**

**PUSLINCH TOWNSHIP, ONTARIO**

**2017 AERIAL PHOTOGRAPH**

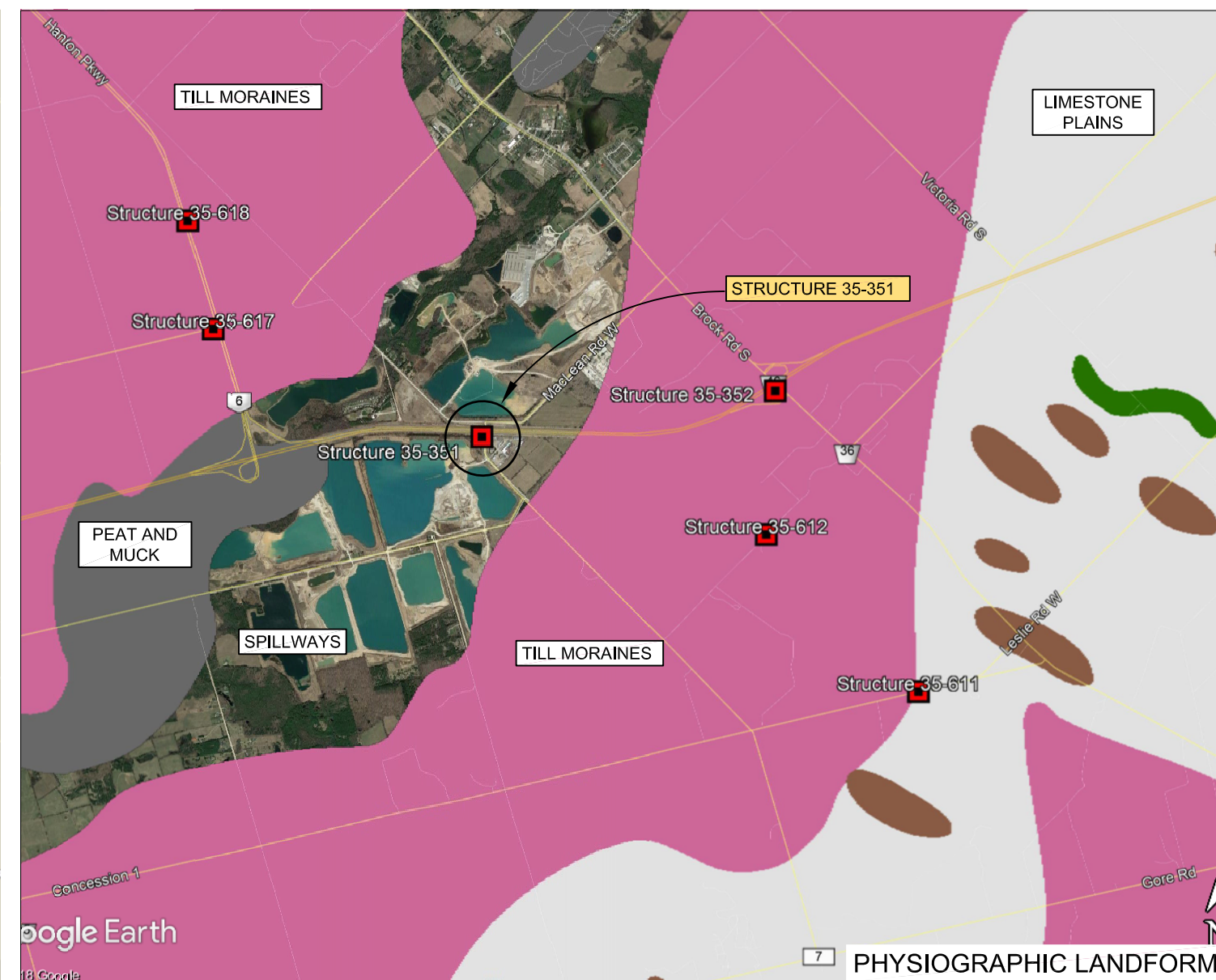
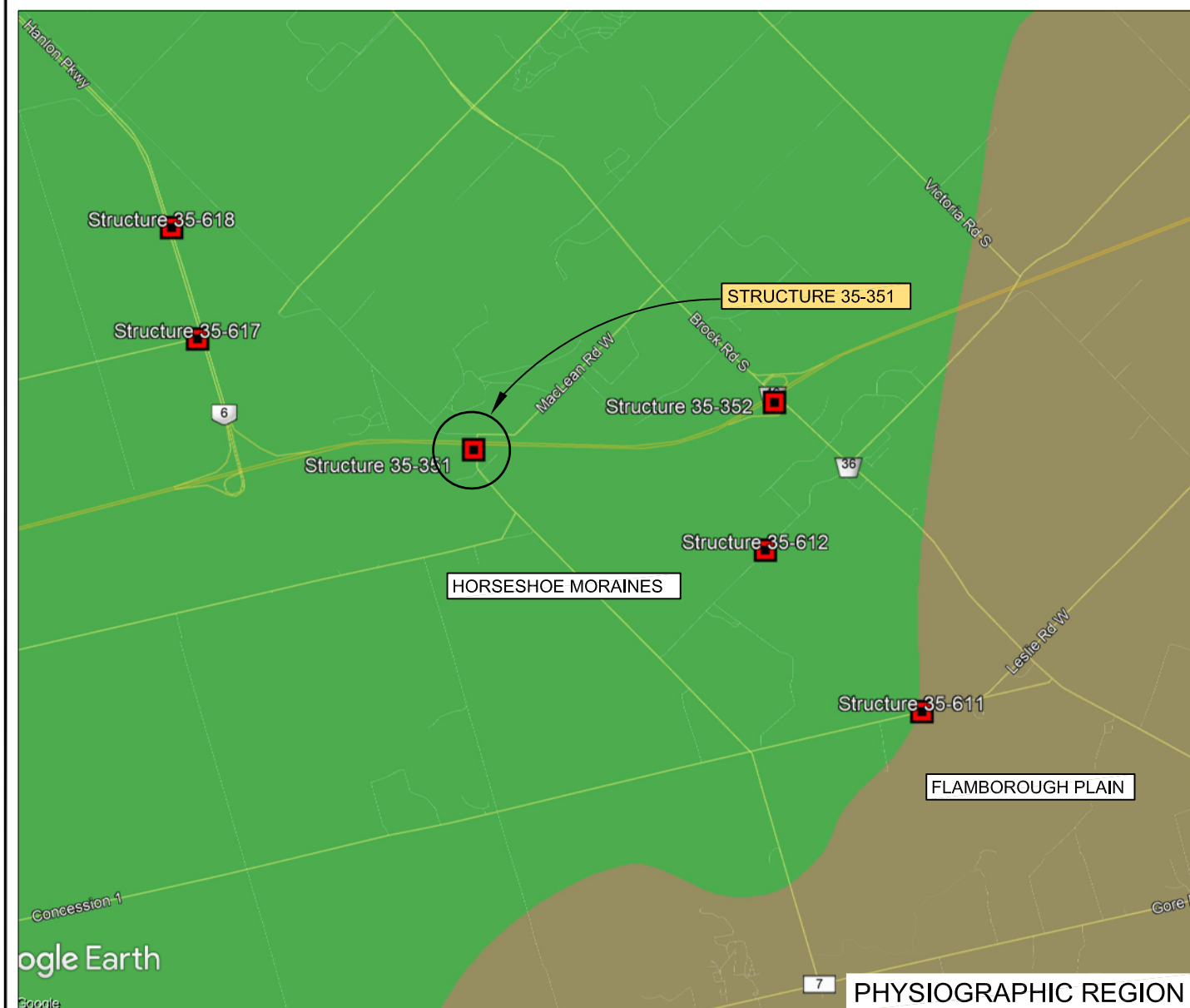


**Peto MacCallum Ltd.**  
CONSULTING ENGINEERS

DRAWN: <b>T.C.</b>	DATE	SCALE	JOB NO.	FIGURE NO.
CHECKED: <b>A.C.</b>	<b>NOV. 2018</b>	<b>1 : 10,000</b>	<b>17TF006C</b>	<b>1</b>
APPROVED: <b>A.C.</b>				

REFERENCE: THIS FIGURE WAS PREPARED FROM GOOGLE EARTH PRO.



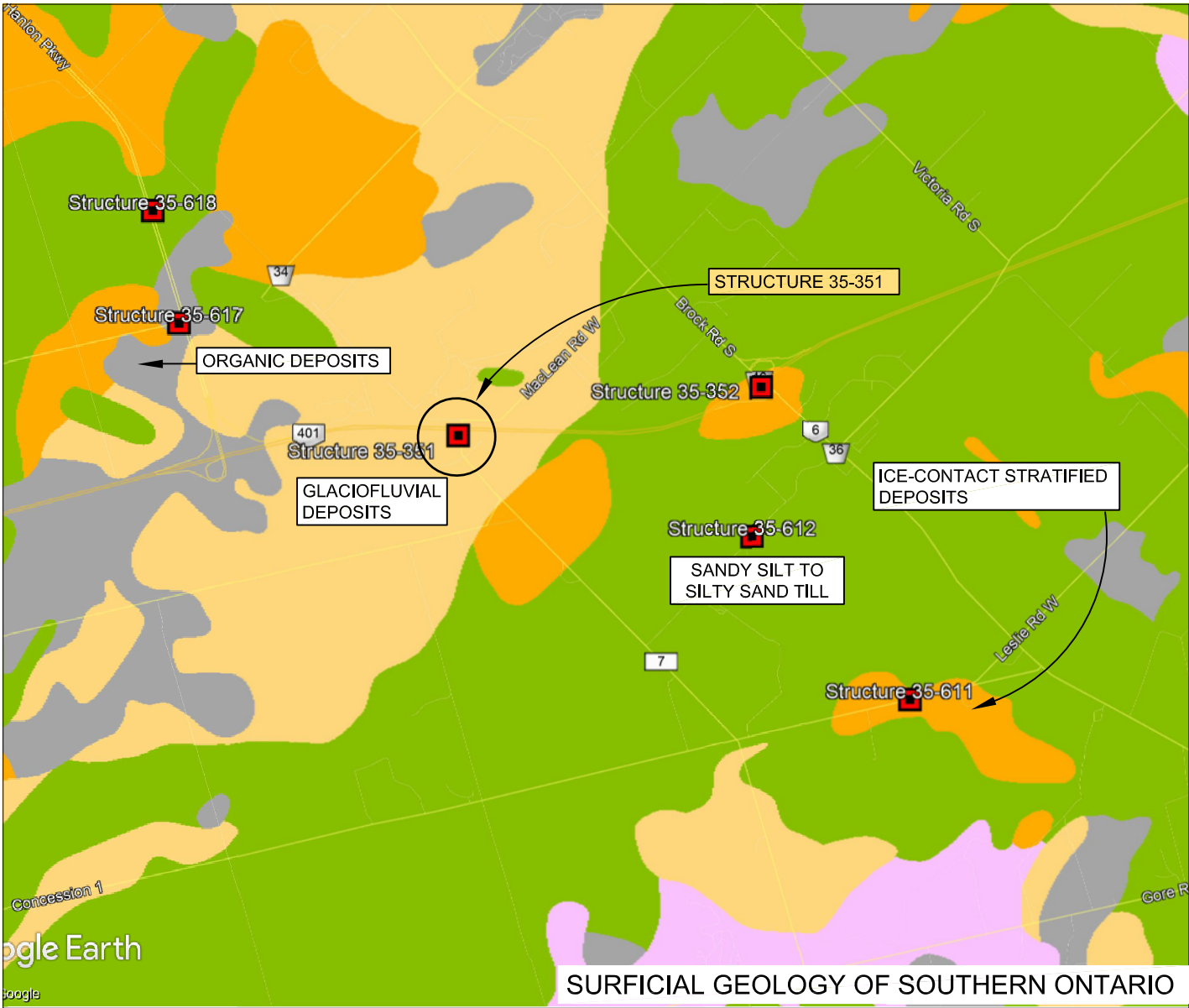


REFERENCE:  
OGSEARTH, PHYSIOGRAPHY OF SOUTHERN ONTARIO,  
CHAPMAN, L.J. AND PUTNAM, D.F., 2007.

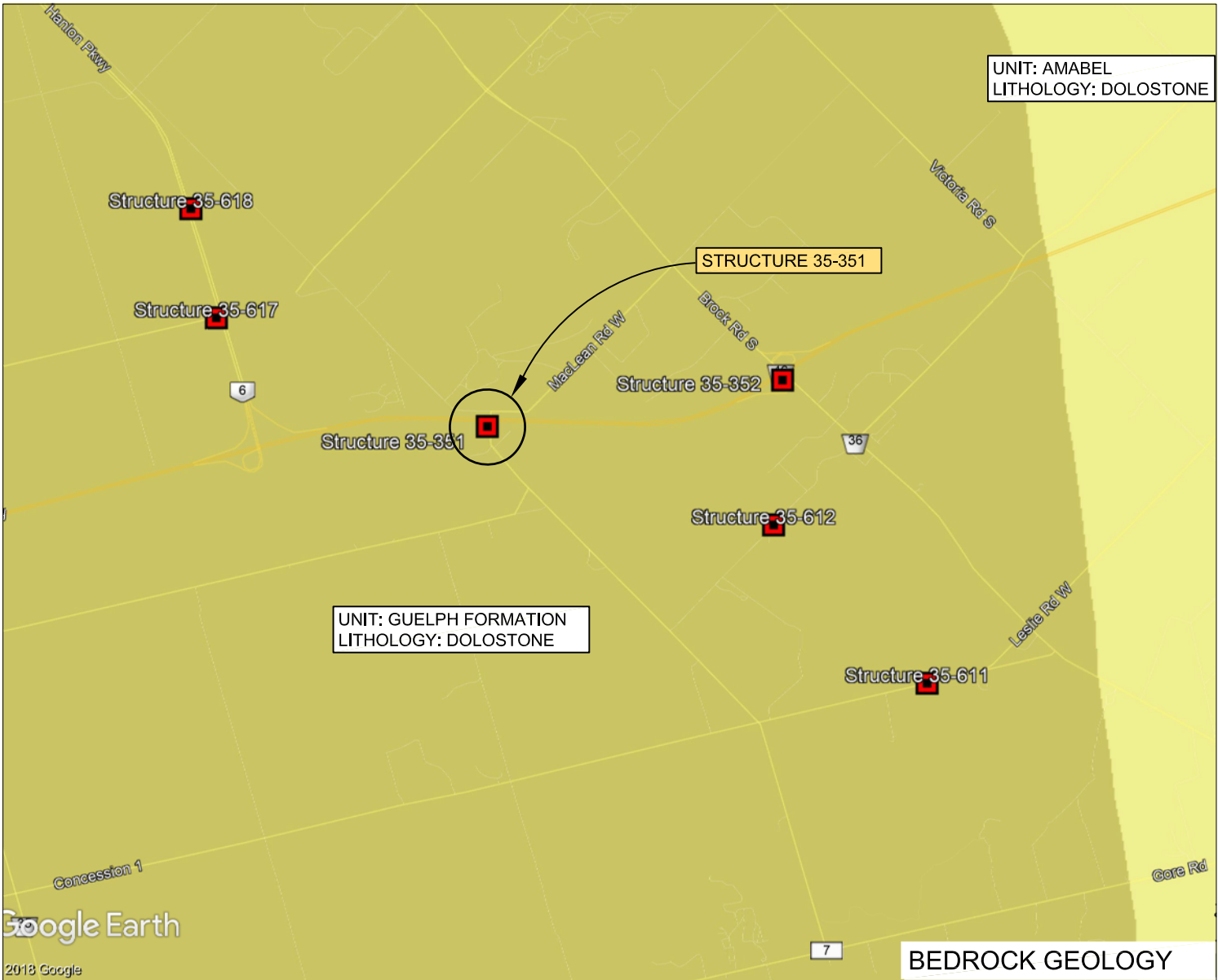
REVISIONS							
DATE		BY		DESCRIPTION			
Geocres No. 40P8-255							
HWY. No. 401						DIST	CENTRAL
SUBM'D	TC	CHECKED	AC	DATE	NOV. 26, 2018	SITE	35-351
DRAWN	TC	CHECKED	AC	APPROVED	CN	DWG	Fig 2

Geocres No. 40P8-255

HWY No 401				DIST	CENTRAL
SUBM'D	TC	CHECKED AC	DATE NOV. 26, 2018	SITE	35-351
DRAWN	TC	CHECKED AC	APPROVED CN	DWG	Fig 2



REFERENCE:  
OGSEARTH, SURFICIAL GEOLOGY OF SOUTHERN ONTARIO,  
OGS SURVEY, 2010.

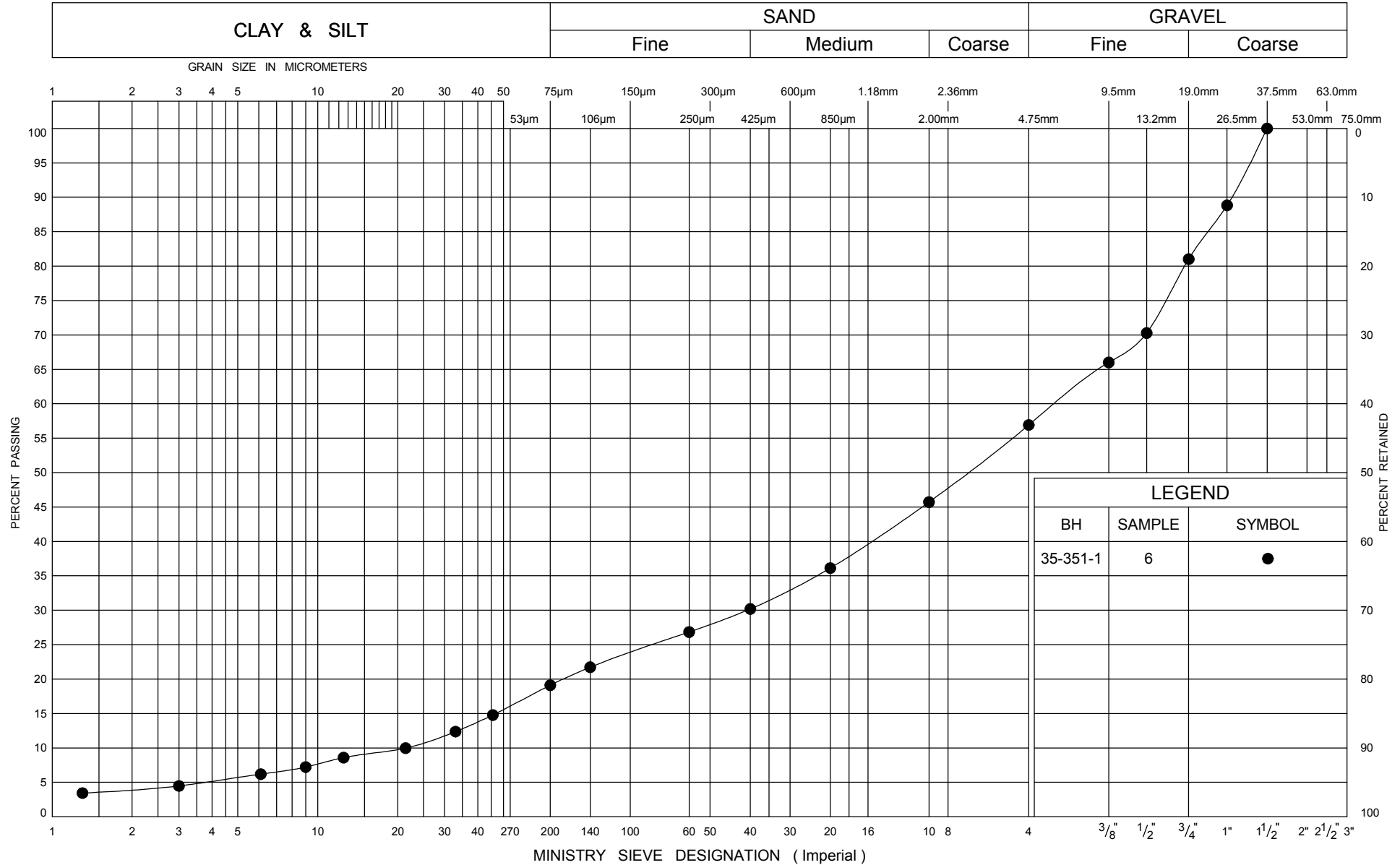


REFERENCE:  
OGSEARTH, PALEOZOIC GEOLOGY OF SOUTHERN ONTARIO,  
ARMSTRONG AND DODGE, 2007.



REVISIONS									
	DATE	BY	DESCRIPTION						
Geocres No. 40PB-255									
	HWY No	401					DIST	CENTRAL	
	SUBM'D	TC	CHECKED	AC	DATE	NOV 26, 2018	SITE	35-351	
	DRAWN	TC	CHECKED	AC	APPROVED	CN	DWG	Fig 3	

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

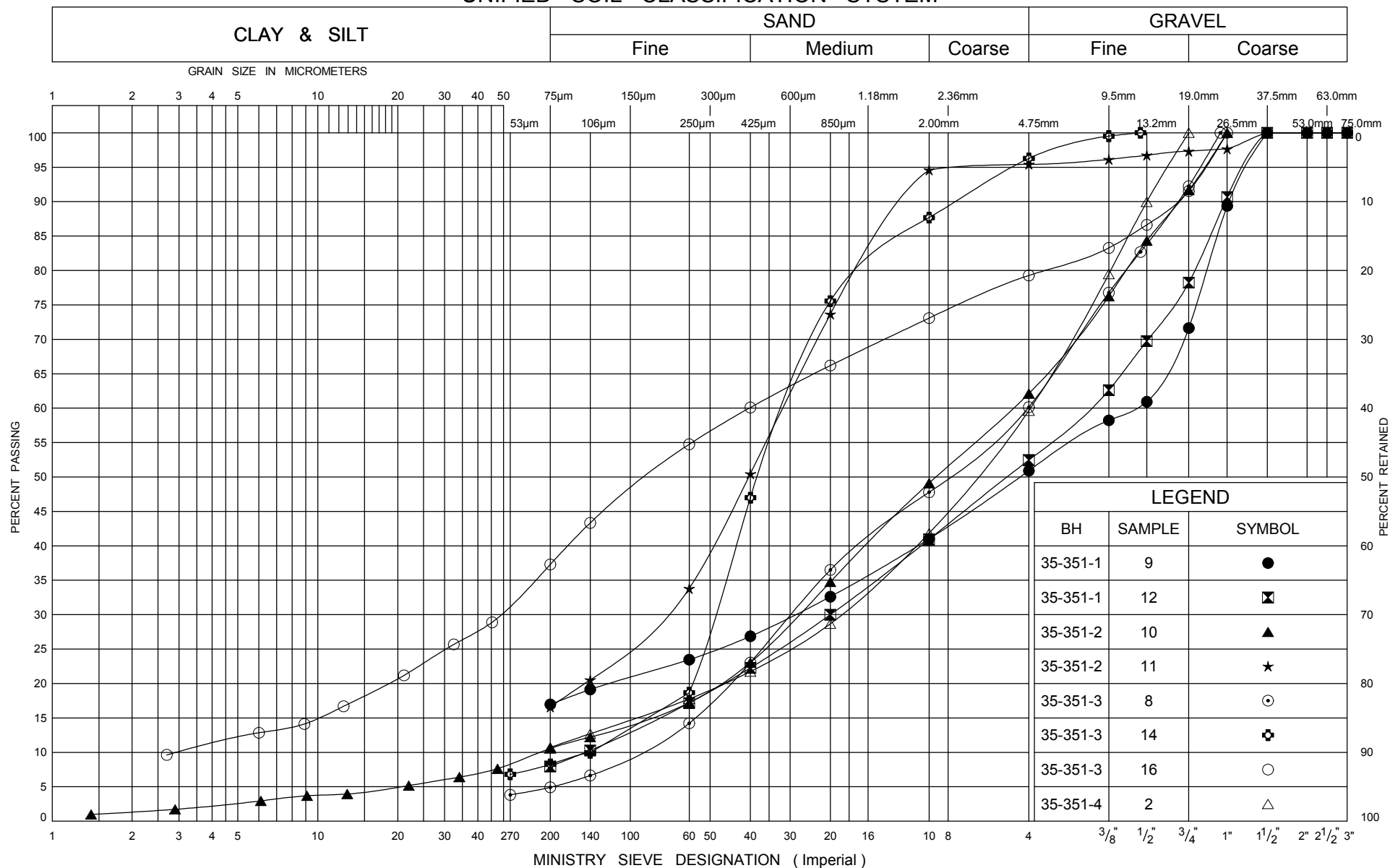
SILTY SAND, with gravel

FIG No: 351-GS-1

HWY: 401

W P: 3224-15-00

## UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION  
SILTY SAND, with gravel

FIG No: 351-GS-2A

HWY: 401

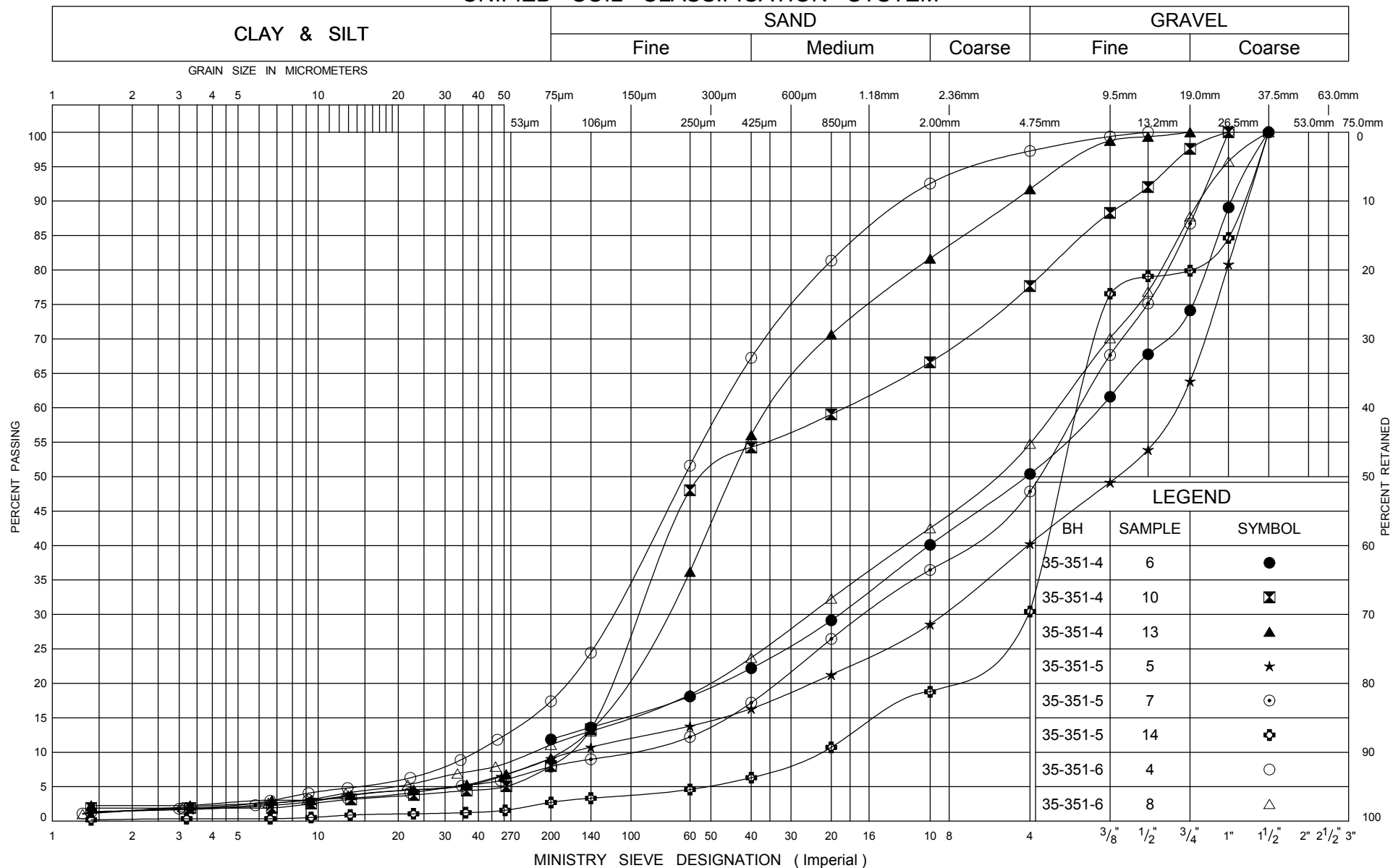
W P: 3224-15-00



Ministry of  
Transportation

Ontario

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

## GRAIN SIZE DISTRIBUTION

SILTY SAND, with gravel

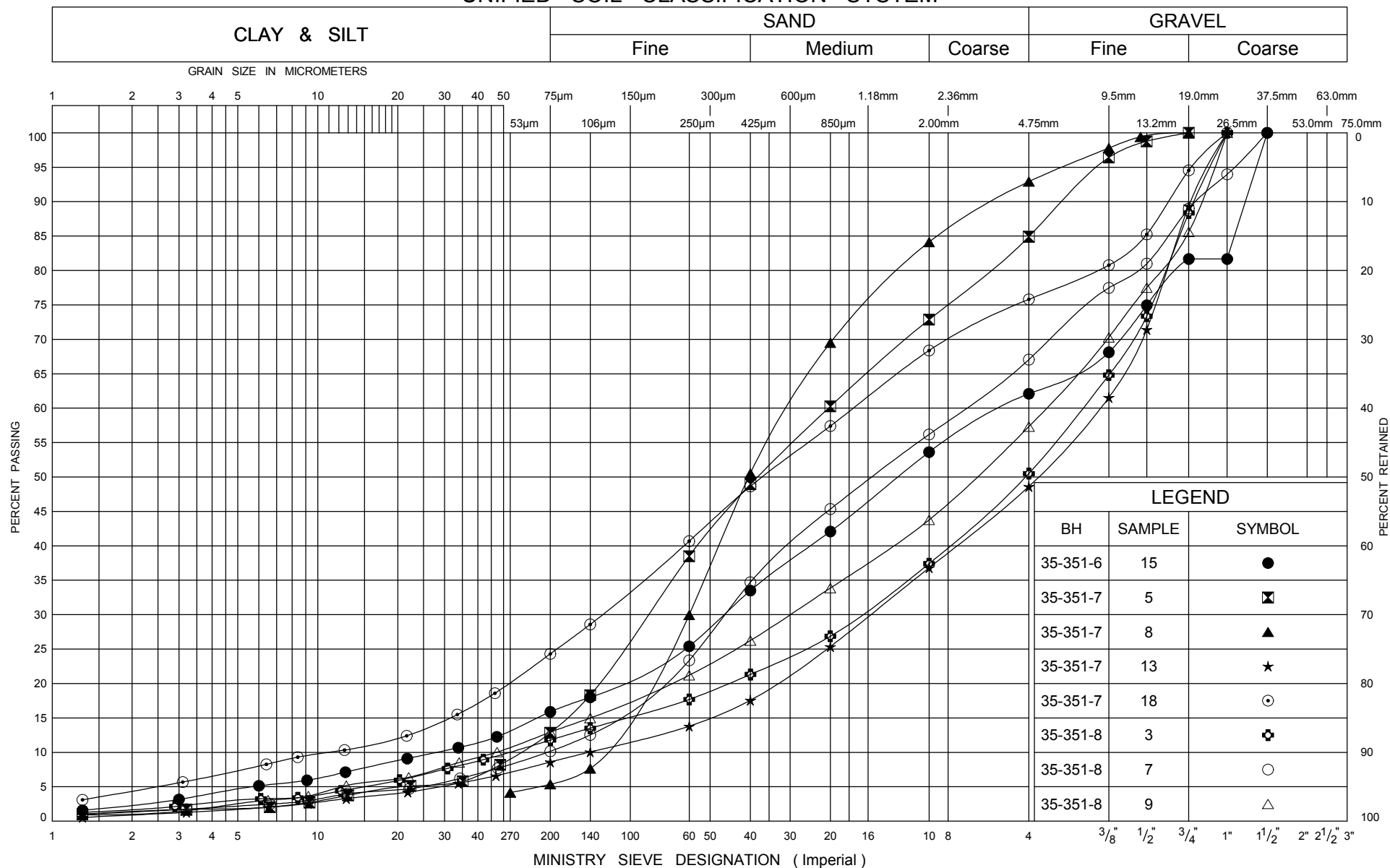
FIG No: 351-GS-2B

HWT: 401

W P: 3224-15-00



## UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

SILTY SAND, with gravel

FIG No: 351-GS-2C

HWY: 401

W P: 3224-15-00

Ministry of  
Transportation

Ontario

GWP No 3224-15-00

CONCESSION ROAD 7 UNDERPASS  
HWY 401 & HWY 6 REALIGNMENT  
BOREHOLE LOCATION AND SOIL STRATA

SHEET



## LEGEND

- Borehole
- Cone
- Borehole by others
- Blows/0.3m (Std. Pen Test, 475 J/blow)
- Blows/0.3m (60 Cone, 475 J/blow)
- WL Encountered During Drilling
- Ground Water Measured Apr. 03, 2018
- Piezometer

BH No	ELEVATION	CO-ORDINATES	
		NORTHINGS	EASTINGS
35-351-1	317	4 812 484.9	251 867.3
35-351-2	318.4	4 812 456.1	251 897.2
35-351-3	311.1	4 812 456.0	251 866.4
35-351-4	311.8	4 812 414.8	251 875.3
35-351-5	311.8	4 812 420.2	251 860.7
35-351-6	310.2	4 812 382.6	251 872.3
35-351-7	311.3	4 812 376.5	251 875.3
35-351-8	313.1	4 812 359.4	251 877.6

## - NOTE -

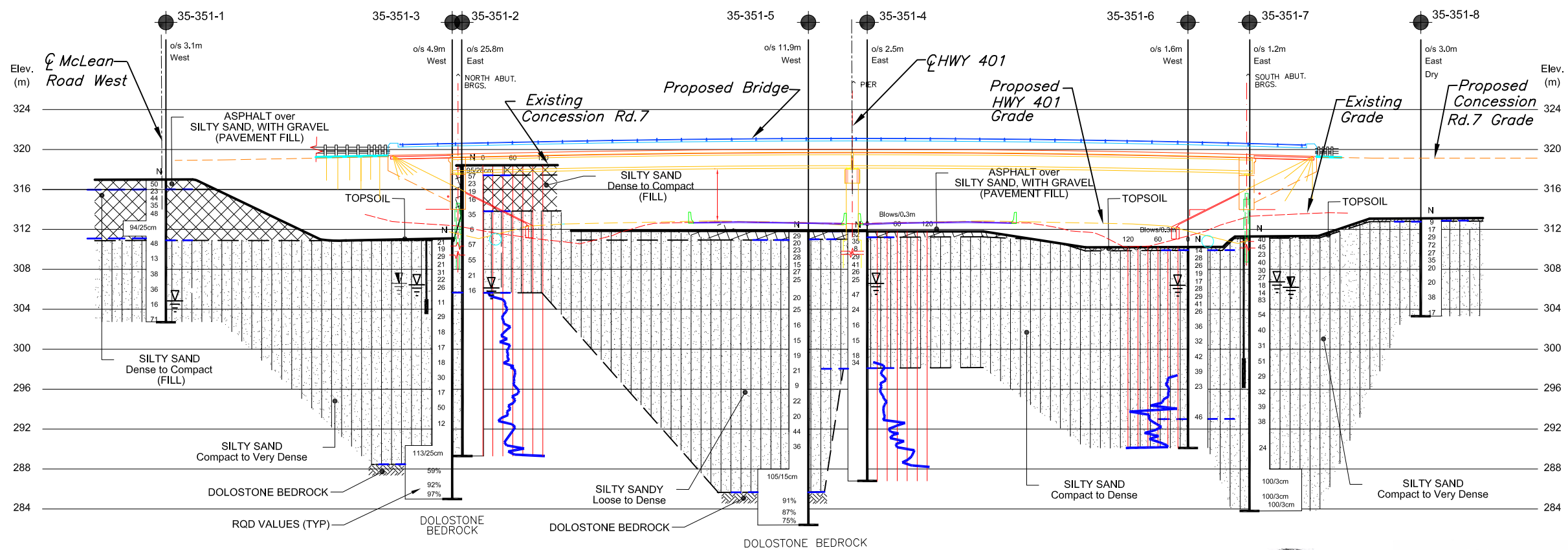
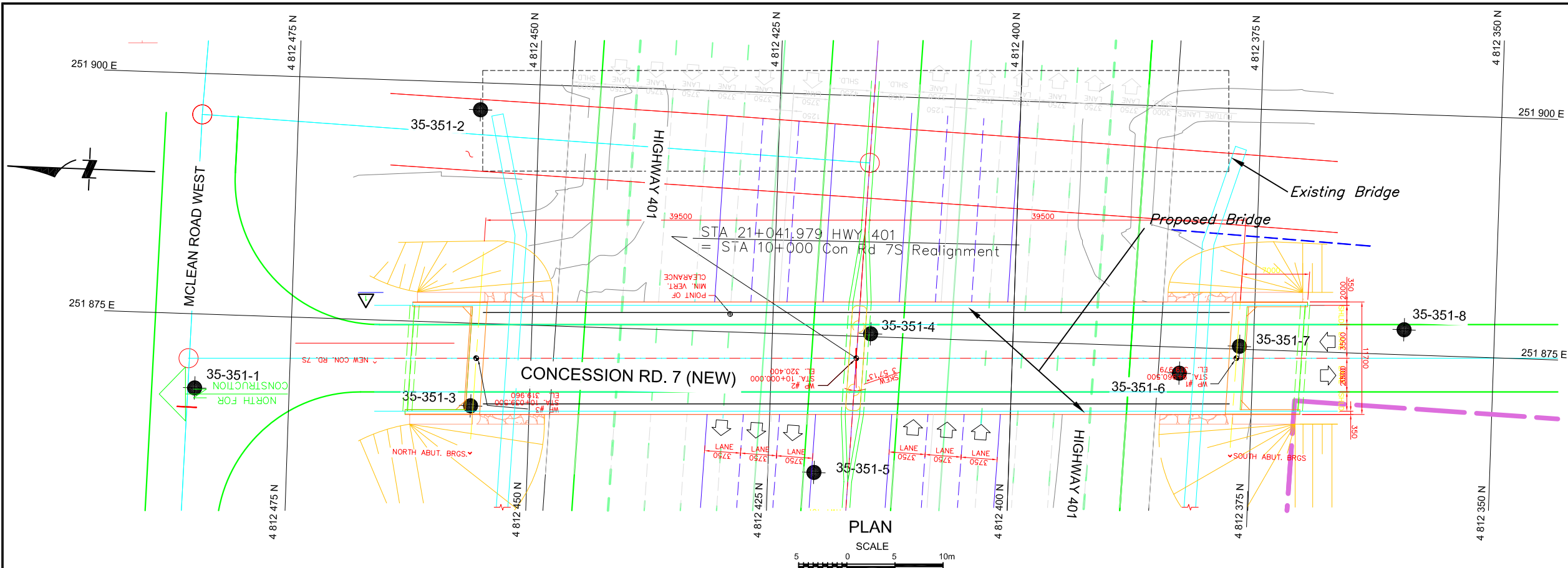
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

DATE	BY	DESCRIPTION

Geocres No. 40P8-255

HWY No	401	DIST	CENTRAL
SUBM'D	TC	CHECKED	AC
DATE	NOV. 26, 2018	SITE	35-351
DRAWN	TC	CHECKED	MV
APPROVED	CN	DWG	35-351-1

Reference AECOM Drawing: 10-REFERENCE/35-351\_Concession Rd\_MTO\_bdr.dwg, dated June 2018



## NOTES:

- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE LOGS.
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
- DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

## PROFILE ALONG C CONCESSION RD 7

SCALE

HORIZONTAL

5 0 5 10m

VERTICAL

4 0 4 8m



## EXPLANATION OF TERMS USED IN REPORT

**N VALUE:** THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS  $\bar{N}$ .

**DYNAMIC CONE PENETRATION TEST:** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**COMPOSITION:** SECONDARY SOIL COMPONENTS ARE DESCRIBED ON THE BASIS OF PERCENTAGE BY MASS OF THE WHOLE SAMPLE AS FOLLOWS:

PERCENT BY MASS	0 - 10	10 - 20	20 - 30	30 - 40	> 40
	TRACE	SOME	WITH	ADJECTIVE (SILTY)	AND (AND SILT)

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$c_u$ (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

**RECOVERY:** SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINTING AND BEDDING:**

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

S S SPLIT SPOON	T P THINWALL PISTON
W S WASH SAMPLE	O S OSTERBERG SAMPLE
S T SLOTTED TUBE SAMPLE	R C ROCK CORE
B S BLOCK SAMPLE	P H T W ADVANCED HYDRAULICALLY
C S CHUNK SAMPLE	P M T W ADVANCED MANUALLY
T W THINWALL OPEN	F S FOIL SAMPLE
F V FIELD VANE	

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{v0}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_i$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	n	1, %	POROSITY	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	w	1, %	WATER CONTENT	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	$S_r$	%	DEGREE OF SATURATION	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\gamma_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$w_L$	%	LIQUID LIMIT	D	mm	GRAIN DIAMETER
$\rho$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_p$	%	PLASTIC LIMIT	$D_n$	mm	n PERCENT - DIAMETER
$\gamma$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_s$	%	SHRINKAGE LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	h	m	HYDRAULIC HEAD OR POTENTIAL
$\gamma_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	q	m <sup>3</sup> /s	RATE OF DISCHARGE
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	v	m/s	DISCHARGE VELOCITY
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	DTPL		DRIER THAN PLASTIC LIMIT	i	1	HYDRAULIC GRADIENT
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	APL		ABOUT PLASTIC LIMIT	k	m/s	HYDRAULIC CONDUCTIVITY
$\gamma'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL	WTP		WETTER THAN PLASTIC LIMIT	j	kN/m <sup>3</sup>	SEEPAGE FORCE
e	1, %	VOID RATIO						

RECORD OF BOREHOLE No 35-351-01

1 OF 2

METRIC

G.W.P. 3224-15-00 LOCATION Coords: 4 812 484.9N; 251 867.3 E ORIGINATED BY S.A.  
DIST Central HWY 6S BOREHOLE TYPE Hollow Stem Augers COMPILED BY A.K.  
DATUM Geodetic DATE 2017.11.14 LATITUDE 43.4504 LONGITUDE -80.15401 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
317.0	GROUND SURFACE													
0.0	130 mm ASPHALT over silty sand with gravel													
	(PAVEMENT FILL)		1	SS	50									
316.0														
1.0	SILTY SAND, with gravel Dense to compact, Brown, Damp		2	SS	23									
			3	SS	44									
			4	SS	35									
			5	SS	48									
	occasional cobbles		6	SS	94/25cm									44 37 15 4
	(FILL)													
310.9														
6.1	SILTY SAND, with gravel Compact to very dense, Brown, Dry		7	SS	48									
			8	SS	13									
			9	SS	38									49 34 (17)
			10	SS	36									
			11	SS	16									
			12	SS	71									47 45 (8)
302.7	End of borehole													
14.3														

Continued Next Page

+ 3, x 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE



# RECORD OF BOREHOLE No 35-351-02

1 OF 3

METRIC

G.W.P. 3224-15-00 LOCATION Coords: 4 812 456.1N; 251 897.2 E ORIGINATED BY S.A.  
 DIST Central HWY 6S BOREHOLE TYPE Hollow Stem Augers & Cone Penetration Test COMPILED BY A.K.  
 DATUM Geodetic DATE 2017.11.13 - 2017.11.14 LATITUDE 43.45014 LONGITUDE -80.15364 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			GR	SA	SI	CL		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL					× LAB VANE	20	40					60	80
318.4	GROUND SURFACE																						
0.0	100 mm ASPHALT over silty sand, with gravel		1	SS	95/28cm		318																
	(PAVEMENT FILL)																						
317.4	SILTY SAND, with gravel		2	SS	57		317																
1.0	Compact to very dense, Brown, Damp																						
	occasional cobbles		3	SS	23		316																
			4	SS	19		315																
			5	SS	16		314																
	(FILL)																						
313.8	SILTY SAND, with gravel		6	SS	35		313																
4.6	Very dense to compact, Brown, Damp																						
			7	SS	6		312																
			8	SS	57		311																
			9	SS	55		310																
			10	SS	21		309																
			11	SS	16		308																

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 35-351-02

2 OF 3

METRIC

G.W.P. 3224-15-00 LOCATION Coords: 4 812 456.1N; 251 897.2 E ORIGINATED BY S.A.  
DIST Central HWY 6S BOREHOLE TYPE Hollow Stem Augers & Cone Penetration Test COMPILED BY A.K.  
DATUM Geodetic DATE 2017.11.13 - 2017.11.14 LATITUDE 43.45014 LONGITUDE -80.15364 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE						● QUICK TRIAXIAL	× LAB VANE
303.4	15.0	End of borehole														
		Probable SILTY SAND, with gravel (Cont.d)														

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

## METRIC

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE



RECORD OF BOREHOLE No 35-351-03

1 OF 3

METRIC

G.W.P. 3224-15-00 LOCATION Coords: 4 812 456.0 N; 251 866.4 E ORIGINATED BY M.F.  
DIST Central HWY 6S BOREHOLE TYPE Hollow Stem Augers, Rotary Mud and NQ Coring COMPILED BY A.K.  
DATUM Geodetic DATE 2017.11.06 - 2017.11.08 LATITUDE 43.45014 LONGITUDE -80.15402 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE															
0.0	GROUND SURFACE						20	40	60	80	100												
310.9	TOPSOIL:																						
0.2	SILTY SAND, with gravel		1	SS	21								○										
	Compact to very dense, Brown, Moist																						
			2	SS	19								○										
			3	SS	29								○										
			4	SS	21								○										
			5	SS	31								○										
			6	SS	22								○										
			7	SS	26								○										
			8	SS	11								○										
			9	SS	29								○										
			10	SS	18								○										
			11	SS	17								○										
			12	SS	18								○										
			13	SS	30								○										
296.1																							

Continued Next Page

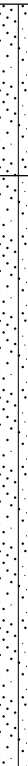
+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 35-351-03

2 OF 3

METRIC

G.W.P. 3224-15-00 LOCATION Coords: 4 812 456.0 N; 251 866.4 E ORIGINATED BY M.F.  
DIST Central HWY 6S BOREHOLE TYPE Hollow Stem Augers, Rotary Mud and NQ Coring COMPILED BY A.K.  
DATUM Geodetic DATE 2017.11.06 - 2017.11.08 LATITUDE 43.45014 LONGITUDE -80.15402 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
								○ UNCONFINED								+ FIELD VANE		
								● QUICK TRIAXIAL								× LAB VANE		
						20	40	60	80	100	20	40	60					
296.1 15.0	SILTY SAND, with gravel														4 89 (7)			
	Compact to very dense, Brown, Moist (Cont.d)		14	SS	17													
	occasional cobbles		15	SS	50													
			16	SS	12													
															21 42 29 8			

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE



RECORD OF BOREHOLE No 35-351-04

1 OF 2

METRIC

G.W.P. 3224-15-00 LOCATION Coords: 4 812 414.8 N; 251 875.3E ORIGINATED BY A.H.  
DIST Central HWY 6S BOREHOLE TYPE Hollow Stem Augers & Cone Penetration Test COMPILED BY A.K.  
DATUM Geodetic DATE 2018.01.17 LATITUDE 43.44977 LONGITUDE -80.15391 CHECKED BY M.V.

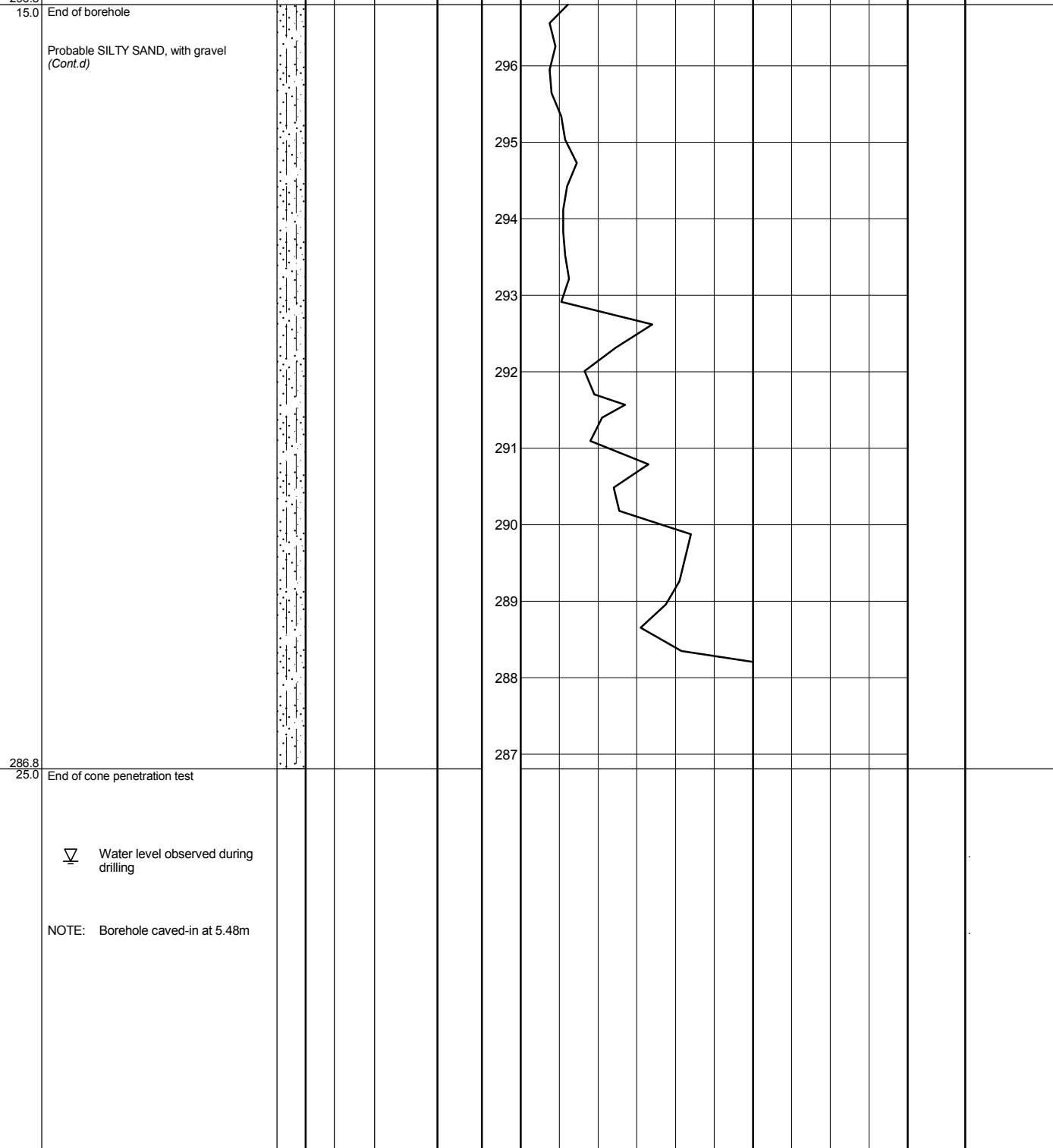
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								○ UNCONFINED	+ FIELD VANE							
								● QUICK TRIAXIAL	× LAB VANE							
311.8 0.0	GROUND SURFACE 180 mm ASPHALT over crushed stone silty sand, with gravel		1	SS	62											
311.0 0.8	(PAVEMENT FILL)															
	SILTY SAND, with gravel Compact to dense, Brown, Moist		2	SS	35											41 48 (11)
			3	SS	8											
			4	SS	29											
			5	SS	41											
			6	SS	26											50 38 (12)
			7	SS	25											
			8	SS	47											
			9	SS	24											
			10	SS	16											22 70 6 2
		11	SS	15												
		12	SS	18												
		13	SS	34											8 83 7 2	
298.1 13.7	End of borehole															
	Probable SILTY SAND, with gravel															
296.8																

Continued Next Page

+ 3, x 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

## METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT	UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES								
296.8							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						



ONTARIO MTO 17TF006A - PART A.GPJ ONTARIO MTO,GDT 6/28/18

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

RECORD OF BOREHOLE No 35-351-05

1 OF 3

METRIC

G.W.P. 3224-15-00 LOCATION Coords: 4 812 420.2 N; 251 860.7 E ORIGINATED BY A.H.  
DIST Central HWY 6S BOREHOLE TYPE Hollow Stem Augers and NQ Coring COMPILED BY A.K.  
DATUM Geodetic DATE 2017.11.29 - 2017.12.06 LATITUDE 43.44982 LONGITUDE -80.15409 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
311.8	GROUND SURFACE													
0.0	180 mm ASPHALT over silty sand with gravel (PAVEMENT FILL)		1	SS	29									
311.0	SILTY SAND, with gravel		2	SS	20		311							
0.8	Loose to dense, Brown, Moist		3	SS	23		310							
			4	SS	28		309							
			5	SS	15		308							60 31 7 2
			6	SS	27		307							52 40 6 2
			7	SS	25		306							
			8	SS	20		305							
			9	SS	25		304							
			10	SS	16		303							
			11	SS	15		302							
			12	SS	19		301							
			13	SS	21		300							
							299							
							298							
							297							
296.8														

Continued Next Page

+ 3, x 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 35-351-05

2 OF 3

METRIC

G.W.P. 3224-15-00 LOCATION Coords: 4 812 420.2 N; 251 860.7 E ORIGINATED BY A.H.  
DIST Central HWY 6S BOREHOLE TYPE Hollow Stem Augers and NQ Coring COMPILED BY A.K.  
DATUM Geodetic DATE 2017.11.29 - 2017.12.06 LATITUDE 43.44982 LONGITUDE -80.15409 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			GR	SA	SI	CL	
								○ UNCONFINED      + FIELD VANE																γ
								● QUICK TRIAXIAL      × LAB VANE																
296.8							20	40	60	80	100		20	40	60									
	SILTY SAND, with gravel																							
	Loose to dense, Brown, Moist (Cont.d)		14	SS	9														70 27 (3)					
			15	SS	22																			
			16	SS	20																			
			17	SS	44																			

Continued Next Page

+ 3, x 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

**RECORD OF BOREHOLE No 35-351-05**

3 OF 3

**METRIC**

G.W.P. 3224-15-00 LOCATION Coords: 4 812 420.2 N; 251 860.7 E ORIGINATED BY A.H.  
 DIST Central HWY 6S BOREHOLE TYPE Hollow Stem Augers and NQ Coring COMPILED BY A.K.  
 DATUM Geodetic DATE 2017.11.29 - 2017.12.06 LATITUDE 43.44982 LONGITUDE -80.15409 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
281.8	NOTES: 1 Groundwater was not encountered during drilling 2 Borehole was charged with drilling water thus water level could not be established upon completion of drilling.																



RECORD OF BOREHOLE No 35-351-06

1 OF 2

METRIC

G.W.P. 3224-15-00 LOCATION Coords: 4 812 382.6 N; 251 872.3 E ORIGINATED BY M.F.  
DIST Central HWY 6S BOREHOLE TYPE Hollow Stem Augers & Cone Penetration Test COMPILED BY A.K.  
DATUM Geodetic DATE 2017.11.09 LATITUDE 43.44948 LONGITUDE -80.15394 CHECKED BY M.V.

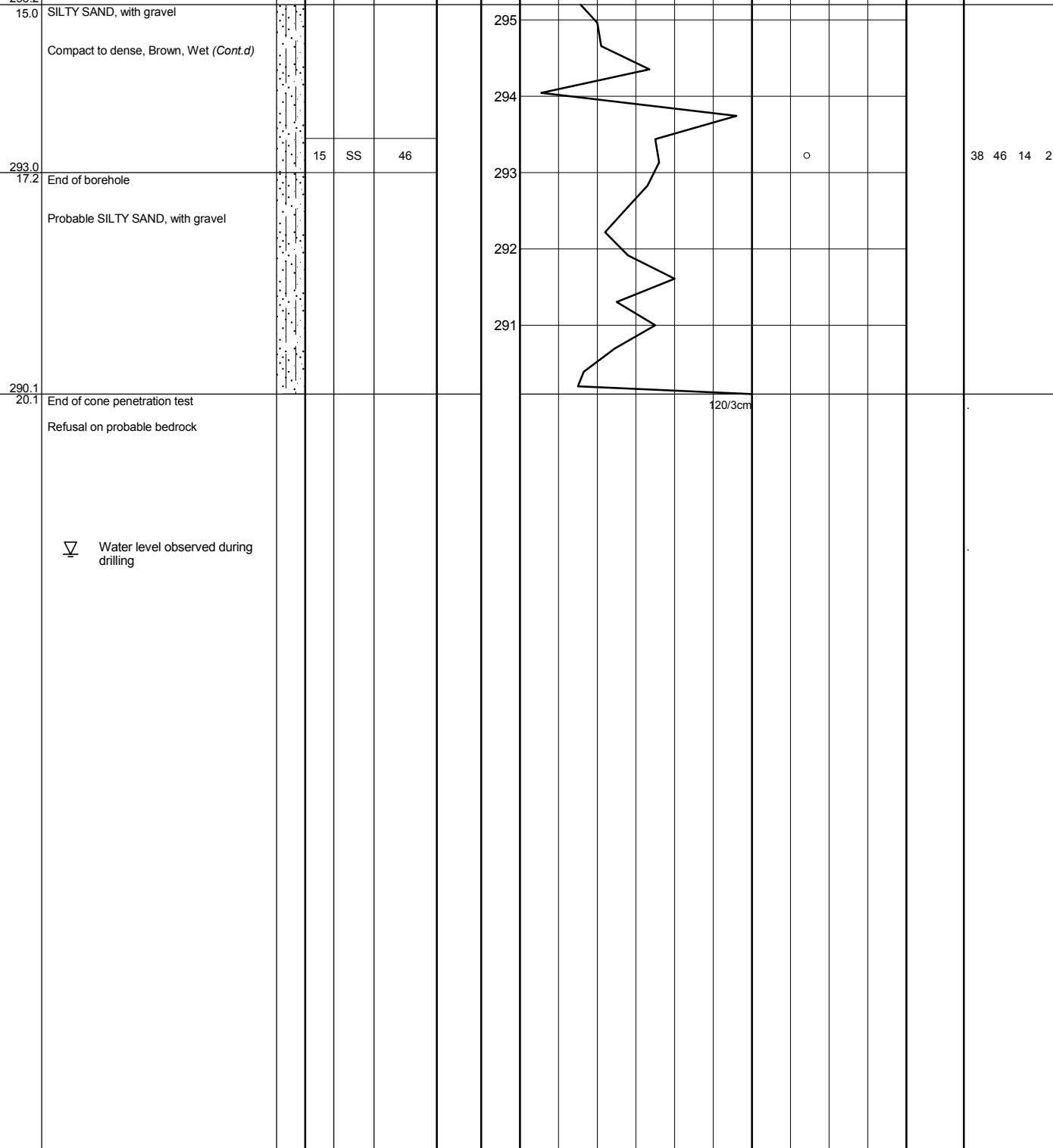
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
310.2	GROUND SURFACE													
0.0	TOPSOIL													
309.9														
0.3	SILTY SAND, with gravel		1	SS	14		310							
	Compact to dense, Brown, Wet		2	SS	28		309							
			3	SS	26		308							
			4	SS	19		307							3 80 16 1
			5	SS	17		306							
			6	SS	28		305							45 44 10 1
			7	SS	29		304							
			8	SS	41		303							
			9	SS	26		302							
			10	SS	36		301							
			11	SS	32		300							
			12	SS	42		299							
			13	SS	39		298							
			14	SS	23		297							
							296							
295.2														

Continued Next Page

+ 3, x 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

## METRIC

SOIL PROFILE				SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20	40					
295.2														
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		W <sub>p</sub>	W	W <sub>L</sub>		
								20 40 60 80 100		WATER CONTENT (%)				
								20 40 60 80 100		20 40 60				
										kN/m <sup>3</sup>				GR SA SI CL



# RECORD OF BOREHOLE No 35-351-07

1 OF 3

METRIC

G.W.P. 3224-15-00 LOCATION Coords: 4 812 376.5 N; 251 875.3 E ORIGINATED BY M.F.  
 DIST Central HWY 6S BOREHOLE TYPE Hollow Stem Augers COMPILED BY A.K.  
 DATUM Geodetic DATE 2017.10.31 - 2017.11.01 LATITUDE 43.44942 LONGITUDE -80.1539 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT  w <sub>p</sub>	NATURAL MOISTURE CONTENT  w	LIQUID LIMIT  w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			GR	SA	SI	CL
								20	40	60	80	100					○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL				
311.3	GROUND SURFACE																						
0.0	200mm Topsoil																						
311.1	SILTY SAND, some gravel		1	SS	40		311																
0.2	Compact to very dense, Brown, Moist																						
			2	SS	45		310																
			3	SS	23		309																
			4	SS	40		308																
			5	SS	30		307																
			6	SS	27		306																
			7	SS	18		305																
			8	SS	14		304																
			9	SS	83		303																
			10	SS	54		302																
			11	SS	40		301																
			12	SS	31		300																
			13	SS	51		299																
			14	SS	29		298																
							297																
296.3																							

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 35-351-07

2 OF 3

METRIC

G.W.P. 3224-15-00 LOCATION Coords: 4 812 376.5 N; 251 875.3 E ORIGINATED BY M.F.  
DIST Central HWY 6S BOREHOLE TYPE Hollow Stem Augers COMPILED BY A.K.  
DATUM Geodetic DATE 2017.10.31 - 2017.11.01 LATITUDE 43.44942 LONGITUDE -80.1539 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT $w_p$	NATURAL MOISTURE CONTENT $w$	LIQUID LIMIT $w_L$	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			GR	SA	SI	CL		
								20	40	60					80	100	○ UNCONFINED					+ FIELD VANE	● QUICK TRIAXIAL
296.3 15.0	SILTY SAND, some gravel  Compact to very dense, Brown, Moist (Cont.d)						296																
			15	SS	32		295																
							294																
			16	SS	39		293																
							292																
							291																
			17	SS	38		290																
							289																
							288																
							287																
			18	SS	24		286																
							285																
					284																		
					283																		
					282																		
					281																		
					280																		
					279																		
					278																		
					277																		
					276																		
					275																		
					274																		
					273																		
					272																		
					271																		
					270																		
					269																		
					268																		
					267																		
					266																		
					265																		
					264																		
					263																		
					262																		
					261																		
					260																		
					259																		
					258																		
					257																		
					256																		
					255																		
					254																		
					253																		
					252																		
					251																		
					250																		
					249																		
					248																		
					247																		
					246																		
					245																		
					244																		
					243																		
					242																		
					241																		
					240																		
					239																		
					238																		
					237																		
					236																		
					235																		
					234																		
					233																		
					232																		
					231																		
					230																		
					229																		
					228																		
					227																		
					226																		
					225																		
					224																		
					223																		
					222																		
					221																		
					220																		
					219																		
					218																		
					217																		
					216																		
					215																		
					214																		
					213																		
					212																		
					211																		
					210																		
					209																		
					208																		
					207																		
					206																		
					205																		
					204																		
					203																		
					202																		
					201																		
					200																		
					199																		
					198																		
					197																		
					196																		
					195																		
					194																		
					193																		
					192																		
					191																		
					190																		
					189																		
					188																		
					187																		
					186																		
					185																		
					184																		
					183																		
					182																		
					181																		
					180																		
					179																		
					178																		
					177																		
					176																		
					175																		
					174																		
					173																		
					172																		
					171																		
					170																		
					169																		
					168																		
					167																		
					166																		
					165																		
					164																		
					163																		
					162																		
					161																		
					160																		
					159																		
					158																		
					157																		
					156																		

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

# RECORD OF BOREHOLE No 35-351-07

3 OF 3

**METRIC**

G.W.P. 3224-15-00 LOCATION Coords: 4 812 376.5 N; 251 875.3 E ORIGINATED BY M.F.  
 DIST Central HWY 6S BOREHOLE TYPE Hollow Stem Augers COMPILED BY A.K.  
 DATUM Geodetic DATE 2017.10.31 - 2017.11.01 LATITUDE 43.44942 LONGITUDE -80.1539 CHECKED BY M.V.

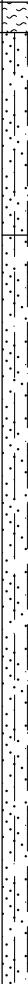
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL																				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>																						
281.3																																					
<p><u>Monitoring Well Readings:</u></p> <table border="1"> <thead> <tr> <th>Date</th> <th>Depth (m)</th> <th>Elev.</th> </tr> </thead> <tbody> <tr> <td>Nov. 14/17</td> <td>5.6</td> <td>305.7</td> </tr> <tr> <td>Dec. 01/17</td> <td>5.75</td> <td>305.6</td> </tr> <tr> <td>Jan. 09/18</td> <td>5.6</td> <td>305.7</td> </tr> <tr> <td>Jan. 17/18</td> <td>5.4</td> <td>305.9</td> </tr> <tr> <td>Feb. 14/18</td> <td>5.2</td> <td>306.1</td> </tr> <tr> <td>Apr. 03/18</td> <td>5.1</td> <td>306.2</td> </tr> </tbody> </table> <p><u>Monitoring Well Legend:</u></p> <div style="display: flex; align-items: center;"> <div style="width: 20px; height: 10px; background-color: black; margin-right: 5px;"></div> <div>Bentonite seal</div> </div> <div style="display: flex; align-items: center;"> <div style="width: 20px; height: 10px; border: 1px solid black; border-style: dashed; margin-right: 5px;"></div> <div>Filter sand</div> </div> <div style="display: flex; align-items: center;"> <div style="width: 20px; height: 10px; border: 1px solid black; border-style: dotted; margin-right: 5px;"></div> <div>Screen</div> </div>																	Date	Depth (m)	Elev.	Nov. 14/17	5.6	305.7	Dec. 01/17	5.75	305.6	Jan. 09/18	5.6	305.7	Jan. 17/18	5.4	305.9	Feb. 14/18	5.2	306.1	Apr. 03/18	5.1	306.2
Date	Depth (m)	Elev.																																			
Nov. 14/17	5.6	305.7																																			
Dec. 01/17	5.75	305.6																																			
Jan. 09/18	5.6	305.7																																			
Jan. 17/18	5.4	305.9																																			
Feb. 14/18	5.2	306.1																																			
Apr. 03/18	5.1	306.2																																			

RECORD OF BOREHOLE No 35-351-08

1 OF 1

METRIC

G.W.P. 3224-15-00 LOCATION Coords: 4 812 359.4 N; 251 877.6 E ORIGINATED BY M.F.  
DIST Central HWY 6S BOREHOLE TYPE Hollow Stem Augers COMPILED BY A.K.  
DATUM Geodetic DATE 2017.11.03 LATITUDE 43.44927 LONGITUDE -80.15387 CHECKED BY M.V.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE												
313.1	GROUND SURFACE						20	40	60	80	100									
0.0	TOPSOIL																			
312.8	SILTY SAND, with gravel Compact to dense, Brown, Moist  occasional cobbles		1	SS	9															
0.3																				
			2	SS	17															
			3	SS	29													50 38 11 1		
			4	SS	72															
			5	SS	27															
			6	SS	35															
			7	SS	20													33 57 9 1		
			8	SS	20															
			9	SS	38													43 44 12 1		
	10	SS	17																	
303.3	End of borehole																			
9.8																				
	NOTE: Groundwater was not encountered during and on completion of drilling																			

ONTARIO MTO 17TF006A - PART A.GPJ ONTARIO MTO.GDT 6/28/18



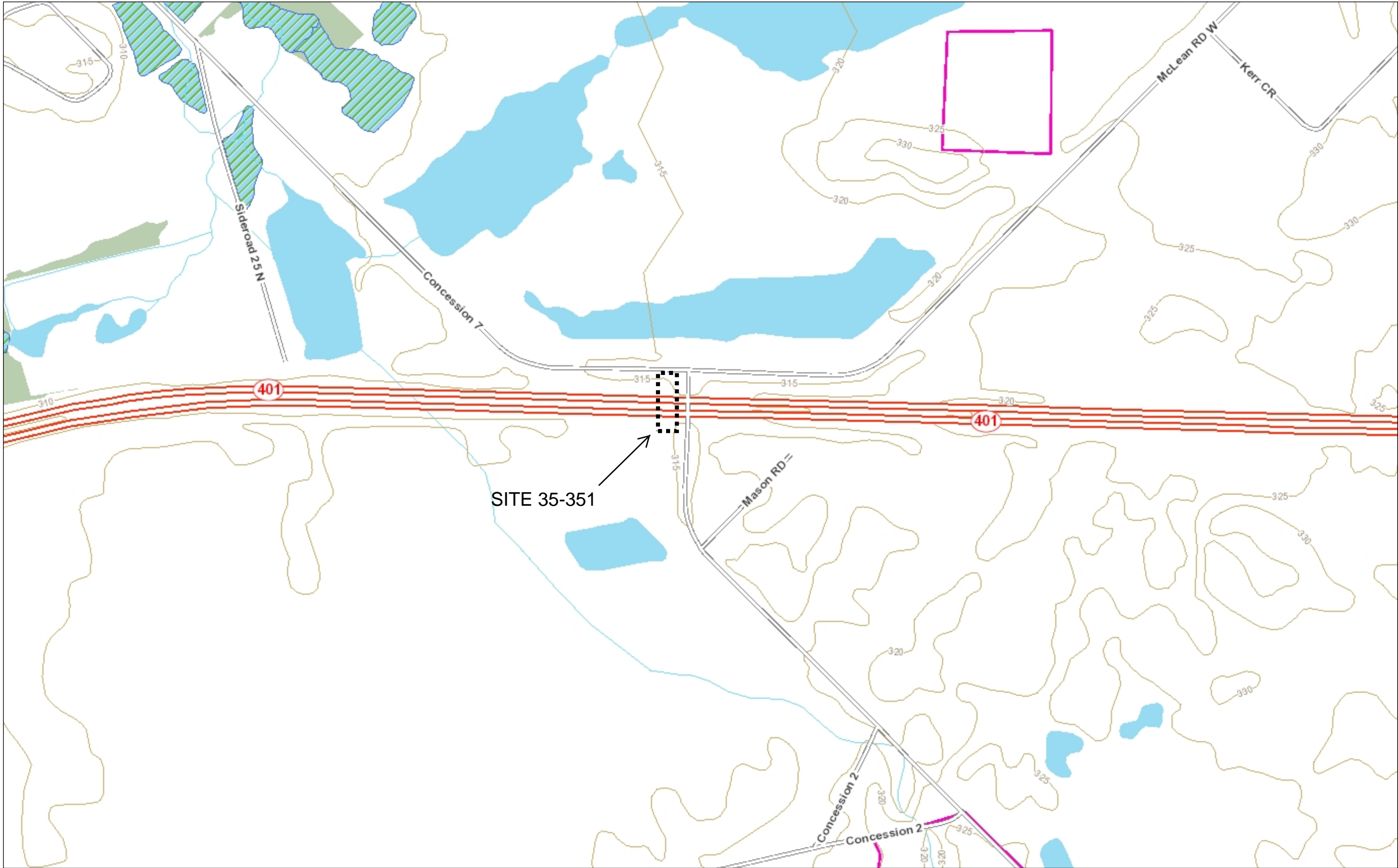
## **APPENDIX A**

Site GIS Map



Legend

- Roads
  - Local Road
  - County Road
  - Highway
- Railways
- Contours
- Earth Science ANSI
- Life Science ANSI
- Waterbodies
- Watercourses
- MNR Wetlands
- Significant Wooded Areas
- Parks



1: 9,000



Notes

0.3 0 0.14 0.3 Miles

WGS\_1984 Web\_Mercator\_Auxiliary\_Sphere  
Includes material © 2016 of the Queen's Printer for Ontario. All rights reserved.

THIS IS NOT SURVEY DATA. Parcels - Teranet 2002, Wellington County 2016

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

Produced using information under License with the Grand River Conservation Authority. Copyright © Grand River Conservation Authority, 2016.





## **APPENDIX B**

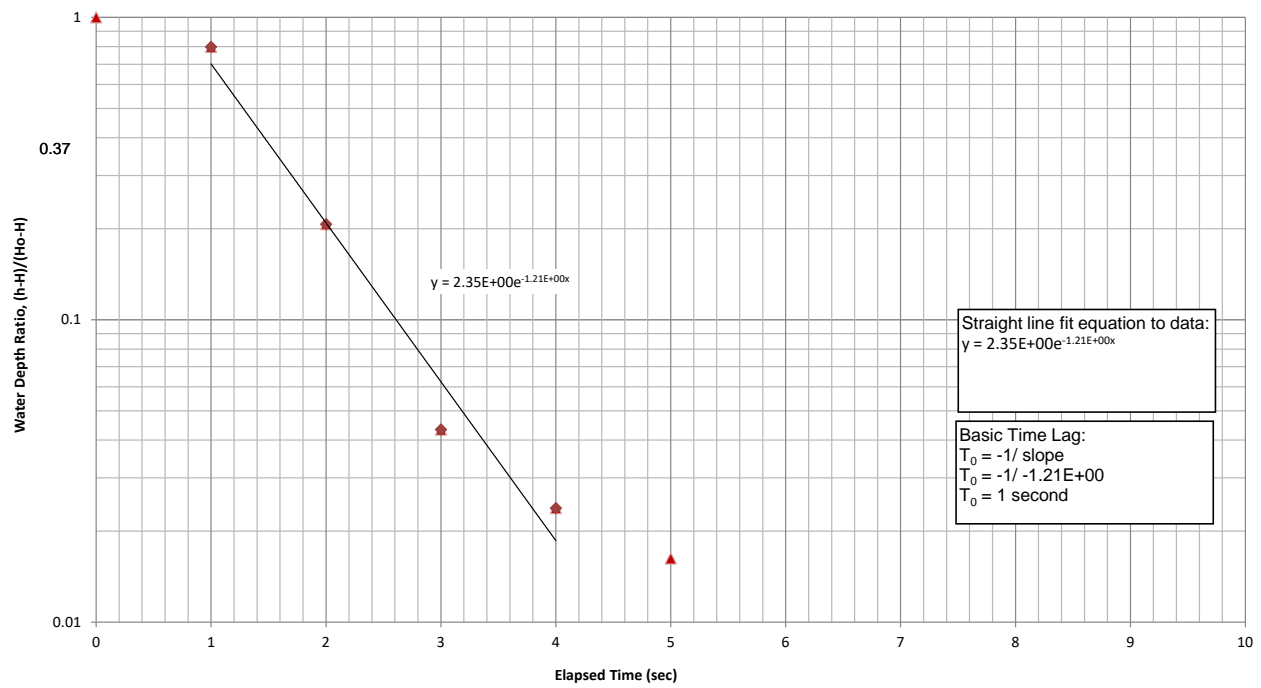
### Borehole Permeability Testing Plots

Date:	Feb. 15 2018	Static water depth, H:	4.65	mbgs
Conducted by:	J. O	Water depth at time t = 0, Ho:	4.83	mbgs
		Water depth at time t, h:	see below	mbgs
Well Number:	MW351-3	Basic time lag, To:	1	sec
Well Screen Bottom:	7.4			mbgs
Top of Pipe:				mags
		Length of well screen, L:	152	cm
Well Casing Diameter:	5.1			cm
		Diameter of the borehole, 2R:	15.2	cm
Well Elevation:	311.076			masl
		Diameter of the well casing, 2r:	5.1	cm
Static Water Level:	4.65			mbgs
Ground Elevation:	311.076			masl
		$K = r^2 \ln(L/R)/(2LT_o) =$	<b>6.4E-02</b>	cm/s
WATER LEVEL BEFORE TEST = H =	4.65			mbgs

[illegible][illegible]

# Plot of Normalized Head Versus Elapsed Time

## Borehole MW351-3

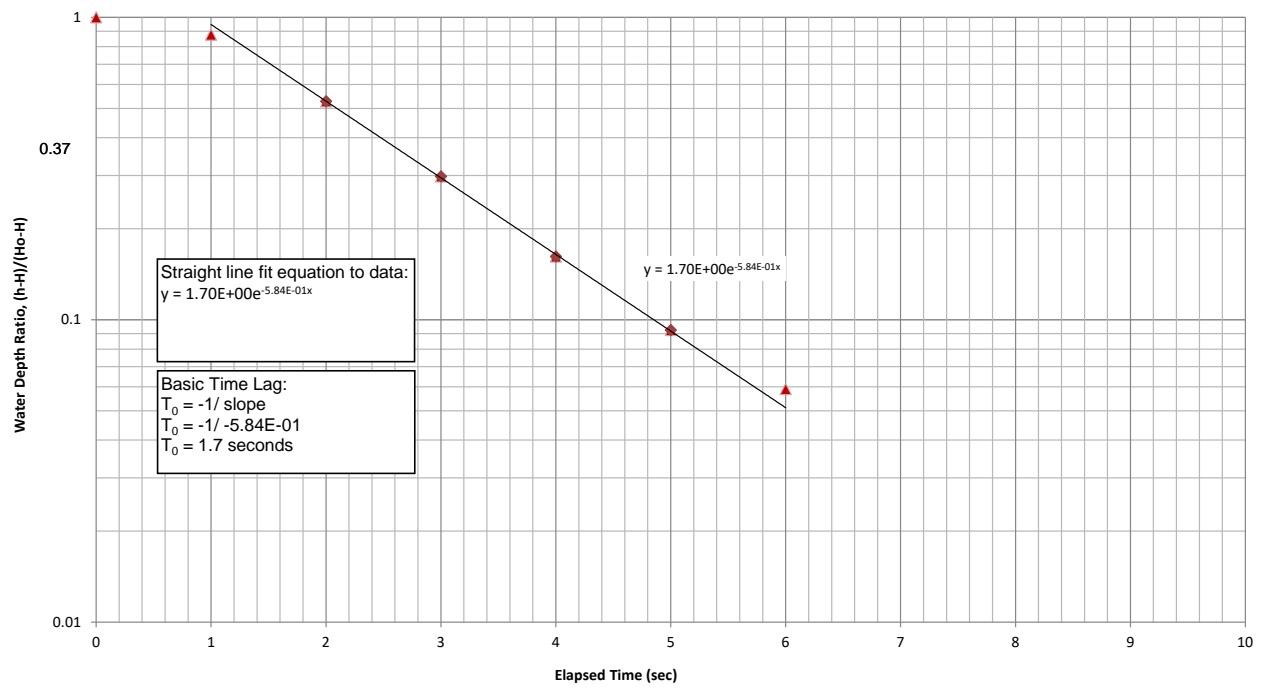


## Date: Feb. 14 2018

WATER LEVEL BEFORE TEST = H = 5.20 mbgs

[illegible][illegible]

**Plot of Normalized Head Versus Elapsed Time**  
**Borehole MW351-7**





## **APPENDIX C**

### Water Sample Laboratory Certificates of Analyses



## FINAL REPORT

CA14399-JAN18 R1

17TF006C Guelph

Prepared for

**Peto MacCallum Ltd**

## First Page

### CLIENT DETAILS

Client Peto MacCallum Ltd

Address 165 Cartwright Ave  
Toronto, ON  
M6A 1V5.

Contact Andrew Cooke

Telephone 416-785-5110

Facsimile 416-785-5120

Email acooke@petomacallum.com

Project 17TF006C Guelph

Order Number

Samples Ground Water (5)

### LABORATORY DETAILS

Project Specialist Deanna Edwards, B.Sc, C.Chem

Laboratory SGS Canada Inc.

Address 185 Concession St., Lakefield ON, K0L 2H0

Telephone 705-652-2000

Facsimile 705-652-6365

Email deanna.edwards@sgs.com

SGS Reference CA14399-JAN18

Received 01/19/2018

Approved 01/24/2018

Report Number CA14399-JAN18 R1

Date Reported 01/24/2018

### COMMENTS

RL - SGS Reporting Limit

Temperature of Sample upon Receipt: 3 degrees C

Cooling Agent Present: Yes

Custody Seal Present: No

Chain of Custody Number: 00095

### SIGNATORIES

Deanna Edwards, B.Sc, C.Chem







TABLE OF CONTENTS

---

First Page..... 1

Index..... 2

Results..... 3-5

Exceedance Summary..... 6

QC Summary..... 7-11

Legend..... 12

Annexes..... 13-14



# FINAL REPORT

CA14399-JAN18 R1

Client: Peto MacCallum Ltd

Project: 17TF006C Guelph

Project Manager: Andrew Cooke

Samplers: J O

PACKAGE: **SANSEW - 1.3 Other (ORP) (WATER)**

Sample Number	7	8	9	10	11
Sample Name	617-3	351-3	612-2	611-6	351-3 Field Filtered
Sample Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Sample Date	19/01/2018	19/01/2018	19/01/2018	19/01/2018	19/01/2018

L1 = SANSEW / WATER / - - Guelph - Storm Sewer Discharge - BL\_1996\_15202

Parameter	Units	RL	L1	Result	Result	Result	Result	Result
<b>1.3 Other (ORP)</b>								
pH	no unit	0.05	9	7.57	7.79	7.19	8.13	7.82
Mercury (total)	mg/L	0.00001	0.001	0.00001	0.00002	0.00002	0.00001	< 0.00001
Mercury (dissolved)	mg/L	0.00001	0.001	< 0.00001	0.00002	< 0.00001	< 0.00001	< 0.00001

PACKAGE: **SANSEW - UNDEFINED (WATER)**

Sample Number	7	8	9	10	11
Sample Name	617-3	351-3	612-2	611-6	351-3 Field Filtered
Sample Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Sample Date	19/01/2018	19/01/2018	19/01/2018	19/01/2018	19/01/2018

L1 = SANSEW / WATER / - - Guelph - Storm Sewer Discharge - BL\_1996\_15202

Parameter	Units	RL	L1	Result	Result	Result	Result	Result
<b>UNDEFINED</b>								
Fecal Coliform	cfu/100mL	-	200	0	0	3	5	0
Biochemical Oxygen Demand (BOD5)	mg/L	2	15	< 4 ↑	< 4 ↑	< 4 ↑	< 4 ↑	< 4 ↑
Total Suspended Solids	mg/L	2	15	155	342	261	44	< 2
Aluminum (total)	mg/L	0.001		1.07	1.36	6.10	0.847	0.009
Aluminum (dissolved)	mg/L	0.001		0.024	0.007	0.007	0.378	0.005
Antimony (total)	mg/L	0.0002		< 0.0002	< 0.0002	0.0004	0.0007	< 0.0002
Arsenic (total)	mg/L	0.0002		0.0030	0.0033	0.0048	0.0005	< 0.0002
Boron (total)	mg/L	0.002		0.014	0.035	0.021	0.007	0.031
Bismuth (total)	mg/L	0.00000 7		< 0.000007	0.000025	0.000124	0.000014	< 0.000007
Beryllium (total)	mg/L	0.00000 7		0.000052	0.000092	0.000369	0.000058	< 0.000007



# FINAL REPORT

CA14399-JAN18 R1

Client: Peto MacCallum Ltd

Project: 17TF006C Guelph

Project Manager: Andrew Cooke

Samplers: J O

PACKAGE: SANSEW - UNDEFINED (WATER)

L1 = SANSEW / WATER / - - Guelph - Storm Sewer Discharge - BL\_1996\_15202

Sample Number	7	8	9	10	11
Sample Name	617-3	351-3	612-2	611-6	351-3 Field Filtered
Sample Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Sample Date	19/01/2018	19/01/2018	19/01/2018	19/01/2018	19/01/2018

Parameter	Units	RL	L1	Result	Result	Result	Result	Result
UNDEFINED (continued)								
Cadmium (total)	mg/L	0.00000 3	0.001	0.000224	0.000727	0.000328	0.000183	0.000066
Chromium (total)	mg/L	0.00003		0.00200	0.00253	0.0172	0.00180	0.00008
Cobalt (total)	mg/L	0.00000 4		0.000636	0.00202	0.00364	0.000913	0.000033
Copper (total)	mg/L	0.00002	0.01	0.00538	0.0169	0.0322	0.00692	0.00090
Iron (total)	mg/L	0.007		1.78	3.57	10.2	0.865	0.016
Lead (total)	mg/L	0.00001	0.05	0.00796	0.0674	0.0291	0.00721	0.00017
Manganese (total)	mg/L	0.00001		0.0548	0.375	0.473	0.117	0.0334
Molybdenum (total)	mg/L	0.00001		0.00128	0.00166	0.00530	0.00101	0.00165
Nickel (total)	mg/L	0.0001	0.05	0.0018	0.0033	0.0150	0.0025	0.0004
Phosphorus (total)	mg/L	0.003		0.064	0.196	0.300	0.047	0.007
Selenium (total)	mg/L	0.00004		0.00018	0.00006	0.00012	0.00006	0.00004
Silver (total)	mg/L	0.00005		< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Thallium (total)	mg/L	0.00000 5		0.000028	0.000060	0.000077	0.000013	0.000025
Tin (total)	mg/L	0.00001		0.00128	0.00058	0.00101	0.00345	0.00031
Titanium (total)	mg/L	0.00005		0.0226	0.0527	0.0661	0.0110	0.00043
Uranium (total)	mg/L	0.00000 2		0.00170	0.000549	0.00176	0.000465	0.000276
Vanadium (total)	mg/L	0.00001		0.00195	0.00287	0.00737	0.00150	0.00004
Tungsten (total)	mg/L	0.00002		0.00007	0.00132	0.0113	0.00246	0.00162
Zinc (total)	mg/L	0.002	0.05	0.085	0.473	0.118	0.105	0.020



FINAL REPORT

CA14399-JAN18 R1

Client: Peto MacCallum Ltd  
Project: 17TF006C Guelph  
Project Manager: Andrew Cooke  
Samplers: J O

PACKAGE: SANSEW - UNDEFINED (WATER)

L1 = SANSEW / WATER / - - Guelph - Storm Sewer Discharge - BL\_1996\_15202

				Sample Number	7	8	9	10	11
				Sample Name	617-3	351-3	612-2	611-6	351-3 Field Filtered
				Sample Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
				Sample Date	19/01/2018	19/01/2018	19/01/2018	19/01/2018	19/01/2018
Parameter	Units	RL	L1	Result	Result	Result	Result	Result	Result
UNDEFINED (continued)									
Zirconium (total)	mg/L	0.002		< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002

## EXCEEDANCE SUMMARY

				SANSEW / WATER / - - Guelph - Storm Sewer Discharge - BL_1996_15202 L1
Parameter	Method	Units	Result	

### 617-3

Total Suspended Solids	SM 2540D	mg/L	155	15
Zinc	SM 3030/EPA 200.8	mg/L	0.085	0.05

### 351-3

Total Suspended Solids	SM 2540D	mg/L	342	15
Copper	SM 3030/EPA 200.8	mg/L	0.0169	0.01
Lead	SM 3030/EPA 200.8	mg/L	0.0674	0.05
Zinc	SM 3030/EPA 200.8	mg/L	0.473	0.05

### 612-2

Total Suspended Solids	SM 2540D	mg/L	261	15
Copper	SM 3030/EPA 200.8	mg/L	0.0322	0.01
Zinc	SM 3030/EPA 200.8	mg/L	0.118	0.05

### 611-6

Total Suspended Solids	SM 2540D	mg/L	44	15
Zinc	SM 3030/EPA 200.8	mg/L	0.105	0.05



FINAL REPORT

CA14399-JAN18 R1

QC SUMMARY

Biochemical Oxygen Demand  
Method: SM 5210 | Internal ref.: ME-CA-IENVIEWL-LAK-AN-007

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Biochemical Oxygen Demand (BOD5)	BOD0034-JAN18	mg/L	2	< 2	1	30	99	70	130	82	70	130

Mercury by CVAAS  
Method: EPA 7471A/SM 3112B | Internal ref.: ME-CA-IENVISPE-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Mercury (total)	EHG0035-JAN18	mg/L	0.00001	< 0.00001	ND	20	98	80	120	102	70	130
Mercury (dissolved)	EHG0035-JAN18	mg/L	0.00001	< 0.00001	ND	20	98	80	120	102	70	130



# FINAL REPORT

CA14399-JAN18 R1

## QC SUMMARY

Metals in aqueous samples - ICP-MS

Method: SM 3030/EPA 200.8 | Internal ref.: ME-CA-ENVISPE-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Silver (total)	EMS0131-JAN18	mg/L	0.00005	<0.00005	ND	20	99	90	110	NV	70	130
Aluminum (total)	EMS0131-JAN18	mg/L	0.001	<0.001	13	20	105	90	110	NV	70	130
Aluminum (dissolved)	EMS0131-JAN18	mg/L	0.001	<0.001	13	20	105	90	110	NV	70	130
Arsenic (total)	EMS0131-JAN18	mg/L	0.0002	<0.0002	ND	20	100	90	110	101	70	130
Beryllium (total)	EMS0131-JAN18	mg/L	0.000007	<0.000007	ND	20	101	90	110	122	70	130
Boron (total)	EMS0131-JAN18	mg/L	0.002	<0.002	3	20	96	90	110	NV	70	130
Bismuth (total)	EMS0131-JAN18	mg/L	0.000007	<0.000007	ND	20	101	90	110	80	70	130
Cadmium (total)	EMS0131-JAN18	mg/L	0.000003	<0.000003	ND	20	99	90	110	106	70	130
Cobalt (total)	EMS0131-JAN18	mg/L	0.000004	<0.000004	ND	20	100	90	110	102	70	130
Chromium (total)	EMS0131-JAN18	mg/L	0.00003	<0.00003	4	20	99	90	110	93	70	130
Copper (total)	EMS0131-JAN18	mg/L	0.00002	<0.00002	1	20	102	90	110	98	70	130
Iron (total)	EMS0131-JAN18	mg/L	0.007	<0.007	ND	20	101	90	110	NV	70	130
Manganese (total)	EMS0131-JAN18	mg/L	0.00001	<0.00001	19	20	105	90	110	113	70	130
Molybdenum (total)	EMS0131-JAN18	mg/L	0.00001	<0.00001	4	20	97	90	110	104	70	130
Nickel (total)	EMS0131-JAN18	mg/L	0.0001	<0.0001	0	20	100	90	110	95	70	130
Lead (total)	EMS0131-JAN18	mg/L	0.00001	<0.00001	ND	20	101	90	110	98	70	130
Antimony (total)	EMS0131-JAN18	mg/L	0.0002	<0.0002	ND	20				113	70	130
Selenium (total)	EMS0131-JAN18	mg/L	0.00004	<0.00004	3	20	99	90	110	113	70	130
Tin (total)	EMS0131-JAN18	mg/L	0.00001	<0.00001	10	20	97	90	110	NV	70	130
Titanium (total)	EMS0131-JAN18	mg/L	0.00005	<0.00005	ND	20	102	90	110	NV	70	130



# FINAL REPORT

CA14399-JAN18 R1

## QC SUMMARY

### Metals in aqueous samples - ICP-MS (continued)

Method: SM 3030/EPA 200.8 | Internal ref.: ME-CA-IENVISPE-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Thallium (total)	EMS0131-JAN18	mg/L	0.000005	<0.000005	ND	20	100	90	110	97	70	130
Uranium (total)	EMS0131-JAN18	mg/L	0.000002	<0.000002	8	20	99	90	110	97	70	130
Vanadium (total)	EMS0131-JAN18	mg/L	0.00001	<0.00001	10	20	99	90	110	104	70	130
Tungsten (total)	EMS0131-JAN18	mg/L	0.00002	<0.00002	ND	20	98	90	110	NV	70	130
Zinc (total)	EMS0131-JAN18	mg/L	0.002	<0.002	ND	20	95	90	110	98	70	130
Zirconium (total)	EMS0131-JAN18	mg/L	0.002	<0.002	ND	20	97	90	110	NV	70	130

### Metals in aqueous samples - ICP-OES

Method: SM 3030/EPA 200.8 | Internal ref.: ME-CA-IENVISPE-LAK-AN-003

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Phosphorus (total)	EMS0131-JAN18	mg/L	0.003	<0.003	ND	20	100	90	110	NV	70	130





FINAL REPORT

CA14399-JAN18 R1

QC SUMMARY

Microbiology  
Method: SM 9222D | Internal ref.: ME-CA-~~I~~ENVIMIC-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Fecal Coliform	BAC9318-JAN18	cfu/100mL	-	ACCEPTED	ACCEPTED							
					D							

pH  
Method: SM 4500 | Internal ref.: ME-CA-~~I~~ENVIEWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0275-JAN18	no unit	0.05	NA	0		100			NA		

Suspended Solids  
Method: SM 2540D | Internal ref.: ME-CA-~~I~~ENVIEWL-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Total Suspended Solids	EWL0283-JAN18	mg/L	2	< 2	0	10	100	90	110	NA		

## QC SUMMARY

---

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

**Multielement Scan Qualifier:** as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

**Duplicate Qualifier:** for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

**Matrix Spike Qualifier:** for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

## LEGEND

### FOOTNOTES

**NSS** Insufficient sample for analysis.

**RL** Reporting Limit.

↑ Reporting limit raised.

↓ Reporting limit lowered.

**NA** The sample was not analysed for this analyte

**ND** Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at [http://www.sgs.com/terms\\_and\\_conditions.htm](http://www.sgs.com/terms_and_conditions.htm). The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

This report must not be reproduced, except in full. This report supersedes all previous versions.

-- End of Analytical Report --





# SAMPLE INTEGRITY REPORT

Project Number: 1777006C

ONTARIO REGULATION 153/04

SGS Sample ID CH4399-Jan18

Date / Time Sampled 01/19/18

Client Sample ID See CoC

## ALL

### Sample Submission General Sample Integrity Violations

- Temperature >10 C upon receipt if not sampled same day
- No evidence of cooling trend initiated if sampled same day
- Chain of Custody not submitted
- Chain of Custody incomplete
- Chain of Custody not signed / dated
- Chain of Custody not a current version
- Bottles / Samples listed on CoC but not received
- Bottles / Samples received but not listed on the CoC
- Sample container received empty

☐  
☐  
☐  
☐  
☐  
☐  
☐  
☐  
☐

rec'd 2 total metals Bottles

### Sample Specific Sample Integrity Violations

- Sample received past hold time
- Incorrect preservation (including no preservation where required)
- Headspace present in VOC vial (aqueous)
- Sample(s) received frozen
- Bottle(s) broken or damaged in transport
- Discrepancy between sample label and chain of custody
- Analysis requirements absent / unclear
- Missing or incorrect sample label(s)
- Inappropriate sample container used
- Insufficient number of bottles received
- Limited sample volume
- Insufficient sample volume
- Sample contains multiple phases

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

### Sediment Log

- Groundwater samples contain visible sediment / particulate
- Groundwater contains greater than 1cm of sediment / particulate matter in bottle

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

### Additional Comments/Remarks:

No Issues upon receipt

☐

Initials:

WJ



## FINAL REPORT

CA14399-JAN18 R

17TF006C Guelph

Prepared for

**Peto MacCallum Ltd**

## First Page

## CLIENT DETAILS

Client Peto MacCallum Ltd

Address 165 Cartwright Ave  
Toronto, ON  
M6A 1V5.

Contact Andrew Cooke

Telephone 416-785-5110

Facsimile 416-785-5120

Email acooke@petomacallum.com

Project 17TF006C Guelph

Order Number

Samples Ground Water (5)

## LABORATORY DETAILS

Project Specialist Deanna Edwards, B.Sc, C.Chem

Laboratory SGS Canada Inc.

Address 185 Concession St., Lakefield ON, K0L 2H0

Telephone 705-652-2000

Facsimile 705-652-6365

Email deanna.edwards@sgs.com

SGS Reference CA14399-JAN18

Received 01/19/2018

Approved 01/24/2018

Report Number CA14399-JAN18 R

Date Reported 01/24/2018

## COMMENTS

RL - SGS Reporting Limit

Temperature of Sample upon Receipt: 3 degrees C

Cooling Agent Present: Yes

Custody Seal Present: No

Chain of Custody Number: 00095

PWQO - Provincial Water Quality Objectives

Limits based on MOE PIBS 3303E publication July 1994 reprinted February 1999

a PWQO limit based on pH >6.5-9.0 (at pH 4.5-5.5 PWQO = 15ug/L, pH >5.5-6.5 PWQO 10% above background levels in geological area.

b PWQO limit based on Hardness <75 mg/L (For Hardness >75 mg/L PWQO = 1100 ug/L)

c PWQO limit based on Hardness 0-100 mg/L (For Hardness >100 mg/L PWQO = 0.5 ug/L)

d PWQO limit based on Cr VI (PWQO limit for Cr III = 8.9 ug/L)

e PWQO limit based on Hardness 0-20 (For Hardness >20 mg/L PWQO = 5 ug/L)

f PWQO limit based on Hardness <30 (For Hardness 30-80 PWQO = 3 ug/L, & >80 PWQO=5)

## SIGNATORIES

Deanna Edwards, B.Sc, C.Chem





TABLE OF CONTENTS

---

First Page..... 1

Index..... 2

Results..... 3-5

Exceedance Summary..... 6

QC Summary..... 7-11

Legend..... 12

Annexes..... 13-14





# FINAL REPORT

CA14399-JAN18 R

Client: Peto MacCallum Ltd

Project: 17TF006C Guelph

Project Manager: Andrew Cooke

Samplers: J O

PACKAGE: PWQOSANSEW - 1.3 Other (ORP)  
(WATER)

Sample Number	7	8	9	10	11
Sample Name	617-3	351-3	612-2	611-6	351-3 Field Filtered
Sample Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Sample Date	19/01/2018	19/01/2018	19/01/2018	19/01/2018	19/01/2018

L1 = PWQOSANSEW / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Parameter	Units	RL	L1	Result	Result	Result	Result	Result
1.3 Other (ORP)								
pH	no unit	0.05	8.5	7.57	7.79	7.19	8.13	7.82
Mercury (total)	mg/L	0.00001	0.2	0.00001	0.00002	0.00002	0.00001	< 0.00001
Mercury (dissolved)	mg/L	0.00001		< 0.00001	0.00002	< 0.00001	< 0.00001	< 0.00001

PACKAGE: PWQOSANSEW - UNDEFINED (WATER)

Sample Number	7	8	9	10	11
Sample Name	617-3	351-3	612-2	611-6	351-3 Field Filtered
Sample Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Sample Date	19/01/2018	19/01/2018	19/01/2018	19/01/2018	19/01/2018

L1 = PWQOSANSEW / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Parameter	Units	RL	L1	Result	Result	Result	Result	Result
UNDEFINED								
Fecal Coliform	cfu/100mL	-		0	0	3	5	0
Biochemical Oxygen Demand (BOD5)	mg/L	2		< 4 †	< 4 †	< 4 †	< 4 †	< 4 †
Total Suspended Solids	mg/L	2		155	342	261	44	< 2
Aluminum (total)	mg/L	0.001	0.015	1.07	1.36	6.10	0.847	0.009
Aluminum (dissolved)	mg/L	0.001		0.024	0.007	0.007	0.378	0.005
Antimony (total)	mg/L	0.0002	0.02	< 0.0002	< 0.0002	0.0004	0.0007	< 0.0002
Arsenic (total)	mg/L	0.0002	0.005	0.0030	0.0033	0.0048	0.0005	< 0.0002
Boron (total)	mg/L	0.002	0.2	0.014	0.035	0.021	0.007	0.031
Bismuth (total)	mg/L	0.00000		< 0.000007	0.000025	0.000124	0.000014	< 0.000007
		7						



# FINAL REPORT

CA14399-JAN18 R

Client: Peto MacCallum Ltd

Project: 17TF006C Guelph

Project Manager: Andrew Cooke

Samplers: J O

PACKAGE: PWQOSANSEW - UNDEFINED (WATER)

Sample Number	7	8	9	10	11
Sample Name	617-3	351-3	612-2	611-6	351-3 Field Filtered
Sample Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
Sample Date	19/01/2018	19/01/2018	19/01/2018	19/01/2018	19/01/2018

L1 = PWQOSANSEW / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Parameter	Units	RL	L1	Result	Result	Result	Result	Result
UNDEFINED (continued)								
Beryllium (total)	mg/L	0.00000 7	0.011	0.000052	0.000092	0.000369	0.000058	< 0.000007
Cadmium (total)	mg/L	0.00000 3	0.0001	0.000224	0.000727	0.000328	0.000183	0.000066
Chromium (total)	mg/L	0.00003	0.001	0.00200	0.00253	0.0172	0.00180	0.00008
Cobalt (total)	mg/L	0.00000 4	0.0009	0.000636	0.00202	0.00364	0.000913	0.000033
Copper (total)	mg/L	0.00002	0.001	0.00538	0.0169	0.0322	0.00692	0.00090
Iron (total)	mg/L	0.007	0.3	1.78	3.57	10.2	0.865	0.016
Lead (total)	mg/L	0.00001	0.001	0.00796	0.0674	0.0291	0.00721	0.00017
Manganese (total)	mg/L	0.00001		0.0548	0.375	0.473	0.117	0.0334
Molybdenum (total)	mg/L	0.00001	0.04	0.00128	0.00166	0.00530	0.00101	0.00165
Nickel (total)	mg/L	0.0001	0.025	0.0018	0.0033	0.0150	0.0025	0.0004
Phosphorus (total)	mg/L	0.003	0.01	0.064	0.196	0.300	0.047	0.007
Selenium (total)	mg/L	0.00004	0.1	0.00018	0.00006	0.00012	0.00006	0.00004
Silver (total)	mg/L	0.00005	0.0001	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
Thallium (total)	mg/L	0.00000 5	0.0003	0.000028	0.000060	0.000077	0.000013	0.000025
Tin (total)	mg/L	0.00001		0.00128	0.00058	0.00101	0.00345	0.00031
Titanium (total)	mg/L	0.00005		0.0226	0.0527	0.0661	0.0110	0.00043
Uranium (total)	mg/L	0.00000 2	0.005	0.00170	0.000549	0.00176	0.000465	0.000276
Vanadium (total)	mg/L	0.00001	0.006	0.00195	0.00287	0.00737	0.00150	0.00004



FINAL REPORT

CA14399-JAN18 R

Client: Peto MacCallum Ltd  
Project: 17TF006C Guelph  
Project Manager: Andrew Cooke  
Samplers: J O

PACKAGE: PWQOSANSEW - UNDEFINED (WATER)

L1 = PWQOSANSEW / WATER / - - Table 2 - General - July 1999 PIBS 3303E

				Sample Number	7	8	9	10	11
				Sample Name	617-3	351-3	612-2	611-6	351-3 Field Filtered
				Sample Matrix	Ground Water	Ground Water	Ground Water	Ground Water	Ground Water
				Sample Date	19/01/2018	19/01/2018	19/01/2018	19/01/2018	19/01/2018
Parameter	Units	RL	L1	Result	Result	Result	Result	Result	Result
UNDEFINED (continued)									
Tungsten (total)	mg/L	0.00002	0.03	0.00007	0.00132	0.0113	0.00246	0.00162	
Zinc (total)	mg/L	0.002	0.02	0.085	0.473	0.118	0.105	0.020	
Zirconium (total)	mg/L	0.002	0.004	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	

## EXCEEDANCE SUMMARY

				PWQOSANSEW / WATER / - - Table 2 - General - July 1999 PIBS 3303E L1
Parameter	Method	Units	Result	

### 617-3

Aluminum	SM 3030/EPA 200.8	mg/L	1.07	0.015
Cadmium	SM 3030/EPA 200.8	mg/L	0.000224	0.0001
Chromium	SM 3030/EPA 200.8	mg/L	0.00200	0.001
Copper	SM 3030/EPA 200.8	mg/L	0.00538	0.001
Iron	SM 3030/EPA 200.8	mg/L	1.78	0.3
Lead	SM 3030/EPA 200.8	mg/L	0.00796	0.001
Phosphorous	SM 3030/EPA 200.8	mg/L	0.064	0.01
Zinc	SM 3030/EPA 200.8	mg/L	0.085	0.02

### 351-3

Aluminum	SM 3030/EPA 200.8	mg/L	1.36	0.015
Cadmium	SM 3030/EPA 200.8	mg/L	0.000727	0.0001
Chromium	SM 3030/EPA 200.8	mg/L	0.00253	0.001
Cobalt	SM 3030/EPA 200.8	mg/L	0.00202	0.0009
Copper	SM 3030/EPA 200.8	mg/L	0.0169	0.001
Iron	SM 3030/EPA 200.8	mg/L	3.57	0.3
Lead	SM 3030/EPA 200.8	mg/L	0.0674	0.001
Phosphorous	SM 3030/EPA 200.8	mg/L	0.196	0.01
Zinc	SM 3030/EPA 200.8	mg/L	0.473	0.02

### 612-2

Aluminum	SM 3030/EPA 200.8	mg/L	6.10	0.015
Cadmium	SM 3030/EPA 200.8	mg/L	0.000328	0.0001
Chromium	SM 3030/EPA 200.8	mg/L	0.0172	0.001
Cobalt	SM 3030/EPA 200.8	mg/L	0.00364	0.0009
Copper	SM 3030/EPA 200.8	mg/L	0.0322	0.001
Iron	SM 3030/EPA 200.8	mg/L	10.2	0.3
Lead	SM 3030/EPA 200.8	mg/L	0.0291	0.001
Phosphorous	SM 3030/EPA 200.8	mg/L	0.300	0.01
Vanadium	SM 3030/EPA 200.8	mg/L	0.00737	0.006
Zinc	SM 3030/EPA 200.8	mg/L	0.118	0.02

### 611-6

Aluminum	SM 3030/EPA 200.8	mg/L	0.847	0.015
Cadmium	SM 3030/EPA 200.8	mg/L	0.000183	0.0001
Chromium	SM 3030/EPA 200.8	mg/L	0.00180	0.001
Cobalt	SM 3030/EPA 200.8	mg/L	0.000913	0.0009
Copper	SM 3030/EPA 200.8	mg/L	0.00692	0.001
Iron	SM 3030/EPA 200.8	mg/L	0.865	0.3
Lead	SM 3030/EPA 200.8	mg/L	0.00721	0.001
Phosphorous	SM 3030/EPA 200.8	mg/L	0.047	0.01
Zinc	SM 3030/EPA 200.8	mg/L	0.105	0.02



FINAL REPORT

CA14399-JAN18 R

QC SUMMARY

Biochemical Oxygen Demand  
Method: SM 5210 | Internal ref.: ME-CA-IENVIEWL-LAK-AN-007

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Biochemical Oxygen Demand (BOD5)	BOD0034-JAN18	mg/L	2	< 2	1	30	99	70	130	82	70	130

Mercury by CVAAS  
Method: EPA 7471A/SM 3112B | Internal ref.: ME-CA-IENVISPE-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Mercury (total)	EHG0035-JAN18	mg/L	0.00001	< 0.00001	ND	20	98	80	120	102	70	130
Mercury (dissolved)	EHG0035-JAN18	mg/L	0.00001	< 0.00001	ND	20	98	80	120	102	70	130



# FINAL REPORT

CA14399-JAN18 R

## QC SUMMARY

Metals in aqueous samples - ICP-MS

Method: SM 3030/EPA 200.8 | Internal ref.: ME-CA-ENVISPE-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Silver (total)	EMS0131-JAN18	mg/L	0.00005	<0.00005	ND	20	99	90	110	NV	70	130
Aluminum (total)	EMS0131-JAN18	mg/L	0.001	<0.001	13	20	105	90	110	NV	70	130
Aluminum (dissolved)	EMS0131-JAN18	mg/L	0.001	<0.001	13	20	105	90	110	NV	70	130
Arsenic (total)	EMS0131-JAN18	mg/L	0.0002	<0.0002	ND	20	100	90	110	101	70	130
Beryllium (total)	EMS0131-JAN18	mg/L	0.000007	<0.000007	ND	20	101	90	110	122	70	130
Boron (total)	EMS0131-JAN18	mg/L	0.002	<0.002	3	20	96	90	110	NV	70	130
Bismuth (total)	EMS0131-JAN18	mg/L	0.000007	<0.000007	ND	20	101	90	110	80	70	130
Cadmium (total)	EMS0131-JAN18	mg/L	0.000003	<0.000003	ND	20	99	90	110	106	70	130
Cobalt (total)	EMS0131-JAN18	mg/L	0.000004	<0.000004	ND	20	100	90	110	102	70	130
Chromium (total)	EMS0131-JAN18	mg/L	0.00003	<0.00003	4	20	99	90	110	93	70	130
Copper (total)	EMS0131-JAN18	mg/L	0.00002	<0.00002	1	20	102	90	110	98	70	130
Iron (total)	EMS0131-JAN18	mg/L	0.007	<0.007	ND	20	101	90	110	NV	70	130
Manganese (total)	EMS0131-JAN18	mg/L	0.00001	<0.00001	19	20	105	90	110	113	70	130
Molybdenum (total)	EMS0131-JAN18	mg/L	0.00001	<0.00001	4	20	97	90	110	104	70	130
Nickel (total)	EMS0131-JAN18	mg/L	0.0001	<0.0001	0	20	100	90	110	95	70	130
Lead (total)	EMS0131-JAN18	mg/L	0.00001	<0.00001	ND	20	101	90	110	98	70	130
Antimony (total)	EMS0131-JAN18	mg/L	0.0002	<0.0002	ND	20				113	70	130
Selenium (total)	EMS0131-JAN18	mg/L	0.00004	<0.00004	3	20	99	90	110	113	70	130
Tin (total)	EMS0131-JAN18	mg/L	0.00001	<0.00001	10	20	97	90	110	NV	70	130
Titanium (total)	EMS0131-JAN18	mg/L	0.00005	<0.00005	ND	20	102	90	110	NV	70	130



# FINAL REPORT

CA14399-JAN18 R

## QC SUMMARY

### Metals in aqueous samples - ICP-MS (continued)

Method: SM 3030/EPA 200.8 | Internal ref.: ME-CA-ENVISPE-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Thallium (total)	EMS0131-JAN18	mg/L	0.000005	<0.000005	ND	20	100	90	110	97	70	130
Uranium (total)	EMS0131-JAN18	mg/L	0.000002	<0.000002	8	20	99	90	110	97	70	130
Vanadium (total)	EMS0131-JAN18	mg/L	0.00001	<0.00001	10	20	99	90	110	104	70	130
Tungsten (total)	EMS0131-JAN18	mg/L	0.00002	<0.00002	ND	20	98	90	110	NV	70	130
Zinc (total)	EMS0131-JAN18	mg/L	0.002	<0.002	ND	20	95	90	110	98	70	130
Zirconium (total)	EMS0131-JAN18	mg/L	0.002	<0.002	ND	20	97	90	110	NV	70	130

### Metals in aqueous samples - ICP-OES

Method: SM 3030/EPA 200.8 | Internal ref.: ME-CA-ENVISPE-LAK-AN-003

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Phosphorus (total)	EMS0131-JAN18	mg/L	0.003	<0.003	ND	20	100	90	110	NV	70	130



FINAL REPORT

CA14399-JAN18 R

QC SUMMARY

Microbiology  
Method: SM 9222D | Internal ref.: ME-CA-~~I~~ENVIMIC-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Fecal Coliform	BAC9318-JAN18	cfu/100mL	-	ACCEPTED	ACCEPTED							

pH  
Method: SM 4500 | Internal ref.: ME-CA-~~I~~ENVIEWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0275-JAN18	no unit	0.05	NA	0		100			NA		

Suspended Solids  
Method: SM 2540D | Internal ref.: ME-CA-~~I~~ENVIEWL-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Total Suspended Solids	EWL0283-JAN18	mg/L	2	< 2	0	10	100	90	110	NA		



## QC SUMMARY

---

**Method Blank:** a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

**Duplicate:** Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

**LCS/Spike Blank:** Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

**Matrix Spike:** A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

**Reference Material:** a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

**RL:** Reporting limit

**RPD:** Relative percent difference

**AC:** Acceptance criteria

**Multielement Scan Qualifier:** as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

**Duplicate Qualifier:** for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

**Matrix Spike Qualifier:** for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

## LEGEND

### FOOTNOTES

**NSS** Insufficient sample for analysis.

**RL** Reporting Limit.

↑ Reporting limit raised.

↓ Reporting limit lowered.

**NA** The sample was not analysed for this analyte

**ND** Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at [http://www.sgs.com/terms\\_and\\_conditions.htm](http://www.sgs.com/terms_and_conditions.htm). The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

This report must not be reproduced, except in full. This report supersedes all previous versions.

-- End of Analytical Report --





# SAMPLE INTEGRITY REPORT

Project Number: 1777006C

ONTARIO REGULATION 153/04

SGS Sample ID CH4399-Jan18

Date / Time Sampled 01/19/18

Client Sample ID See CoC

## ALL

### Sample Submission General Sample Integrity Violations

- Temperature >10 C upon receipt if not sampled same day
- No evidence of cooling trend initiated if sampled same day
- Chain of Custody not submitted
- Chain of Custody incomplete
- Chain of Custody not signed / dated
- Chain of Custody not a current version
- Bottles / Samples listed on CoC but not received
- Bottles / Samples received but not listed on the CoC
- Sample container received empty

☐  
☐  
☐  
☐  
☐  
☐  
☐  
☐  
☐

rec'd 2 total metals Bottles

### Sample Specific Sample Integrity Violations

- Sample received past hold time
- Incorrect preservation (including no preservation where required)
- Headspace present in VOC vial (aqueous)
- Sample(s) received frozen
- Bottle(s) broken or damaged in transport
- Discrepancy between sample label and chain of custody
- Analysis requirements absent / unclear
- Missing or incorrect sample label(s)
- Inappropriate sample container used
- Insufficient number of bottles received
- Limited sample volume
- Insufficient sample volume
- Sample contains multiple phases

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

### Sediment Log

- Groundwater samples contain visible sediment / particulate
- Groundwater contains greater than 1cm of sediment / particulate matter in bottle

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

### Additional Comments/Remarks:

No Issues upon receipt

☐

Initials:

WJ



## **APPENDIX D**

MOECC Recorded Water Well Location Map and MOECC Records





**NOTES:**

- THIS FIGURE WAS REPRODUCED FROM THE MOECC WATER WELL MAPPING WEBSITE (APR 2018).
- STUDY AREA RADIUS IS APPROXIMATE.
- WELLS IN STUDY AREA ARE NUMBERED FOR IDENTIFICATION IN ACCOMPANYING WELL RECORD SUMMARY TABLE.

**MINISTRY OF TRANSPORTATION**  
**HYDROGEOLOGICAL INVESTIGATION REPORT FOR**  
**REPLACEMENT OF UNDERPASS AT**  
**HIGHWAY 401 AND CONCESSION ROAD 7**  
**PUSLINCH TOWNSHIP, ONTARIO**

**MOECC RECORDED WATER WELL**  
**LOCATION MAP**



DRAWN: <b>A.C.</b>	DATE	SCALE	JOB NO.	FIGURE NO.
CHECKED: <b>A.C.</b>	<b>NOV. 2018</b>	<b>AS SHOWN</b>	<b>17TF006</b>	<b>D-1</b>
APPROVED: <b>S.T.</b>				

## MOECC WELL RECORD SUMMARY

### Structure 35-351

Summarized well records of wells within UTM Easting +/- 500 m and UTM Northing +/- 500 m of centre of Site

PML Number*	UTM ZONE	UTM EASTING	UTM NORTHING	LOT	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
1	17	567993	4811234	W	2015/06 7282	2			MO	0012 3	7243729 (Z210859) A177675	GREY SILT SAND 0017
2	17	568643	4810999	W	2010/06 7238	2.00 2.00			MO		7148919 (M06043) A099608	BRWN SAND GRVL 0025
3	17	568560	4811330	W	2008/09 3428	6 4			IN		7112837 (Z85322) A	
4	17	568601	4810719	L	2003/06 2336	6 6	FR 0200	23/30/25/1:0	DO		6714523 (254147)	BRWN CLAY STNS 0014 BRWN ROCK 0110 GREY ROCK 0200
5	17	568554	4810923	W	1981/12 3518	5 5	FR 0081	24/33/12/4:30	DO		6707762 ()	PRDG 0005 GREY GRVL BLDR LOOS 0020 GREY HPAN GRVL HARD 0073 GREY SAND GRVL SLTY 0078 GREY LMSN 0090
6	17	568514	4810943	W	1977/05 1906	50	UK 0025	12/40/15/1:0	DO		6706444 ()	BRWN CLAY GRVL 0020 CGVL 0025
7	17	568464	4811503	W	1970/12 4208	6 5	UK 0045 FR 0140	9/18/15/48:0	CO		6703870 ()	PRDG 0005 BRWN GRVL MSND 0017 GREY CLAY MSND GRVL 0042 GREY LMSN 0147
8	17	568574	4811553	W	1970/01 4208	6 4	FR 0140	29/130/7/1:0	IN		6703640 ()	PRDG 0005 BRWN GRVL STNS 0056 GREY ROCK 0150
9	17	568374	4811563	W	1969/05 2519	30 24	FR 0004	4/12/5/1:0	DO		6703373 ()	GRVL MSND 0012 MSND CLAY 0014 GRVL 0020
10	17	568110	4811385	W	1964/07 2519	30	FR 0018	18/25/8/1:30	DO		6702525 ()	LOAM 0001 MSND GRVL 0025
11	17	568622	4810945	W	1964/03 4208	6	FR 0072	24/30/30/0:30	DO		6702526 ()	PRDG 0024 CLAY MSND GRVL 0070 GRVL 0072

#### NOTES:

i) Source: MOECC well record data report "Wellington 20180108 121441"

ii) See "MOECC Well Record Table Abbreviations and Descriptions" for abbreviation definitions

iii) \* : wells numbered on map within a radius of 500 m of site.

## MOECC WELL RECORD TABLE ABBREVIATIONS AND DESCRIPTIONS

### Header Descriptions

ABBREVIATION	DESCRIPTION
UTM	UTM in Zone, Easting, Northing and Datum is NAD83
L	UTM estimated from Centroid of Lot
W	UTM not from Lot Centroid
DATE CNTR	Date Work Completed and Well Contractor Licence Number
CASING DIA	Casing diameter in inches
WATER	Unit of Depth in Feet. See below for Meaning of Code
PUMP TEST	Static Water Level in Feet / Water Level After Pumping in Feet / Pump Test Rate in GPM / Pump Test Duration in Hour:Minutes
WELL USE	See below for Meaning of Code
SCREEN	Screen Depth and Length in feet
WELL	Well ID, AUDIT #, Well Tag, A for abandonment; P for Partial Data Entry Only
FORMATION	See below for Meaning of Code

### Meaning of Core Material and Descriptive Terms

ABBV	DESCRIPTION	ABBV	DESCRIPTION	ABBV	DESCRIPTION	ABBV	DESCRIPTION
CLN	CLEAN	FILL	FILL	MARL	MARL	SILT	SILT
DRY	DRY	FLDS	FELDSPAR	MGRD	MEDIUM-GRAINED	SLTE	SLATE
QTZ	QUARTZ	FLNT	FLINT	MGVL	MEDIUM GRAVEL	SLTY	SILTY
BLDR	BOULDERS	FOSS	FOSILIFEROUS	MRBL	MARBLE	SNDS	SANDSTONE
BSLT	BASALT	FSND	FINE SAND	MSND	MEDIUM SAND	SNDY	SAN DY
CGRD	COARSE-GRAINED	GNIS	GNEISS	MUCK	MUCK	SOFT	SOFT
CGVL	COARSE GRAVEL	GRNT	GRANITE	OBDN	OVERBURDEN	SPST	SOAPSTONE
CHRT	CHERT	GRSN	GREENSTONE	PCKD	PACKED	STKY	STICKY
CLAY	CLAY	GRVL	GRAVEL	PEAT	PEAT	STNS	STONES
CLYY	CLAYEY	GRWK	GREYWACKE	PGVL	PEA GRAVEL	STNY	STONEY
CMTD	CEMENTED	GVLY	GRAVELLY	PORS	POROUS	THIK	THICK
CONG	CONGLOMERATE	GYPS	GYPSUM	PRDG	PREVIOUSLY DUG	THIN	THIN
CRYS	CRYSTALLINE	HARD	HARD	PRDR	PREV. DRILLED	TILL	TILL
CSND	COARSE SAND	HPAN	HARDPAN	QRTZ	QUARTZITE	UNKN	UNKNOWN TYPE
DKCL	DARK-COLOURED	IRFM	IRON FORMATION	QSND	QUICKSAND	VERY	VERY
DLMT	DOLOMITE	LIMY	LIMY	ROCK	ROCK	WBRG	WATER-BEARING
DNSE	DENSE	LMSN	LIMESTONE	SAND	SAND	WDFR	WOOD FRAGMENTS
DRTY	DIRTY	LOAM	TOPSOIL	SHLE	SHALE	WTHD	WEATHERED
FCRD	FRACTURED	LOOS	LOOSE	SHLY	SHALY		
FGRD	FINE-GRAINED	LTCL	LIGHT-COLOURED	SHRP	SHARP		
FGVL	FINE GRAVEL	LYRD	LAYERED	SHST	SCHIST		

### Core Color

ABBV	DESCRIPTION
WHIT	WHITE
GREY	GREY
BLUE	BLUE
GRN	GREEN
YLLW	YELLOW
BRWN	BROWN
RED	RED
BLC K	BLACK
BLGY	BLUE-GREY

### Well Use

ABBV	DESCRIPTION
DO	Domestic
ST	Livestock
IR	Irrigation
IN	Industrial
CO	Commercial
MN	Municipal
PS	Public
AC	Cooling And AC
NU	Not Used
OT	Other
TH	Test Hole
DE	Dewatering
MO	Monitoring
MT	Monitoring and Test Hole

### Water Kind

ABBV	DESCRIPTION
FR	Fresh
SA	Salty
SU	Sulphur
MN	Mineral
UK	Not Stated
GS	Gas
IR	Iron
UT	Untested
OT	Other