



FINAL REPORT

Foundation Investigation Report

Replacement of Structural Culvert No. 11X-0136/C0

Highway 401, Belleville, Ontario

MTO GWP 4053-18-00, WP 4135-22-01, Assignment 4020-E-0012

Submitted to:

Ministry of Transportation Ontario

1355 John Counter Boulevard,
Kingston, Ontario K7K 0E5

Submitted by:

WSP Canada Inc.

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Ottawa, Ontario K2H 5B7

GEOCREs No.: 31C03-009

Latitude: 44.177124

Longitude: -77.459510°

20148061B (4300) - Potter

April 25, 2025



Distribution List

1 e-copy: MTO Eastern Region

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1.0 INTRODUCTION

WSP Canada Inc. has been retained by the Ministry of Transportation, Ontario (MTO) to support future procurement-ready design phases of the widening of Highway 401 from 1 km west of Wallbridge-Loyalist Road to 4.3 km east of Highway 37 in Belleville, Ontario as part of GWP 4053-18-00, with foundation investigation services delivered under MTO Agreement No. 4020-E-0012. The overall project includes the replacement of six bridges, several structural and non-structural culverts, and operational improvements and reconfiguration of existing interchanges.

This report presents the results of the detailed foundation investigation carried out for the replacement of the Culvert 11X-0136/C0 (WP 4135-22-00) under Highway 401 to the west of the Highway 401 / Wallbridge-Loyalist Road interchange.

2.0 SITE DESCRIPTION AND GEOLOGY

2.1 Site Description

Culvert 11X-0136/C0 is located approximately 1.2 km west of the Highway 401 / Wallbridge-Loyalist Road interchange passing under both the eastbound and westbound lanes of Highway 401 in Belleville, Ontario. The site location is shown on Drawing 1 – Key Plan.

At this location, Highway 401 is generally oriented in an east-west direction and has a four-lane cross-section with two eastbound and two westbound through lanes with paved shoulders separated by a concrete median wall. Near the location of the Potter Creek culvert, the lands to the north and south are predominantly of agricultural usage. Height of highway embankment fill is approximately 1.5 m to 2.0 m. Based on visual observations at the time of the current site investigation, the existing embankment side slopes at the existing culvert appear to be performing satisfactorily. Potter Creek flows south to north through the existing culvert.

Site photographs showing the general conditions of the site are presented in Appendix E.

2.2 Regional Geology

As delineated in *The Physiography of Southern Ontario*¹, the proposed culvert site lies within a physiographic region known as the Napanee Plain which is characterized as a flat-to-undulating plain of limestone of the Gull River and Bobcaygeon Formations overlain by glacially worked thin overburden deposits.

3.0 INVESTIGATION PROCEDURES

3.1 Current Investigation

The field work for this investigation was carried out on September 15, 2022, and included advancing two boreholes, numbered C-01 and C-02 near the general location of the proposed culvert alignment. The borehole locations are shown on Drawing 1.

The boreholes were advanced with a CME55 rubber track-mounted drill rig. The drilling equipment was supplied and operated by CCC Geotechnical & Environmental Drilling Ltd. (CCC) of Ottawa, Ontario.

¹ Chapman, L. J. and Putnam, D. F., 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey. Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000. Ontario Ministry of Natural Resources

Soil samples were obtained using a 50 mm outer diameter split-spoon sampler in general accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586²). Soil samples were obtained at vertical sampling intervals of about 0.76 m. NQ-sized bedrock core samples were obtained using rotary diamond drilling technique and a triple-tube core-barrel at all boreholes.

A methane pocket was encountered during bedrock coring at Borehole C-02 at an approximate depth of 4.6 m (Elev. 97.5 m). Methane concentrations above the lower explosive level were measured at the site using an RKI Model GX-2012, 4-Gas Monitor. After discussion with MTO Foundations, as a safety precaution further bedrock coring was carried out at this site after waiting for some time to naturally vent and subside the methane. Based on the methane encountered in this borehole and in other boreholes near this site, it should be expected that methane could be encountered during excavation/construction activities at elevations near or within the bedrock, throughout the project limits.

A monitoring well was installed in Borehole C-01 to observe the stabilized groundwater level at the site. The monitoring well consists of 52 mm outside diameter PVC tubing with a 1.5 m long slotted screen. Installation details are shown on the borehole record for C-01, provided in Appendix A.

The boreholes without monitoring wells were backfilled with bentonite within the bedrock, and bentonite mixed with soil cuttings within the overburden. The boreholes were backfilled in general accordance with the intent of Ontario Regulation (O.Reg.) 903, as amended. The site conditions were restored following the completion of the field work. The monitoring well has been left in place to allow for the monitoring of groundwater levels up to the time of construction. As part of the construction, the monitoring well will need to be decommissioned by qualified personnel in accordance with O.Reg. 903, as amended.

Prior to commencement of the field work, WSP personnel coordinated to locate all known buried utilities near the proposed borehole locations. The field work was supervised on a full-time basis by WSP's technical staff who located the boreholes in the field, directed the drilling, sampling, and in-situ testing operations, and logged the boreholes. The soil and bedrock samples were identified in the field, placed in labelled containers, and transported to WSP's laboratory in Ottawa for further examination and testing. Index and classification tests consisting of water content determinations and grain size distribution analyses were carried out on selected soil samples and uniaxial compressive strength (UCS) testing was carried out on selected samples of the bedrock. The laboratory tests were carried out to MTO LS and/or ASTM Standards, as applicable, at WSP's Ottawa laboratory.

One soil sample was submitted to Eurofins Environmental Testing Canada Inc. (Eurofins) for basic chemical analysis related to potential corrosion of buried steel elements and sulfate attack on buried concrete elements (corrosion and sulphate attack).

The borehole locations and elevations were surveyed by WSP using a Trimble R10 GPS unit referenced to the NAD83 CSRS CBNv6-2010.0 MTM Zone 9 geodetic datum. The Trimble R10 GPS data has a vertical accuracy of approximately 0.1 m and a horizontal accuracy of approximately 0.5 m. The borehole locations, including northing and easting coordinates, ground surface elevations, and drilled depths are summarized in Table 1.

² ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

Table 1: Summary of Borehole Locations

Borehole	NAD83 CSRS CBNv6-2010.0 MTM Zone 9		Ground Surface Elevation (m)	Drilled Depths (m)	Comments
	Northing (m) (Latitude)	Easting (m) (Longitude)			
C-01	4893460.8 (44.177124°)	228077.7 (-77.459510°)	102.7	6.2	Bedrock Cored 3.5 m
C-02	4893402.0 (44.176602°)	228131.4 (-77.458840°)	102.1	6.1	Bedrock Cored 4.1 m

3.2 Previous Investigation

A previous preliminary foundation investigation was carried out at culvert site No. 11X-0136/C0 in 2020. The subsurface information and results of the original investigation are contained in the following report:

- **MTO GEOCRETS No. 31C-309:** “Preliminary Foundation Investigation and Design Report, Potter Creek Culvert Replacement, Site No. 11-316/C, Belleville, Ontario G.W.P. 4193-15-00” dated July 08, 2021, prepared by Thurber Engineering Ltd.

A total of two boreholes were advanced at the site as part of the 2020 investigation for the proposed Potter Creek culvert replacement. In particular, Boreholes PC20-01 and PC20-02 were advanced from the Highway 401 WBL and EBL shoulders, near the culvert inlet and outlet areas. A copy of the Borehole Location and Soil Strata Drawings and Record of Boreholes relevant to the current investigation are provided for reference in Appendix C. In general, the bedrock elevations encountered during the 2020 investigation are consistent with the current investigation.

4.0 DESCRIPTION OF SUBSURFACE CONDITIONS

4.1 General

The subsurface soil, bedrock and groundwater conditions encountered in the boreholes and the results of in-situ testing from the investigation are shown on the Record of Borehole and Drillhole sheets in Appendix A. The results of the in-situ field tests as presented in the borehole records and in Section 4.2 are uncorrected and are based on the use of an automatic hammer for the SPT. The results of the geotechnical laboratory testing carried out during the investigation are presented on the borehole records as well as on Figures B1 and B2 provided in Appendix B.

Photographs of the core recovered from the underlying bedrock at the boreholes are shown on Figures A1 to A4, provided in Appendix A. The results of the analytical testing completed on select soil samples are provided in Appendix D.

The stratigraphic boundaries shown on the borehole and drillhole records and on the interpreted stratigraphic section in Drawing 1 are inferred from observations of the drilling progress and non-continuous soil sampling and therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations.

4.2 Site Stratigraphy Overview

At the borehole locations, the subsurface conditions generally consist of topsoil over fill over glacial till, underlain

by bedrock. A more detailed description of the overburden soil deposits, and bedrock geology conditions encountered during the field investigation is provided in the following sections.

4.2.1 Surface Cover / Surficial Materials

Topsoil with thickness of approximately 100 mm was encountered at the ground surface at Boreholes C-01 and C-02.

4.2.2 Fill

Sand and gravel pavement base was encountered at the ground surface at Boreholes PC20-01 and PC20-02 and extends to elevations 103.3 m and 103.0 m with a thickness of 0.7 m and 0.9 m, respectively.

Embankment fill consisting preliminary of gravelly sand to gravelly silty sand to sand was encountered below the topsoil at Borehole C-01 and below the pavement base deposit at Boreholes PC20-01 and PC20-02. The top of this layer was encountered at elevations of 102.6 m to 103.3 m. The thickness of this layer ranges from 0.7 to 2.1 m.

The SPT N-values recorded in this layer range from 10 to 30 blows per 0.3 m of penetration indicating a compact state of compactness. The measured water content of eight samples of the fill ranged from 2% and 16%.

4.2.3 Till – Silty Sand and Gravel to Sandy Silty Gravel

A non-cohesive till deposit varying in composition from silty sand, sandy silty gravel, and silty sand and gravel, containing cobbles and boulders was encountered below the topsoil at Borehole C-02, and below the fill at Boreholes PC20-02 and C-01. The top of this layer was encountered at elevations of 100.9 m to 102.0 m with thickness of 1.6 m to 1.9 m. Coring techniques were required to advance through the cobbles and boulders at Borehole C-02.

The SPT N-values recorded in this till layer range from 16 to greater than 100 blows per 0.3 m of penetration indicating a compact to very dense state of compactness. The higher blow counts (e.g., 126/230 mm, 100/130 mm, 60/150 mm, and 50/25 mm) recorded in this non-cohesive till may have been influenced by the presence of cobbles or boulders within the till or by the presence of bedrock surface, rather than the consistency of the soil matrix. The measured water contents of three samples of the till range from 5% to 7%. The results of grain size distribution testing carried out on two samples of this till are provided in Figure B1 in Appendix B.

A layer of clayey silt till with sand, containing some gravel was encountered below the fill at Borehole PC20-01. The top of the clayey silt till was encountered at elevation of 101.6 m, with thickness of 1.9 m.

The SPT N-values recorded in this cohesive till range from 6 to greater than 50 blows per 0.3 m of penetration, indicating a firm to hard consistency. The higher blow count (e.g., 50/0 mm,) recorded in the clayey silt till may has been influenced by the presence of bedrock surface, rather than the consistency of the soil matrix. The measured water content of two samples of the clayey silt till was 19% and 23%.

4.2.4 Bedrock

The overburden soils are underlain by limestone bedrock.

A methane pocket was encountered during bedrock coring at Borehole C-02 at an approximately depth of 4.6 m (Elev. 97.5 m). Methane concentrations above the lower explosive level (LEL) were measured at the site using an RKI Model GX-2012, 4-Gas Monitor. It should be expected that methane could be encountered within the bedrock if any excavation/construction activities extend to this level.

Table 2 summarizes the depths and the elevations of the bedrock surface as encountered at the borehole locations from both the current and 2020 investigations.

Table 2: Summary of Bedrock Surface Depths and Elevations

Borehole	Existing Ground Surface Elevation (m)	Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)
C-01	102.7	2.7	100.0
C-02	102.1	2.0	100.1
PC20-01	104.0	4.3	99.7
PC20-02	103.9	4.6	99.3

Rock Quality Designation (RQD) values measured on the recovered limestone bedrock core samples range from about 45% to 100%, but more commonly 76% to 100%, indicating a good to excellent rock quality. The UCS testing carried out on two limestone bedrock core samples indicate compressive strength values of 110 MPa and 114 MPa, indicating a very strong bedrock. The results of UCS testing are provided in Figure B2 in Appendix B.

4.3 Groundwater Conditions

A monitoring well was installed at Borehole C-01 to measure the stabilized groundwater level at the site. The groundwater level measured in the monitoring well is presented in Table 3.

It is expected that the groundwater levels will be subject to fluctuations both seasonally and as a result of precipitation events, and these levels may be higher in the spring.

Table 3: Summary of Groundwater Conditions

Borehole	Screened Interval	Ground Surface Elevation (m)	Depth to Groundwater Level (m)	Groundwater Elevation (m)	Date
C-01	Till	102.7	1.4	101.3	September 20, 2022
			0.7	102.0	December 14, 2022
			0.6	102.1	February 27, 2024

4.4 Analytical Laboratory Testing Results

One soil sample was submitted to Eurofins for chemical testing/analysis related to potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements (corrosion and sulphate attack). The test results are provided in Appendix D and are summarized in Table 4.

Table 4: Steel Corrosion and Sulphate Attack, Chemical Analysis

Borehole	Sample Depth (m)	Chloride (%)	Sulphate (%)	Electrical Conductivity (mS/cm)	pH	Resistivity (ohm-cm)
C-01	0.8-1.4	0.093	0.02	0.22	8.36	4,540

5.0 CLOSURE

The field investigation program was supervised by Ben Waechter, EIT. This report was prepared by Ben Waechter, EIT and Kinjal Gajjar, P.Eng.. David Staseff, P.Eng., a Senior Principal Geotechnical Engineer and a MTO Principal Foundations Contact for WSP conducted an independent technical and quality review of this report.

WSP Canada Inc.



Kinjal Gajjar, P.Eng.
Geotechnical Engineer



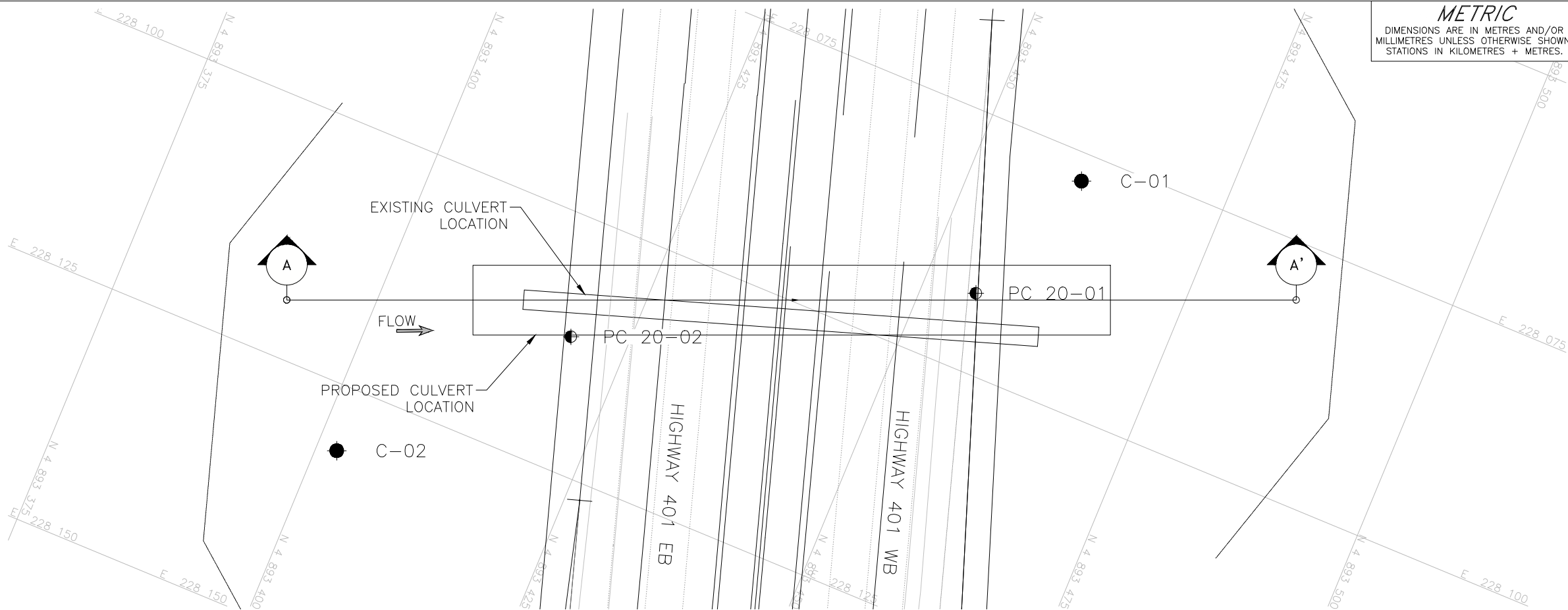
David Staseff, P.Eng.
MTO Principal Foundations Contact

BW/KG/DS/yj

[https://wsonline.sharepoint.com/sites/gld-152692/project files/6 deliverables/08-potter creek_complete/2-final - potter's \(4300\)/gwp 4053-18-00 rev0 final fir site 11x-0136 \(20148061b-potter creek\) 2025-04-22.docx](https://wsonline.sharepoint.com/sites/gld-152692/project%20files/6%20deliverables/08-potter%20creek_complete/2-final%20-%20potter's%20(4300)/gwp%204053-18-00%20rev0%20final%20fir%20site%2011x-0136%20(20148061b-potter%20creek)%202025-04-22.docx)

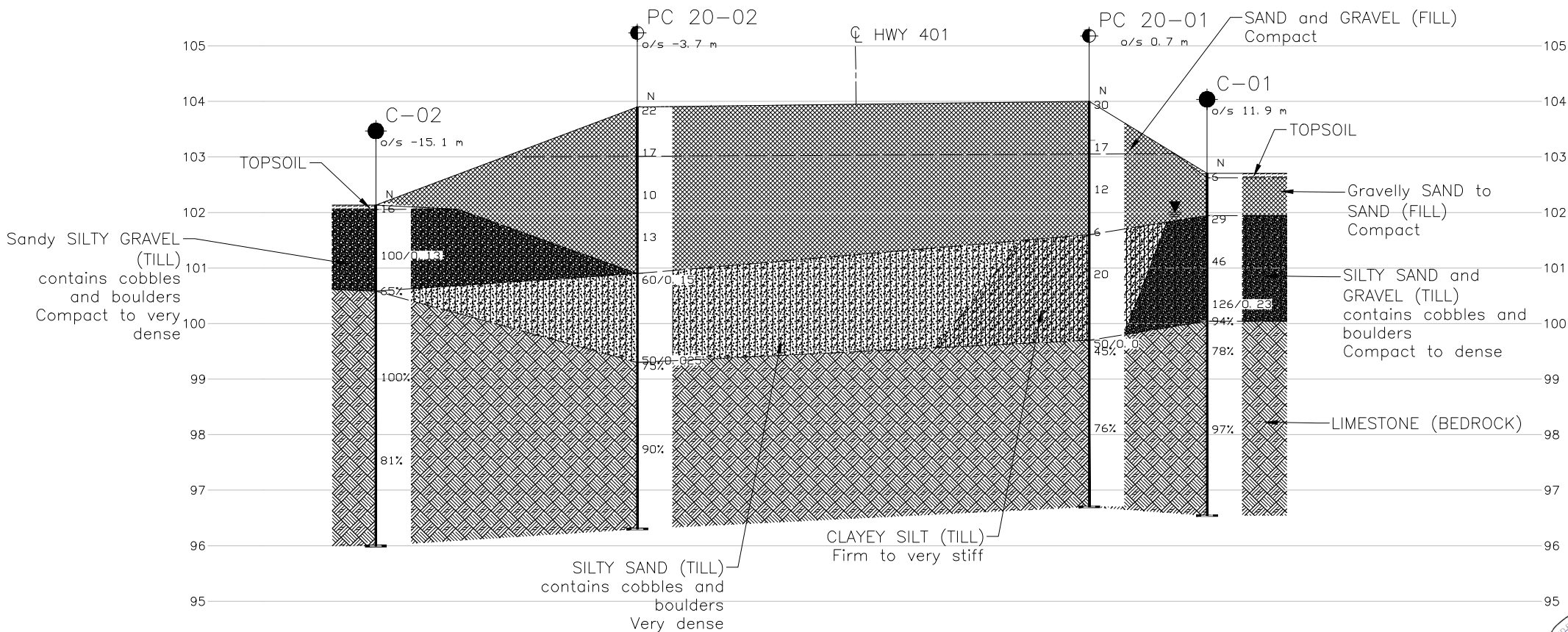
DRAWING

Drawing – 1 Borehole Locations and Soil Strata



PLAN

SCALE



PROFILE

HORIZONTAL SCALE



VERTICAL SCALE



METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

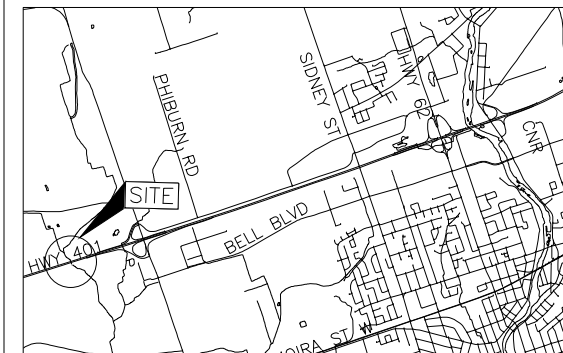
CONT No. 4135-22-01
WP No. 4135-22-01



HIGHWAY 401 WIDENING
REPLACEMENT OF CULVERT 11X-0136/C0

SHEET

BOREHOLES LOCATIONS AND SOIL STRATA



KEY PLAN

SCALE



LEGEND

- Borehole - Current Investigation
- ⊕ Borehole - Previous Investigation (Geocrest 31C-309)
- ⊥ Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- ≡ WL in piezometer, measured on February 27, 2024

BOREHOLE CO-ORDINATES NAD83 (CSRS) MTM ZONE 9

No.	ELEVATION	NORTHING	EASTING
C-01	102.7	4893460.8	228077.7
C-02	102.1	4893402.0	228131.4
PC 20-01	104.0	4893455.3	228092.2
PC 20-02	103.9	4893419.4	228111.8

Structural Site Location: Latitude: 44.177124 Longitude: -77.459510

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Procurement-Ready Design Documents.

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

REFERENCES

Base plans provided in digital format by MTO, drawing file nos 3216057_EP.dwg and 3216057_Hwy 401 _8 Lanes Design_ACAD.dwg, received Oct. 13 2022.

NO.	DATE	BY	REVISION
Geocres No. 31C03-009			
HWY. 401		PROJECT NO. 20148061B	
SUBM'D. KG/BW		CHKD. KG	DATE: 4/22/2025
DRAWN: ZS/SA		CHKD. KCP	APPD. DS
DIST. EASTERN		SITE: 11X-0316/C0	
DWG. 1			



APPENDIX A

Borehole Records and Bedrock Core Photographs

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

MINISTRY OF TRANSPORTATION, ONTARIO

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>200	>8
COBBLES	Not Applicable	75 to 200	3 to 8
GRAVEL	Coarse	19 to 75	0.75 to 3
	Fine	4.75 to 19	(4) to 0.75
		2.00 to 4.75	(10) to (4)
SAND	Coarse	0.425 to 2.00	(40) to (10)
	Medium	0.075 to 0.425	(200) to (40)
	Fine		
FINES	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY COMPONENTS^{1,2}

Percentage by Mass	Modifier
> 35	Use 'and' to combine primary and secondary component (i.e., SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (i.e., some sand)
≤ 10	trace (i.e., trace fines)

1. Only applicable to components not described by Primary Group Name.

2. Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve friction (f_s) are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC / SC	Rock core / Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample
OD / ID	Outer Diameter / Inner Diameter
HSA / SSA	Hollow-Stem Augers / Solid-Stem Augers

SOIL TESTS

w	water content
PL, w_p	plastic limit
LL, w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D_R	relative density (specific gravity, G_s)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

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

COARSE-GRAINED SOILS

Compactness¹

Term	SPT 'N' (blows/0.3m) ²
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

- Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grain size. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.
- SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

FINE-GRAINED SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N' ^{1,2} (blows/0.3m)
Very Soft	< 12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	> 200	> 30

- SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
- SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Field Moisture Condition

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

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

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

I. GENERAL

π	3.1416
$\ln x$	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety
▼	Groundwater level measurement

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)

σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

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

(a) Index Properties (continued)

w	water content
w_L or LL	liquid limit
w_P or PL	plastic limit
I_P or PI	plasticity index $= (w_L - w_P)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index $= (w - w_P) / I_P$
I_c	consistency index $= (w_L - w) / I_P$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
$C_{\alpha(e)}$	secondary compression index
C_{α}	rate of secondary compression
$C_{\alpha(e)}$	modified secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

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

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

Notes: 1
2

$\tau = c' + \sigma' \tan \phi'$
shear strength = (compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERING CLASSIFICATION

Fresh (W1): no visible sign of rock material weathering.

Slightly Weathered (W2): discoloration indicates weathering of rock mass material on discontinuity surfaces. **Less than 5%** of rock mass is altered or weathered.

Moderately Weathered (W3): less than 50% of the rock mass is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as corestones.

Highly Weathered (W4): more than 50% of the rock mass is decomposed and/or disintegrated to a soil. Fresh or discoloured rock is present either as a discontinuous framework or as corestones.

Completely Weathered (W5): 100% of the rock mass is decomposed and/or disintegrated to a soil. The original mass structure is still largely intact.

Residual Soil (W6): all rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole, a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

AXJ Axial Joint	KV Karstic Void
BD Bedding	K Slickensided
BC Broken Core	LC Lost Core
CC Continuous Core	MB Mechanical Break
CL Closed	PL Planar
CO Contact	PO Polished
CU Curved	RO Rough
CT Coated	SA Slightly Altered
FLT Fault	SH Shear
FOL Foliation	SM Smooth
FR Fracture	SR Slightly Rough
GO Gouge	SY Stylolite
IN Infilled	UN Undulating
IR Irregular	VN Vein
JN Joint	VR Very Rough

ISRM Intact Rock Material Strength Classification

Grade	Description	Approx. Range of Uniaxial Compressive Strength (MPa)
R0	Extremely weak rock	0.25 – 1.0
R1	Very weak rock	1.0 – 5.0
R2	Weak rock	5.0 – 25
R3	Medium strong rock	25 – 50
R4	Strong rock	50 -100
R5	Very strong rock	100 -250
R6	Extremely strong rock	>250



PROJECT 20148061B			RECORD OF BOREHOLE No C-01			SHEET 1 OF 2			METRIC								
G.W.P. 4053-18-00			LOCATION N 4893460.8; E 228077.7 MTM NAD 83 ZONE 9 (LAT. 44.177124; LONG. -77.459510)			ORIGINATED BY BW											
DIST Eastern HWY 401			BOREHOLE TYPE CME 55, Power Auger 200 mm Dia. (Hollow Stem), NQ Coring			COMPILED BY GS											
DATUM Geodetic			DATE September 15, 2022			CHECKED BY KCP/KG											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
102.7	GROUND SURFACE																
0.0	TOPSOIL Brown Moist		1	SS	6												
101.9	Gravelly SILTY SAND (SM) (FILL) Loose Light brown to grey Moist		2	SS	29												
0.8	SILTY SAND and GRAVEL (SM/GM), contains rock fragments, possible cobbles and boulders (TILL) Compact to dense Brown Wet		3	SS	46												37 39 18 6
100.0	LIMESTONE (BEDROCK)		4	SS	26/0.2												
2.7	Bedrock cored from 2.7 m to 6.2 m For bedrock coring details see Record of Drillhole C-01		1	RC	REC 100%												RQD = 94%
			2	RC	REC 100%												RQD = 78%
			3	RC	REC 100%												RQD = 97%
96.5	END OF BOREHOLE																
6.2	NOTE: 1. Water level measured in monitoring well: Date Depth (m) Elev. (m) 20-Sep-22 1.4 101.3 14-Dec-22 0.7 102.0 27-Feb-24 0.6 102.1																

[illegible]



PROJECT 20148061B			RECORD OF BOREHOLE No C-02			SHEET 1 OF 2			METRIC								
G.W.P. 4053-18-00			LOCATION N 4893402.0; E 228131.4 MTM NAD 83 ZONE 9 (LAT. 44.176602; LONG. -77.458840)			ORIGINATED BY BW											
DIST Eastern HWY 401			BOREHOLE TYPE CME 55, Power Auger 200 mm Dia. (Hollow Stem), NQ Coring			COMPILED BY GS											
DATUM Geodetic			DATE September 15, 2022			CHECKED BY KCP/KG											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
102.1	GROUND SURFACE																
0.0	TOPSOIL Brown Moist		1	SS	16												
	Sandy SILTY GRAVEL (GM), contains cobbles and boulders (TILL) Compact to very dense Brown to grey Moist -cobbles and boulders from 1.0 m to 2.0 m		2	SS	100/0.13												51 30 (19)
100.1			1	RC	REC 29%												
2.0	LIMESTONE (BEDROCK)																
	Bedrock cored from 2.0 m to 6.1 m For bedrock coring details see Record of Drillhole C-02		2	RC	REC 100%												RQD = 89%
			3	RC	REC 100%												RQD = 100%
			4	RC	REC 100%												RQD = 81%
96.0	END OF BOREHOLE																
6.1	Notes: 1. A methane pocket was encountered during bedrock coring at an approximate depth of 4.6 m (Elev. 97.53 m). 2. Borehole was dry prior to rock coring on September 15, 2022.																

GTA-MTO 001 S:\CLIENTS\MTOWHY_401_BELLEVILLE\02_DATA\GINT\HWY_401_BELLEVILLE.GPJ GAL-GTA.GDT 4/22/25

PROJECT: 20148061B

RECORD OF DRILLHOLE: C-02

SHEET 2 OF 2

LOCATION: N 4893402.0 ;E 228131.4

DRILLING DATE: September 15, 2022

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 55

DRILLING CONTRACTOR: CCC

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	CORRELATION & LOGGING																		NOTES										
						FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA					HYDRAULIC CONDUCTIVITY K, cm/sec			Diametral Point Load Index (MPa)	RMC -Q AVG.														
							TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10	10			10													
																						JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.												
2	Rotary Drill NQ Coring	Cont'd from Record of Borehole C-02.		100.16																														
		Fresh to slightly weathered, medium bedded to thinly laminated, light to dark grey banded black, fine to medium grained, non-porous to slightly porous, very strong, fair to excellent quality limestone with interbedded shale Limestone with thin shale		1.97	2	80																												
3																																		
4					3	100																												
5					4	100																												
6		END OF DRILLHOLE		95.99																														
7				6.14																														
8																																		
9																																		
10																																		
11																																		

UCS = 114 MPa

DEPTH SCALE

1 : 50



LOGGED: BW

CHECKED: KCP/KG

Cobbles and Boulders

BH C-01 (Dry)
Core Box 1 & 2 of 2

Top of Bedrock Elevation 100.0 m



Elevation 96.5 m End of Drillhole



Replacement of Structural Culvert No. 11X-0136/C0
Highway 401, Belleville, Ontario
MTO GWP 4053-18-00, WP 4135-22-01, Assignment 4020-E-0012

Project No.	20148061B
Drawn:	BW
Date:	2024-05-21
Checked:	KCP/ KG
Review:	DS

Figure A1

BH C-01 (Wet)
Core Box 1 & 2 of 2

Cobbles and Boulders

Top of Bedrock Elevation 100.0 m



Replacement of Structural Culvert No. 11X-0136/C0
Highway 401, Belleville, Ontario

MTO GWP 4053-18-00, WP 4135-22-01, Assignment 4020-E-0012

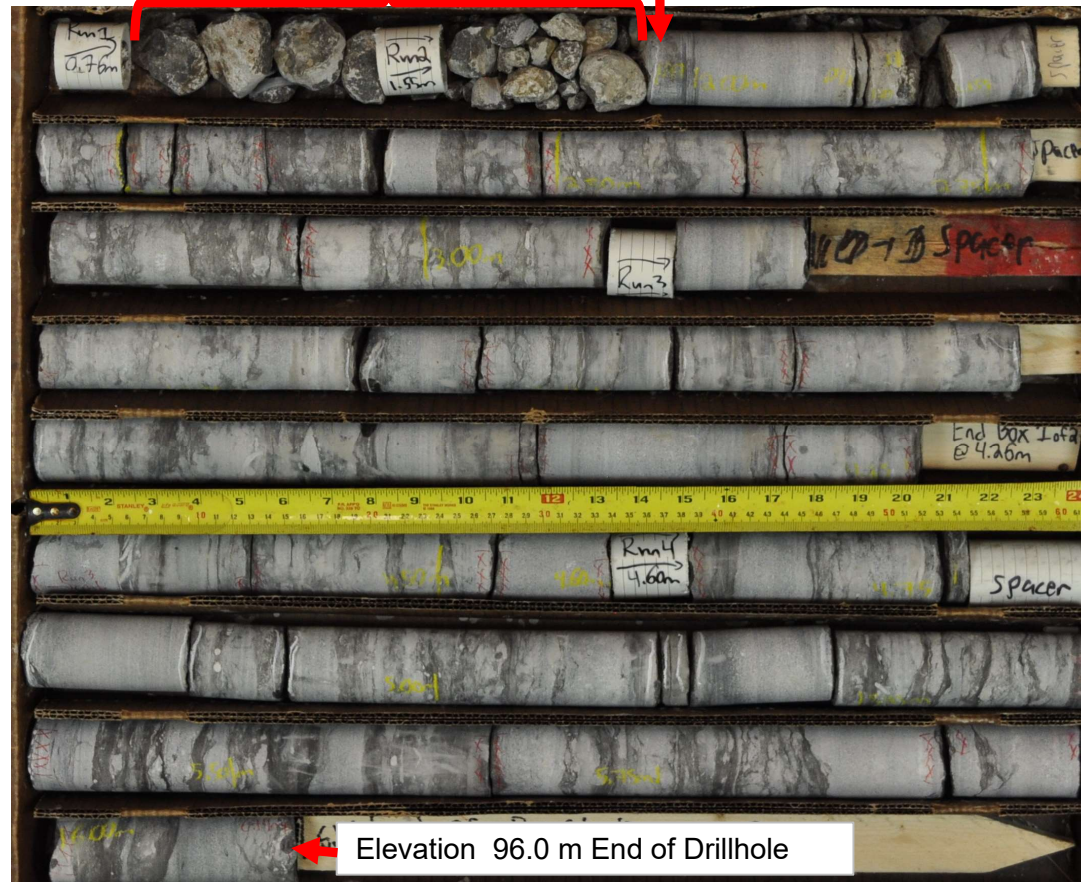
Project No.	20148061B
Drawn:	BW
Date:	2024-05-21
Checked:	KCP/ KG
Review:	DS

Figure A2

**BH C-02 (Dry)
Core Box 1 & 2 of 2**

Cobbles and Boulders

Top of Bedrock Elevation 100.1 m



Elevation 96.0 m End of Drillhole

Note:

1. Methane encountered while advancing final run leading to termination of Borehole



Replacement of Structural Culvert No. 11X-0136/C0

Highway 401, Belleville, Ontario

MTO GWP 4053-18-00, WP 4135-22-01, Assignment 4020-E-0012

Project No.	20148061B
Drawn:	BW
Date:	2024-05-21
Checked:	KCP/ KG
Review:	DS

Figure A3

BH C-02 (Wet)
Core Box 1 & 2 of 2

Cobbles and Boulders

Top of Bedrock Elevation 100.1 m



Note:

1. Methane encountered while advancing final run leading to termination of Borehole



Replacement of Structural Culvert No. 11X-0136/C0

Highway 401, Belleville, Ontario

MTO GWP 4053-18-00, WP 4135-22-01, Assignment 4020-E-0012

Project No.	20148061B
Drawn:	BW
Date:	2024-05-21
Checked:	KCP/ KG
Review:	DS

Figure A4

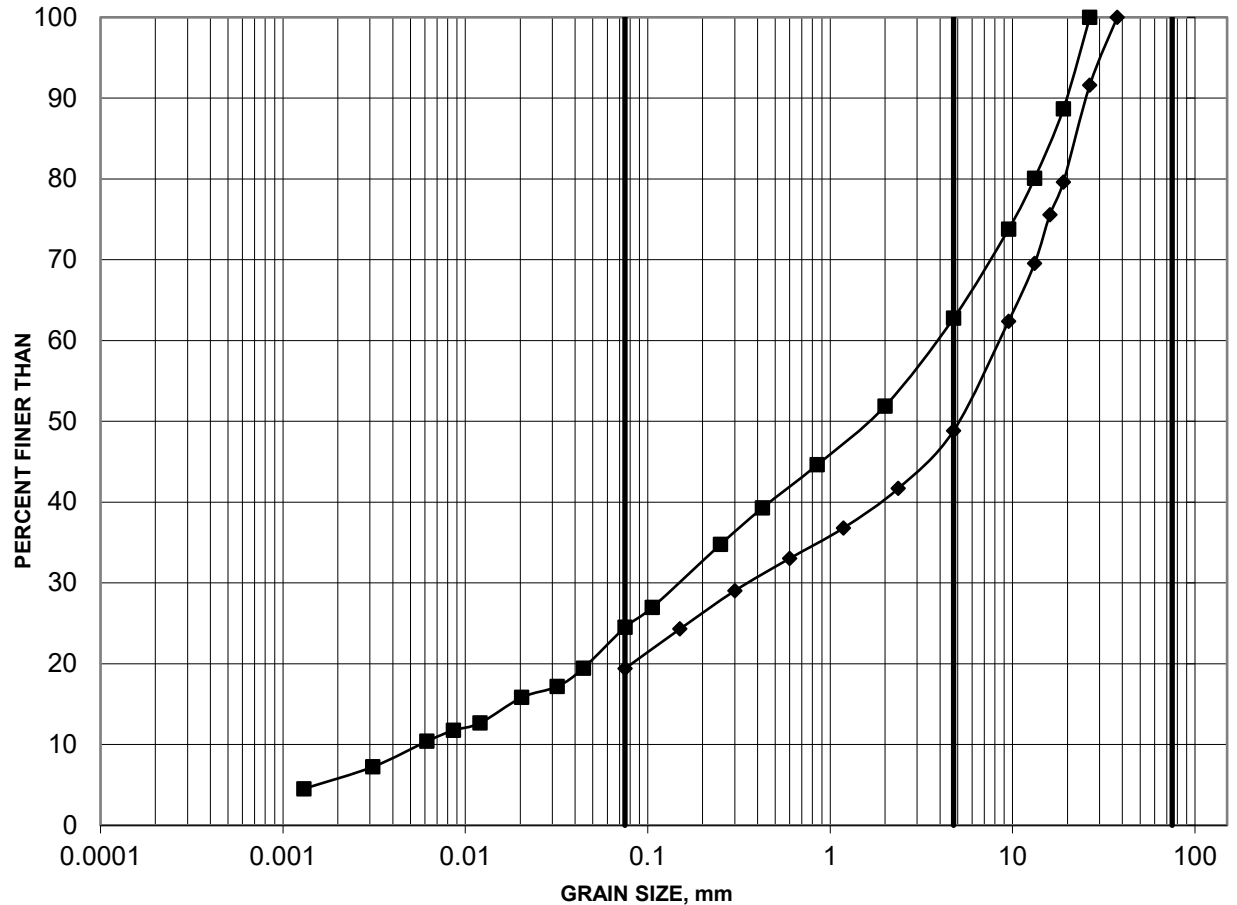
APPENDIX B

Geotechnical Laboratory Test Results

GRAIN SIZE DISTRIBUTION

FIGURE B1

SILTY SAND AND GRAVEL TO SANDY SILTY GRAVEL (TILL)



SILT AND CLAY	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
	SAND SIZE			GRAVEL SIZE		

	Borehole	Sample	Depth (m)	Constituents (%)			
				Gravel	Sand	Silt	Clay
■	C-01	3	1.52-2.13	37	39	18	6
◆	C-02	2	0.76-1.07	51	30	19	



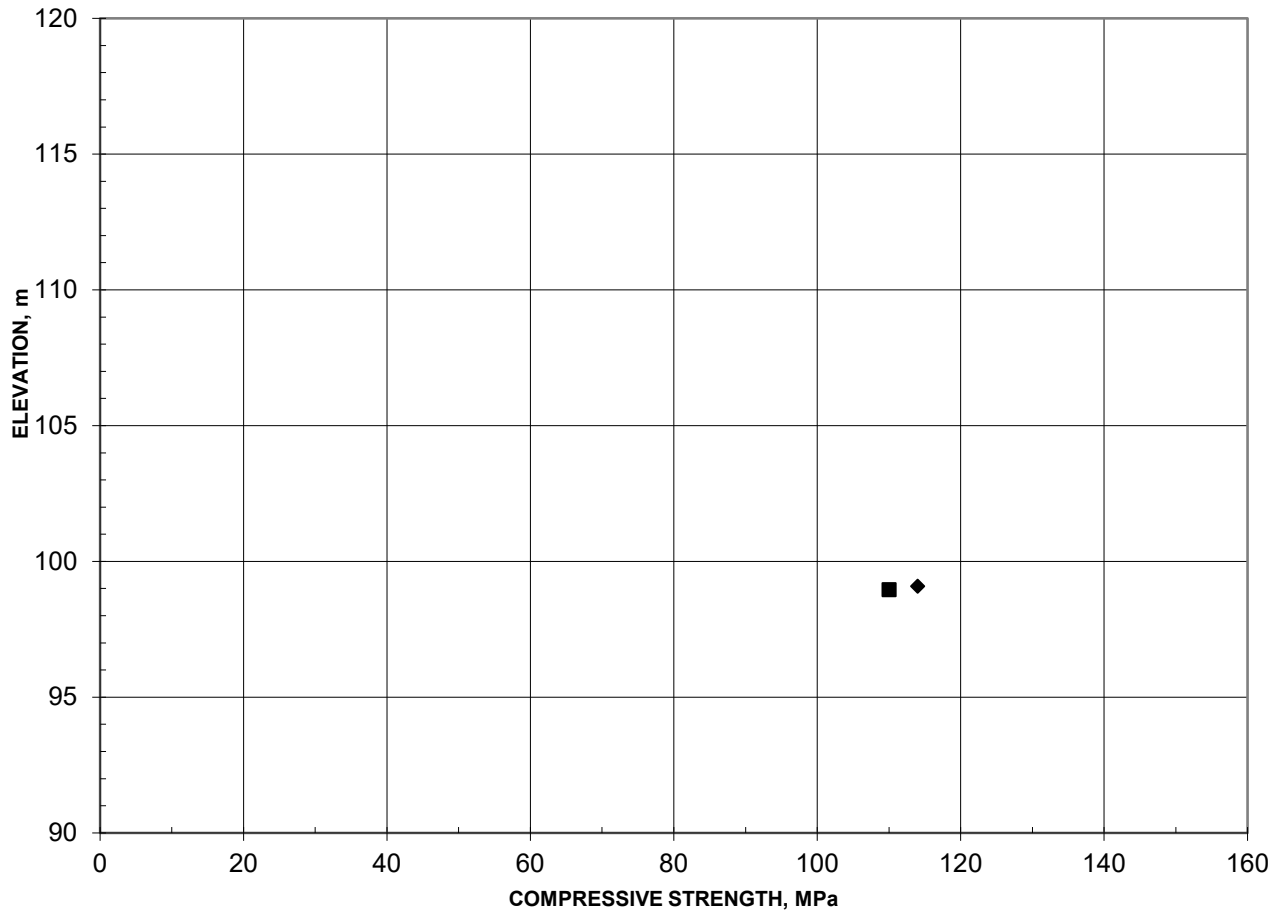
Project: 20148061B (4300) - Potter

[https://golderassociates.sharepoint.com/sites/152692/Project Files/5 Technical Work/lab/1-Figures/figures/8.Potter's Creek Culvert/](https://golderassociates.sharepoint.com/sites/152692/Project%20Files/5%20Technical%20Work/lab/1-Figures/figures/8.Potter's%20Creek%20Culvert/)

Created by: KG
Checked by: MI

ASTM D7012 - Method C
UNIAXIAL COMPRESSIVE STRENGTH OF ROCK CORE
SUMMARY OF LABORATORY TEST RESULTS

FIGURE B2



Borehole	Depth (m)	L/D	Bulk Density (kg/m ³)	Lithology	UCS (MPa)	Failure Type
■ BHC-01 RC1	3.7	2.5	2671	Limestone	110	1
◆ BHC-02 RC1	3.0	2.4	2616	Limestone	114	1

Notes:

Failure Types

1. Well formed cones on both ends
2. Well formed cones on one end, vertical cracks through cap
3. Columnar vertical cracking through both ends
4. Diagonal fracture with no cracking through ends
5. Side fractures at top or bottom
6. Side fractures at both sides of top or bottom

Remarks

- Cores tested in vertical direction.
- Cores tested in air-dry condition.
- Time to failure > 2 and < 15 minutes.

Project: 20148061B (4300) - Potter



Created by: KG

Checked by: MI






APPENDIX C

Previous Investigation Results



KEYPLAN

LEGEND

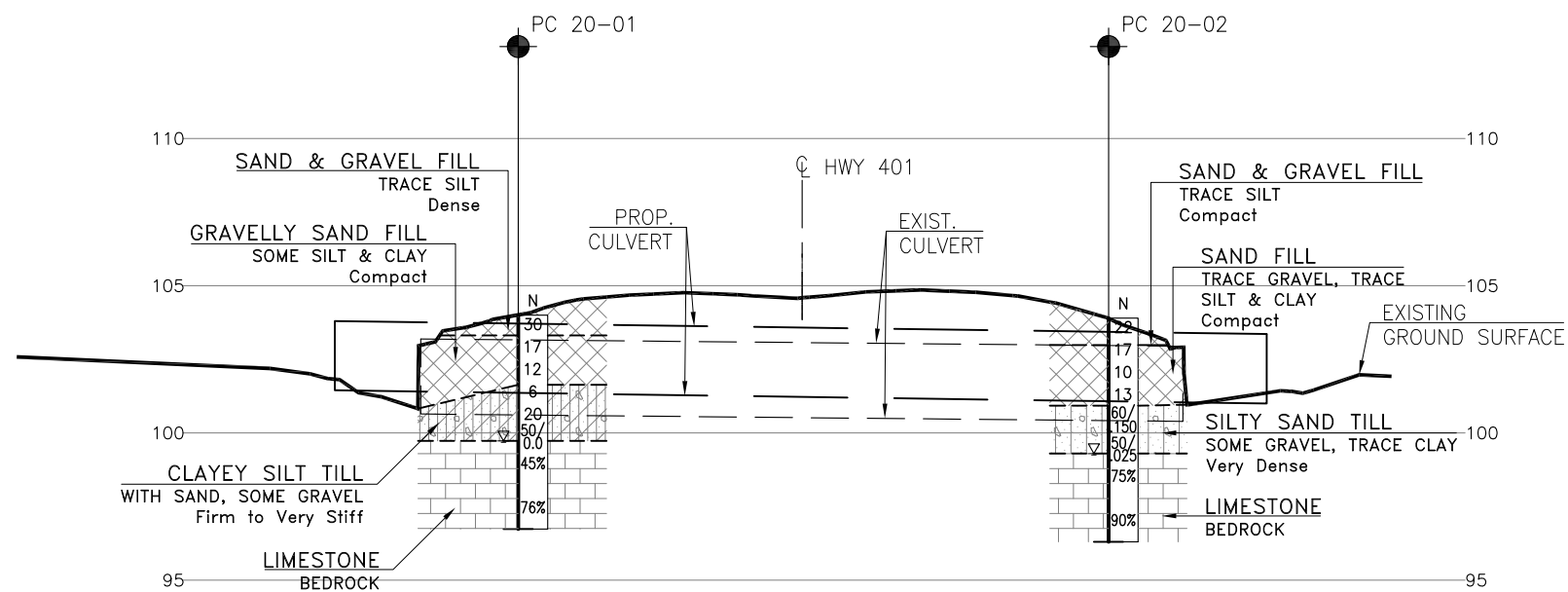
	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

[illegible]

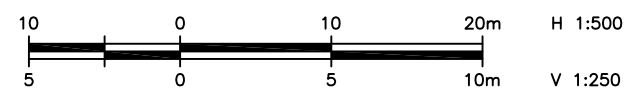
-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 9.

GEOCRES No. 31C-309



PROFILE ALONG \mathbb{C} CULVERT



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RECORD OF BOREHOLE No PC 20-01

1 OF 2

METRIC

W.P. 4193-15-00 LOCATION Potter Creek Culvert, MTM NAD83-9 N 4 893 455.3 E 228 092.2 ORIGINATED BY GA
DIST Eastern HWY 401 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
DATUM Geodetic DATE 2020.11.10 - 2020.11.10 LATITUDE 44.177068 LONGITUDE -77.459334 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
104.0	GROUND SURFACE							20	40	60	80	100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
0.0	SAND and GRAVEL , trace silt Compact Brown Moist (FILL)		1	SS	30												
103.3																	
0.7	Gravelly SAND , some silt and clay Compact Brown Moist (FILL)		2	SS	17												24 64 12 (SI+CL)
			3	SS	12												
101.6																	
2.4	Clayey SILT , with sand, some gravel Firm to Very Stiff Brown to Grey Moist (TILL)		4	SS	6												11 44 30 15
			5	SS	20												
	No recovery Spoon bouncing																
99.7	Coring started at 4.3m																
4.3	LIMESTONE , moderately weathered, grey to dark grey, with shale interbeds, laminated, horizontally bedded: (Simcoe Group)		6	SS	50/ 0.0												FI
	Highly fractured zone from 4.6m to 4.8m		1	RUN													4 6 6 5 4 5 2 1 1
	Horizontal fractures at 4.37m, 4.49m, 4.58m, 4.78m, 4.83m, 4.90m, 5.02m, 5.06m, 5.10m, 5.11m, 5.15m, 5.21m, 5.28m, 5.38m, 5.47m, 5.49m, 5.59m, 5.64m, 5.65m, 5.67m, 5.69m and 5.77m Clay seam: 4.90m - 4.91m (10mm) Shale interbeds: 4.56m - 4.58m (20mm) 4.94m - 4.99m (50mm) 5.48m - 5.51m (30mm) 5.63m - 5.64m (10mm) 5.73m - 5.74m (10mm) 5.80m - 5.83m (30mm) 5.90m - 5.93m (30mm) 5.97m - 5.98m (10mm) 6.08m - 6.12m (40mm) 6.60m - 6.61m (10mm) 6.66m - 6.68m (20mm) 6.69m - 6.79m (100mm) 6.89m - 6.99m (100mm) Vertical fracture from 5.28m to 5.38m Moderately to slightly weathered Horizontal fractures at 5.84m, 5.90m, 5.91m, 6.04m, 6.13m, 5.19m, 6.27m, 6.30m, 6.33m, 6.40m and 6.82m		2	RUN													RUN #1 TCR=100% SCR=83% RQD=45% UCS=99MPa (Average) UCS=15MPa at 5.7m UCS=6.8MPa at 5.9m RUN #2 TCR=100% SCR=98% RQD=76% UCS=86MPa (Average)
96.7																	
7.3	END OF BOREHOLE AT 7.3m. BOREHOLE OPEN TO 7.3m AND WATER LEVEL AT 4.3m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH																

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

ONTMT4S2 MTO-11566.GPJ 2017TEMPLATE(MTO) GDT 6/1/21

RECORD OF BOREHOLE No PC 20-01

2 OF 2

METRIC

W.P. 4193-15-00 LOCATION Potter Creek Culvert, MTM NAD83-9 N 4 893 455.3 E 228 092.2 ORIGINATED BY GA
 DIST Eastern HWY 401 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2020.11.10 - 2020.11.10 LATITUDE 44.177068 LONGITUDE -77.459334 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W _p	W	W _L		
	Continued From Previous Page BENTONITE HOLEPLUG TO 0.3m THEN SAND AND GRAVEL TO SURFACE.																

ONTMT4S2 MTO-11566.GPJ 2017TEMPLATE(MTO).GDT 6/1/21

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

APPENDIX D

Analytical Laboratory Test Results

Certificate of Analysis

Client: Golder Associates Ltd (Ottawa)
1931 Robertson Road,
Ottawa, Ontario

Attention: Mr. Kenton Power

PO#:

Invoice to: Golder Associates Ltd


Report Number: 1986686
Date Submitted: 2022-09-22
Date Reported: 2022-09-29
Project: Belleville 20148061B-1-162
COC #: 900600

Page 1 of 3

Dear Kenton Power:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Report Comments:


Emma-
Dawn
Ferguson
2022.09.2
9 15:05:09
-04'00'

APPROVAL:

Emma-Dawn Ferguson, Chemist

All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise indicated.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at: <https://directory.cala.ca/>.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is licensed by the Ontario Ministry of the Environment, Conservation, and Parks (MECP) for specific tests in drinking water (license #2318). A copy of the license is available upon request.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by the Ontario Ministry of Agriculture, Food, and Rural Affairs for specific tests in agricultural soils.

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Certificate of Analysis

Client: Golder Associates Ltd (Ottawa)
1931 Robertson Road,
Ottawa, Ontario

Attention: Mr. Kenton Power

PO#:

Invoice to: Golder Associates Ltd

Report Number: 1986686
Date Submitted: 2022-09-22
Date Reported: 2022-09-29
Project: Belleville 20148061B-1-162
COC #: 900600

					Lab I.D.	1652793	1652794	1652795	1652796
					Sample Matrix	Soil	Soil	Soil	Soil
					Sample Type				
					Sampling Date	2022-09-08	2022-09-08	2022-09-15	2022-09-14
					Sample I.D.	H62-01 SS6	H62-05 SS3 5-7'	C-01 SS2 2.5-4.5'	C-08 SS4 7.5-9.5'
						12.5-14.5'			
Group	Analyte	MRL	Units	Guideline					
Anions	Cl	0.002	%		0.135	0.083	0.093	0.009	
	SO4	0.01	%		0.03	0.02	0.02	0.02	
General Chemistry	Electrical Conductivity	0.05	mS/cm		2.93	2.03	0.22	0.30	
	pH	2.00			8.33	8.89	8.36	8.50	
	Resistivity	1	ohm-cm		341	493	4540	3330	

					Lab I.D.	1652797	1652798	1652799	1652800
					Sample Matrix	Soil	Soil	Soil	Soil
					Sampling Date	2022-08-31	2022-09-07	2022-09-13	2022-09-13
					Sample I.D.	C-09 SS3 5-7'	C-10 SS3 5-6.75'	H-37-02 SS2 2.5-4.5'	H37-01 SS3 5-7'
Group	Analyte	MRL	Units	Guideline					
Anions	Cl	0.002	%		0.005	0.002	0.002	0.014	
	SO4	0.01	%		0.04	0.02	0.02	0.03	
General Chemistry	Electrical Conductivity	0.05	mS/cm		0.44	0.17	0.17	0.47	
	pH	2.00			7.87	8.23	8.20	8.56	
	Resistivity	1	ohm-cm		2270	5880	5880	2130	

Guideline = *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

Certificate of Analysis

Client: Golder Associates Ltd (Ottawa)
1931 Robertson Road,
Ottawa, Ontario

Attention: Mr. Kenton Power

PO#:

Invoice to: Golder Associates Ltd

Report Number: 1986686
Date Submitted: 2022-09-22
Date Reported: 2022-09-29
Project: Belleville 20148061B-1-162
COC #: 900600

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 430396 Analysis/Extraction Date 2022-09-27 Analyst IP Method Cond-Soil			
Electrical Conductivity	<0.05 mS/cm	101	90-110
pH	7.85	100	90-110
Resistivity			
Run No 430430 Analysis/Extraction Date 2022-09-28 Analyst AA Method C CSA A23.2-4B			
Chloride	<0.002 %		90-110
Run No 430473 Analysis/Extraction Date 2022-09-28 Analyst IP Method AG SOIL			
SO4	<0.01 %	98	70-130

Guideline = * = **Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

APPENDIX E

Site Photographs



Photograph 1: Location of Borehole C-01; July 7, 2022



Photograph 2: Looking northwest from Borehole C-02; July 7, 2022

