FOUNDATION INVESTIGATION REPORT – REV.2

Clay River Culvert Replacement at Station 11+501 (Site No. 38C-0157/C0)

Highway 17, Township of Goodwillie
Ministry of Transportation, Ontario
Assignment No. 5022-E-0002, GWP 5114-20-00, WP 5230-21-01

Submitted to:

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Reference No. 22525353-006-R05

May 6, 2026

GEOCRES No.: 41N07-005
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Bureau Veritas - Certificate of Analysis – Report No. R8171529

1.0 INTRODUCTION

WSP Canada Inc. (WSP) has been retained by D.M. Wills Associates Ltd. (DM Wills) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation investigation and design services required for the full replacement of the Clay River Culvert along Highway 17 at Station 11+501, Township of Goodwillie, Ontario.

This report presents the results of the foundation investigation carried out for the culvert replacement along Highway 17 at Station 11+501. The locations of the boreholes advanced at this site are shown in plan on Drawing 1. The foundation investigation services for this project have been delivered under MTO Assignment No. 5022-E-0002 as part of GWP 5114-20-00 and WP 5230-21-01.

2.0 SITE DESCRIPTION

The Clay River Culvert is located at Station 11+501 along Highway 17, approximately 72 km south of Highway 101. The site location is shown on the key plan in Drawing 1. The existing culvert is an approximate 3.7 m x 2.4 m (span x rise) structural plate corrugated steel pipe arch (SPCSPA) with a 3.9 m x 2.7 m (span x rise) extension, and crosses below Highway 17 northbound lanes (NBL) and southbound lanes (SBL) with a total length of about 28 m. We understand the existing culvert is to be replaced by a 25 m long, 4.0 m wide by 2.2 m high (minimum) open footing concrete rigid frame culvert.

Highway 17, in the vicinity of the culvert, currently consists of three-lanes (a single lane in each direction and a passing lane is present for the SBL) with a granular shoulder along the NBL and guide rail along the edge of the SBL. There is dense tree cover beyond the MTO right of way on both sides of the highway. Based on the survey data provided by D.M Wills, the highway grade is at approximately Elevation 211.7 m, and the adjacent ground surface at about Elevation 208 m to 209 m with the overall topography sloping upwards to the north and east. The existing embankment is sloped between about 1.25H:1V and 2H:1V in the vicinity of the culvert.

The watercourse (i.e. Clay River) flows from north to south with the water level in the river measured to be at about Elevation 208.8 m on at the inlet (north) side and about Elevation 208.0 m at the outlet (south) side of the existing culvert (as shown on the General Arrangement drawing).

The existing ground surface features and conditions at the culvert location are shown in Photographs 1 to 4 (taken during the field investigation in June 2023) following the text of this report. There are near vertical rock cuts exposed on both sides of the highway about 100 m north and 300 m south of the site, and cobble to boulder sized rock fill fragments were observed near the toes of the embankment directly north and south of the culvert.

Based on our site observations at the time of the field investigation and a review of the available site photographs/satellite images, the existing embankment in the culvert area appears to be performing satisfactorily. There was no visual evidence of global instability (i.e., soil movement) on the embankment side slopes, and no tension cracks near the embankment crest that would be indicative of instability. Pavement cracking in the vicinity of the culvert was observed and the connection between the original culvert and extension appeared to have partially separated and exposed plywood, and concrete was visible at the interface.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation consisted of four boreholes (Boreholes CR-1 to CR-4). Boreholes CR-1 and CR-2 were drilled on June 21 and 22, 2023, respectively, whereas Boreholes CR-3 and CR-4 were drilled on August 17 and July 10, 2023, respectively. The approximate borehole locations are shown on Drawing 1.

Boreholes CR-1 and CR-2 were located on Highway 17 to the south and north of the culvert and in the southbound and northbound lane respectively. Boreholes CR-3 and CR-4 were located to the north and south of Highway 17, in the vicinity of culvert inlet and outlet respectively. Boreholes CR-1 and CR-2 were advanced using a truck-mounted D-90 drill rig and Borehole CR-3 was drilled using a track-mounted CME 55 drill rig. Borehole CR-4 was advanced using portable drilling equipment. Boreholes CR-1 to CR-3 were advanced using 114 mm outer diameter solid stem augers, NW casing and NQ coring techniques. Drilling equipment was supplied and operated by Walker Drilling Ltd. (formerly RPM Drilling), of Utopia, Ontario.

Soil samples were generally obtained using a 50 mm outer diameter split-spoon sampler driven by an automatic hammer in general accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586[1]), unless otherwise noted. Soil samples were generally obtained at vertical sampling intervals of about 0.76 m and 1.5 m. Bedrock was continuously cored using NQ sized coring tools.

The groundwater levels in the open boreholes were observed during and upon completion of the drilling operations and are described on the Record of Boreholes sheets in Appendix A. Boreholes CR-2, CR-3 and CR-4 were dry upon completion of the drilling operations. In Borehole CR-1, the groundwater level was likely influenced by the addition of water during drilling operations. Boreholes were backfilled in general accordance with the intent of Ontario Regulation (O.Reg.) 903, as amended, and the site conditions were restored following completion of the field work.

The field work was supervised on a full-time basis by members of WSP technical staff who located the boreholes in the field, supervised the drilling, sampling, and in-situ testing operations, and logged the boreholes. The soil and bedrock core samples were identified in the field, placed in labelled containers or core boxes, and transported to the WSP laboratory in Sudbury for further examination and testing. Laboratory tests such as grain size distribution analyses, water content and organic content determination were carried out on selected soil samples, in general accordance with MTO and/or ASTM Standards, as applicable. Uniaxial compressive strength testing was performed on selected rock core samples.

The as-drilled borehole locations, in station and offset, were measured in reference to the centreline alignment staked on the highway shoulder and was subsequently converted into MTM NAD 83 coordinates. The ground surface elevation at the borehole locations was surveyed by WSP using rod and level equipment relative to the highway centreline where reference ground surface elevations were provided by Callon Dietz Incorporated. The borehole locations, including northing / easting and geographic coordinates, ground surface elevations referenced to Geodetic datum, and borehole drilled depths (including bedrock coring depths) are summarized below.

[1] ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.

Borehole No.	NAD83 – MTM Zone 13 Coordinates (Geographic Coordinates)		Ground Surface Elevation (m)	Drilled Depth (m)	Length of Bedrock Cored (m)
	Northing (m) (Latitude (°))	Easting (m) (Longitude (°))			
CR-1	5254745.5 (47.429675)	250006.4 (-84.726361)	211.9	6.9	2.9
CR-2	5254760.5 (47.429810)	249996.7 (-84.726491)	211.1	6.4	3.3
CR-3	5254741.7 (47.429640)	249991.3 (-84.726560)	210.4	6.0	2.9
CR-4	5254767.7 (47.429876)	250016.5 (-84.726230)	208.9	0.9	0.0

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

As delineated in the Northern Ontario Engineering Geological Terrain Study (NOEGTS)[2] Mapping, bedrock knobs are present in the vicinity of the culvert. The NOEGTS mapping also indicates the presence of primarily sandy material with gravel as a secondary material in the area of the culvert.

Based on geological mapping by the Ministry of Northern Development and Mines (MNDM)[3], the bedrock at the site consists of gneissic tonalite to granodiorite (foliated) to gneissic (with minor supracrustal inclusions).

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes during the investigation, together with the results of laboratory tests carried out on selected soil samples are presented on the Record of Boreholes sheets in Appendix A. The detailed results of the geotechnical laboratory tests are presented in Appendix B. The results of the in-situ field tests (SPT N-values), as presented in the borehole records and in Section 4, are uncorrected. The results of the analytical testing completed on select soil samples are provided in Appendix C.

The borehole locations and the interpreted stratigraphic profile projected along the proposed culvert alignment are provided in Drawing 1. The stratigraphic boundaries shown on the Record of Borehole sheets and on the interpreted stratigraphic section in Drawing 1 are inferred from observations of the drilling progress and noncontinuous soil sampling and therefore, represent transitions between soil types rather than exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

A summary description of the major soil deposits and groundwater conditions encountered in the boreholes is provided below.

4.2.1 Asphalt

An approximately 110 mm and 220 mm thick layer of asphalt was encountered at the Highway 17 pavement surface (measured to be at Elevations 211.9 m and 211.1 m) in Boreholes CR-1 and CR-2, respectively.

4.2.2 Silty Sand (SM) to Gravel (GP) (FILL)

A 0.4 m to 1.6 m thick layer of fill, comprised of silty sand, gravelly sand, sand and gravel and gravel was encountered below the asphalt or ground surface (between Elevations 208.9 m and 211.8 m) in Boreholes CR-1 to CR-3. In Borehole CR-4, a sandy silt to gravelly silty sand fill containing organic silt seams/interlayers was encountered from ground surface (Elevation 208.9 m) and was explored for 0.9 m depth before termination of the borehole due to auger refusal.

The SPT ‘N’-values measured within the fill layer typically ranged from 11 blows to 75 blows per 0.3 m of penetration indicating a compact to very dense state of compactness; however, spit spoon and auger refusal (as well as auger and casing grinding) were encountered at many of the sample depths.

[2] Ministry of Natural Resources. 2005. Digital Northern Ontario Engineering Geology Terrain Study. Ontario Geological Survey, Miscellaneous Release – Data 160.

[3] Ministry of Northern Development of Mines. Bedrock Geology of Ontario – Southern Sheet, Ontario Geological Survey - Map 2544.

The moisture content measured on one sample of the sand and gravel fill in Borehole CR-3 is 9%. The results of grain size analyses testing carried out on one sample from the fill are shown in Figure B-1 in Appendix B. The organic content measured on one sample of the organic silt seams encountered within the granular fill is about 12%.

4.2.3 Cobbles and Boulders with Silty Sand and Gravel infill (ROCK FILL)

A 1.5 m to 3.2 m thick layer of rock fill comprised of predominantly cobble and boulder sized rock fragments with silty sand and gravel infill was encountered below the silty sand to gravel fill (between Elevations 208.8 m and 211.1 m) in Boreholes CR-1 to CR-3. In Borehole CR-1, a 270 mm and 200 mm diameter cobble were encountered at 3.4 m and 3.7 m depth, respectively, and confirmed by coring. In Borehole CR-3, a 100 mm and 225 mm diameter cobble and a 600 mm diameter boulder were encountered between 1.6 m and 3.1 m depth and confirmed by coring. The cobbles and boulders are inferred to be rock fill that was also observed to be present near the toe of the embankment near the culvert, especially on the south side.

Where penetrated with the split-spoon sampler within the granular infill, the SPT 'N'-values measured typically ranged from 14 blows to 28 blows per 0.3 m of penetration indicating a compact state of compactness; however, split spoon and auger refusal (as well as auger and casing grinding) were encountered at many of the sample depths suggesting that frequent rock fragments (cobble to boulder sized) are present. One SPT 'N' value of 4 blows per 0.3 m of penetration was measured in an organic silt interlayer within the fill in Borehole CR-2.

The moisture content measured on a sample of the sandy gravel infill from the rock fill deposit was about 6%. A moisture content measured within the organic silt interlayer in Borehole CR-2 was 43%. The results of grain size analyses testing carried out on two samples from the granular infill are shown in Figure B-2 in Appendix B. The organic content measured on one sample of the organic silt interlayer encountered within the granular infill is about 6%.

4.2.4 Bedrock/Refusal

Bedrock was encountered at depths between 3.1 m and 4.0 m below ground surface (corresponding to between Elevation 208.1 m and 207.3 m) in Boreholes CR-1 to CR-3 where the bedrock surface was confirmed by coring for lengths between 2.9 m and 3.3 m. In Borehole CR-4, auger refusal was encountered at 0.9 m (Elevation 208.0 m) which could be bedrock or an obstruction (e.g. cobble/boulder). As noted in the borehole record for CR-4, an additional three boreholes were advanced in proximity to Borehole CR-4 and encountered refusal between 0.8 m and 1.1 m depth.

In general, the bedrock is classified as granite or gneiss rock. In Borehole CR-1, the 2.9 m of bedrock cored from Elevation 207.9 m was classified as granite. In Borehole CR-2, the bedrock was cored for 3.3 m from Elevation 206.1 m, with the upper 0.6 m being classified as granite and the lower 2.7 m being classified as gneiss. In Borehole CR-3, the 2.9 m of bedrock cored from Elevation 207.3 m was classified as gneiss. The retrieved granite rock is described as medium to very coarse grained, fresh, strong, and pinkish grey whereas the gneiss rock is described as fine to coarse grained, fresh, strong and pinkish grey. Photographs of the retrieved bedrock core samples (including the overlying cobbles / boulders were included in the rock core) are provided on Figure A1 in Appendix A.

The Total Core Recovery (TCR) measured on the core samples is 100%. The Solid Core Recovery (SCR) of the rock core samples ranges from 91 % to 100 %. The Rock Quality Designation (RQD) measured on the core samples ranges from 72 % to 100 %, indicating a rock mass of fair to excellent quality.

Laboratory Uniaxial Compressive Strength (UCS) tests were carried out on three selected bedrock core samples. The UCS values are presented on the Record of Drillhole sheets in Appendix A and are summarized below and indicate that the bedrock is strong.

Borehole	Elevation (m)	Rock Classification	UCS (MPa)
CR-1	206.2	Granite	61.8
CR-2	207.4	Granite/Gneiss	62.9
CR-3	205.7	Gneiss	60.7

4.3 Groundwater Conditions

Groundwater levels were measured within the open boreholes upon completion of drilling. Boreholes CR-2, CR-3 and CR-4 were dry upon completion of drilling operations. A water level was observed and measured in CR-1 as summarized below; however, it is noted that water was introduced as part of drilling activities (wash boring during casing advancement and coring) and the water level is not considered representative of the stabilized groundwater level at the site.

Borehole No.	Ground Surface Elevation (m)	Depth to Groundwater Level (m)	Groundwater Elevation (m)	Date	Reading
CR-1	211.9	1.7	210.2	June 21, 2023	Open Borehole after water was introduced

The water level in Clay River is shown on the General Arrangement drawing to be at about Elevation 208.8 m at the culvert inlet and about Elevation 208.0 at the culvert outlet. Based on observations of the water level in the river while on site and the water levels provided on the GA drawing, and considering the granular nature of the embankment fill, the groundwater level adjacent to the culvert is anticipated to be near the river water level. The groundwater levels (and river water level) at this site will be subject to fluctuations both seasonally and as a result of precipitation events.

4.4 Analytical Testing Results

One soil sample was submitted to Bureau Veritas for chemical testing/analysis of indicators related to potential corrosion of exposed buried steel and concrete. The test results are provided in Appendix C and are summarized below.

Borehole No.	Sample Depth (m)	Chloride (ug/g)	Sulphate (ug/g)	Conductivity (umho/cm)	pH	Resistivity (ohm-cm)
CR-1	3.0	89	27	223	5.86	4,500

5.0 CLOSURE

The field drilling program was carried out under the supervision of Mr. Tibor Berecz, Mr. Jordan Schaaf and Mr. Biswajit Nandi, under the overall direction of Mr. Matthew Thibeault, P.Eng. This Foundation Investigation Report was prepared by Sumesh Cherukatt, and reviewed by Mr. Tibor Berecz, P.Eng., a Geotechnical Engineer with WSP. Mr. Kevin Bentley, P.Eng., an MTO Principal Foundations Contact for WSP, conducted an independent technical and quality review of the report.

Signature Page

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Geotechnical Engineer

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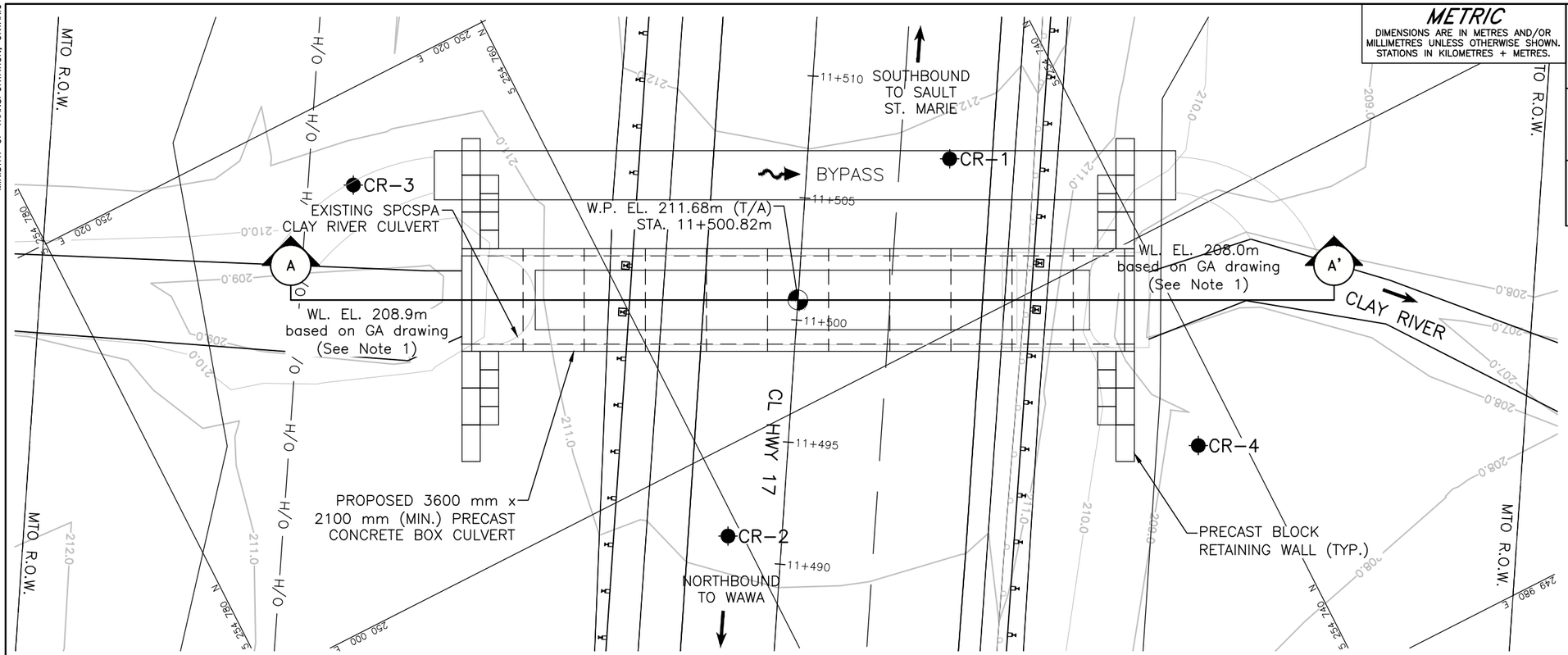
TB/AB/KB/ar

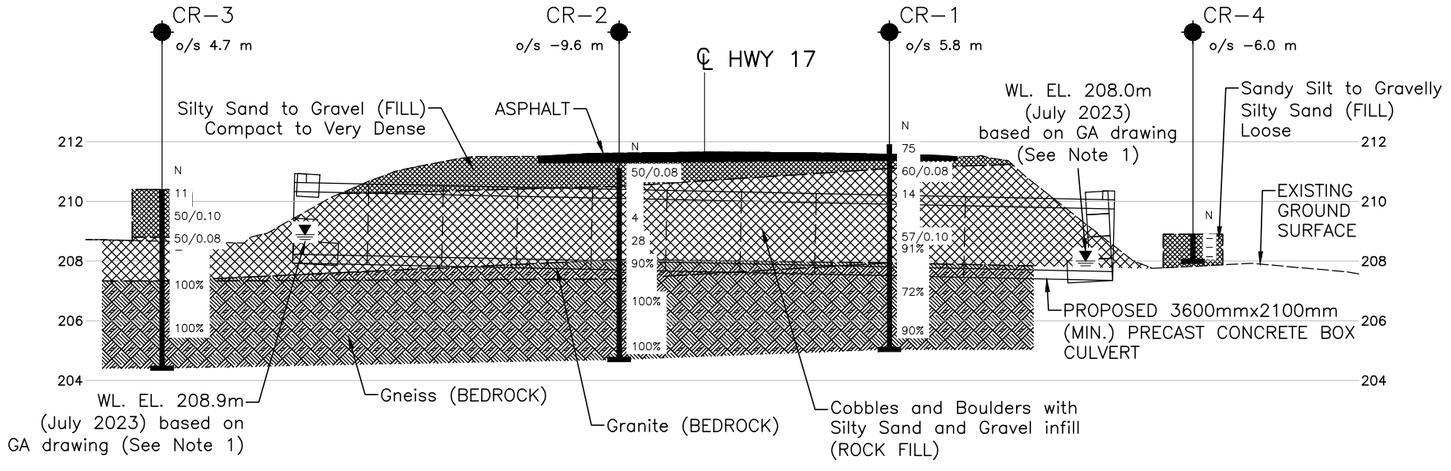
https://wsponline.sharepoint.com/sites/gld-163060/project files/6 deliverables/002_issued/006-r05-clay river culvert/3-revised final-rev2/22525353-006-r05-r-rev2-clay river culv. hwy 17 fidr 07may_26.docx

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

SCALE
2 0 2 4 m



SCALE: 1:100 m (A–A') CROSS–SECTION

SCALE
2 0 2 4 m

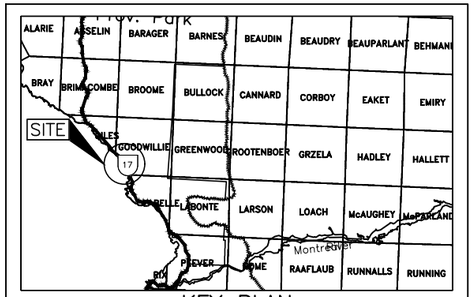
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 5114–20–00

SHEET

HIGHWAY 17
CLAY RIVER CULVERT
BOREHOLE LOCATIONS AND SOIL STRATA

wsp



KEY PLAN
SCALE
1 0 1 2 km

LEGEND

- Borehole – Current Investigation
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% — Rock Quality Designation (RQD)
- WL measured in river (July, 2023)

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MAY 06, 2026
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BOREHOLE CO–ORDINATES (NAD 83 MTM ZONE 13)			
No.	ELEVATION	NORTHING	EASTING
CR–1	211.9	5254745.5	250006.4
CR–2	211.1	5254760.5	249996.7
CR–3	210.4	5254767.7	250016.4
CR–4	208.9	5254741.7	249991.3

NOTES

1. Approximate groundwater level inferred to be near the existing culvert invert based on the soil types encountered in the boreholes and observations of the water level in the culvert during the drilling operations.

2. 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 Contracts Documents.

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

4. Plan and profile GA's were scaled and aligned by WSP. Actual locations may vary.

REFERENCE

Base plan and Topography provided in digital format by Callon Dietz, drawing file no. B0885017001 GWP 5114–20–00.dwg, Received October 31, 2023.
GA's provided in digital format by DM Wills, drawing file no. Clay River Culvert – GA for WSP.dwg, Received February 5, 2026.

NO.	DATE	BY	REVISION
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Geocres No. 41N07–005A

HWY. 17	PROJECT NO. 22525353		DIST. .
SUBM'D. .	CHKD. .	DATE: 5/6/2026	SITE: 38C–0157/C0
DRAWN: TR	CHKD. TB	APPD. KJB	DWG. 1

PLOT DATE: May 6, 2026
FILENAME: R:\Ministry_of_Transportation_Ontario-MTO\Hwy17\99_PROJECTS\22525353\1000\1400\001-CR_Geotech_Invert\02_PRODUCTION\DWG\22525353-1000-1400-001-01.dwg

Photograph 1: Highway 17 – Clay River Culvert – Embankment West Slope at Culvert Outlet, Looking North

Photograph 2: Highway 17 – Clay River Culvert – Embankment West Slope at Inlet, Looking East

Photograph 3: Highway 17 – Clay River Culvert – Embankment East Slope at Inlet, Looking North

Photograph 4: Highway 17 – Clay River Culvert – Outlet

APPENDIX A

Borehole Records

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 Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
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 cm^2 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, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

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

COARSE-GRAINED SOILS

Compactness[1]

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

1. 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 grainsize. 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.
2. 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

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. 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.

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

II. STRESS AND STRAIN

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

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

(a) Index Properties (continued)

w	water content
w_L or LL	liquid limit
w_P or PL	plastic limit
I_P or PI	plasticity index = $(w_l - w_p)$
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
$C_{\alpha(\varepsilon)}$	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 = σ'_p / σ'_{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 δ
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

Notes: 1 $\tau = c' + \sigma' \tan \phi'$
2 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
BD Bedding
BC Broken Core
CC Continuous Core
CL Closed
CO Contact
CU Curved
CT Coated
FLT Fault
FOL Foliation
FR Fracture
GO Gouge
IN Infilled
IR Irregular
JN Joint
KV Karstic Void
K Slickensided
LC Lost Core
MB Mechanical Break
PL Planar
PO Polished
RO Rough
SA Slightly Altered
SH Shear
SM Smooth
SR Slightly Rough
SY Stylolite
UN Undulating
VN Vein
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 22525353

RECORD OF BOREHOLE No. CR-1

1 OF 1 **METRIC**

G.W.P. 5114-20-00 LOCATION N 5254745.5; E 250006.4 NAD83 MTM ZONE 13 (LAT. 47.429675; LONG. -84.726361) ORIGINATED BY TB

DIST HWY 17 BOREHOLE TYPE 114 mm O.D. Solid Stem Augers, NW Casing, NQ Coring COMPILED BY TR

DATUM GEODETIC DATE June 21, 2023 CHECKED BY MT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
211.9	GROUND SURFACE										
0.0	ASPHALT (110 mm)										
0.1	Gravelly SAND (SP) to GRAVEL (GP) (FILL) Compact to very dense Brown to grey Moist to wet		1	SS	75						
211.1											
0.8	Cobbles and boulders with sandy gravel infill (ROCK FILL) - Split-spoon refusal at 0.8 m depth. - Auger grinding at 1.0 m depth, switched the NW Casing. - Casing grinding between 1.5 m and 3.0 m depth. - Split-spoon refusal at 3.4 m depth. (Hammer Bouncing) - 270 mm diameter cobble / boulder encountered at 3.4 m depth. - NQ coring from 3.4 m to 4.0 m depth. - 200 mm diameter cobble encountered at 3.7 m depth.		2	SS	60/0.08	▽	211				
			3	SS	14		210	○			80 20 (0)
			4	SS	57/0.10		209				
207.9											
4.0	GRANITE (BEDROCK) Bedrock cored from 4.0 m to 6.9 m depth. For coring details refer to Record of Drillhole CR-1.		1	RC	REC 100%		208				RQD = 91%
			2	RC	REC 100%		207				RQD = 72%
			3	RC	REC 100%		206				RQD = 90%
205.0											
6.9	END OF BOREHOLE										

NOTES:

1. Water added during casing/coring advancement during drilling operations.

2. Water level measured at a depth of 1.7 m below ground surface (Elev. 210.2 m) upon completion of drilling.

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

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PROJECT: 22525353

RECORD OF DRILLHOLE: CR-1

SHEET 1 OF 1

LOCATION: N 5254745.5; E 250006.4 (LAT. 47.429675; LONG. -84.726361)

DRILLING DATE: June 21, 2023

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Diedrich D-90

DRILLING CONTRACTOR: Walker / RPM Drilling

JN - Joint; FLT - Fault; SHR- 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; MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY k, cm/s	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		BEDROCK		207.9																
4	NQ Coring	GRANITE Medium to very coarse grained Fresh Strong Light pink to light grey		4.0	1	Grey 100							JNIRRo JNIRRo JNIRRo							
5					2	Grey 100							JNIRRo JNIRRo JNIRRo							UCS = 61.8 MPa
6		- Fractured between 5.8 m and 6.0 m depth.			3	Grey 100							JNIRRo							
7		END OF DRILLHOLE		205.0 6.9																
8																				
9																				
10																				
11																				
12																				
13																				
14																				
15																				

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DEPTH SCALE

1 : 60

LOGGED: TB

CHECKED: MT

PROJECT 22525353

RECORD OF BOREHOLE No. CR-2

1 OF 1 **METRIC**

G.W.P. 5114-20-00 LOCATION N 5254760.5; E 249996.7 NAD83 MTM ZONE 13 (LAT. 47.429811; LONG. -84.726491) ORIGINATED BY TB

DIST HWY 17 BOREHOLE TYPE 114 mm O.D. Solid Stem Augers, NW Casing, NQ Coring COMPILED BY TR

DATUM GEODETIC DATE June 22, 2023 CHECKED BY MT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
211.1	GROUND SURFACE										
0.0 / 210.9	ASPHALT (220 mm)		1	SS	50/0.08		211				
0.2 / 210.5	SILTY SAND (SM) to GRAVEL (GP) and sand (FILL) Loose to very dense Brown Dry										
0.6	Cobbles and boulders with silty sand and gravel infill (ROCK FILL) - Auger refusal at 0.6 m depth, switched to NW Casing. - Casing grinding between 0.6 m and 1.5 m depth. - Organic silt pockets at 1.5 m depth. - Casing grinding at 2.9 m depth and switched to NQ coring. - 150 mm diameter cobble encountered at 2.9 m depth.		2	SS	4		210		○	OC=6.4%	2 53 (45)
			3	SS	28		209				
208.1 / 3.1	GRANITE (BEDROCK) Bedrock cored from 3.1 m to 6.4 m depth. For coring details refer to Record of Drillhole CR-2.		1	RC	REC 100%		208				RQD = 90%
207.4 / 3.7	GNEISS (BEDROCK)						207				
			2	RC	REC 100%		206				RQD = 100%
204.7			3	RC	REC 100%		205				RQD = 100%
6.4	END OF BOREHOLE NOTE: 1. Borehole dry upon completion of drilling.										

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

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PROJECT: 22525353

RECORD OF DRILLHOLE: CR-2

SHEET 1 OF 1

LOCATION: N 5254760.5; E 249996.7 (LAT. 47.429811; LONG. -84.726491)

DRILLING DATE: June 22, 2023

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Diedrich D-90

DRILLING CONTRACTOR: Walker / RPM Drilling

JN - Joint; FLT - Fault; SHR- 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; MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY k, cm/s	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		BEDROCK		208.1																
	NQ Coring	GRANITE Coarse grained Fresh Strong Pink-cream white		3.1 207.4	1	Grey / brown 100							JNIRRo JNIRRo							UCS = 62.9 MPa
4		GNEISS Medium to fine grained with leucocratic banding Fresh Strong Light to medium grey		3.7																
5					2	Grey / brown 100														
6					3	Grey / brown 100														
				204.7																
		END OF DRILLHOLE		6.4																
7																				
8																				
9																				
10																				
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DEPTH SCALE

1 : 60

LOGGED: TB

CHECKED: MT

PROJECT 22525353

RECORD OF BOREHOLE No. CR-3

1 OF 1 **METRIC**

G.W.P. 5114-20-00 LOCATION N 5254767.7; E 250016.4 NAD83 MTM ZONE 13 (LAT. 47.429876; LONG. -84.726229) ORIGINATED BY BN

DIST HWY 17 BOREHOLE TYPE 114 mm O.D. Solid Stem Augers, NQ Coring COMPILED BY TR

DATUM GEODETIC DATE August 17, 2023 CHECKED BY MT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
210.4	GROUND SURFACE										
0.0	SAND (SP) and gravel to GRAVEL (GP) and sand, trace non-plastic fines (FILL) Compact to very dense Brown Moist - 100 mm and 225 mm diameter cobbles and 600 mm diameter boulder was encountered between 1.6 m and 3.1 m depth.		1	SS	11		210		○		50 44 (6)
			2	SS	50/0.1						
208.8			3	SS	50/0.08		209				
1.6	- Auger / split-spoon refusal at 1.6 m depth and switched to NQ coring. Cobbles and boulders with gravel infill (ROCK FILL)		1	RC	-		208				
207.3											
3.1	GNEISS (BEDROCK) Bedrock cored from 3.1 m to 6.0 m depth. For coring details refer to Record of Drillhole CR-3.		2	RC	REC 100%		207				RQD = 100%
							206				
			3	RC	REC 100%						RQD = 100%
204.4							205				
6.0	END OF BOREHOLE NOTE: 1. Borehole dry upon completion of drilling.										

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

PROJECT: 22525353

RECORD OF DRILLHOLE: CR-3

SHEET 1 OF 1

LOCATION: N 5254767.7; E 250016.4 (LAT. 47.429876; LONG. -84.726229)

DRILLING DATE: August 17, 2023

DATUM: GEODETIC

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Walker / RPM Drilling

JN - Joint; FLT - Fault; SHR - 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; MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN	FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY k, cm/s	Diametral Point Load Index (MPa)	RMC -Q' AVG.	
		BEDROCK		207.3																	
4	NQ Coring	GNEISS Coarse grained with leucocratic banding Fresh Strong Grey / pink		3.1	2									JNIRRo							
5					3									JNIRRo							UCS = 60.7 MPa
6				204.4										JNIRRo							
		END OF DRILLHOLE		6.0																	

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DEPTH SCALE

1 : 60

LOGGED: BN

CHECKED: MT

PROJECT 22525353

RECORD OF BOREHOLE No. CR-4

1 OF 1 **METRIC**

G.W.P. 5114-20-00 LOCATION N 5254741.7; E 249991.3 NAD83 MTM ZONE 13 (LAT. 47.429641; LONG. -84.726559) ORIGINATED BY JS

DIST HWY 17 BOREHOLE TYPE Portable Equipment COMPILED BY TR

DATUM GEODETIC DATE July 10, 2023 CHECKED BY MT

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
208.9	GROUND SURFACE										
0.0	Organic SILT (OL) to Gravelly SILTY SAND (SM), trace organics (FILL) Loose Brown Moist		1	AS	-						OC=11.6%
			2	AS	-						
208.0			3	AS	-						
0.9	END OF BOREHOLE AUGER REFUSAL						208				

NOTES:

1. Additional three boreholes were advanced within 1.0 m of CR-4 and encountered refusal between 0.8 m and 1.1 m depth.

2. Bedrock was visible along the river bed, approximately 5.0 m from Borehole CR-4.

3. State of compactness inferred from SPT carried out in adjacent borehole.

4. Borehole was dry upon completion of drilling.

$+^3, \times^3$: Numbers refer to Sensitivity

$\circ^{3\%}$ STRAIN AT FAILURE

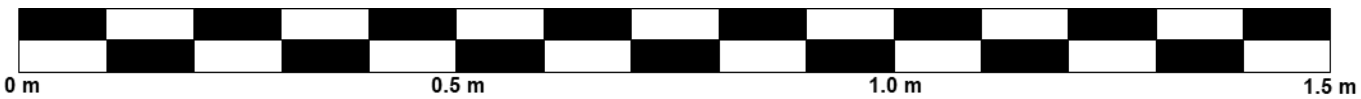
Core Box Photographs
Borehole:CR-1, CR-2 & CR-3

FIGURE A-1
Box

CR-1
3.4 m to 4.0 m (Gravels, 270 mm and 200 mm Cobbles)
4.0 m to 6.9 m (Bedrock)

CR-2
2.9 m to 3.1 m (Gravels, 150 mm Cobble)
3.1 m to 6.4 m (Bedrock)

CR-3
1.6 m to 3.1 m (Gravel, 100-225 mm Cobbles, 600 mm Boulder)
3.1 m to 5.9 m (Bedrock)

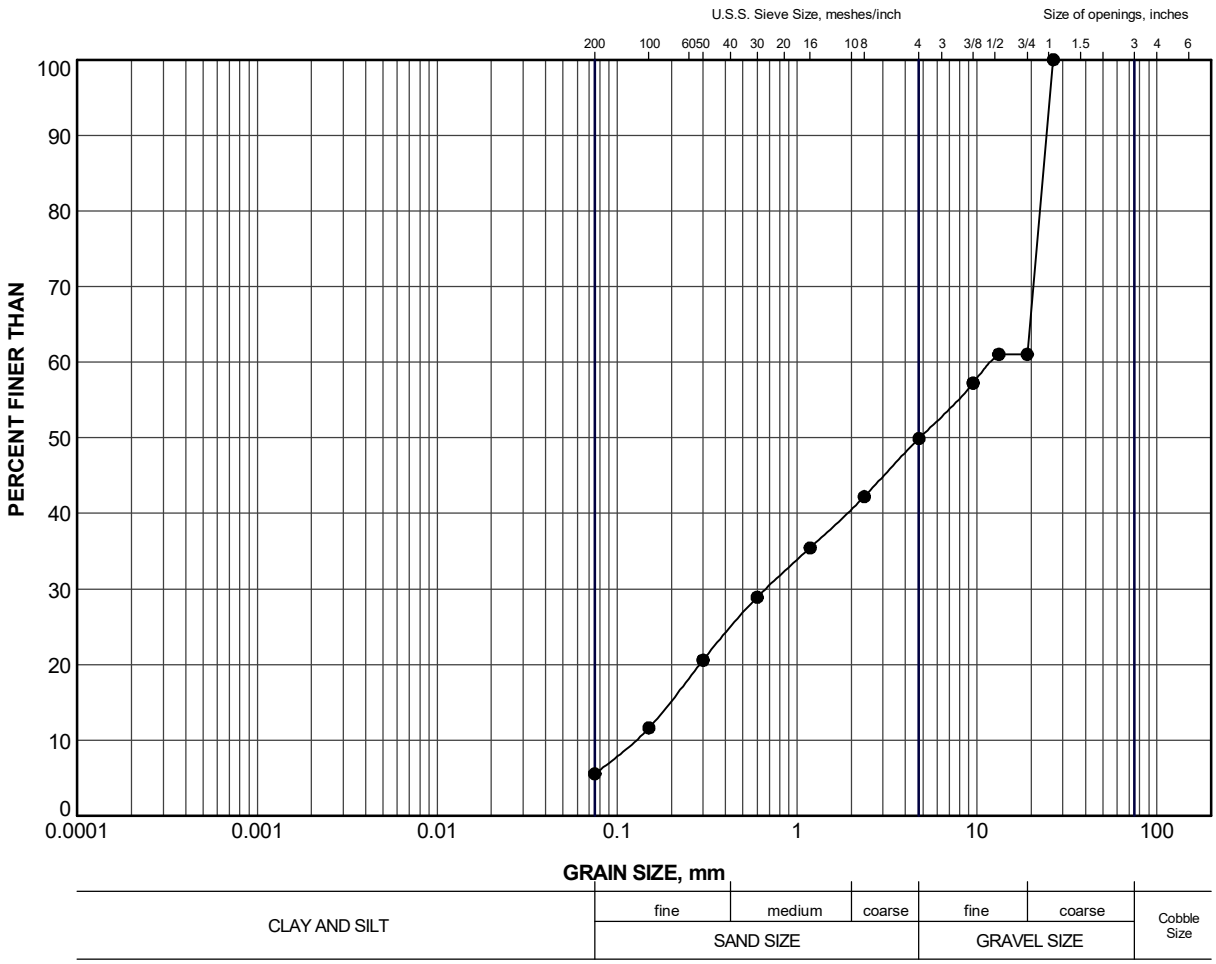


Date: May 2024
Project: 22525353

Drawn: SC
Checked: MT

APPENDIX B

Geotechnical Laboratory Test Results



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	CR-3	1	210.1

PROJECT

HIGHWAY 17
CLAY RIVER CULVERT
STATION 11+501 (SITE NO 38C-0157/C0)

TITLE

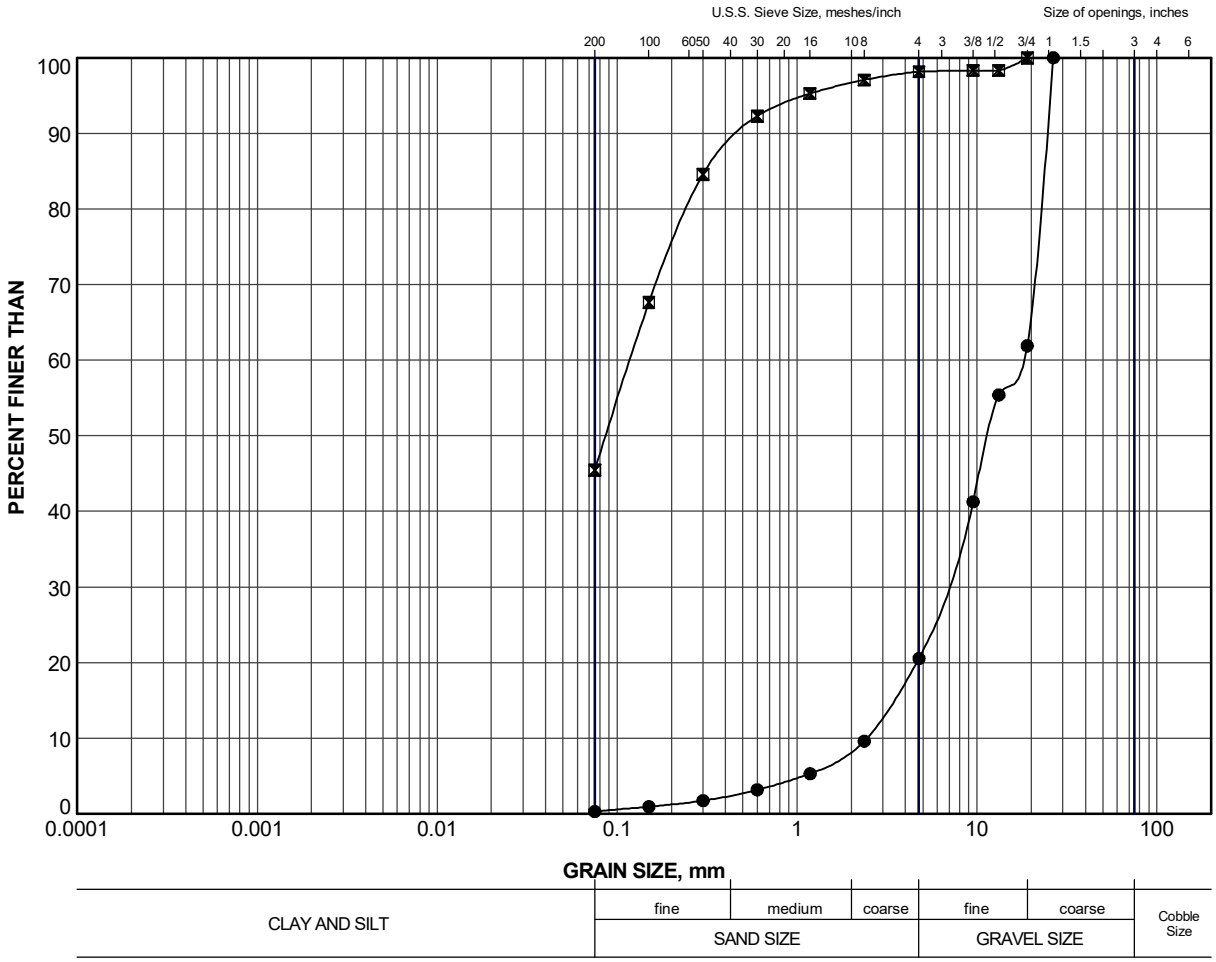
GRAIN SIZE DISTRIBUTION

SILTY SAND (SP) to GRAVEL (GP) (FILL)

SUDBURY, ONTARIO

PROJECT No.	22525353		FILE No.	22525353.GPJ	
DRAWN	TR	Oct 2024	SCALE	N/A	REV.
CHECK	MT	Oct 2024			
APPR	JPD	Oct 2024	FIGURE	B-1	

SUD-MTO GSD_GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	CR-1	3	210.1
⊠	CR-2	2	209.3

PROJECT

HIGHWAY 17
CLAY RIVER CULVERT
STATION 11+501 (SITE NO 38C-0157/C0)

TITLE

GRAIN SIZE DISTRIBUTION

SILTY SAND (SP) and GRAVEL (GP) INFILL (ROCK FILL)

SUDBURY, ONTARIO

PROJECT No.	22525353		FILE No.	22525353.GPJ	
DRAWN	TR	Oct 2024	SCALE	N/A	REV.
CHECK	MT	Oct 2024			
APPR	JPD	Oct 2024	FIGURE	B-2	

SUD-MTO GSD_GLDR_LDN.GDT

APPENDIX C

Analytical Laboratory Test Results

Your Project #: 22525353/1400
Site Location: HWY 17 WAWA
Your C.O.C. #: N/A

Attention: Matthew Thibeault

WSP Canada Inc.
33 Mackenzie Street
Suite 100
Sudbury, ON
Canada P3C 4Y1

Report Date: 2024/05/31
Report #: R8171529
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C4E2018
Received: 2024/05/09, 15:30

Sample Matrix: Soil
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Chloride (20:1 extract)	1	2024/05/15	2024/05/16	CAM SOP-00463	MOE E3013 m
Conductivity	1	2024/05/16	2024/05/16	CAM SOP-00414	OMOE E3530 v1 m
Moisture (Subcontracted) (1, 2)	1	N/A	2024/05/16	AB SOP-00002	CCME PHC-CWS m
Sulphide in Soil (1)	1	N/A	2024/05/16	AB SOP-00080	EPA9030B/SM4500S2-DF
pH CaCl2 EXTRACT	1	2024/05/15	2024/05/15	CAM SOP-00413	EPA 9045 D m
Redox Potential (3)	1	2024/05/15	2024/05/16	CAM SOP-00421	SM 24 2580 B
Resistivity of Soil	1	2024/05/13	2024/05/16	CAM SOP-00414	SM 24 2510 m
Sulphate (20:1 Extract)	1	2024/05/15	2024/05/16	CAM SOP-00464	MOE E3013 m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, EPA, APHA or the Quebec Ministry of Environment.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
(1) This test was performed by Bureau Veritas Calgary (19th), 4000 19th Street NE , Calgary, AB, T2E 6P8
(2) Offsite analysis requires that subcontracted moisture be reported.
(3) Oxidation-Reduction Potential (ORP) values are determined using a Ag/AgCl reference electrode. The test is therefore, not SCC accredited for this matrix.

Your Project #: 22525353/1400
Site Location: HWY 17 WAWA
Your C.O.C. #: N/A

Attention: Matthew Thibeault

WSP Canada Inc.
33 Mackenzie Street
Suite 100
Sudbury, ON
Canada P3C 4Y1

Report Date: 2024/05/31
Report #: R8171529
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

BUREAU VERITAS JOB #: C4E2018
Received: 2024/05/09, 15:30

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:
Julie Clement, Technical Account Manager
Email: Julie.CLEMENT@bureauveritas.com
Phone# (613)868-6079

==========

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation, please refer to the Validation Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Rodney Major, General Manager responsible for Ontario Environmental laboratory operations.

Bureau Veritas Job #: C4E2018
Report Date: 2024/05/31

WSP Canada Inc.
Client Project #: 22525353/1400
Site Location: HWY 17 WAWA
Sampler Initials: MT

RESULTS OF ANALYSES OF SOIL

Bureau Veritas ID		ZDL071			ZDL071		
Sampling Date		2023/06/21 12:00			2023/06/21 12:00		
COC Number		N/A			N/A		
	UNITS	CR-1 SA #4	RDL	QC Batch	CR-1 SA #4 Lab-Dup	RDL	QC Batch
Calculated Parameters							
Resistivity	ohm-cm	4500		9388975			
CONVENTIONALS							
Redox Potential	mV	350	N/A	9394126			
Inorganics							
Soluble (20:1) Chloride (Cl-)	ug/g	89	20	9394545	100	20	9394545
Conductivity	umho/cm	223	2	9396777	222	2	9396777
Available (CaCl2) pH	pH	5.86		9395189			
Soluble (20:1) Sulphate (SO4)	ug/g	27	20	9394555	29	20	9394555
Sulphide	mg/kg	0.6 (1)	0.5	9398411			
Physical Testing							
Moisture-Subcontracted	%	16	0.30	9398410			

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable
(1) Extracted past method specified hold time
Sample contained greater than 10% headspace at time of extraction.

Bureau Veritas 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvna.com

Bureau Veritas Job #: C4E2018
Report Date: 2024/05/31

WSP Canada Inc.
Client Project #: 22525353/1400
Site Location: HWY 17 WAWA
Sampler Initials: MT

TEST SUMMARY

Bureau Veritas ID: ZDL071
Sample ID: CR-1 SA #4
Matrix: Soil

Collected: 2023/06/21
Shipped:
Received: 2024/05/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9394545	2024/05/15	2024/05/16	Alina Dobreanu
Conductivity	AT	9396777	2024/05/16	2024/05/16	Gurparteek KAUR
Moisture (Subcontracted)	BAL	9398410	N/A	2024/05/16	Basilla Ashrafi
Sulphide in Soil	SPEC	9398411	N/A	2024/05/16	Ly Vu
pH CaCl2 EXTRACT	AT	9395189	2024/05/15	2024/05/15	Kien Tran
Redox Potential	COND	9394126	2024/05/15	2024/05/16	Gurparteek KAUR
Resistivity of Soil		9388975	2024/05/16	2024/05/16	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9394555	2024/05/15	2024/05/16	Alina Dobreanu

Bureau Veritas ID: ZDL071 Dup
Sample ID: CR-1 SA #4
Matrix: Soil

Collected: 2023/06/21
Shipped:
Received: 2024/05/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9394545	2024/05/15	2024/05/15	Alina Dobreanu
Conductivity	AT	9396777	2024/05/16	2024/05/16	Gurparteek KAUR
Sulphate (20:1 Extract)	SKAL/EC	9394555	2024/05/15	2024/05/16	Alina Dobreanu

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GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	11.7°C

Results relate only to the items tested.

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Bureau Veritas Job #: C4E2018
Report Date: 2024/05/31

QUALITY ASSURANCE REPORT

WSP Canada Inc.
Client Project #: 22525353/1400
Site Location: HWY 17 WAWA
Sampler Initials: MT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
9394126	Redox Potential	2024/05/16			101	95 - 105			9.4	35
9394545	Soluble (20:1) Chloride (Cl-)	2024/05/15	NC	70 - 130	102	70 - 130	<20	ug/g	11	35
9394555	Soluble (20:1) Sulphate (SO4)	2024/05/16	NC	70 - 130	101	70 - 130	<20	ug/g	7.7	35
9395189	Available (CaCl2) pH	2024/05/15			100	97 - 103			0.82	N/A
9396777	Conductivity	2024/05/16			102	90 - 110	<2	umho/cm	0.47	10
9398410	Moisture-Subcontracted	2024/05/15					<0.30	%		
9398411	Sulphide	2024/05/15	84	75 - 125	106	75 - 125	<0.5	mg/kg	23	30

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

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

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

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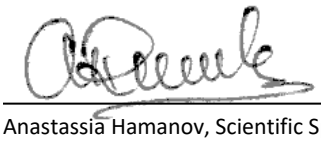
Bureau Veritas Job #: C4E2018
Report Date: 2024/05/31

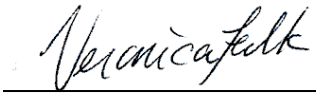
WSP Canada Inc.
Client Project #: 22525353/1400
Site Location: HWY 17 WAWA
Sampler Initials: MT

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:



Anastassia Hamanov, Scientific Specialist



Veronica Falk, B.Sc., P.Chem., QP, Scientific Specialist, Organics

Suwan (Sze Yeung) Fock, B.Sc., Scientific Specialist

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www.BVNA.com

6740 Campobello Road, Mississauga, Ontario L5N 2L8
Phone: 905-817-5700 Fax: 905-817-5779 Toll Free: 800-563-6266

Received in Sudbury

CHAIN OF CUSTODY RECORD

ENV COC - 00014v5

NONT-2024-05-1385

Invoice Information	Invoice to (requires report)	Report Information (if differs from invoice)		Project Information	
Company:	WSP Canada Inc.	Company:		Quotation #:	~~22~~
Contact Name:	Matt Thibeault	Contact Name:		P.O. #/ AFE#:	
Street Address:	33 Mackenzie Street	Street Address:		Project #:	22525353/1400
City:	Sudbury Prov: ON Postal Code: P3C4Y1	City: Prov: Postal Code:		Site #:	Hwy 17 Walla
Phone:	705-561-7012	Phone:		Site Location:	
Email:	matt.thibeault@wsp.com	Email:		Site Location Province:	
Copies:		Copies:		Sampled By:	

Regulatory Criteria

REG 153: Table 1 / Table 2 / Table 3 / Table _____ — Res/Park / Ind/Comm / Agri/other — Med/Fine / Coarse / For RSC

OTHER: CCME / Reg 558* / *min 3 day TAT / MISA / PWQO — Reg 406, Table: _____ / Sanitary Sewer Bylaw / Storm Sewer Bylaw / Municipality _____ / Other: _____

Include Criteria on Certificate of Analysis (check if yes):

SAMPLES MUST BE KEPT COOL (<10°C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

Regular Turnaround Time (TAT): ☐ 5 to 7 Day ☑ 10 Day

Rush Turnaround Time (TAT) Surcharges apply: Same Day ☐ 1 Day / 2 Day ☐ 3 Day / 4 Day

Date Required: YYYY MM DD

	Sample Identification (Please print or Type)	Date Sampled YYYY	MM	DD	Time (24hr) HH	MM	Matrix	1 FIELD FILTERED	2 FIELD PRESERVED	3 LAB FILTRATION REQUIRED	4 BTEX/ F1	5 F2 - F4	6 VOCs	7 Reg 153 metals and inorganics	8 Reg 153 ICPMS metals	9 Reg 153 metals (Hg, Cr VI, ICPMS metals, HWS - B)	10	11	12	13	14	15	16	17	18	19	20	21 # OF CONTAINERS SUBMITTED	22 HOLD - DO NOT ANALYZE	Comments
1	CR-1 Sand	2023	06	21	12	00	Soil																						
2																													
3																													
4																													
5																													
6																													
7																													
8																													
9																													
10																													
11																													
12																													

LAB USE ONLY	Yes	No	°C				Temperature reading by:
Seal present		✓					
Seal intact		✓					
Cooling media present		✓		1 13	2 11	3 11	

LAB USE ONLY	Yes	No	°C			
Seal present	✓					
Seal intact	✓					
Cooling media present	✓			1 5	2 5	3 5

LAB USE ONLY	Yes	No	°C			
Seal present						
Seal intact						
Cooling media present				1	2	3

	Relinquished by: (Signature/ Print)	Date YYYY	MM	DD	Time HH	MM	Received by: (Signature/ Print)	Date YYYY	MM	DD	Time HH	MM	Special instructions
1	Matt Thibeault	2024	05	09	15	05	1 Victor Esparza	2024	05	09	15	30	
2							2 [illegible]	2024	05	11	11	06	

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