Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION INVESTIGATION AND DESIGN REPORT

for

REPLACEMENT OF SOUTH CULVERT AT CNR OVERHEAD
SITE 14X-0290/B2
G.W.P. 3064-11-00
W.P. 3064-11-02
GEOGRAPHICAL TOWNSHIP OF SARNIA
LAMBTON COUNTY, ONTARIO
LATITUDE AND LONGITUDE: 42.955329, -82.345831

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PML Ref.: 20TF017
Index No.: 026FIR and 027FDR
Geocres No.: 40J16-91
January 19, 2022

Peto MacCallum Ltd.
CONSULTING ENGINEERS

PART A - FOUNDATION INVESTIGATION REPORT

for

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Peto MacCallum Ltd.
CONSULTING ENGINEERS

PART A - FOUNDATION INVESTIGATION REPORT
For
Replacement of South Culvert at CNR Overhead, Highway 40
Site 14X-0290/B2, GWP 3064-11-00
Geographical Township of Sarnia
Lambton County, Ontario

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1. INTRODUCTION

The Ministry of Transportation Ontario (MTO) has retained WSP Canada Ltd. (WSP) as the Prime Consultant, to provide Foundation Engineering Services for the detail foundation investigation and design for the new Canadian National Railway (CNR) Overhead on Highway 40. WSP retained Peto MacCallum Ltd. (PML) on behalf of MTO to provide geotechnical engineering services for the assignment.

PML has carried out the foundation investigation work for the new Highway 40 alignment in the Township of Sarnia, Lambton County, Ontario. The foundation investigation work reported herein is for the replacement of the existing south culvert located at the CNR Overhead and Highway 40.

The Scope of Work for the Foundation Engineering services are outlined in the PML proposal, dated April 17, 2020 by PML. The Foundation Investigation and Design Reports for the proposed new CNR overhead structure and Retained Soil System (RSS) walls, and new embankments will be submitted by PML under separate covers.

This report summarizes the results of the foundation investigation carried out to support the replacement of the culvert at Highway 40 and CNR. The culvert is located approximately 480 m south of Confederation Line and Highway 40 intersection, at Station 19+941.4 along the centerline of the new Highway 40 alignment, in Lambton County, Ontario.

The purpose of the investigation was to explore the subsurface conditions expected to influence the design of the foundation options to facilitate the culvert replacement.

The elevations (EL.) in this report are expressed in metres, unless otherwise noted.

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2. SITE DESCRIPTION

The surrounding area is typically flat except for the existing overhead structure embankments. The surrounding areas include transit, industrial and commercial business areas.

The existing culvert is crossing under the existing south embankments at Station 19+942.5. The existing box culvert is approximately 81.2 m long, with an opening size of 1.24 m in span and 1.24 m in rise. The station and dimensions of the culverts are based on the General Arrangement (GA) drawing for the proposed CNR overhead provided by WSP via email dated May 12, 2021. The outlet and inlet inverts of the existing culvert are approximately EL. 185.7 and EL. 185.9, respectively, based on 1964-0307 Contract Drawings provided by WSP via email dated August 11, 2021. The existing "south" culvert is part of the drainage channel system along the existing embankments and across the CNR right-of-way (ROW). The drainage channel system includes ditches, drains and culverts along the toe of the embankments, and a culvert crossing across the CNR ROW. The drawings are attached to this report in Appendix A.

Geocres Report (40J16-013) reported that the CNR had constructed a small embankment about 1.5 m (5.0 ft.) above the original ground level using a heterogeneous fill material of clayey silt, sand, gravel, boulders and cinders prior to construction of the existing Highway 40 and CNR overhead structure.

The existing Highway 40 embankments, north and south of the existing overhead, was placed more than 40 years ago during the construction of the existing overhead structure. Though there were no record of boreholes for this fill, Geocres Report 40J16-61 (1994) indicated that "this approach fill consists of clayey silt to silty clay with varying proportion of sand, boulders and cinders. The thickness of this fill varies from 2.7 m to a maximum of 9.9 m".

3. SITE RECONNAISSANCE

PML staff visited the site with CNR representatives on April 9, 2020 to conduct a site reconnaissance and confirm the accessibility of the boreholes within the existing CNR track alignment and Right-of-way (ROW).

4. PREVIOUS FOUNDATION INVESTIGATION AND SUBSURFACE CONDITIONS

The general subsurface conditions presented in this section are based on the Foundation Investigation Report, GEOCRES 40J16-013, dated March 25, 1963, and GEOCRES 40J16-61, dated October 12, 1994.

The original investigation was carried out for the proposed extension of Highway 40 (Line 'A') crossing the Canadian National Railway tracks by means of an overhead structure.

The Foundation Investigation Report included the Borehole Location and Soil Strata Drawing (Drawing No. 63-F-12A), dated February 1963, which shows the location of Boreholes 1 to 8 and the inferred soil stratigraphy based on the borehole data across the site location. The previous Record of borehole sheets and drawings are provided in Appendix A.

The foundation investigation was carried out between January 29 and February 11, 1963 by Canadian Longyear Drilling Company. The field investigation comprised eight (8) boreholes that were advanced using 125 mm (5 in.) diameter flight augers to depths of 9.3 m to 38.1 m (30.5 ft. to 125.0 ft.), EL. 150.6 to 178.2 (494.0 ft. to 584.5 ft.). A summary of the subsurface soil and groundwater conditions are provided in the following paragraphs.

Very stiff to firm heterogeneous silty clay to clayey silt fill, with sand, gravel, boulders and cinders, was encountered immediately at the ground surface in Boreholes 1, 4 and 5, extending to EL. 186.1 to EL. 185.9. The thickness of the fill ranged from 2.7 m to 3.1 m. Standard Penetration Test (SPT) N values recorded varied between 4 and 24. Moisture content determinations of samples from the fill layer ranged approximately from 9.0% to 23.0%.

Hard to firm clayey silt to silty clay was encountered below the fill in Boreholes 1, 4 and 5, and immediately at the ground surface in the remaining boreholes. Borehole 8 was terminated in this deposit at a depth of 9.3 m, EL. 178.2, below ground surface. In the remaining boreholes, the cohesive deposit extended 36.2 m to 38.2 m, EL. 150.6 to EL. 150.9, below ground surface, overlying probable bedrock. The thickness of the deposit ranged from 35.0 m to 36.9 m, where fully penetrated. Moisture content determinations for the cohesive samples ranged approximately between 8.0%

and 23.0%. The undrained shear strength of the till soil was measured in the field by in-situ vane testing and by unconfined compression tests in the laboratory. The field vane shear test results obtained were between approximately 45 and 132 kPa with sensitivity ranging between 1.5 and 3.0. Laboratory shear strengths obtained for clayey silt till ranged from in excess of 239 kPa (5000.0 psf) in the crust to a minimum 26 kPa (540.0 psf) at EL. 181.1 (594.0 ft.).

Groundwater was observed in all boreholes, except for Borehole 8, during the site investigation between elevations 181.3 m (595.0 ft.) and 186.5 m (612.0 ft.), about 1.1 m (3.5 ft.) to 6.1 m (20 ft.) below ground surface. No artesian water was observed at the site location. Natural gas was observed in all boreholes when contact was made with the bedrock.

For further details, refer to GEOCRES 40J16-013, dated March 25, 1963, and GEOCRES 40J16-61, dated October 12, 1994.

5. CURRENT FIELD INVESTIGATION PROCEDURES

The fieldwork for the foundation investigation was carried out between July 20, 2020 and September 11, 2020. A total of 17 boreholes were drilled for this project. Five (5) boreholes, relevant to the culvert (Boreholes C-1, C-2, C-3, CN-7, and RW-1), were advanced to depths ranging from 11.3 m to 48.7 m below the existing ground surface (EL. 176.2 to EL. 147.0). The borehole location plan, and the soil stratigraphic profile are presented on drawing DWG C-1. A summary of the depths and locations of the boreholes with respect to the proposed replacement structures are provided on Table 1.

Table 1: Summary of Borehole Location Details

BOREHOLE ID	GROUND SURFACE ELEVATION (m)	BOREHOLE DEPTH (m)	COORDINATES			
			NORTHING (MTM ON-11)	EASTING (MTM ON-11)	LATITUDE	LONGITUDE
C-1	187.5	11.3	4 757 278.2	317 429.5	42.955195	-82.345212
C-2	188.8	11.3	4 757 293.0	317 378.9	42.955329	-82.345831
C-3	188.5	41.5	4 757 291.0	317 350.3	42.955311	-82.346182
CN-7	195.9	48.7	4 757 275.2	317 383.1	42.955168	- 82.345780
RW-1	196.0	45.7	4 757 272.4	317 370.3	42.955144	- 82.345938

The borehole locations were selected based on the preliminary Highway 40/CNR Overhead plan and profile drawing, received via email dated November 4, 2019. The locations of these boreholes were reviewed and approved by WSP and MTO prior to commencement of field work.

PML staff used a portable GPS device to establish the borehole locations in the field. Subsequently, PML carried out the survey of the borehole locations as drilled and elevations using a Sokkia SHC5000 Differential GPS system, equipped with a GCX3 (Network RTK rover) GNSS Receiver. The vertical and horizontal accuracy of this equipment are within 0.1 m and 0.5 m, respectively. The survey information provided in this report are referred to in MTM NAD 83 Northing and Easting (MTM Zone – ON11) Geodetic datum and expressed in meters.

PML engineering staff arranged for the clearance of underground services and appropriate permit applications. The respective utility companies cleared the underground services at the borehole locations. Public and private utility authorities were informed, and all of the utility clearance documents were obtained prior to commencement of drilling work.

Due to accessibility issues, borehole CN-6, which was located along the centerline of the existing CNR tracks, was cancelled from the investigation program. Upon discussion and approval by WSP/MTO, Borehole C-3, located at the proposed culvert outlet was extended to a depth of 41.5 m to supplement the bedrock data in lieu of Borehole CN-6. Borehole C-1 was moved approximately 12.4 m southeast from the original staked location due to overhead utilities and drill rig accessibility issues.

The equipment used for drilling were owned and operated by London Soil Test Ltd. of London, Ontario, Aardvark drilling Inc. of Guelph, Ontario) and Drilling Tech of Newmarket, Ontario All specialist drilling contractors worked under the full-time supervision of a PML engineering field supervisor. The boreholes were advanced using DIEDRICH D50T track-mounted drilling rig, CME 75 truck-mounted drilling rig and MARL M5T Track-mounted drilling rig. The drill rigs were equipped with 200 mm diameter hollow stem augers and rotary drilling capable of coring HQ size bedrock core samples. Traffic control was provided by Facca Inc. during the investigation of boreholes CN-7 and RW-1. Water trucks were provided by the respective drillers during bedrock coring. A CNR flag personnel was provided by Facca Inc. during the investigation of boreholes C-2 and C-3.

Representative soil samples were recovered from the boreholes at 0.75 m intervals to 6.0 m depth, at 1.5 m intervals to 20.0 m depth, and at 3.0 m intervals beyond 20.0 m depth using a conventional 51 mm OD split spoon sampler in accordance with the SPT procedure. SPTs were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata. In-situ field vane tests were carried with MTO vane, where the SPT N value recorded was less than 8 blows for 300 mm penetration. Undisturbed samples were recovered by utilizing Shelby (thin wall) tubes, where possible. The recovered soil and rock samples were returned to the PML laboratory for detailed visual examination, and testing.

During drilling, natural methane gas was encountered in Borehole CN-7 from EL. 149.2 to EL. 150.2, in Borehole C-3 at EL. 171.7 and in Borehole RW-1 from EL. 149.3 to EL. 150.3. The drilling activity was immediately stopped when natural gas was encountered, and the gas level was immediately measured in the borehole using RKI Eagle 2. Once the natural gas completely dissipated from the borehole, confirmed by gas reading, drilling activity commenced to the termination depth of the borehole.

The groundwater conditions at the borehole locations were observed during the drilling by visual examination of the soil samples, sampler and drill rods as the samples were retrieved. In addition, water level measurements were taken, using a Solinst flat tape water level reader, in the open boreholes upon completion of drilling. A monitoring well consisting of a 50 mm diameter PVC pipe, was installed in Borehole CN-7. The monitoring well was decommissioned on August 17, 2020. Refer to the Record of Borehole Sheets in Appendix B for details of the monitoring well installation.

Upon completion of drilling and monitoring of groundwater levels in the monitoring wells, the boreholes and monitoring wells were decommissioned in accordance with the MTO guidelines and R.R.O. 1990, Reg. 903: Wells, under Ontario Water Resources Act, as amended.

6. LABORATORY TEST PROCEDURES

6.1 Soil and Rock Testing

Laboratory tests were conducted on representative SPT soil samples and rock core samples recovered during the fieldwork investigation work. Testing was conducted at PML's laboratory facility located in Toronto, Ontario. The laboratory testing program included the following:

- Natural moisture content determinations (90)
- Grain size distribution analysis (23)
- Atterberg limit tests (24)
- One-dimensional consolidation (1)
- Unconfined compressive strength test on rock specimen (4)

All laboratory tests to determine the index properties were performed in accordance with the MTO test procedures, which follow the American Society for Testing Materials (ASTM) standards, with the exception of specific gravity (LS-705) and hydrometer test (LS-702). The one-dimensional consolidation (ODC) test was conducted in accordance with ASTM D2435. The unconfined compressive strength (UCS) test on rock core samples was carried out in accordance with ASTM D4543. The results of the grain size distribution analyses are presented on Figures GS-1 to GS-4. The results of the Atterberg limit tests are presented on Figures PC-1 to PC-4. All the test results are summarized on the attached Record of Borehole Logs and provided in Appendix B.

6.2 Chemical Analysis

A total of 12 representative soil samples were sent to SGS Canada Inc.'s (SGS) laboratory located in Toronto, Ontario, which is accredited by Canadian Analytical Laboratory Association (CALA). The corrosivity test results provided by SGS are presented in Appendix C. A summary of the test results is also presented in Section 7.2.5 Table 3.

7. SITE GEOLOGY AND SUBSURFACE CONDITIONS

7.1 Site Geology

In general, the project area is located within the Lambton clay plains of the St. Clair Clay Plains physiographic region, which consists of lacustrine clay over the underlying till, as outlined in The Physiography of Southern Ontario (Chapman and Putnam, 1984).

The Quaternary Geology map published by the Ontario Ministry of Northern Development and Mines (MNDM), indicates that the surface conditions in the site area consist of St. Joseph Till clays. Based on the Bedrock Geology map (MRD126-REV1, 2011) published by the MNDM, the overhead site lies within Upper Devonian black shale of the Kettle Point formations.

7.2 Subsurface Conditions

Generally, the subsurface soil and groundwater conditions encountered during the current investigation are consistent with the conditions encountered during the previous investigation. The subsurface conditions encountered during the current investigation along with the field and laboratory test results are presented in the attached Record of Borehole Sheets. The borehole locations and stratigraphic profile are shown on drawing DWG C-1. The boundaries between subsurface strata have been established at the borehole locations only. The boundaries of soil and rock strata between and beyond the boreholes are assumed and may vary from location to location.

In general, the subsoil conditions consist of 1.5 m to 9.2 m of fill, which is underlain by approximately 36.5 m to 36.7 m thick of soft to very stiff silty clay/clayey silt deposit, where fully

penetrated, which in turn underlain by Shale bedrock. For classification purposes, the subsurface conditions encountered at this site can be divided into three (3) distinct zones:

1. Fill
   i) Sand and Gravel/Gravelly Sand, trace silt
   ii) Clayey Silt, Some/Trace Sand, Trace Gravel
2. Silty Clay/Clayey Silt, Sandy/Some Sand, Trace Gravel
3. Shale Bedrock

7.2.1 Fill

i. Sand and Gravel/Gravelly Sand Fill

The sand and gravel/gravelly sand fill layer was encountered immediately below the existing ground surface in Boreholes C-2 and C-3, extending to depths of 1.5 m (EL. 187.3) and 0.8 m (EL. 187.7), respectively, below the existing ground surface.

The SPT N value in this layer ranges between 26 blows to 31 blows for 30 cm penetration, indicating compactness condition raging from compact to dense.

The moisture contents of three (3) samples tested from this layer were 2.2%, 4.4%, and 7.4%.

ii. Clayey Silt Fill

The clayey silt fill layer was encountered immediately below the existing ground surface in boreholes C-1, CN-7, and RW-1, and below the sand and gravel/gravelly sand fill layer in boreholes C-2 and C-3. The deposit ranges from 0.8 m to 9.2 m in thickness, and extends to depths ranging from 1.5 m to 9.2 m (EL. 187.0 to EL. 185.8), below the existing ground surface.

The SPT N values in this layer range from 6 blows to 16 blows for 30 cm penetration, indicating firm to very stiff consistency.

In-situ vane shear tests were carried out at depths where low ‘N’ values were observed. In-situ vane test was performed at five (5) locations in Boreholes CN-7 and RW-1 between EL. 195.0 and

EL. 191.0 within the fill layer, and all these measured vane shear strengths (C_u) exceeded 120 kPa, indicating very stiff consistency.

The moisture content of the samples tested from this layer varies from 5% to 26.3%, with an average value of 15.7%. The results of the sieve and hydrometer analysis tests performed on three (3) representative samples from this layer are provided on Figures GS-1. The test results indicate that this deposit consists of 1% to 6% gravel, 18% to 34% sand, 29% to 47% silt, and 31% to 37% clay sized particles. Atterberg limits tests were performed on the same samples selected for sieve analysis and the results are provided on Figures PC-1. The test results indicate liquid limit values ranging from 30 to 35, plastic limit values ranging from 15 to 16, and the corresponding plasticity index values ranging from 15 to 20. Based on the test results, the fill may be classified as Clayey Silt (CL) in the MTO classification system.

7.2.2 Clayey Silt/Silty Clay

This clayey silt/silty clay layer was encountered immediately below the fill in all investigated boreholes. The thickness of this layer ranged from 36.5 m to 36.7 m in Boreholes C-3, CN-7 and RW-1, where the layer was fully penetrated. This layer was not fully penetrated in Boreholes C-1, and C-2, extending to the borehole termination depths of 11.3 m (EL. 176.2 and EL. 177.5). During drilling, natural methane gas was encountered in Borehole CN-7 from EL. 149.2 to EL. 150.2, in Borehole C-3 at EL. 171.7 and in Borehole RW-1 from EL. 149.3 to EL. 150.3.

The SPT N values in this layer vary from as low as 1 blow to over 30 blows for 30 cm penetration, indicating very soft to hard consistency. Within this layer, in-situ vane shear tests were carried out at 18 locations and the vane shear strengths (C_u) measured ranged from 33 kPa to 120 kPa, with a sensitivity ratio value between 1 and 2, indicating firm to very stiff consistency, compared to the very soft to hard consistency based on SPT N values.

The moisture content of samples tested from this layer varies from 2.3% to 41.7%, with an average value of 21.5%. The results of the sieve and hydrometer analysis test performed on 18 representative samples from this layer are provided on Figures GS-2 and GS-3. The test results indicate that this deposit consists of 0% to 4% gravel, 8% to 27% sand, 39% to 64% silt, and 27% to 50% clay sized

particles. Atterberg limits tests were performed on 19 samples, which included samples selected for grain size analysis, and the results are provided on Figures PC-2 and PC-3. The test results indicate liquid limit values ranging from 24 to 41, plastic limit values ranging from 13 to 21, and the corresponding plasticity index values ranging from 10 to 21. Based on the test results, this layer may be as Clayey Silt (CL) / Silty Clay (CI) in the MTO classification system.

The results of the sieve and hydrometer analysis tests performed on two (2) representative samples from the clayey sand seams are provided on Figure GS-4. Atterberg limits tests performed the same samples, and the results are provided on Figure PC-4.

One-dimensional consolidation test was conducted on one (1) Shelby tube sample (Sample 15; Depth 15.2 to 15.8 m) obtained from Borehole CN-7, and the test results are provided in Appendix B. The estimated present effective overburden pressure (σ'_{vo}) is 216.0 kPa, the preconsolidation pressure (σ'_{p}) was estimated to be 491 kPa, an approximate compression index (c_c) value of 0.30 was determined, and an approximate value of 0.07 was determined for the recompression index (c_{cr}). The virgin consolidation curve including σ'_{vo}, σ'_{p}, c_c and c_{cr} are presented in Appendix B, Figure CT-2.

As part of the one-dimensional consolidation and particle size analysis of soils (LS-702), specific gravity and unit weight tests were also performed on the selected sample. Specific gravity and unit weight tests were conducted on five (5) additional split spoon soil samples selected from Boreholes C-3 and CN-7. The specific gravity of the selected samples were 2.709 and 2.744. The unit weights of the tested samples ranged from 18.1 kN/m^3 to 20.4 kN/m^3.

7.2.3 Shale Bedrock

Borehole RW-1 was terminated on probable bedrock at 45.7 m (EL. 150.3).

Bedrock was encountered in Boreholes C-3 and CN-7, below the existing ground surface at elevations of EL. 150.3 and 150.2, respectively. The presence of bedrock was confirmed by obtaining 3.0 m and 3.3 m of rock cores from the boreholes. The boreholes were advanced using a HQ sized core barrel. The rock core recovery ranged from 74% to 100% and the Rock Quality Designation (RQD) of the rock

cores ranged from 75% to 100%, with the exception of Run 1 in borehole C-3 which had an RQD of 0%. Based on the RQD value, the quality of the bedrock at this site may be described as fair to excellent with the exception of Run 1 in borehole C-3, which is described as very poor.

Unconfined compressive strength (UCS) of four (4) rock core samples tested ranged from 60.8 MPa to 84.1 MPa. Based on the unconfined compression test values, the bedrock may be classified as Type R4 (strong) with respect to strength.

The bedrock was identified as unweathered Shale bedrock. For complete description of the bedrock, refer to the Rock Core Photographs and the Rock Core Description logs provided in Appendix B.

7.2.4 Groundwater Conditions

Groundwater was encountered upon completion of drilling in boreholes C-2, CN-7, and RW-1 at depths of 6.1 m (EL. 182.7), 8.2 m (EL. 187.7), and 9.1 m (EL. 186.9), respectively, below the existing ground surface. The groundwater level was not encountered or could not be established during drilling or upon completion of drilling in Boreholes C-1 and C-3. Groundwater levels are shown on the Record of Borehole sheets in Appendix B. Groundwater levels may fluctuate due to the influence of precipitation and seasonal changes.

A monitoring well, consisting of a 50 mm diameter PVC pipe, was installed in Borehole CN-7. Groundwater level readings following the installation of monitoring wells are shown on the Record of Borehole Sheets provided in Appendix B, and summarized in Table 2.

Table 2: Summary of Groundwater Level in Monitoring Wells

BOREHOLE NO. (Ground Surface Elevation)	GROUNDWATER LEVEL UPON COMPLETION OF DRILLING		GROUNDWATER LEVEL MEASURED IN MONITORING WELL					
	DEPTH (m)	EL. (m)	DEPTH (m)	EL. (m)	DEPTH (m)	EL. (m)	DEPTH (m)	EL. (m)
			JULY 22, 2020		AUGUST 10, 2020		AUGUST 17, 2020	
CN-7 (195.9)	8.0	187.9	8.0	187.9	7.9	188.0	8.9	187.0

7.2.5 Chemical Analysis

A total of 12 representative soil samples from the five (5) boreholes were sent to SGS for corrosivity test. The corrosivity test results provided by SGS are presented in Appendix B. A summary of the test results is presented in Table 3.

Table 3: Summary of Soil Chemical Analysis Results

BOREHOLE No.	SAMPLE No.	DEPTH (m)	CORROSIVITY INDEX	CONDUCTIVITY (µS/cm)	SULPHATE (µg/g)	CHLORIDE (µg/g)	pH	RESISTIVITY (Ohm-cm)
C-1	5	3.81-4.42	10	415	190	91	8.55	2410
C-1	8	7.62-8.23	8	237	200	9.4	8.51	4220
C-2	5	4.57-5.18	4	130	240	13	8.35	7700
C-2	7	6.10-6.71	4	274	230	9.1	8.2	3650
C-3	6	3.66-4.27	6	527	3.1	37	7.75	1900
C-3	8	7.62-8.23	8	169	220	7.6	9.05	5910
C-3	12	13.72-14.33	6	404	310	12	8.37	2480
C-3	20	32.00-32.61	4	159	420	32	8.41	6290
RW-1	10	7.6 - 8.2	1	174	49	3.6	8.50	5740
RW-1	16	16.8 - 17.4	8	387	190	10	8.50	2580
CN-7	19	22.9 - 23.5	8	308	340	12	8.54	3250
CN-7	25	39.6 - 40.2	8	387	480	30	8.54	2580

8. CLOSURE

Mr. M. Mohamed carried out the field investigations under the supervision of Mr. Nazibur Rahman, P.Eng. This report was prepared by Ms. Natasha Leong-Sem, EIT and reviewed by Mr. Nazibur Rahman, P.Eng. Mr. Robert Ng, P.Eng., Designated Principal Contact, conducted an independent review of the report.

Yours very truly,

Peto MacCallum Ltd.

Natasha Leong-Sem
EIT, Geotechnical Services

Nazibur Rahman, P.Eng.
Senior Engineer, Geotechnical Services

Robert Ng, MBA, PhD, P.Eng.
MTO Designated Principal Contact

NLS/NR//RN: nls-nr-nk

APPENDIX A

Previous Borehole Logs and Drawings (GEOCRES 40J16-013)
1964-0307 Contract Drawings

...MENT OF HIGHWAYS - ONTARIO
...RIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

... 63-F-12 LOCATION 276+14 53' Lt. ORIGINATED BY T.F.W.
... 53-63 BORING DATE Jan. 29, 1963. COMPILED BY T.F.W.
...M Geodetic BOREHOLE TYPE 5" Ø Auger. CHECKED BY H.S.

SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT — SHEAR STRENGTH P.S.F. + Field Vane o Unconfined Shear Strength (500 1000 1500 2000 2500)	LIQUID LIMIT w_L — PLASTIC LIMIT w_P — WATER CONTENT w — WATER CONTENT % (20 40 60)	BULK DENSITY γ P.C.F.	REMARKS
619.5 Groundlevel					620				
0.0 Hard to soft Heterogeneous clay fill.		1	SS	24					
		2	SS	4					
610.5					610				▽W.L. 611.5
9.0		3	SS	42				137.0	8.0
		4	SS	22					
Hard to firm Brown to grey clay silt with sand and gravel.					600	2.0		128.0	
		5	TW	PH					
		6	TW	PH		1.8		133.0	
		7	TW	PH	590	1.8		128.0	
		8	TW	PH				128.0	
580.5									
39.0		9	TW	PH	580			128.0	
		10	SS	26					
		11	SS	27	570			133.0	
Very stiff Grey silty clay with sand and gravel.		12	SS	22				129.0	
		13	SS	26	560			128.0	
		14	SS	27				130.0	
		15	SS	22	550				
		16	TW	PH	540				
					530				
					520				
		17	SS	23					
					510				
					500				
494.0									
125.0 End of borehole Probable Bedrock.					490				

FORM OB MI 26 REV ... DEPTH REPORT ON SOIL EXPLORATION

81-4391

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 63-F-12 LOCATION 275+52 ℄ ORIGINATED BY T.F.W.

W P 53-63 BORING DATE Feb. 1, 1963. COMPILED BY T.F.W.

DATUM Geodetic BOREHOLE TYPE 5" Ø Auger CHECKED BY H.S.

ELEV. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE
614.0	Groundlevel					620
0.0	Hard to firm Brown to grey clayey silt with sand and gravel.		1	SS	18	610
			2	TW		
			3	SS	42	
			4	TW		
			5	SS	25	
			6	TW	PH	600
			7	TW	PH	
			8	TW	PH	590
			9	TW	PH	
			10	SS	P	580
			11	TW	PH	
575.0						
39.0	Very stiff to firm, grey, silty clay with sand and gravel.		12	TW	PH	
			13	TW	PH	570
			14	TW	PH	
			15	TW	PH	560
			16	TW	PH	550
			17	TW	PH	540
			18	TW	PH	530
			19	TW	PH	520
			20	TW	PH	510
495.0						500
119.0	Shale Bedrock.		21	SS	30 for ½"	
490.0	End of borehole.					490
124.0						

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.
+ Field Vane
○ Unconfined Shear Strength
1000 2000 3000 4000 5000

1.6 (+)
2.2 (+)
>4550 (⊙)

LIQUID LIMIT ——— w_L
PLASTIC LIMIT ——— w_P
WATER CONTENT ——— w
w_P w w_L
WATER CONTENT %
20 40 60

BULK DENSITY γ P.C.F.	REMARKS
137.0	▽wl 610.0 4.0
133.0	
133.0	
133.0	
128.0	
123.0	
125.0	
125.0	
125.0	
130.0	
130.0	
129.0	
126.0	
129.0	
122.0	
125.0	
123.0	

DEPARTMENT OF HIGHWAYS ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 63-F-12 LOCATION 275/52 48.0' Rt. ORIGINATED BY T.F.W.
W.P 53-63 BORING DATE Feb. 5, 1963. COMPILED BY T.F.W.
DATUM Geodetic BOREHOLE TYPE 5" Ø Auger CHECKED BY H.S.

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FOOT	ELEV SCALE
614	Groundlevel					620
						610
	Hard to firm. Brown to grey clayey silt with sand and gravel.		1	SS	29	
			2	SS	25	
			3	TW	PH	600
			4	TW	PH	
			5	TW	PH	590
			6	TW	PH	
			7	TW	PH	580
						570
						560
						550
						540
						530
						520
						510
						500
495.0						
119.0	End of borehole Probable Bedrock.					

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT
SHEAR STRENGTH P.S.F.
+ Field Vane
o Unconfined Shear Strength
500 1000 1500 2000 2500

2.1
2.0
1.8
1.8

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT %
20 40 60

BULK DENSITY P.C.F.	REMARKS
136	▽wl 610.5 3.5
137.0	
139.0	
128.0	
129.0	
129.	

...HWAYS - ONTARIO
...RESEARCH DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

...-12 LOCATION 276+55 33' Rt. ORIGINATED BY T.F.W.

...-62 BORING DATE Feb. 6, 1963. COMPILED BY T.F.W.

...odetic BOREHOLE TYPE 5" Ø Auger. CHECKED BY H.S.

...OFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT; SHEAR STRENGTH P.S.F. + Field Vane o Unconfined Shear strength (500 1000 1500 2000 2500)	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w (w_P w w_L) WATER CONTENT % (20 40 60)	BULK DENSITY γ P.C.F.	REMARKS
...oundlevel					620				
...terogeneous fill. ...ayey silt with sand ...d boulders.		1	SS	10					
		2	SS	8					▽wl 612.0 8.0
		3	SS	20	610				
		4	SS	38					
		5	SS	10	600	1.8			
		6	TW	PH		o 1.7 +		130.0	
...rd to firm. ...rown to grey clayey ...lt with sand and ...avel.		7	TW	PH	590	o 1.7 +		129.0	
		8	TW	PH	580			130.0	
					570				
					560				
					550				
					540				
					530				
					520				
					510				
					500				
End of borehole. Probable Bedrock.									

FORM OB-ML-136 REV 1961 OFFICE REPORT ON SOIL EXPLORATION

61-4391

DEPARTMENT OF HIGHWAYS ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 63-F-12 LOCATION 276/55 29.0' Lt. ORIGINATED BY T.F.W.

W P 53-63 BORING DATE Feb. 7, 1963. COMPILED BY T.F.W.

DATUM Geodetic BOREHOLE TYPE 5" Ø Auger CHECKED BY H.S.

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT; SHEAR STRENGTH P.S.F + Field Vane, o Unconfined Shear Strength (500 1000 1500 2000 2500)	LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w; WATER CONTENT % (20 40 60)	BULK DENSITY P.C.F.	REMARKS
619.5	Groundlevel					620				
0.0	Heterogeneous fill. Clayey silt with sand and boulders.		1	SS	6					
			2	TW	PH	610			119.0	▽wl 611.5 8.0
610.5			3	SS	29				131.0	
9.0	Hard to firm. Brown to grey clayey silt with sand and gravel.		4	SS	40					
			5	TW	PH	600	1.5		132.0	
			6	TW	PH		2.3		130.0	
			7	TW	PH	590	1.8		128.0	
			8	TW	PH		1.8		128.0	
			9	TW	PH	580			129.0	
						570				
						560				
						550				
						540				
						530				
						520				
						510				
						500				
494.0										
125.0	End of borehole. Probable Bedrock.									

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

HWY 63-F-12 LOCATION 277+65 38.0' Lt. ORIGINATED BY T.F.W.
W.P. 53-63 BORING DATE Feb. 8, 1963. COMPILED BY T.F.W.
DATUM Geodetic BOREHOLE TYPE 5" Ø Auger CHECKED BY H.S.

ELEV / DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT — SHEAR STRENGTH P.S.F. + Field Vane o Unconfined Shear Strength (500 1000 1500 2000 2500)	LIQUID LIMIT w_L — PLASTIC LIMIT w_P — WATER CONTENT w (w_P w w_L) — WATER CONTENT % (20 40 60)	BULK DENSITY γ P.C.F.	REMARKS
						620				
615.0 / 0.0	Groundlevel									
			1	SS	14	610			134.0	
			2	SS	31				142	
			3	SS	37				137	
	Hard to firm Brown to grey clayey silt with sand and gravel.		4	TW	PH	600	2		131	▽ wl 599
			5	TW	PH		1.8		132	16.0
			6	TW	PH	590	1.8		125	
			7	TW	PH		1.8		128	
			8	TW	PH	580	1.5		128	
			9	TW	PH				130	
						570				
						560				
						550				
						540				
						530				
						520				
						510				
						500				
494.5 / 120.5	End of borehole Probable Bedrock									

FORM OB W 26 REV 961

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

JOB 63-F-12 LOCATION 278/00 49.0' Rt. ORIGINATED BY T.F.W.

W P 53-63 BORING DATE Feb. 11, 1963. COMPILED BY T.F.W.

DATUM Geodetic BOREHOLE TYPE 5" Ø Auger CHECKED BY H.S.

ELEV / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — SHEAR STRENGTH P.S.F. + Field Vane o Unconfined Shear Strength (500 1000 1500 2000 2500)	LIQUID LIMIT w_L — PLASTIC LIMIT w_P — WATER CONTENT w (WATER CONTENT % 20 40 60)	BULK DENSITY P C F.	REMARKS
615.0 / 0.0	Groundlevel					620				
	Hard to firm Brown to grey clayey silt with sand and gravel.		1	TW	PH	610	>5000		128	
			2	TW	PH					
			3	TW	PH		1.8			
			4	TW	PH	600	2.5		133	
			5	TW	PH		1.8		128	▽wl 595.0 2.0
			6	TW	PH	590	3.0		129	
			7	TW	PH		1.6		128	
			8	TW	PH	580			128	
570.0 / 45.0			9	TW	PH	570			128	
	Very stiff to stiff grey. Silty clay with sand and gravel.		10	TW	PH	560			128.0	
			11	TW	PH	550			125.0	
			12	TW	PH	540			125.0	
			13	TW	PH	530			124.0	
			14	TW	PH	520			124.0	
			15	TW	PH	510			125.0	
			16	TW	PH	500			124.0	
494.0										
121.0	Shale Bedrock									
122.0	End of borehole					490				

...TMENT OF HIGHWAYS - ONTARIO
...RIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 8

FOUNDATION SECTION

63-F-12 LOCATION 278/12 50.0' Lt. ORIGINATED BY T.F.W.

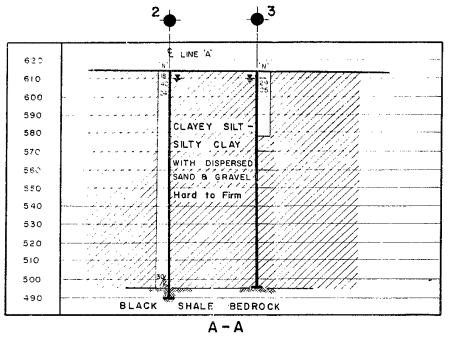
53-63 BORING DATE Feb. 11, 1963. COMPILED BY T.F.W.

...TUM Geodetic BOREHOLE TYPE 5" Ø Auger CHECKED BY H.S.

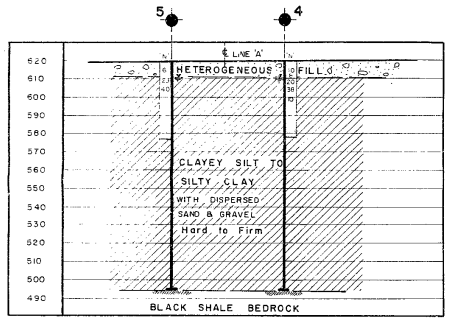
SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT — SHEAR STRENGTH P.S.F. + Field Vane o Unconfined Shear Strength (500 1000 1500 2000 2500)	LIQUID LIMIT — w_L PLASTIC LIMIT — w_P WATER CONTENT — w (WATER CONTENT % 20 40 60)	BULK DENSITY P.C.F.	REMARKS
					620				
35.0 Groundlevel 0.0									
Hard to firm Brown to grey clayey silt with sand and gravel.		1	SS	27	610		o	137	
		2	SS	36			o	137.0	
		3	TW	PH	600	o 2.0 +	o	132.0	
		4	TW	PH		o 2.0 +	o	127.0	
		5	SS	9	590	2.1 +			
34.5		6	SS	21		1.8 +	o	132.0	
30.5 End of borehole.					580				

390250 E
4756500 N

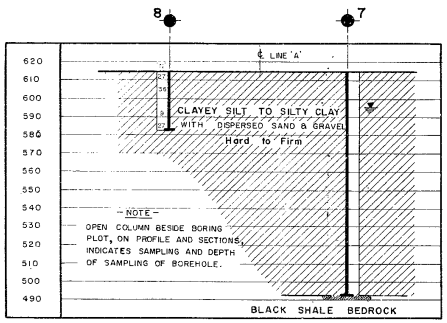
40J16W



A-A



B-B

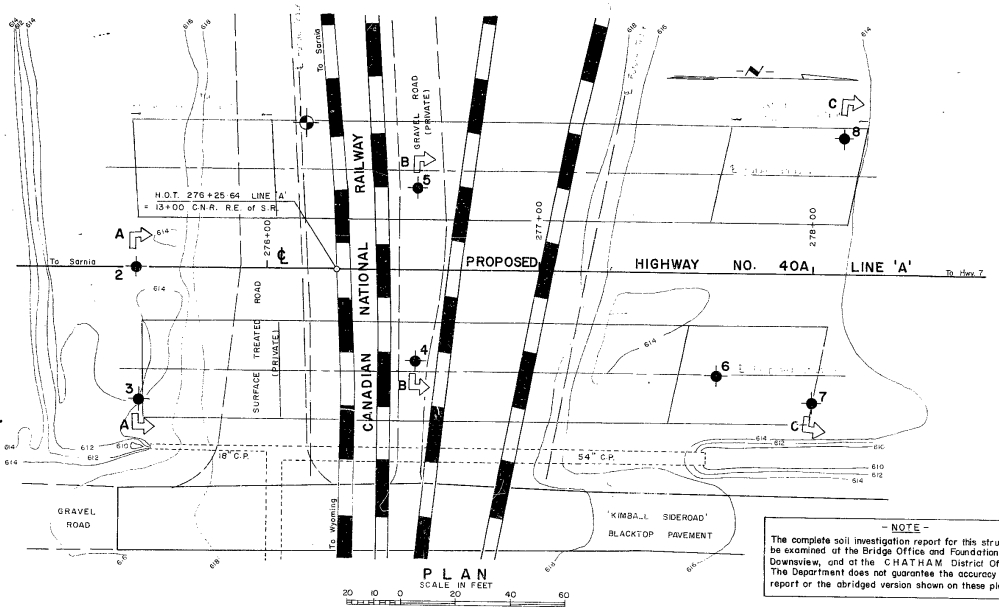


C-C

SECTIONS

SCALE IN FEET

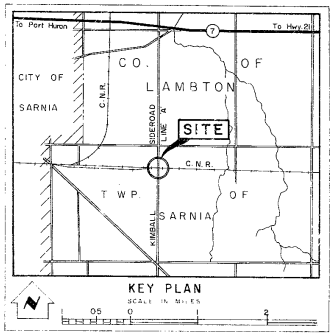
30 15 0 30 60 90



PLAN

SCALE IN FEET

20 10 0 20 40 60



KEY PLAN

SCALE IN MILES

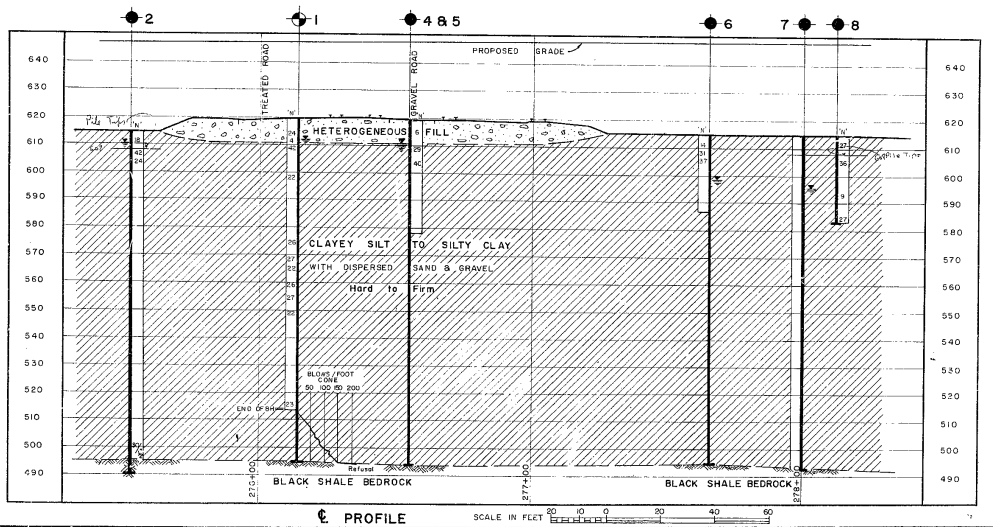
LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established during field investigation Feb. 1963

NO.	ELEVATION	STATION	OFFSET
1	619.5	276+14	53'LT.
2	614.0	275+52	℄
3	314.0	275+52	48'RT.
4	620.0	276+55	33'RT.
5	619.5	276+59	29'LT.
6	615.0	277+65	38'RT.
7	615.0	278+00	49'RT.
8	615.0	278+12	50'LT.

- NOTE -

The complete soil investigation report for this structure may be examined at the Bridge Office and Foundation Office, Downsview, and at the CHATHAM District Office. The Department does not guarantee the accuracy of this report or the abridged version shown on these plans.



℄ PROFILE

SCALE IN FEET 20 10 0 20 40 60

- NOTE -

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

PRINT RECORD

NO.	FOR	DATE

REVISIONS

DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

CANADIAN NATIONAL RAILWAY

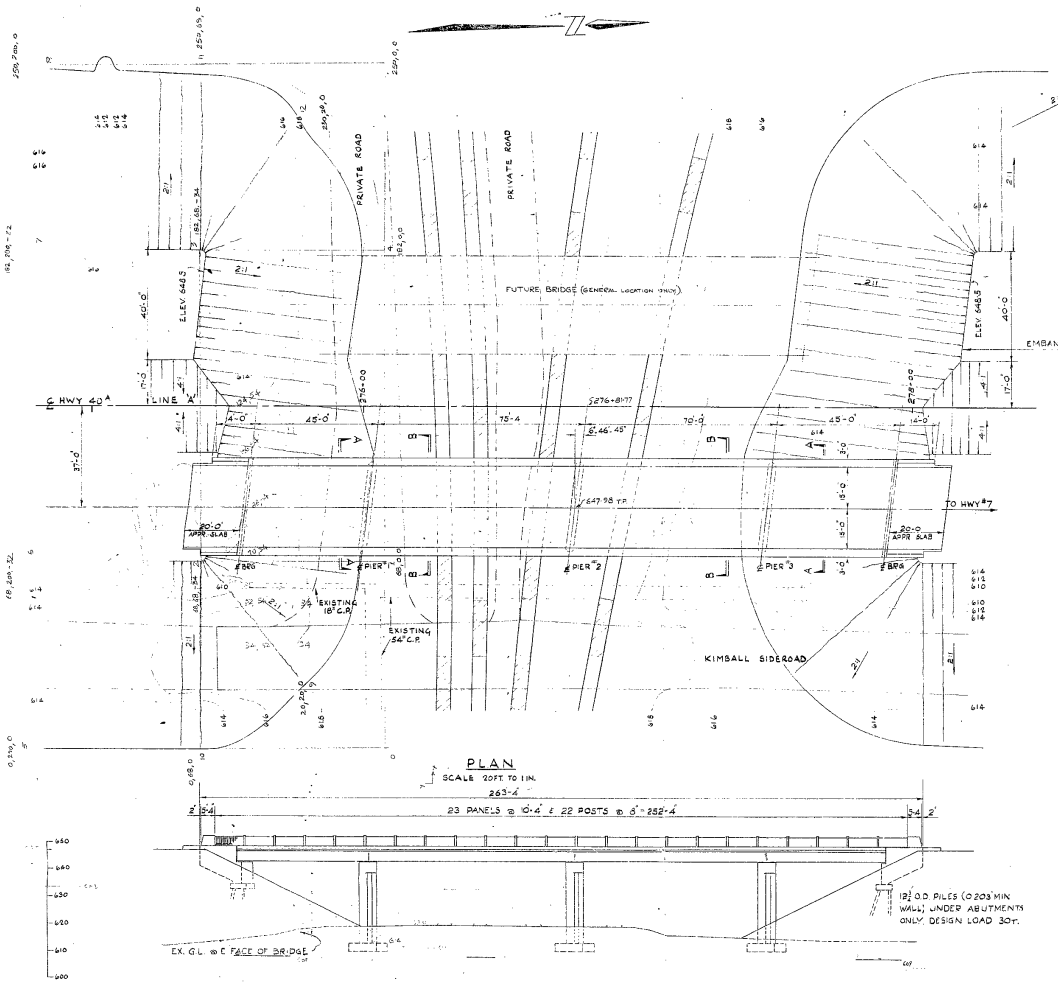
KING'S HIGHWAY NO. 40A LINE 'A' REVISION DIST. NO. 1

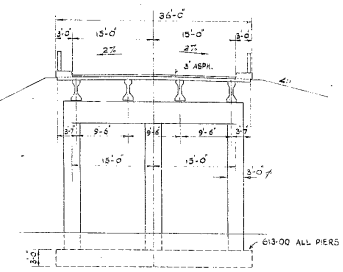
CO. LAMBTON

TWP. SARNIA LOT 15 & 16 CON. IV

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D T.W.	CHECKED J.P.	W.P. NO. 53-63	M.&R. DRAWING NO. 63-F-12A
DRAWN F.C.	CHECKED	JOB NO. 63-F-12	
DATE FEB. 18, 1963		SITE NO.	BRIDGE DRAWING NO.
APPROVED		CONT. NO.	



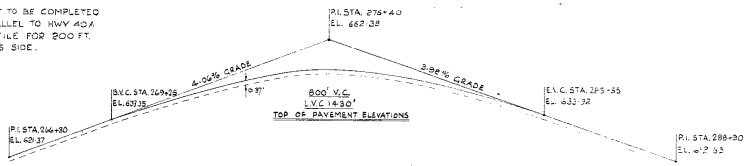


A-A

B-B

CROSS SECTIONS

SCALE 10FT TO 1 IN.



PROFILE OF HWY #40A
LINE 'A'
N.T.S.

GEODETIC DATUM
B.M. Elev. 614.79 N.&W. in W. root of 1'-0" maple 180'-0" rt. of Sta. 275+77

REFERENCE PLANS
C-2889
E-4168-1
C-179-11
B-179-15
BA-1617

DRAWING LIST

NOTES

TO CONTRACTOR
Structure to be built in accordance with Form No. 9 and the special provisions, extra copies of which may be obtained from the Engineer.

CONCRETE MIX

	MIN. STRENGTH AT 28 DAYS	MAX. SIZE AGGREGATE
Footings	3000 P.S.I.	¾"
Elsewhere	5000 P.S.I.	¾"

CLEAR COVER ON REINFORCING STEEL (Unless otherwise stated.)
Footings 3", Abutments 2", Piers 2", Deck 1¼", End Posts 1½", Approach Slabs 1½".

CONSTRUCTION NOTES
All exposed edges to be chamfered 1" x 1" except as noted.
All construction joints must be approved by the engineer.
Ballast walls shall not be poured until the Deck has been constructed.

PRINT RECORD

No.	FOR	DATE

REVISIONS			
	DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

C.N.R. O'HEAD ON HWY 40A
2 MILES SOUTH OF HIGHWAY 402

KING'S HIGHWAY No. 40A — DIST. No. 1
CO. LAMBTON
TWP. SARNIA — LOT 15 & 16 — CON. IV

PRELIMINARY GENERAL PLAN

APPROVED ... BRIDGE ENGINEER			SITE No.	W.P. No. 53-63	
DESIGN	CHECK		CONTRACT Nos.		
DRAWING	CHECK				
DATE AUG. 63	LOADING H20-S16		DRAWING No.	D-5312-P1	

Form PL-RD-36A

CONTRACT No. 64-307
W.P. No. 200-62

9

FEMCO
FOUNDATION OF CANADA ENGINEERING CORPORATION LIMITED
No. 2584-H-7

E.C. 20+80.84

CURVE DATA
Δ - 102°30'
D - 15°00' LT.
R - 381.97'
T - 475.93'
L - 683.33'
E - 228.28'

INV. EL. 611.80
INV. EL. 611.50
INV. EL. 610.00
INV. EL. 612.90
INV. EL. 608.40

C.N.R. MAIN LINE TO LONDON
C.N.R. MILEAGE 56.70
H.O.T. 276+25.64 C.N.R. MEDIAN
H.O.T. 279+25.21 C.N.R.
H.O.T. 285+02.05 C.N.R.
H.O.T. 293+00.64 C.N.R.

C.N.R. SERVICE ROAD
Pl. STA. 265+44.05 ℄ MEDIAN
Pl. STA. 267+93.81 RD.
R/W
℄ OF DITCH
TRANSITION SECTION DD 604-A
CURB DD 601-K
FUTURE LANE
℄ MEDIAN
Pl. STA. 18+73.44
℄ CULV. Nº68
℄ OF 15/16 SIDEROAD DRAIN
MATERIAL EXCAVATED FROM OPEN DRAIN NOT TO BE PLACED ON PRIVATE PROPERTY
C.I.P. 24"ø P.C.
TOPSOIL FROM OPEN DRAIN TO BE STOCKPILED WEST OF DRAIN OR DISPOSED AS DIRECTED BY ENGINEER
CONFEDERATION ROAD
H.O.T. STA. 375+59.91

TYPICAL CROSS-SECTION A-A OF 15/16 SIDE ROAD DRAIN.
SCALE 1"=10 FEET.
℄ OF DRAIN
VARIABLE
40'
5'
D.H.O. RIGHT OF WAY
2:1
GRADE OF DRAIN
1.5'
3'

CULVERT Nº71 STA. 292+73 EXISTING

P.I. STA. 256+48.55

CURB & GUTTER DD 601-A
C.B. SETBACK DD-609
℄ OF DITCH
R/W
16" ø TILE
15/16 SIDEROAD DRAIN
H.O.T. 272+83.39
DITCH EL. 612.34
INV. EL. 609.90
INV. EL. 609.20
INV. EL. 609.10
FOR DETAILS SEE DWG. Nº 2584-H-23
TRANSITION SECTION DD 602-J
℄ CULV. Nº67
INV. EL. 608.75
INV. EL. 608.80
C.B. DD 702
INTERSECTION
(SEE DETAIL ON DWG. 2584-H-2)
D.I.M.H. DD 707C
6" TILE CONNECTION TO M.H.
EXISTING TILE

CURVE DATA ℄ MEDIAN
A - 4°29'15"
D - 0°30' RT.
R - 11,459.15'
T - 448.98'
L - 897.50'
E - 8.79'

CURVE DATA ℄ ROAD
A - 2°28'32"
D - 0.5102°
R - 11,422.15'
T - 247.59'
L - 495.11'
E - 2.69'

E.C. 269+91.35 RD. BK.
℄ E.C. 269+98.87 RD. AHD.
℄ E.C. 269+92.57 MED. 57' RT.

NOTES.
FOR GRADING DETAILS & PRIVATE ENTRANCES SEE DRAWING Nº 2584-H-16
FOR ALIGNMENT OF C.N.R. SERVICE ROAD SEE DRAWING Nº 2584-H-21

PLAN
ALIGNMENT AND MUNICIPAL DRAIN

+40 P.I. 662.01

PROFILE GRADE
+4.06 %
-3.98 %
-0.172 %
V.C. 600' L.V.C. 426'
V.C. 600' L.V.C. 1430'
V.C. 600' L.V.C. 380'
P.I. STA. 231+00 EL. 625.50
P.I. STA. 309+00 EL. 610.00
+68.4 P.I. 618.50
+58.79 P.I. 613.50
BOTTOM OF DITCH LEFT
EL. 613.60
EL. 612.50
C 14 SS 16" ø TILE 0.144% 1396'
DITCH GRADE RIGHT
CULV. Nº67.
CULV. Nº68.
EXISTING GROUND LINE
EL. 608.40
EL. 607.79
BOTTOM OF DITCH (CHANNEL)
INV. EL. 609.45
INV. EL. 609.90
INV. EL. 609.10
INV. EL. 608.75
INV. EL. 608.80
C.B. Nº 36
EL. 603.60
D.I.M.H. DD-707-C.
C76-57 T III.42"ø 100'
C.B. DD 702 TOP OF GRATE EL 612-7 INV. OUT EL. 608-50 LEFT 24"ø C.I.P. 260' OUTLET EL. 607-00
D.I.M.H. DD 707C TOP OF GRATE EL. 607-50 INV. OUT. EL. 604-70 LEFT 24"ø C.I.P. 214' OUTLET EL. 604-20
STA. 292+73 ℄ OF CONFEDERATION RD.
℄ MEDIAN CURVE
Δ-4°29'15" D-0°30' RT. T-448.98' L-897.50' E-8.79'
269+92.57 E.C.
B.M. ELEV. 614.79 N.S.W. IN W. ROOT OF 10" MAPLE 180.0 RT. OF STA. 275+77

650
640
630
620
610

SCALES
50 0 100
Horizontal
5 0 10
Vertical

CENTRE LINE PAVEMENT ELEVATION	620.07	21.81	24.56	28.29	32.35	36.25	39.61	42.40	44.63	46.30	47.41	47.96	47.93	47.36	46.22	44.52	42.25	39.42	36.03	32.14	28.16	24.18	20.25	17.08	14.92	13.76	13.47	13.30	13.13	12.96	12.79
Earth Cut																															
Sub-Excavation																															
Stripping														ST. 500 C.Y.																	
Ditching														D. 1,200 C.Y.																	
Muskeg Excavation																															
Earth Fill																															
Rock Cut																															
Shatter																															
Rock Fill																															
Muskeg Backfill																															
Drain Grade														- 0.30 %							- 0.306 %								- 0.137 %	

Drain Totals C.Y.	
Earth Cut	
Sub-Excavation	
Stripping	1,250
Ditching	3,800
Muskeg Excav.	
Earth Fill	
Rock Cut	
Shatter	
Rock Fill	
Muskeg Backfill	
Drain Grade	

Form PL-RD-36A

CONTRACT No. 64-307
W.P. No. 200-62

FENCO
FOUNDATION OF CANADA ENGINEERING CORPORATION LIMITED

18

No. 2584-H-16

PLAN
GRADING AND DRAINAGE

CON. IV
LOT 16

CON. V
LOT 16

LOT 15
CON. IV

LOT 15
CON. V

G. MILLIKEN

T. SAGAN

SANDERCOCK

STANDARD	Nos OF C.B.
DD-701 (M.H.)	19 21 24 28 31 34 35B
DD-702 (C.B)	18A 22 25 29 32 35 35A 36
DD-707-C	26 37
DD-707-F	20 23 27 30 18 33

C.B. TO C.B.	DESCRIPTION OF PIPES
18-19	24"ø C 76-57 T III
19-OUT	24"ø C.I.P. 14 GAUGE RG.
33-OUT	24"ø C.I.P. 14 GAUGE RG.
26-BOX	42"ø C 76-57 T III
20-21	12"ø C 14-SS
21-22	" "
23-24	" "
24-25	" "
27-28	" "
28-29	" "
30-31	" "
31-32	" "
34-35	" "
34-33	" "
23-20	" "
20-18	" "
33-30	" "
30-27	" "
18A-OUT	12"ø C.I.P. 16 GAUGE RG.
33-OUT	24"ø C.I.P. 14 GAUGE RG.
359-OUT	12"ø C.I.P. 16 GAUGE RG.
35A-35B	12"ø C 14-SS

NOTE 'W'
EXIST. 54" CONC PIPE UNDER RAILWAY TRACKS TO BE PLUGGED AND FILLED WITH CONCRETE f'c 1500 PSI. IN THE LENGTH DIRECTED BY THE ENGINEER

CURVE DATA ℄ MEDIAN
Δ - 4° 29' 15"
D - 0° 30' RT
R - 11459.15'
T - 448.98'
L - 897.50'
E - 8.79'

CURVE DATA ℄ ROAD
Δ - 2°28'32"
D - 0.510°
R - 11,422.15'
T - 247.59'
L - 495.11
E - 2.69'

CURVE DATA
Δ - NOT=90.00
D - 15° 00' LT.
R - 381.97'
T - 475.93'
L - 683.33'
E - 228.28'

P.I. STA. 265+44.05 ℄ MEDIAN
P.I. STA. 267+45.61 RD.
P.I. STA. 238+48.55
P.I. STA. 375+59.91
P.I. STA. 231+00 EL. 625.50
P.I. STA. 309+00 EL. 610.00

REMOVE CULV. Nº 62 STA. 270+44
REMOVE CULV. Nº 65 STA. 275+58
REMOVE CULV. Nº 66 STA. 276+00
REMOVE CULV. Nº 69 STA. 292+84
REMOVE EXIST. PAVT.

CULV. Nº 63 STA. 18+40 36"ø C.I.P.
INV. EL. 611.80
INV. EL. 611.50

CULV. Nº 64 STA. 276+77 4'x4'
CULV. Nº 67 STA. 276+77 6'4"x4'9"
CULV. Nº 68 STA. 277+76 6'x5'
CULV. Nº 71 STA. 292+73 6'x5' CONC.
CULV. Nº 72 STA. 293+10 18"ø C.I.P.

INV. EL. 610.0
INV. EL. 608.40
INV. EL. 608.75
INV. EL. 608.80
INV. EL. 609.90
INV. EL. 609.20
INV. EL. 609.10
INV. EL. 607.00
INV. EL. 606.80
INV. EL. 603.80
INV. EL. 603.95
INV. EL. 615.0
INV. EL. 614.50
INV. EL. 607.6
INV. EL. 607.7

C.B. DD-702 (38)
M.H. DD-701

GROUTED RIP RAP
EXCAVATE & DEMOLISH CONCRETE PIPES
ERECT FENCE DD-901
EXCAVATE & DEMOLISH CLAY PIPE
24"ø C.I.P.
15/16 SIDEROAD DRAIN
STEEL BEAM GUIDE RAIL DD-908
ABANDONED WELL BACKFILL WITH SANDCUSHION
SUBDRAIN
DITCH EL. 612.34
DETOUR
SEE NOTE 'W'
SEE DWG. 2584-H-23 FOR CROSSING OF C.N.R. DRIVEWAY & RAIL ROAD.
BELL TELEPHONE UNDERGROUND CABLES
UNSUITABLE MATERIAL AT BOTTOM OF EXISTING OPEN DRAIN TO BE EXCAVATED AS DIRECTED BY THE ENGINEER AND BACKFILLED WITH SUITABLE EARTH MATERIAL.

NOTE:
THE LOCATION OF UNDERGROUND UTILITIES IS APPROXIMATE ONLY, AND THE EXACT LOCATION SHOULD BE DETERMINED BY CONSULTING THE MUNICIPAL AUTHORITIES AND UTILITY COMPANIES CONCERNED

C.N.R. SERVICE ROAD
C.N.R.
R/W
℄ DITCH
℄ ROAD 2nd STAGE
EXISTING ROAD
PAVED ROAD HL-6+2" & HL-3+1½"
LIMIT OF PAVING
CONFEDERATION ROAD
FOR C.N.R. SERVICE RD. SEE DWG. Nº 2584-H-21

EL. 626.15 EL. 630.22 EL. 634.12 EL. 637.48 EL. 640.27 EL. 642.50 EL. 644.17 EL. 645.28
EL. 644.09 EL. 642.39 EL. 640.12 EL. 637.29 EL. 633.90 EL. 630.01 EL. 626.03 EL. 622.05 EL. 618.12

+ 40 P.I. 662.01
V.C. 800'
L.V.C. 1430'

NOTE: FOR DETAIL GRANULAR BACKFILL SEE BRIDGE DRAWING NO. D-5312-1

LIMIT OF PAVING
℄ MEDIAN
ROW
1%
BOTTOM OF SAND CUSHION
SAND CUSHION BACKFILL
Str. = 250 C.Y. E.C. = 450 C.Y.
E.F. = 40 C.Y.

PROFILE OF CONFEDERATION RD.

3100 C.Y.
1800 C.Y.
+4.06%
-3.98%
V.C. 600'
L.V.C. 426'
V.C. 600'
L.V.C. 380'
9' 60' WIDE
60' WIDE
6'
310'
270'
-0.78%
-0.55%
-0.08%
-0.72%
PROFILE GRADE
EXISTING GROUND LINE
DITCH GRADE RIGHT
EL. 613.60
EL. 612.50
EL. 612.34
GRANULAR BACKFILL
6" ø PERF. C.I.P.
8" ø PERF. C.I.P.
BOTTOM OF SAND CUSHION
+68.4 P.I. 618.50
B.C. 269+92.57
+58.79 P.I. 613.50
B.M. ELEV. 614.79 N. & W. IN W. ROOT OF 10" APPLE 180.0' RT. OF STA. 275+77
B.M. ELEV. 611.84 N. & W. IN W. ROOT OF 20" OAK 110.0' RT. OF STA. 290+18.
℄ MEDIAN CURVE
Δ - 4°29'15" D - 0°30' RT. T = 448.98' L - 897.50' E - 8.79'

NOTES:
FOR DETAILS OF HIGHWAY ALIGNMENT, MUNICIPAL DRAIN LAYOUT, PROFILE & GRADING SEE DWG. Nº 2584-H-7
FOR PROFILE OF SEWER SEE DWG. Nº 2584-H-17
FOR TYPICAL CROSS SECTION OF APPROACHES TO C.N.R. OVERHEAD SEE DWG. Nº 2584-H-23
FOR DETOUR SEE DWG. Nº 2584-H-22 WITH DETAIL FOR CONSTRUCTION OF C.N.R. SERVICE ROADS
FOR PROFILE OF DRIVEWAY FROM CONFEDERATION RD. SEE DWG. Nº 2584-H-18

SCALES
Horizontal: 50 0 100
Vertical: 5 0 10

				Totals	C.Y.
Earth Cut	E.C. 50 C.Y.		E.C. 350 C.Y.	400	Earth Cut
Sub-Excavation		S.E. 300 C.Y.	S.E. 550 C.Y.	850	Sub-Excavation
Stripping	STR. 400 C.Y.		STR. 1600 C.Y.	2000	Stripping
Ditching	D. 150 C.Y.			150	Ditching
Muskeg Excavation					Muskeg Excav.
Earth Fill	E.F. 145000 C.Y.	E.F. 136000 C.Y.	E.F. 19500 C.Y.	300500	Earth Fill
Rock Cut					Rock Cut
Shatter					Shatter
Rock Fill					Rock Fill
Muskeg Backfill					Muskeg Backfill

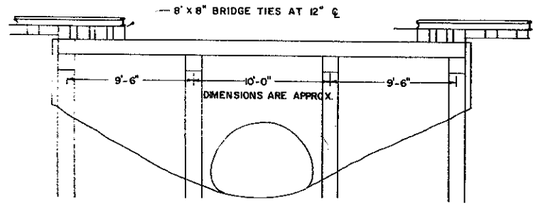
SELECTED GRAN. BASE COURSE CLASS 'A' — SAND CUSHION — ⅜" CRUSHED GRAVEL TYPE 'B' — H.L.-6 = 3" (2 x 1½") — H.L.-3 = 1½" (1 x 1½")

Form DB-RD-41

CONTRACT No. 64-307
W.P. No. 200-62

25

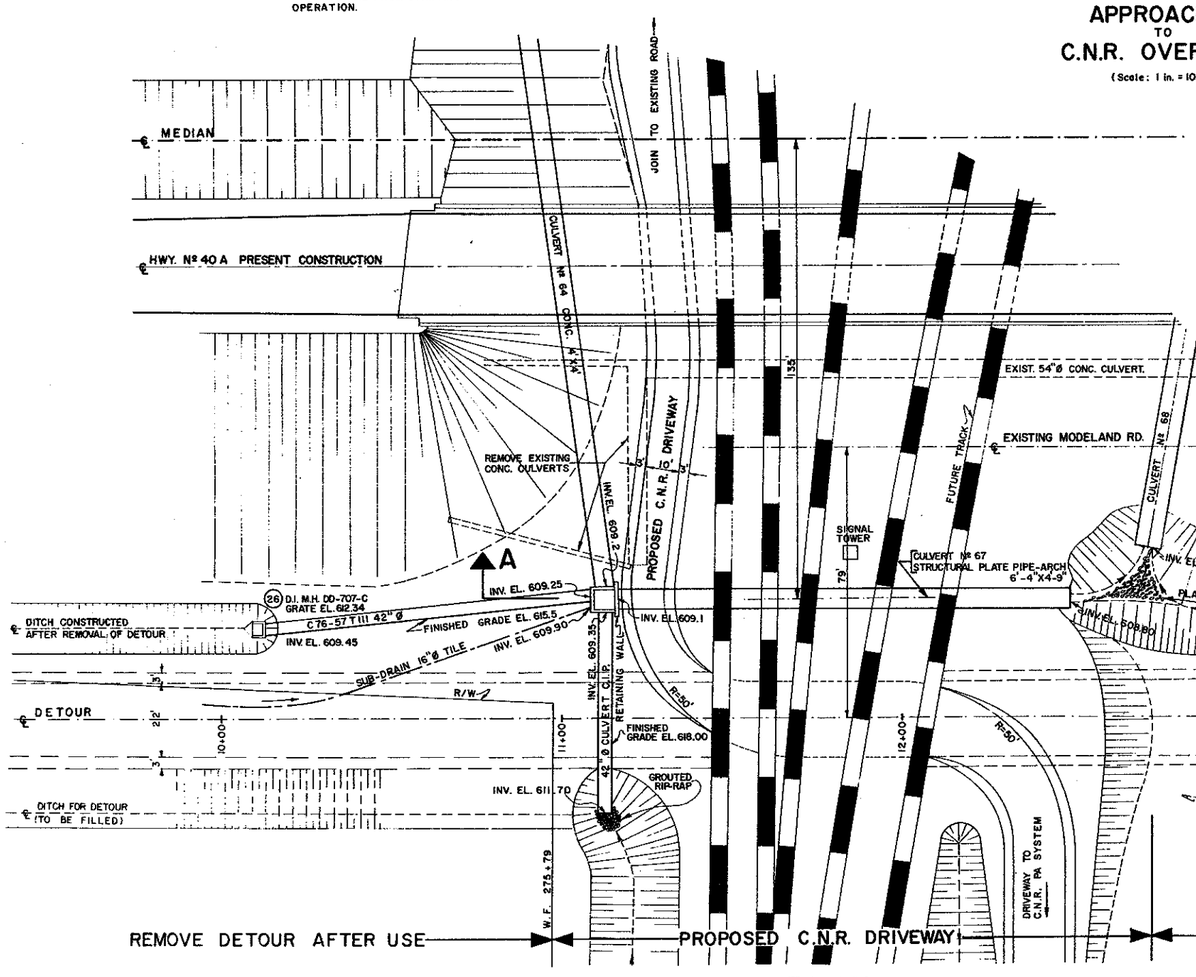
FENCO
FOUNDATION OF CANADA ENGINEERING CORPORATION LIMITED
No. 2584 - H - 23



SCHEMATIC SECTION THROUGH TEMPORARY TRESTLE FOR PLACING OF STRUCTURAL PLATE PIPE ARCH CULVERT Nº 67

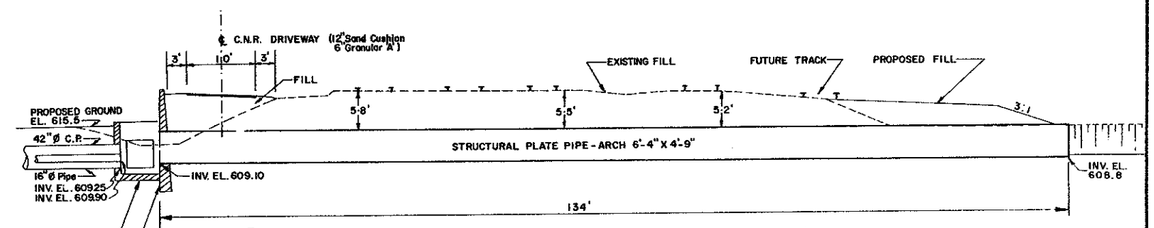
TYPICAL CROSS SECTION OF APPROACHES TO C.N.R. OVERHEAD

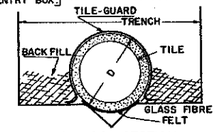
(Scale : 1 in. = 10 ft.)



PLAN

(Scale 1 in. = 20 ft.)

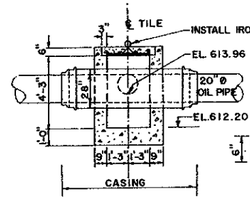




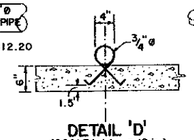
TYPICAL SECTION FOR PLACING OF GLASS FIBRE FELT MATTING AND TILE GUARD FOR COVERED MUNICIPAL DRAIN (NOT TO SCALE)

SECTION A-A

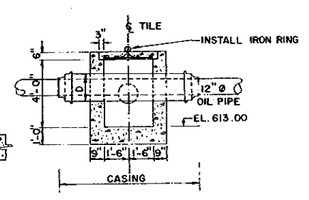
(Scale : 1 in.= 10 ft.)



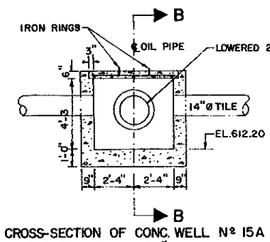
SECTION B-B



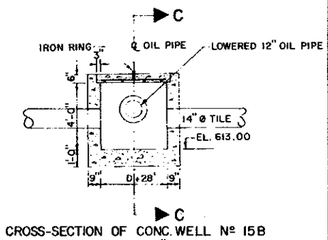
DETAIL 'D' (SCALE: 1 in. = 16 in.)



SECTION C-C

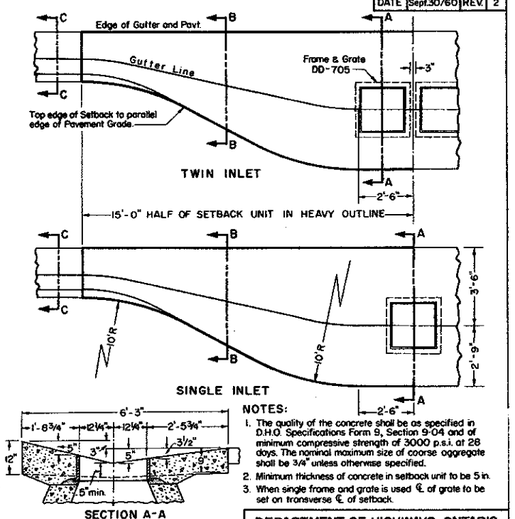


CROSS-SECTION OF CONC. WELL Nº 15A FOR CROSSING OF 20" ø OIL PIPE AND 14" ø TILE (SCALE: 1 in. = 4 ft.)



CROSS-SECTION OF CONC. WELL Nº 15B FOR CROSSING OF 12" ø OIL PIPE AND 14" ø TILE (SCALE 1 in. = 4 ft.)

No. DD-609
DATE Sept.30/60 REV. 2



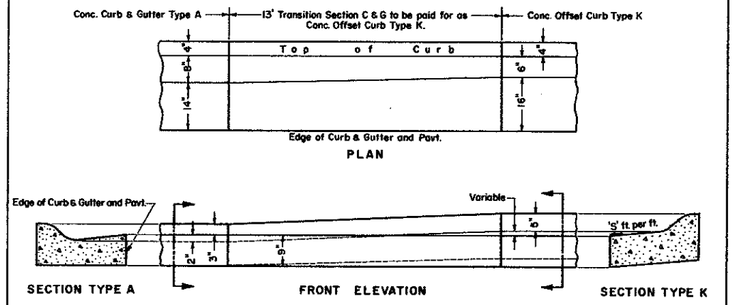
NOTES:
1. The quality of the concrete shall be as specified in D.H.O. Specifications Form 9, Section 9-04 and of minimum compressive strength of 3000 p.s.i. at 28 days. The nominal maximum size of coarse aggregate shall be 3/4" unless otherwise specified.
2. Minimum thickness of concrete in setback unit to be 5 in.
3. When single frame and grate is used ℄ of grate to be set on transverse ℄ of setback.

DEPARTMENT OF HIGHWAYS-ONTARIO

LONG TYPE
CATCH BASIN SETBACK
FOR CONCRETE CURB & GUTTER DD-601-A

APPROVED
March 5/56 — Date
Road Design Engineer

No. DD-604-A
Date — Rev.



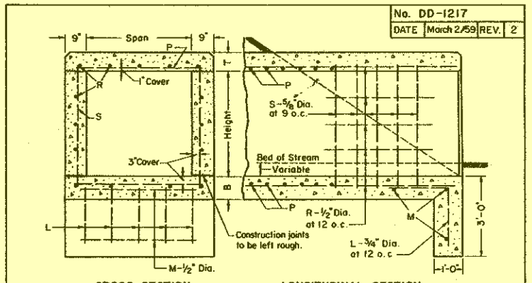
NOTES:
1. 'S' = rate of pavement superelevation.
2. See Stds. DD-601-A and DD-601-K for details of curb and gutter and offset curb.
3. The quality of the concrete shall be as specified in D.H.O. Specifications Form 9, Section 9-04 and of minimum compressive strength of 3000 p.s.i. at 28 days. The nominal maximum size of coarse aggregate shall be 3/4 in. unless otherwise specified.

DEPARTMENT OF HIGHWAYS-ONTARIO

CURB AND GUTTER TRANSITION SECTION
FROM TYPE A TO TYPE K

APPROVED
Oct. 16/59 — Date
Road Design Engineer

No. DD-1217
DATE March 2/59 REV. 2



Culvert Size Span x Height	Concrete Cu.Yds/Ft.	T	B
3×3	0·40	7½"	9½"
3×4	0·46	7½"	9½"
3×5	0·51	7½"	9½"
4×3	0·47	8"	10"
4×4	0·53	8"	10"
4×5	0·58	8"	10"
4×6	0·64	8"	10"
5×4	0·60	8½"	10½"
5×5	0·66	8½"	10½"
5×6	0·71	8½"	10½"
5×7	0·77	8½"	10½"

CONCRETE TABLE

Steel Lbs./Ft.	P-Rods Straight Dia.	P-Rods Straight Spacing	P-Rods Straight Length	S-Rods Straight Length	L Rods	M-Rods Straight Length	R Rods
33	½"	5" o.c.	4'-0"	4'-0"	Length 4'-6"	4'-0"	Maximum length of 20'-0" with minimum laps of 1'-6"
37	½"	5" o.c.	4'-0"	5'-0"		4'-0"	
41	½"	5" o.c.	4'-0"	6'-0"		4'-0"	
43	⅝"	7½" o.c.	5'-0"	4'-1"		5'-0"	
47	⅝"	7½" o.c.	5'-0"	5'-1"		5'-0"	
51	⅝"	7½" o.c.	5'-0"	6'-1"		5'-0"	
49	⅝"	7" o.c.	6'-0"	5'-2"	2'-3½"	6'-0"	
53	⅝"	7" o.c.	6'-0"	6'-2"		6'-0"	
57	⅝"	7" o.c.	6'-0"	7'-2"		6'-0"	
61	⅝"	7" o.c.	6'-0"	8'-2"	1'-2·3½"	6'-0"	

STEEL TABLE

NOTES:
1. All exposed corners to be chamfered 1 in.
2. Culverts of sizes shown on this sheet may be used with unlimited fill.
3. Structure to be built in accordance with D.H.O. Specifications Form 9 (revised March 1957) and the Special Provisions outlined in the Tender Form.
4. Concrete Mix - 3000 p.s.i. in 28 days.
5. Elevation of invert to be set by the Engineer. See Std. DD-804.
6. For spans 6 ft. and over use Standard Rigid Frame Box Type. (Stds. DD-1215-A and B.)

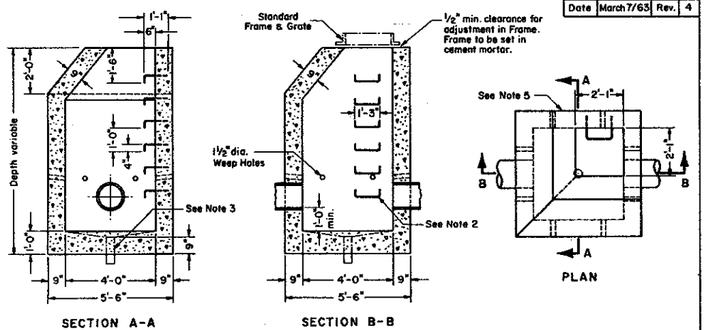
DEPARTMENT OF HIGHWAYS-ONTARIO

STANDARD CONCRETE CULVERTS
BOX TYPE - WITHOUT HEADWALLS

APPROVED
Oct. 21/57 — Date
Road Design Engineer

CULVERT Nº 64

No. DD-701
Date March 7/63 Rev. 4



NOTES:
1. Porous backfill to be placed to min. thickness of 1 ft. on all sides.
2. Ladder rungs to be ¾ in. intermediate grade Hi-Bond bars, galvanized.
3. 4 in. dia. tile in porous ground only, slope bottom as indicated when tile is used.
4. The quality of the concrete shall be as specified in D.H.O. Specifications Form 9, Section 9-04 and of min. compressive strength of 3000 p.s.i. at 28 days. The nominal max. size of coarse aggregate shall be ¾ in. unless otherwise specified.
5. Vertical wall containing ladder rungs to be placed adjacent to edge of pavement.
6. This Standard to be read in conjunction with D.H.O. Form 407.

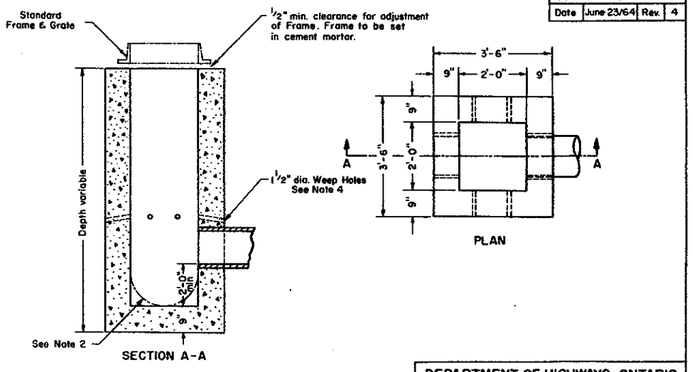
DEPARTMENT OF HIGHWAYS-ONTARIO

4'x4' CATCH BASIN AND MANHOLE

Drawn by
Traced by
Checked by
Passed by
APPROVED May 12/56 Original Date
Road Design Engineer

MANHOLE Nº 2,3,4,5,8,9,10,11,12,13,14,15,16,17,19,21,24,28,31,34,35B,38 & 39.

No. DD-702
Date June 23/64 Rev. 4



NOTES:
1. All concrete work to conform to Section 9-04 of D.H.O. Form 9. Class of concrete: 3000 p.s.i.
2. To permit use of collapsible forms, semi-circular bottom may be employed at Contractor's option.
3. Porous backfill to be placed to a minimum thickness of 1 ft. on all sides.
4. Weep holes shall be placed so that the bottom of the weeper on the inside and the top of the weeper on the outside are level.
5. This Standard to be read in conjunction with D.H.O. Form 407.

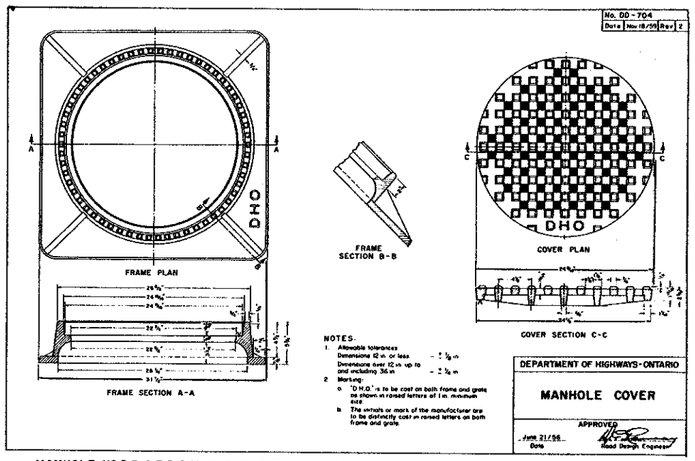
DEPARTMENT OF HIGHWAYS-ONTARIO

2'x 2' CATCH BASIN

Drawn by
Traced by GS
Checked by M.
Passed by L.B.S.
APPROVED May 12/56 Original Date
Road Design Engineer

CATCH BASIN Nº 7,18A,22,25,29,32,35,35A & 36.

No. DD-704
Date Nov 18/59 Rev. 2



NOTES:
1. Allowable tolerances
   Dimensions 12 in. or less — ± 1/8 in
   Dimensions over 12 in. up to and including 36 in — ± 1/4 in
2. Marking:
   a. "D.H.O." is to be cast on both frame and grate as shown in raised letters of 1 in. minimum size
   b. The initials or mark of the manufacturer are to be distinctly cast in raised letters on both frame and grate

DEPARTMENT OF HIGHWAYS-ONTARIO

MANHOLE COVER

APPROVED
June 21/56 — Date
Road Design Engineer

MANHOLE Nº 2,3,4,5,8,9,10,11,12,13,14,15,16,17,38 & 39.

FENCO Nº 2584-H-29

APPENDIX B

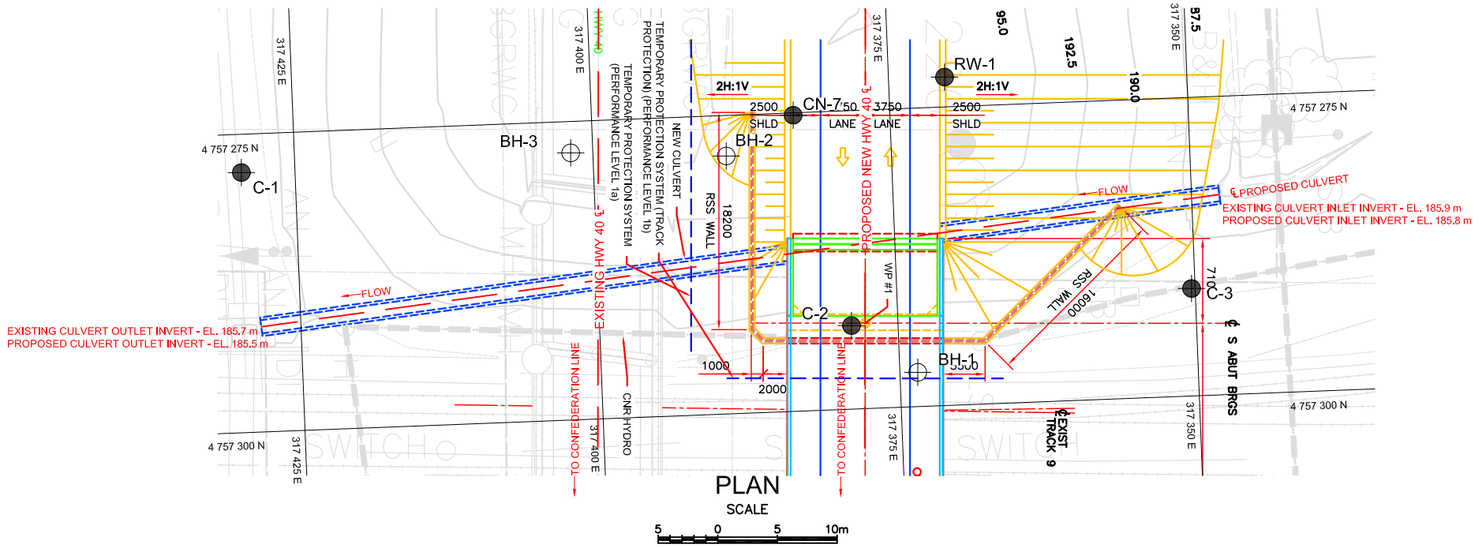
Borehole Locations Plan & Profile Drawing DWG C-1
Explanation of Terms Used in Report
Record of Borehole Sheets – C-1 to C-3, CN-7 and RW-1
Results of Grain Size Distribution Analyses – Figures GS-1 to GS-4
Results of Atterberg Limits Tests (Plasticity Charts) – Figures PC-1 to PC-4
Results of One-Dimensional Consolidation Test – Figures No.CT-2
Results of Unconfined Compressive Strength Tests on Rock
Rock Core Photographs
Rock Core Description Logs

CONT No.
GWP No. 3064-11-00
WP No. 3064-11-02

REPLACEMENT OF SOUTH CULVERT AT CNR OVERHEAD

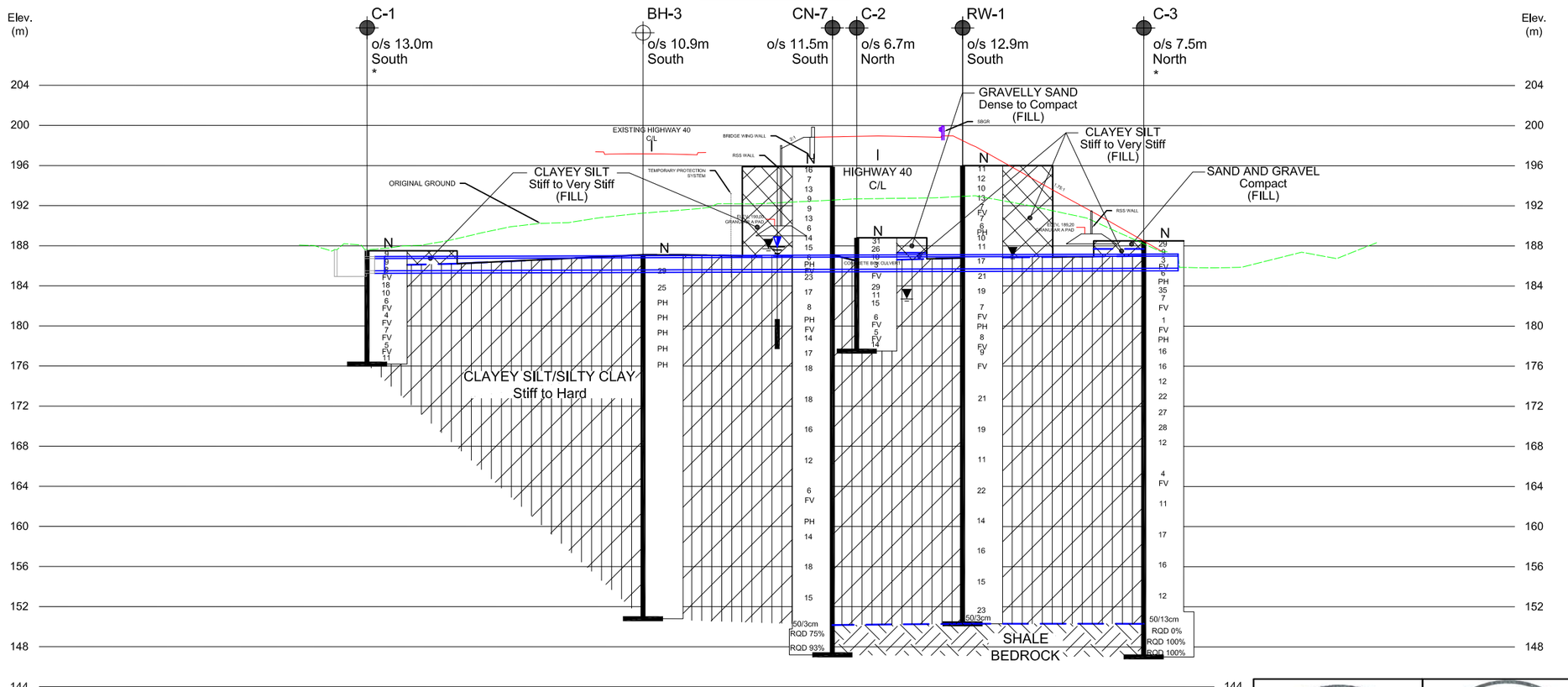
BOREHOLE LOCATION PLAN & PROFILE

SHEET



PLAN

SCALE 5 0 5 10m



PROFILE ALONG PROPOSED CULVERT CENTERLINE

SCALE 5 0 5 10m

NOTES:

1. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.
2. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF THE REPORT AND RECORD OF BOREHOLE SHEETS.

LEGEND

- Borehole Location (Current Investigation - 2020)
- Previous Borehole Location (GEOCRES 40J16-058)
- N Blows/0.3m (Std. Pen. Test, 475 J/blow)
- Monitoring Well
- Water Level Upon Completion of Drilling
- Water Level in Monitoring Well (August 2020)
- * Water Level Not Encountered During Investigation

BH No.	ELEVATION	NORTHINGS	EASTINGS
BOREHOLE LOCATIONS (CURRENT INVESTIGATION – 2020)			
C-1	187.5	4 757 278.2	317 429.5
C-2	188.8	4 757 293.0	317 378.9
C-3	188.5	4 757 291.0	317 350.3
CN-7	195.9	4 757 275.2	317 383.1
RW-1	196.0	4 757 272.5	317 370.3
PREVIOUS BOREHOLES (GEOCRES 40J16-058)			
BH-1	178.6	4 757 297.1	317 373.5
BH-2	178.5	4 757 278.4	317 388.8
BH-3	178.1	4 757 277.6	317 401.9

NOTE

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

LICENSED PROFESSIONAL ENGINEER R. M. C. NG Dec 17, 2020 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER A. N. RAHMAN 100189818 January 17, 2022 PROVINCE OF ONTARIO

REF WSP Drawing: GWP S3813001-330-001GA.dwg, Dated Dec., 2021

REVISIONS		
DATE	BY	DESCRIPTION

Geocres No. 40J16-92

HWY No 40			DIST West Region
SUBM'D NL	CHECKED NR	DATE JAN 17, 2022	SITE
DRAWN NL	CHECKED	APPROVED RN	DWG C-1

EXPLANATION OF TERMS USED IN REPORT

SPT N VALUE: THE STANDARD PENETRATOIN TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT-BARREL SAMPLER TO PENETRATE 0.3 m, AFTER AN INITIAL PENETRATIO OF 150 mm, INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5 kg, FALLING FREELY A DISTANCE OF 0.76 m FOR PENETRATIONS. A SPT N VALUE IS INDICATED AS THE NUMBER OF BLOWS REQUIRED TO DRIVE THE SPLIT-BARREL SAMPLER A DISTANCE OF 300 MM. AN AVERAGE SPT N VALUE IS DENOTED as $\bar{N}$.

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION, CONSISTENCY OR COMPACTNESS.

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

PERCENTAGE BY MASS	0 - 10	10 - 20	20 -35	>35	>35 and main fraction
	'trace'	'some'	Adjective (silty, sandy, clayey etc.)	'and'	Noun (gravel, sand, silt, clay)

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

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

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

N (BLOWS/0.3 m PENETRATION)	0 - 4	4 - 10	10 -30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

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

TOTAL CORE RECOVERY (REC): CORE RECOVERED AS A PERCENTAGE OF TOTAL CORE RUN LENGTH.

ROCK QUALITY DESIGNATION (RQD): TOTAL LENGTH OF SOUND ROCK RECEOVED IN PIECES 10 cm OR LARGER AS A PERCENTAGE OF TOTAL CORE RUN LENGTH. CLASSIFICATION OF ROCK WITH RESPECT TO RQD VALUE AS FOLLOWS:

RQD VALUE (%)	<25	25 - 50	50 -75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

UNIAXIAL COMPRESSIVE STRENGTH (UCS): MAXIMUM AXIAL COMPRESSIVE STRESS THAT A ROCK CORE SPECIMEN CAN WITHSTAND BEFORE FAILING.

POINT LOAD STRENGTH INDEX: AN INDEX TEST TO DETERMINE POINT LOAD STRENGTH INDEX OF ROCK.

CLASSIFICATION OF ROCK WITH RESPECT TO STRENGTH IS AS FOLLOWS:

GRADE*	R0	R1	R2	R3	R4	R5	R6
UCS (MPa)	0.25 - 1	1 - 5	5 - 25	25 - 50	50 - 100	100 – 250	>250
POINT LOAD INDEX (MPa)	**	**	**	1 - 2	2 - 4	4 - 10	>10
TERM	*EXTREMELY WEAK*	*VERY WEAK*	*WEAK*	*MEDIUM STRONG*	*STRONG*	*VERY STRONG*	*EXTREMELY STRONG*

*** - GRADE ACCORDING TO THE INTERNATIONAL SOCIETY OF ROCK MECHANICS (ISRM), 1981.**
**** - ROCKS WITH UNIAXIAL COMPRESSIVE STRENGTH BELOW 25 MPa ARE LIKELY TO YIELD HIGHLY AMBIGIOUS RESULTS UNDER POINT LOAD TESTING.**

DISCONTINUITY SPACING: DISTANCE BETWEEN A PAIR OF DISCONTINUITIES MEASURED ALONG A LINE OF SPECIFIED LOCATION AND ORIENTATION. CLASSIFICATION OF ROCK WITH RESPECT TO DISCONTINUITY SPACING IS AS FOLLOWS (ISRM, 1981):

SPACING WIDTH (m)	<0.02	0.02 – 0.06	0.06 – 0.20	0.20 – 0.6	0.6 – 2.0	2.0 – 6.0	<6.0
SPACING CLASSIFICATION	*EXTREMELY CLOSE*	*VERY CLOSE*	*CLOSE*	*MODERATELY CLOSE*	*WIDE*	*VERY WIDE*	*EXTREMELY WIDE*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS – SPLIT SPOON
TP – THINWALL PISTON SAMPLE
WS – WASH SAMPLE
OS – OSTERBERG SAMPLE
AS – AUGER SAMPLE
RC – ROCK CORE
FV – FIELD VANE
BS – BLOCK SAMPLE
CS – CHUNK SAMPLE
FS – FOIL SAMPLE
TW – THINWALL SHELBY TUBE SAMPLE
PH – TW ADVANCED HYDRULICALLY
PM – TW ADVANCED MANUALLY

STRESS AND STRAIN

u_w	PORE WATER PRESSURE (kPa)
r_u	PORE PRESSURE RATIO
σ	TOTAL NORMAL STRESS (kPa)
σ'	EFFECTIVE NORMAL STRESS (kPa)
τ	SHEAR STRESS (kPa)
$\sigma_1, \sigma_2, \sigma_3$	PRINCIPAL STRESSES (kPa)
ϵ	LINEAR STRAIN (%)
$\epsilon_1, \epsilon_2, \epsilon_3$	PRINCIPAL STRAINS (%)
E	MODULUS OF LINEAR DEFORMATION (MPa)
G	MODULUS OF SHEAR DEFORMATION (MPa)
μ	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

C_c	COMPRESSION INDEX
C_{cr}	RECOMPRESSION INDEX
C_s	SWELL INDEX
c_v	COEFFICIENT OF CONSOLIDATION – VERTICAL (cm^2/s)
c_h	COEFFICIENT OF CONSOLIDATION – HORIZONTAL (cm^2/s)
C_α	COEFFICIENT OF SECONDARY CONSOLIDATION
m_v	COEFFICIENT OF VOLUME CHANGE (kPa^{-1})
σ'_p	PRECONSOLIDATION PRESSURE (kPa)
σ'_{vo}	EFFECTIVE OVERBURDEN PRESSURE (kPa)
H	DRAINAGE PATH (m)
U	DEGREE OF CONSOLIDATION
T_v	TIME FACTOR; VERTICAL DRAINAGE
T_h	TIME FACTOR; HORIZONTAL DRAINAGE
S_u, c_u	UNDRAINED SHEAR STRENGTH (kPa)
S_R	RESIDUAL SHEAR STRENGTH (kPa)
S_r	REMOULDED SHEAR STRENGTH (kPa)
σ_C	UNIAXIAL COMPRESSIVE STRENGTH (kPa)
c'	EFFECTIVE COHESION INTERCEPT (kPa)
c	APPARENT COHESION INTERCEPT (kPa)
Φ'	EFFECTIVE ANGLE OF INTERNAL FRICTION (Degrees)
S_t	SENSITIVITY (= c_u/ S_r)
I_s	POINT LOAD STRENGTH INDEX

PHYSICAL PROPERTIES

Wp – PLASTIC LIMIT (%)	W_L – LIQUID LIMIT (%)	W – MOISTURE CONTENT (%)
W_S – SHRINKAGE LIMIT (%)	I_P – PLASTICITY INDEX (%)	Υ_w – UNIT WEIGHT OF WATER (kg/m^3)
Υ – UNIT WEIGHT OF SOIL (kg/m^3)	Υ_{sat} – UNIT WEIGHT OF SATURATED SOIL (kg/m^3)	Υ_d – UNIT WEIGHT OF DRY SOIL (kg/m^3)
ρ_w – DENSITY OF WATER (kN/m^3)	ρ – DENSITY OF SOIL (kN/m^3)	ρ_{sat} – DENSITY OF SATURATED SOIL (kN/m^3)
ρ_d – DENSITY OF DRY SOIL (kN/m^3)	S_r – DEGREE OF SATURATION (%)	D_r , SG – RELATIVE DENSITY (FORMERLY SPECIFIC GRAVITY)
C_u – UNIFORMITY COEFFICIENT	C_c – CURVATURE COEFFICIENT	

RECORD OF BOREHOLE No C-1

1 OF 1

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 278.2 N; 317 429.5 E ORIGINATED BY M.M.

DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE 2020.09.11 LATITUDE 42.955195 LONGITUDE -82.345212 CHECKED BY N.R.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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 × LAB VANE) (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
187.5	Ground Surface										
0.0	CLAYEY SILT, trace/some sand, trace gravel Stiff, Brown, Moist (FILL)		1	SS	9		187		○		
			2	SS	9				○		
186.0							186				
1.5	CLAYEY SILT, sandy, trace gravel Very stiff to stiff, Brown, Moist		3	SS	8				○		
				VANE	FV		185	>>2			
			4	SS	18		184		○		3 21 44 32
			5	SS	10				○		
			6	SS	6		183		○		
				VANE	FV		182	2			
			7	SS	4		181		○		3 25 45 27
				VANE	FV			2			
			8	SS	7		180		○		
				VANE	FV		179	2			
			9	SS	5		178		○		
				VANE	FV		177	2			
176.2			10	SS	11				○		
11.3	End of borehole										

NOTES:
1. Groundwater was not encountered inside the borehole during or upon completion of drilling.
2. No cave-in was noted inside the borehole upon extraction of hollow stem augers.
3. Borehole was moved approximately 4.6 m from the original staked location due to access restrictions and existing underground utilities.

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

RECORD OF BOREHOLE No C-2

1 OF 1

METRIC

G.W.P. 3064-11-00-06 | LOCATION Coords: 4 757 293.0 N; 317 378.9 E | ORIGINATED BY M.M.

DIST West Region | HWY 40 | BOREHOLE TYPE Continuous Flight Hollow Stem Augers | COMPILED BY N.L.

DATUM Geodetic | DATE 2020.09.10 | LATITUDE 42.955329 | LONGITUDE -82.345831 | CHECKED BY N.R.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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, × LAB VANE) (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
188.8	Ground Surface										
0.0	Gravelly SAND, trace silt Dense to compact, Brown, Moist		1	SS	31		188		○		
			2	SS	26				○		
	CLAYEY SILT Stiff, Brown, Moist (FILL)		3	SS	10		187		○		
186.5											
2.3	SILTY CLAY TO CLAYEY SILT, sandy to some sand, trace gravel Firm to very stiff, Brown, Moist		4	SS	3		186		⊢○⊣		4 27 39 30
				VANE	FV		185	3			
			5	SS	29		184		○		
			6	SS	11				○		
			7	SS	15	▼	183		⊢○⊣		2 17 44 37
			8	SS	6		182		○		
	firm			VANE	FV		181	1			
			9	SS	5		180		⊢○⊣		2 16 46 36
				VANE	FV		179	1			
			10	SS	14		178		○		
177.5											
11.3	End of borehole										

▼ Groundwater level measured upon completion of drilling

NOTE: No cave-in was noted inside the borehole upon extraction of hollow stem augers.

>>: Greater than

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

ONTARIO MTO 20TF016.GPJ ONTARIO MTO.GDT 21-9-21

RECORD OF BOREHOLE No C-3

1 OF 3

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 291.0 N; 317 350.3 E ORIGINATED BY M.M.

DIST West Region HWY 40 BOREHOLE TYPE CFHS Augers + Mud Rotary at 3.7 m + HQ Rock Coring COMPILED BY N.L.

DATUM Geodetic DATE 2020.09.03 - 2020.09.10 LATITUDE 42.955311 LONGITUDE -82.346182 CHECKED BY N.R.

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 × LAB VANE 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
188.5	Ground Surface										
0.0	SAND AND GRAVEL, trace silt Compact, Brown, Dry		1	SS	29		188		○		
	CLAYEY SILT, some sand, trace gravel Soft to stiff, Brown, Moist (FILL)		2	SS	9				○		
187.0							187				
1.5	SILTY CLAY/CLAYEY SILT, some sand/ sandy, trace gravel Stiff to hard, Brown, Moist		3	SS	3				○		
				VANE	FV		186	+			
			4	SS	6				○		
			5	TW	PH		185		⊖	18.6	3 18 43 36 SG = 2.788
			6	SS	35		184		⊖		4 27 40 29
			7	SS	7		183		○		
				VANE	FV		182	>>			
			8	SS	1		181		○		
				VANE	FV		180	2			
			9	TW	PH		179		○		
	trace sand		10	SS	16		178		⊖		0 8 64 28
			11	SS	16		177		○		
			12	SS	12		176		○		
173.5							175				
							174				

Continued Next Page

>>: Greater than

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No C-3

2 OF 3

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 291.0 N; 317 350.3 E ORIGINATED BY M.M.

DIST West Region HWY 40 BOREHOLE TYPE CFHS Augers + Mud Rotary at 3.7 m + HQ Rock Coring COMPILED BY N.L.

DATUM Geodetic DATE 2020.09.03 - 2020.09.10 LATITUDE 42.955311 LONGITUDE -82.346182 CHECKED BY N.R.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
173.5 / 15.0	CLAYEY SILT/SILTY CLAY, trace/some sand, trace gravel Stiff to very stiff, Grey, Moist		13	SS	22		173				1 12 45 42
			14	SS	27		172				
			15	SS	28		171				
			16	SS	12		170				
			17	SS	4		169				
				VANE	FV		168	+1			
			18	SS	11		167				3 8 46 43
			19	SS	17		166				
158.5							165				
							164				
							163				
							162				
							161				
							160				
							159				

Continued Next Page

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

RECORD OF BOREHOLE No C-3

3 OF 3 **METRIC**

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 291.0 N; 317 350.3 E ORIGINATED BY M.M.

DIST West Region HWY 40 BOREHOLE TYPE CFHS Augers + Mud Rotary at 3.7 m + HQ Rock Coring COMPILED BY N.L.

DATUM Geodetic DATE 2020.09.03 - 2020.09.10 LATITUDE 42.955311 LONGITUDE -82.346182 CHECKED BY N.R.

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 + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (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
158.5											
30.0	CLAYEY SILT/SILTY CLAY, trace/some sand, trace gravel Stiff to hard, Grey, Moist						158				
							157				
			20	SS	16		156		○		
							155				
							154				
			21	SS	12		153		○		
							152				
							151				
150.3			22	SS	50/13cm						
38.2	SHALE BEDROCK Unweathered		RUN 1	RC HQ	RQD 0%		150				REC = 74%
			RUN 2	RC HQ	RQD 100%		149				REC = 100% UCS = 78.1 MPa
			RUN 3	RC HQ	RQD 100%		148				REC = 100% UCS = 74.1 MPa
147.0							147				
41.5	End of borehole										

NOTES:
1. Borehole was charged with drilling water, thus groundwater level could not be established during or upon completion of drilling.
2. No cave-in was noted inside the borehole upon extraction of hollow stem augers.
3. Gas pocket encountered at EL. 171.7. LEL = 100%. 25 minutes taken to dissipate before resuming drilling.

>>: Greater than $+^3$, $\times^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No CN-7

1 OF 4

METRIC

G.W.P. 3064-11-00-06 | LOCATION Coords: 4 757 275.2 N; 317 383.1 E | ORIGINATED BY M.M.

DIST West Region | HWY 40 | BOREHOLE TYPE Continuous Flight Hollow Stem Augers + HQ Rock Coring | COMPILED BY N.L.

DATUM Geodetic | DATE 2020.07.20 - 2020.07.21 | LATITUDE 42.955168 | LONGITUDE -82.34578 | CHECKED BY N.R.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"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 × LAB VANE) (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
195.9	Ground Surface										
0.0	CLAYEY SILT, some sand/sandy, trace/some gravel Stiff to very stiff, Brown, Moist (FILL)		1	NR	16		195				
			2	SS	7			>>	○		
			3	SS	13		194		○		
			4	SS	9		193		○		
			5	SS	9				⊢○⊣		6 34 29 31
			6	SS	13		192		○		
			7	SS	6		191	>>	○		
			8	SS	14		190		○		
			9	SS	15				○		
							189				
			10	SS	6	▼	188		○		
186.9											
9.0	CLAYEY SILT/SILTY CLAY, sandy, trace gravel Very stiff to stiff, Grey, Moist		11	TW	PH		187		⊢○⊣	18.1	16 35 30 19 SG = 2.709
				VANE	FV		186	>>			
			12	SS	23		185		○		
			13	SS	17		184		○		
			14	SS	8		183		○		
							182		○		
180.9							181				

Continued Next Page

>>: Greater than

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

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

RECORD OF BOREHOLE No CN-7

2 OF 4

METRIC

G.W.P. 3064-11-00-06 | LOCATION Coords: 4 757 275.2 N; 317 383.1 E | ORIGINATED BY M.M.

DIST West Region | HWY 40 | BOREHOLE TYPE Continuous Flight Hollow Stem Augers + HQ Rock Coring | COMPILED BY N.L.

DATUM Geodetic | DATE 2020.07.20 - 2020.07.21 | LATITUDE 42.955168 | LONGITUDE -82.34578 | CHECKED BY N.R.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"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, × LAB VANE (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
180.9											
15.0	CLAYEY SILT/SILTY CLAY, some to trace sand, trace gravel Very stiff to stiff, Grey, Moist		15	TW	PH		180			20.4	4 14 46 36 SG = 2.744 e_o = 0.624 P_c = 491 kPa C_c = 0.301 C_r = 0.065
				VANE	FV				>>		
			16	SS	14		179				3 9 48 40
							178				
			17	SS	17		177				
			18	SS	18		176				
							175				
							174				
			19	SS	18		173				
							172				
							171				
			20	SS	16		170				2 8 44 46
							169				
							168				
							167				
			21	SS	12		166				
165.9											

Continued Next Page

>>: Greater than

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

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

RECORD OF BOREHOLE No CN-7

3 OF 4

METRIC

G.W.P. 3064-11-00-06 | LOCATION Coords: 4 757 275.2 N; 317 383.1 E | ORIGINATED BY M.M.

DIST West Region | HWY 40 | BOREHOLE TYPE Continuous Flight Hollow Stem Augers + HQ Rock Coring | COMPILED BY N.L.

DATUM Geodetic | DATE 2020.07.20 - 2020.07.21 | LATITUDE 42.955168 | LONGITUDE -82.34578 | CHECKED BY N.R.

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, × LAB VANE)	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
165.9											
30.0	CLAYEY SILT/SILTY CLAY, trace sand, trace gravel Stiff to very stiff, Grey, Moist						165				
							164				
			22	SS	6				○		
							163	+ 2			
				VANE	FV						
							162				
							161				
			23	TW	PH				○		
							160				
			24	SS	14		159		○		3 10 40 47
							158				
							157				
			25	SS	18		156		○		
							155				
							154				
			26	SS	15		153		○		3 8 40 49
							152				
150.9							151				

Continued Next Page

>>: Greater than

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No CN-7

4 OF 4

METRIC

G.W.P. 3064-11-00-06 | LOCATION Coords: 4 757 275.2 N; 317 383.1 E | ORIGINATED BY M.M.

DIST West Region | HWY 40 | BOREHOLE TYPE Continuous Flight Hollow Stem Augers + HQ Rock Coring | COMPILED BY N.L.

DATUM Geodetic | DATE 2020.07.20 - 2020.07.21 | LATITUDE 42.955168 | LONGITUDE -82.34578 | CHECKED BY N.R.

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, × LAB VANE)	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
150.9								20 40 60 80 100	20 40 60		
45.0	SILTY CLAY, trace sand, trace gravel Hard, Grey, Moist										
150.2			27	SS	50/3cm						
45.7	SHALE BEDROCK Unweathered		Run 1	RC HQ	RQD 75%		150				REC = 78% UCS = 84.1 MPa
							149				
			Run 2	RC HQ	RQD 93%		148				REC = 93% UCS = 60.8 MPa
147.2											
48.7	End of borehole										

▼ Groundwater level measured upon completion of drilling

▼ Groundwater level measured in monitoring well

NOTES:

1. No cave-in was noted upon extraction of hollow stem augers.
2. The shear vane tests conducted at depths 0.8 m (EL. 195.1) and 4.6 m (EL. 191.3) below the existing ground surface, were carried out in a second borehole drilled adjacent to Borehole CN-7.
3. Gas pocket encountered from EL. 149.2 to EL. 150.2. LEL = 100%. 45 minutes taken to dissipate before rock coring.
4. Gas reading on Aug. 17 2020: LEL = 5% to LEL = 0% in 30 seconds.
5. Gas reading on Aug. 27 2020: LEL = 1% to LEL = 0% in 15 seconds. Monitoring well decommissioned.

Monitoring Well Readings:

Date	Depth (m)	Elev.
Jul. 22/'20	8.0	187.9
Aug. 10/'20	7.9	188.0
Aug. 17/'20	8.9	187.0

Monitoring Well Legend:

- Concrete
- Bentonite seal
- Filter sand
- Screen

>>: Greater than

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

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

RECORD OF BOREHOLE No RW-1

1 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 272.5 N; 317 370.3 E ORIGINATED BY M.M.

DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE 2020.07.24 LATITUDE 42.955144 LONGITUDE -82.345938 CHECKED BY N.R.

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 × LAB VANE 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
196.0	Ground Surface										
0.0	CLAYEY SILT, trace/some sand, trace gravel Stiff to very stiff, Brown, Moist (FILL)		1	SS	11						
			2	SS	12		195				
			3	SS	10		194				
			4	SS	13		193				
			5	SS	7			>>			1 18 47 34
			6	VANE SS	FV 7		192	>>			
			7	SS	6		191	>>			
			8	TW	PH						
			9	SS	10		190				1 20 42 37
			10	SS	11		189				
186.8						▼	188				
9.2	CLAYEY SILT/SILTY CLAY, some sand, trace gravel Very stiff to stiff, Grey, Moist		11	SS	17		187				
			12	SS	21		186				
			13	SS	19		185				
			14	SS	7		184				
181.0				VANE	FV		183				
							182	+2			3 16 42 39

Continued Next Page

>>: Greater than

+3, ×3: Numbers refer to Sensitivity

○3% STRAIN AT FAILURE

RECORD OF BOREHOLE No RW-1

2 OF 4

METRIC

G.W.P. 3064-11-00-06 | LOCATION Coords: 4 757 272.5 N; 317 370.3 E | ORIGINATED BY M.M.

DIST West Region | HWY 40 | BOREHOLE TYPE Continuous Flight Hollow Stem Augers | COMPILED BY N.L.

DATUM Geodetic | DATE 2020.07.24 | LATITUDE 42.955144 | LONGITUDE -82.345938 | CHECKED BY N.R.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L	γ kN/m³	GR SA SI CL
181.0											
15.0	CLAYEY SILT/SILTY CLAY, some sand, trace gravel										
	Stiff to very stiff, Grey, Moist		15	TW	PH						
							180				
			16	SS	8		179				
				VANE	FV			1			
							178				
			17	SS	9						3 13 45 39
							177				
				VANE	FV			>>			
							176				
							175				
							174				
							173				
			18	SS	21						
							172				
							171				
							170				
			19	SS	19						
							169				
							168				
							167				
			20	SS	11						
166.0											

Continued Next Page

>>: Greater than

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

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

RECORD OF BOREHOLE No RW-1

3 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 272.5 N; 317 370.3 E ORIGINATED BY M.M.

DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE 2020.07.24 LATITUDE 42.955144 LONGITUDE -82.345938 CHECKED BY N.R.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	w_P w w_L	γ kN/m³	GR SA SI CL
166.0								20 40 60 80 100	20 40 60		
30.0	CLAYEY SILT/SILTY CLAY, trace sand, trace gravel Very stiff, Grey, Moist						165				
							164				
			21	SS	22						1 9 50 40
							163				
							162				
							161				
			22	SS	14						
							160				
							159				
							158				
			23	SS	16						
							157				
							156				
							155				
			24	SS	15						
							154				
							153				
							152				
	sandy, some gravel		25	SS	23						14 47 27 12
151.0											

Continued Next Page

>>: Greater than $+^{3}$, $\times^{3}$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No RW-1

4 OF 4

METRIC

G.W.P. 3064-11-00-06 LOCATION Coords: 4 757 272.5 N; 317 370.3 E ORIGINATED BY M.M.

DIST West Region HWY 40 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.L.

DATUM Geodetic DATE 2020.07.24 LATITUDE 42.955144 LONGITUDE -82.345938 CHECKED BY N.R.

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 × LAB VANE (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
151.0											
45.0	CLAYEY SILT, some sand, trace gravel Hard, Grey, Moist										
150.3			26	SS	50/3cm						
45.7	End of borehole Auger refusal on probable bedrock										

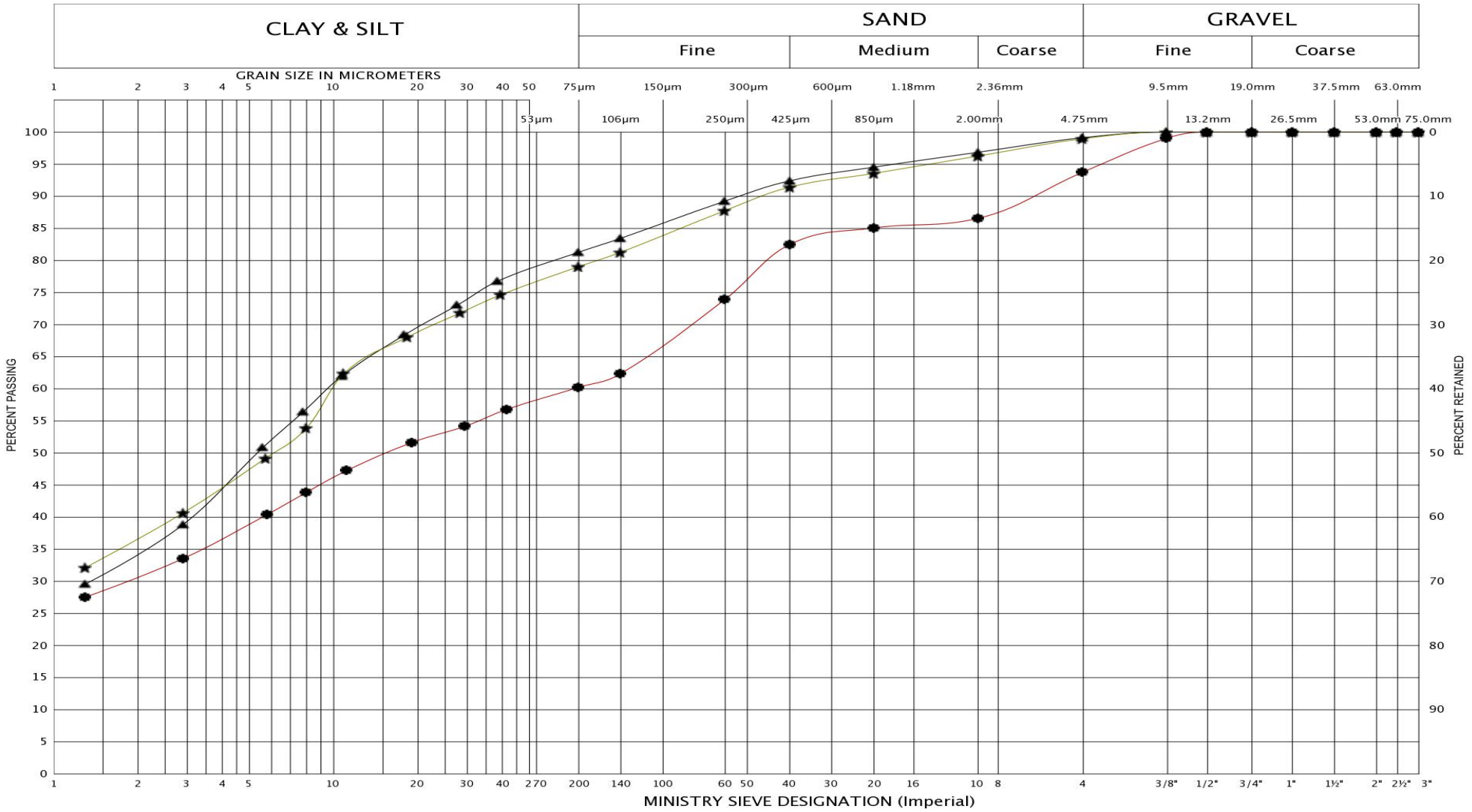
▼ Groundwater level measured upon completion of drilling

NOTES:

1. No cave-in was noted upon extraction of hollow stem augers.
2. Gas pocket encountered from EL. 149.3 to EL. 150.3. LEL = 100%.
3. The shear vane tests conducted at depths 3.1 m (EL. 192.9), 4.0 m (EL. 192.0), and 4.6 m (EL. 191.4) below the existing ground surface, were carried out in a second borehole drilled adjacent to Borehole RW-1.

>>: Greater than $+^{3}$, $\times^{3}$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	CN-7	RW-1	RW-1
	SAMPLE	5	5	9
	SYMBOL	●	▲	★

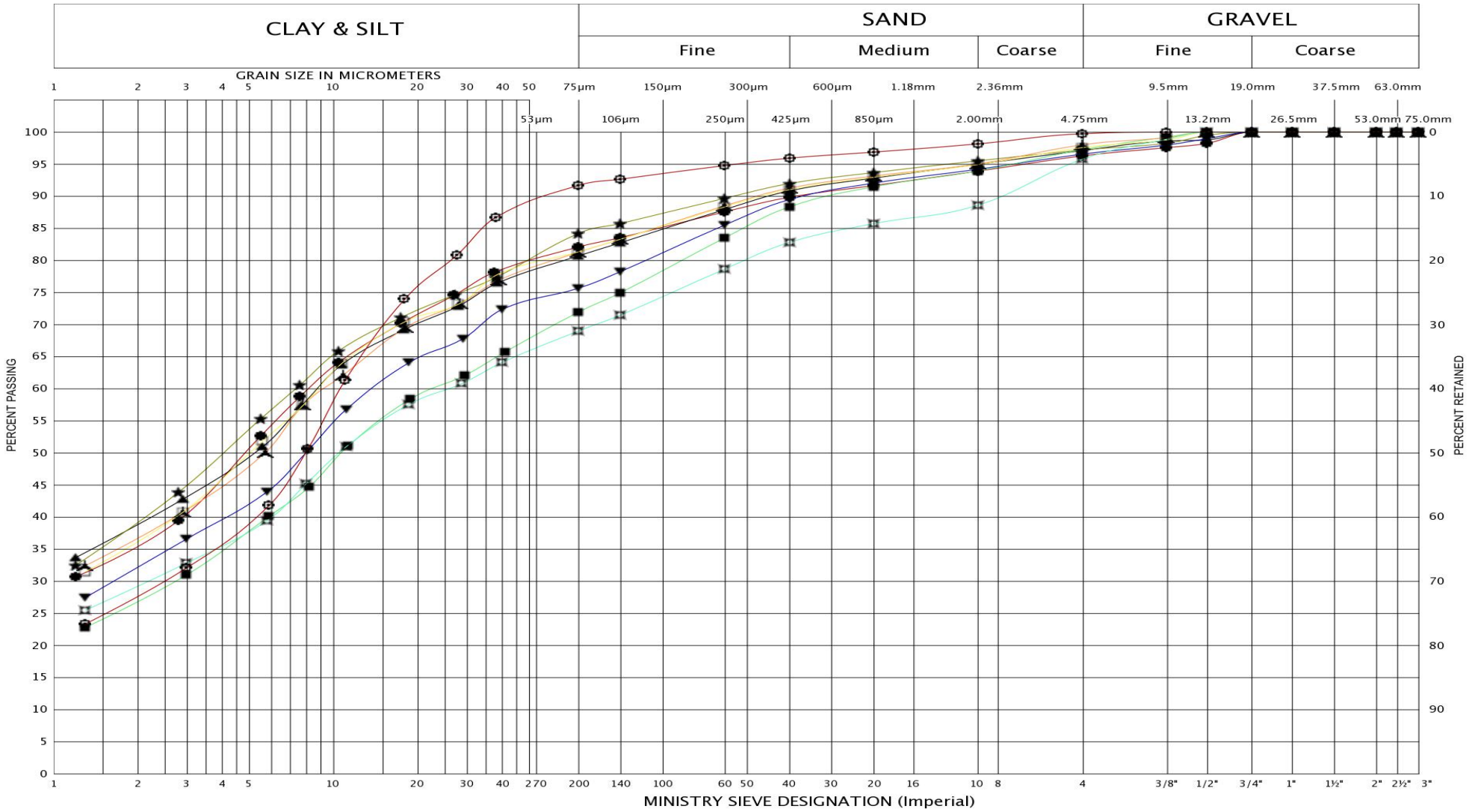
Ontario

GRAIN SIZE DISTRIBUTION

FILL: CLAYEY SILT, Some Sand to Sandy, Trace Gravel

FIG No.:	GS-1
HWY :	40
GWP	3064-11-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	CN-7	RW-1	RW-1	C-1	C-1	C-2	C-2	C-3	C-3
	SAMPLE	15	14	17	4	7	6	8	6	10
	SYMBOL	●	▲	★	▼	■	⅄	□	⊠	⊙

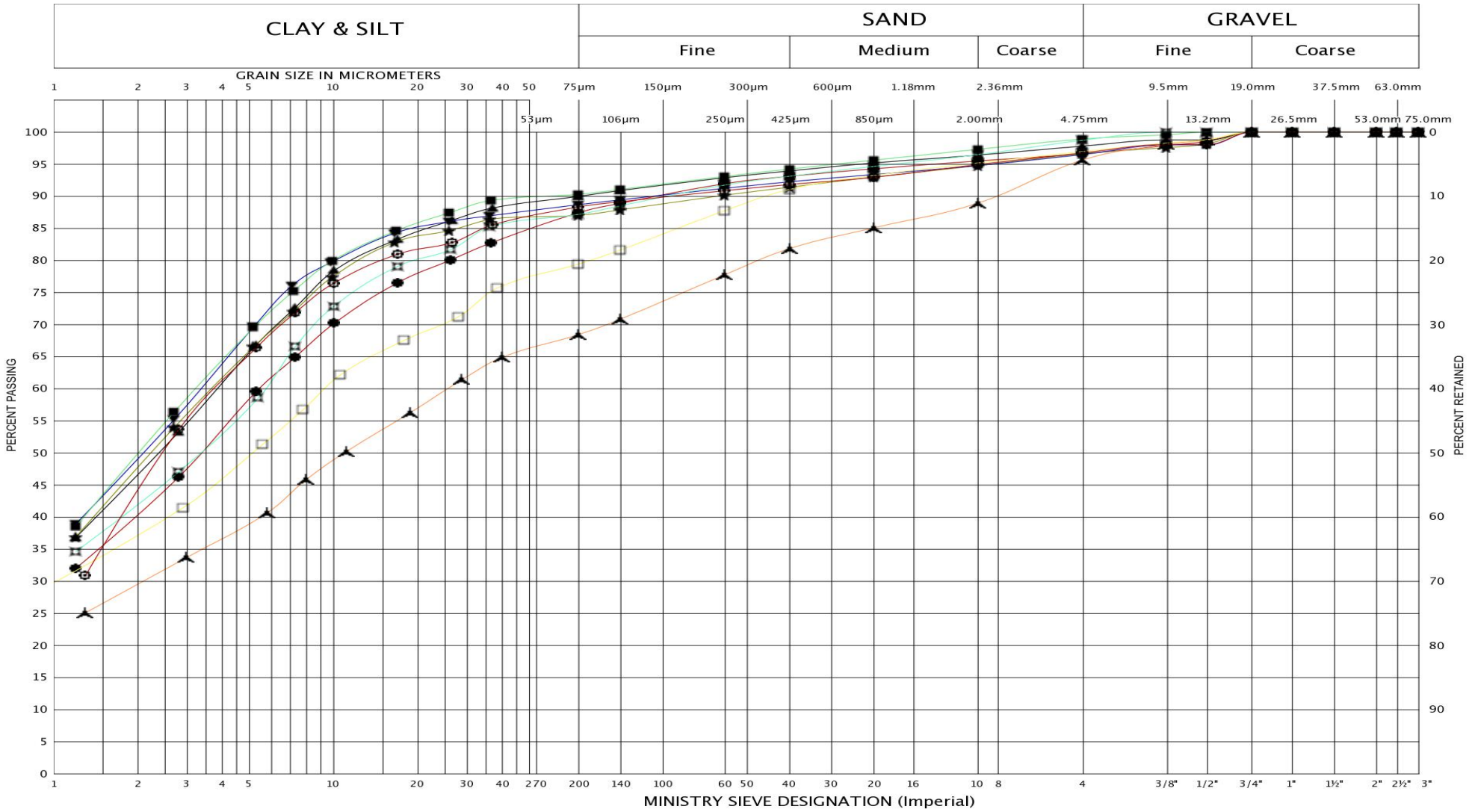
Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, Trace Sand to Sandy, Trace Gravel

FIG No.:	GS-2
HWY :	40
GWP	3064-11-00

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND	BH	CN-7	CN-7	CN-7	CN-7	RW-1	C-2	C-3	C-3	C-3
	SAMPLE	16	20	24	26	21	4	5	13	18
	SYMBOL	●	▲	★	▼	■	⅄	□	⊠	⊙

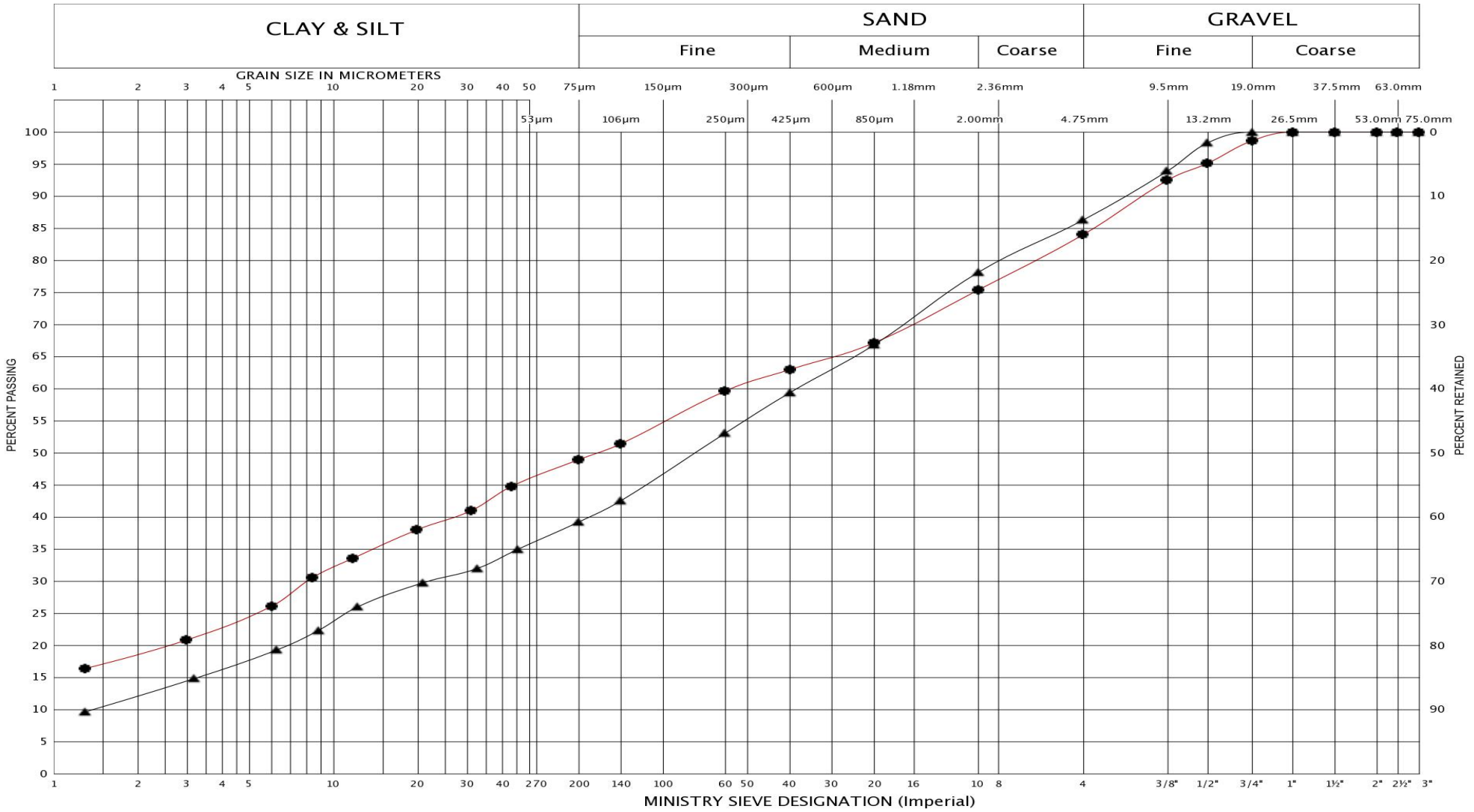
Ontario

GRAIN SIZE DISTRIBUTION

SILTY CLAY, Trace Sand to Sandy, Trace Gravel

FIG No.:	GS-3
HWY :	40
GWP	3064-11-00

UNIFIED SOIL CLASSIFICATION SYSTEM



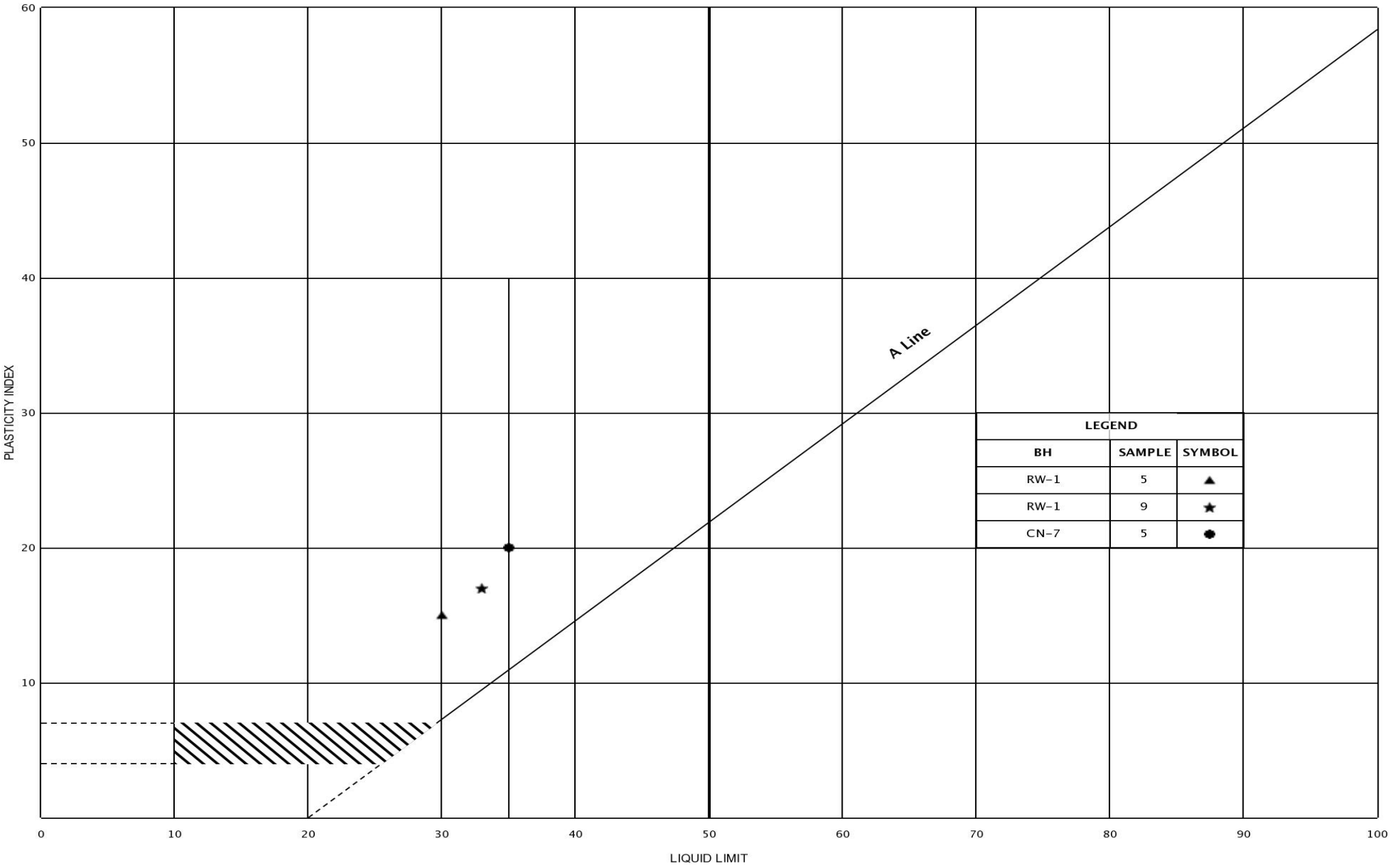
LEGEND	BH	CN-7	RW-1
	SAMPLE	11	25
	SYMBOL	●	▲

Ontario

GRAIN SIZE DISTRIBUTION

CLAYEY SAND, Some Gravel

FIG No.:	GS-4
HWY :	40
GWP	3064-11-00

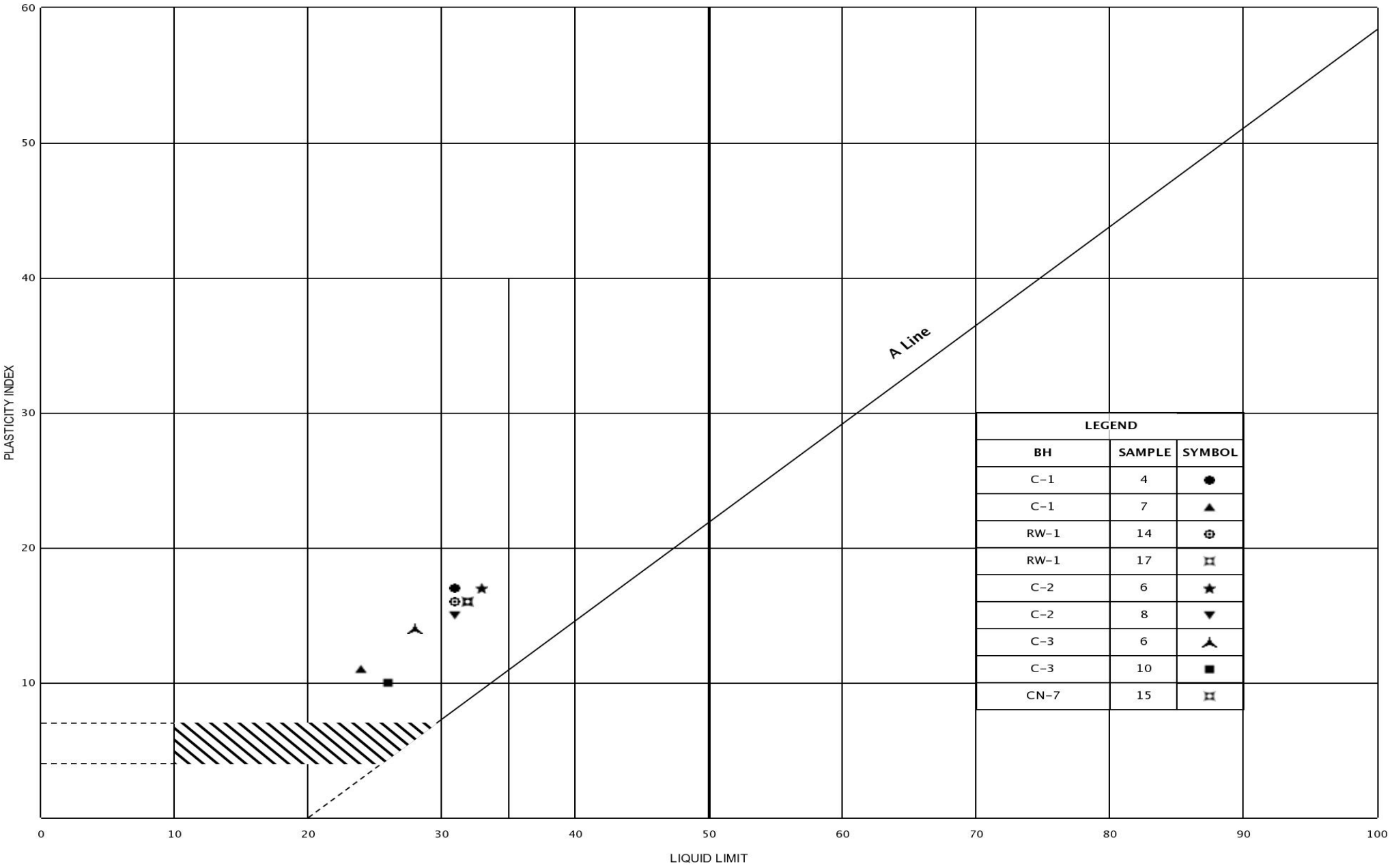


Ontario

PLASTICITY CHART

FILL: CLAYEY SILT, Some Sand to Sandy, Trace Gravel

FIG No.:	PC-1
HWY.:	40
GWP	3064-11-00

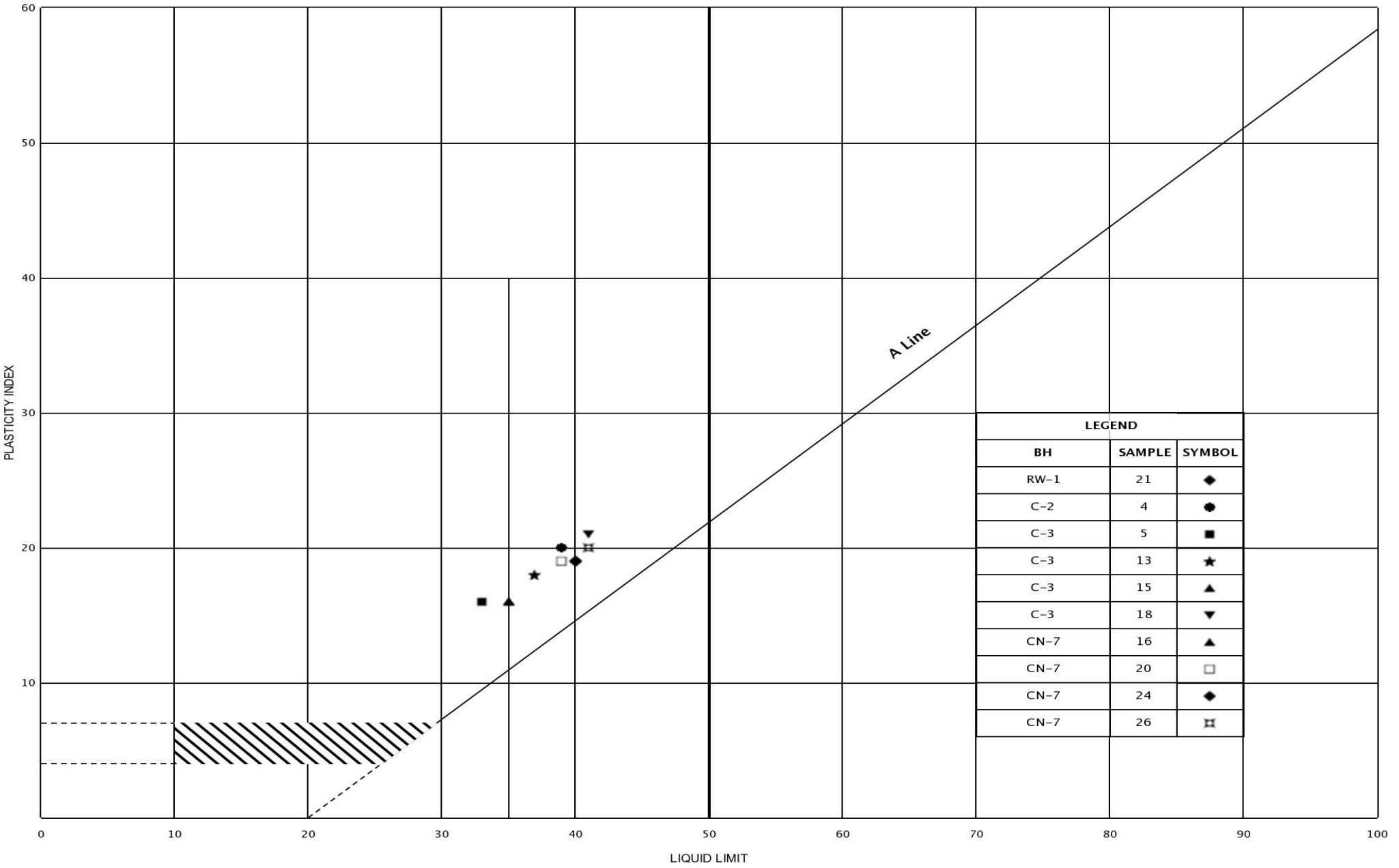


Ontario

PLASTICITY CHART

CLAYEY SILT, Some Sand to Sandy, Trace Gravel

FIG No.:	PC-2
HWY.:	40
GWP	3064-11-00

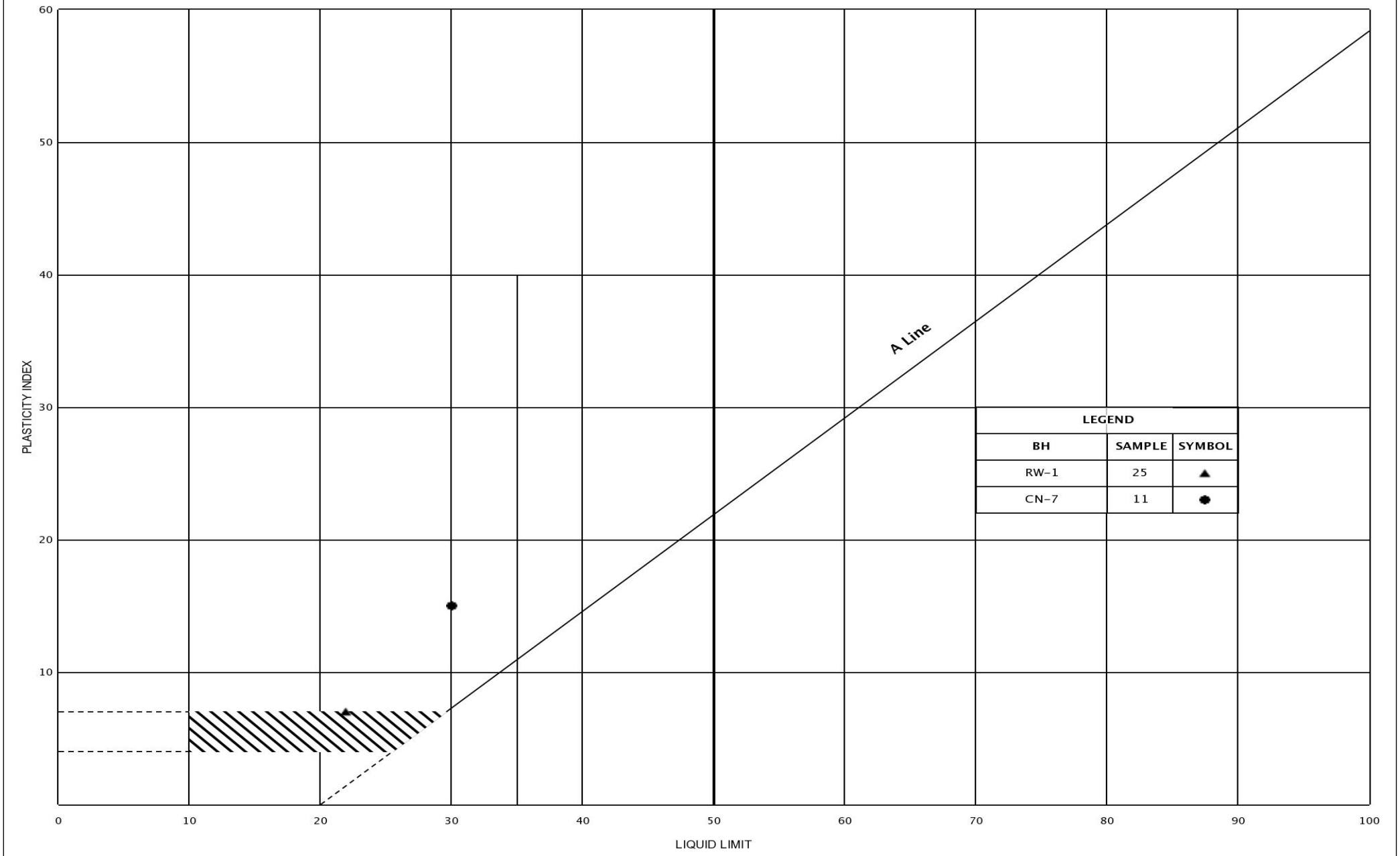


Ontario

PLASTICITY CHART

SILTY CLAY, Trace Sand to Sandy, Trace Gravel

FIG No.:	PC-3
HWY.:	40
GWP	3064-11-00



Ontario

PLASTICITY CHART

CLAYEY SAND, Some Gravel

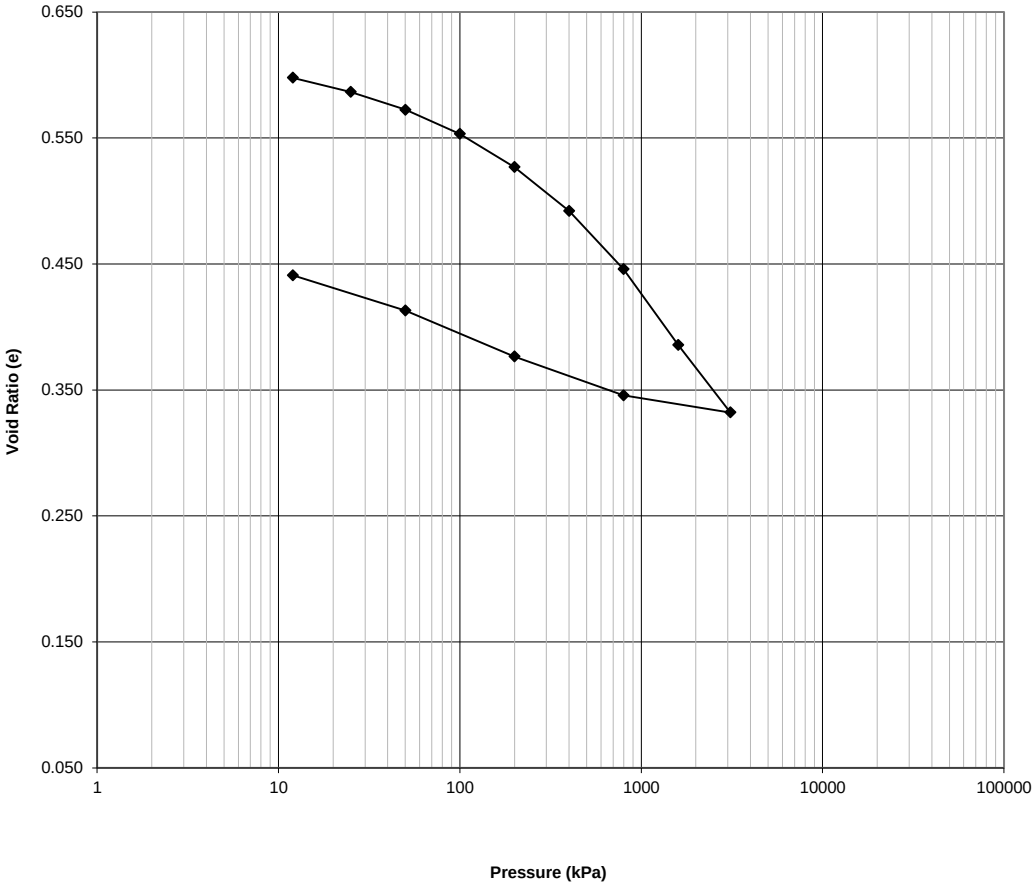
FIG No.:	PC-4
HWY.:	40
GWP	3064-11-00

Peto MacCallum Ltd.
CONSULTING ENGINEERS

Consolidation Test Results
(ASTM D2435)
Highway 40/CNR Overhead (WP3064-11-02)

Borehole CN-7, Sample 15, Depth 15.2 - 15.8 m

Void Ratio versus Log of Pressure



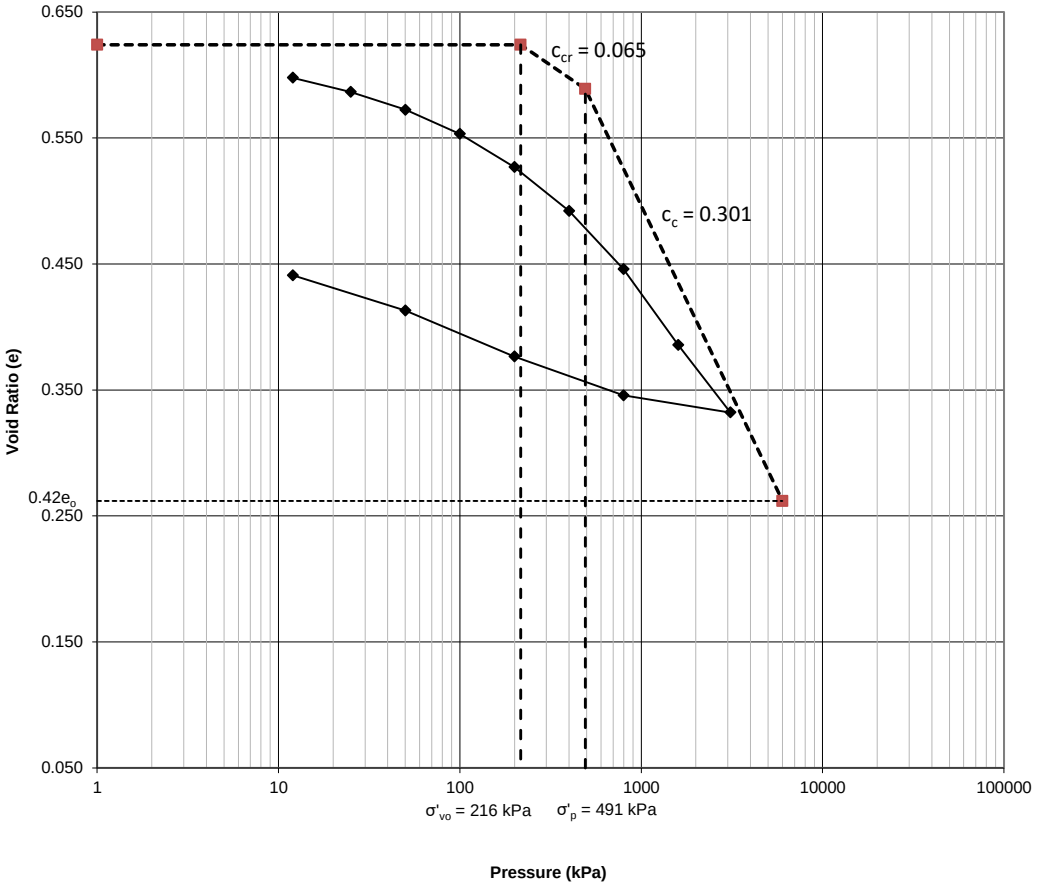
SOIL TYPE:	Silty Clay						
e_0	=	0.624		W_L	=	32	FIGURE No: CT-2
W_0	=	23.1	%	W_P	=	16	Highway 40/CNR Overhead (WP3064-11-02)
γ	=	20.4	kN/m³	PI	=	16	
							PML Ref: 20TF017

Peto MacCallum Ltd.
CONSULTING ENGINEERS

Consolidation Test Results
(ASTM D2435)
Highway 40/CNR Overhead (WP3064-11-02)

Borehole CN-7, Sample 15, Depth 15.2 - 15.8 m

Void Ratio versus Log of Pressure



SOIL TYPE:	Silty Clay					
e_0	=	0.624	W_L	=	32	FIGURE No: CT-2
W_0	=	23.1 %	W_P	=	16	Highway 40/CNR Overhead (WP3064-11-02)
γ	=	20.4 kN/m³	PI	=	16	
						PML Ref: 20TF017

Peto MacCallum Ltd.
CONSULTING ENGINEERS

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK CORE

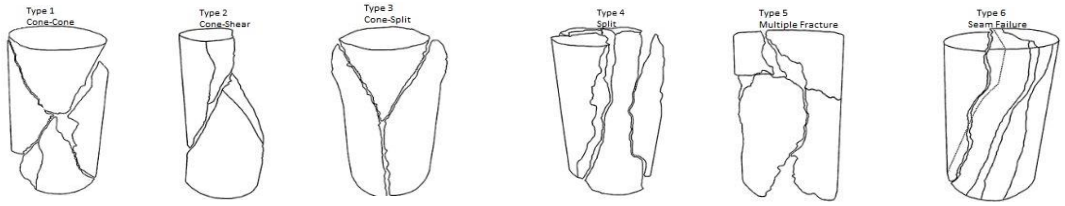
ASTM D7012

CLIENT	WSP	PML REF	20TF017
PROJECT	HWY 401/CNR OVERPASS	LAB NO.	2008570D
SAMPLE IDENTIFICATION	C-3 RUN2 38.86 m - 39.13 m	DATE SAMPLED	2020/12/17
		DATE TESTED	1/5/2021
		TESTED BY	Azar Saidajar

CORE DIMENSIONS		COMPRESSIVE STRENGTH	
SPECIMEN DIAMETER (mm.)	30.544	**TEST TIME (min) (spec. 2 to 15)**	4:00
SPECIMEN LENGTH (mm.)	121.971	**MAXIMUM LOAD APPLIED (kN)**	229.00
	121.641		
	121.869	**COMPRESSIVE STRENGTH (MPa)**	78.1
AVE.	121.818	**TYPE OF FAILURE**	1
CROSS SECTIONAL AREA (sq mm)	2931	**LENGTH TO DIAMETER RATIO (spec 2-2.5)**	1.99

MOISTURE CONTENT		*UNIT WEIGHT*	
WEIGHT OF WET SAMPLE + TARE (g)	943.73	**WEIGHT OF DRY SAMPLE IN AIR (g)**	838.30
WEIGHT OF DRY SAMPLE + TARE (g)	934.57	**VOLUME OF SAMPLE (cu m)**	0.000357
WEIGHT OF WATER (g)	9.16	**UNIT WEIGHT (kg/cu m)**	2348
WEIGHT OF TARE (g)	105.96		
WEIGHT OF DRY SAMPLE (g)	828.61		
MOISTURE CONTENT (%)	1.1		

REMARKS



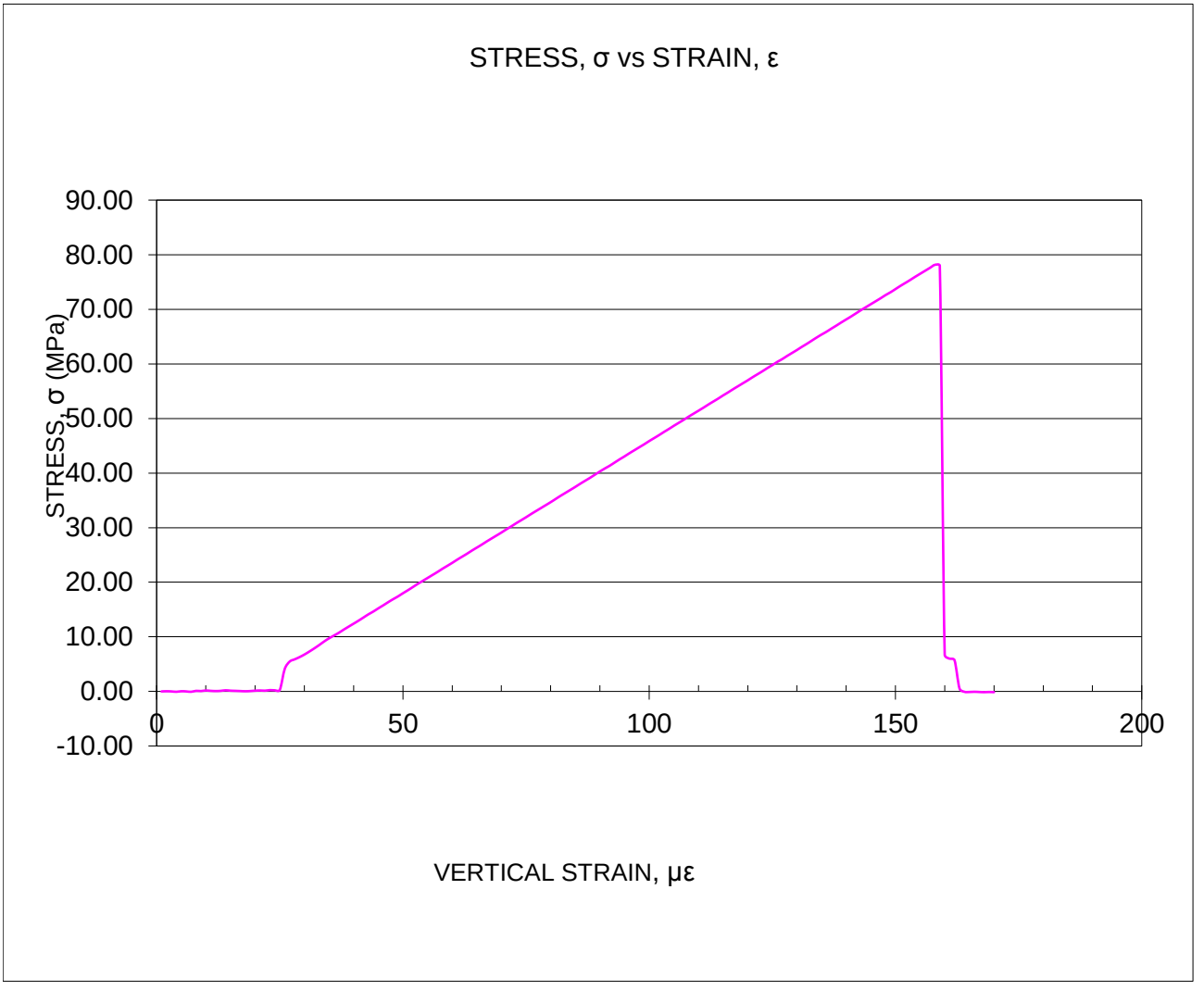
REVIEWED BY J.Noor *DATE* 2021/01/08

Peto MacCallum Ltd.
CONSULTING ENGINEERS

ELASTIC MODULI OF ROCK CORE IN UNIAXIAL COMPRESSION

ASTM D7012

CLIENT	WSP	*PML REF*	20TF017
PROJECT	HWY 401/CNR OVERPASS	*LAB NO.*	2008570D
SAMPLE IDENTIFICATION	C-3 RUN2 38.86 m- 39.13 m	*DATE SAMPLED*	2020/12/17
YOUNG'S MODULUS, E_{tan} (at 50% σ)	GPa	*DATE TESTED*	1/5/2021
YOUNG'S MODULUS, E_{sec} (at 50% σ)	GPa	*TESTED BY*	Azar Saidajan
YOUNG'S MODULUS, $E_{ave.}$ (at 50% σ)	GPa	*POISSON'S RATIO*	



REVIEWED BY J.Noor *DATE* 2021/01/08

Peto MacCallum Ltd.
CONSULTING ENGINEERS

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK CORE

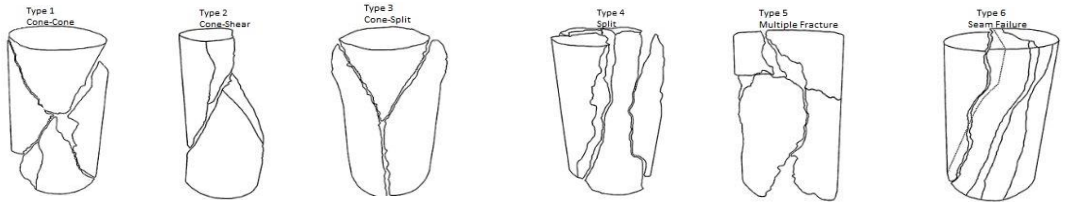
ASTM D7012

CLIENT	WSP	PML REF	20TF017
PROJECT	HWY 401/CNR OVERPASS	LAB NO.	2008570C
SAMPLE IDENTIFICATION	C-3 RUN3 40.4 m - 40.59 m	DATE SAMPLED	2020/12/17
		DATE TESTED	1/5/2021
		TESTED BY	Azar Saidajar

CORE DIMENSIONS		COMPRESSIVE STRENGTH	
SPECIMEN DIAMETER (mm.)	30.298	**TEST TIME (min) (spec. 2 to 15)**	1:36
SPECIMEN LENGTH (mm.)	122.809	**MAXIMUM LOAD APPLIED (kN)**	213.80
	122.377		
	122.301	**COMPRESSIVE STRENGTH (MPa)**	74.1
AVE.	122.504	**TYPE OF FAILURE**	2
CROSS SECTIONAL AREA (sq mm)	2884	**LENGTH TO DIAMETER RATIO (spec 2-2.5)**	2.02

MOISTURE CONTENT		*UNIT WEIGHT*	
WEIGHT OF WET SAMPLE + TARE (g)	943.94	**WEIGHT OF DRY SAMPLE IN AIR (g)**	853.68
WEIGHT OF DRY SAMPLE + TARE (g)	932.26	**VOLUME OF SAMPLE (cu m)**	0.000353
WEIGHT OF WATER (g)	11.68	**UNIT WEIGHT (kg/cu m)**	2416
WEIGHT OF TARE (g)	128.08		
WEIGHT OF DRY SAMPLE (g)	804.18		
MOISTURE CONTENT (%)	1.5		

REMARKS



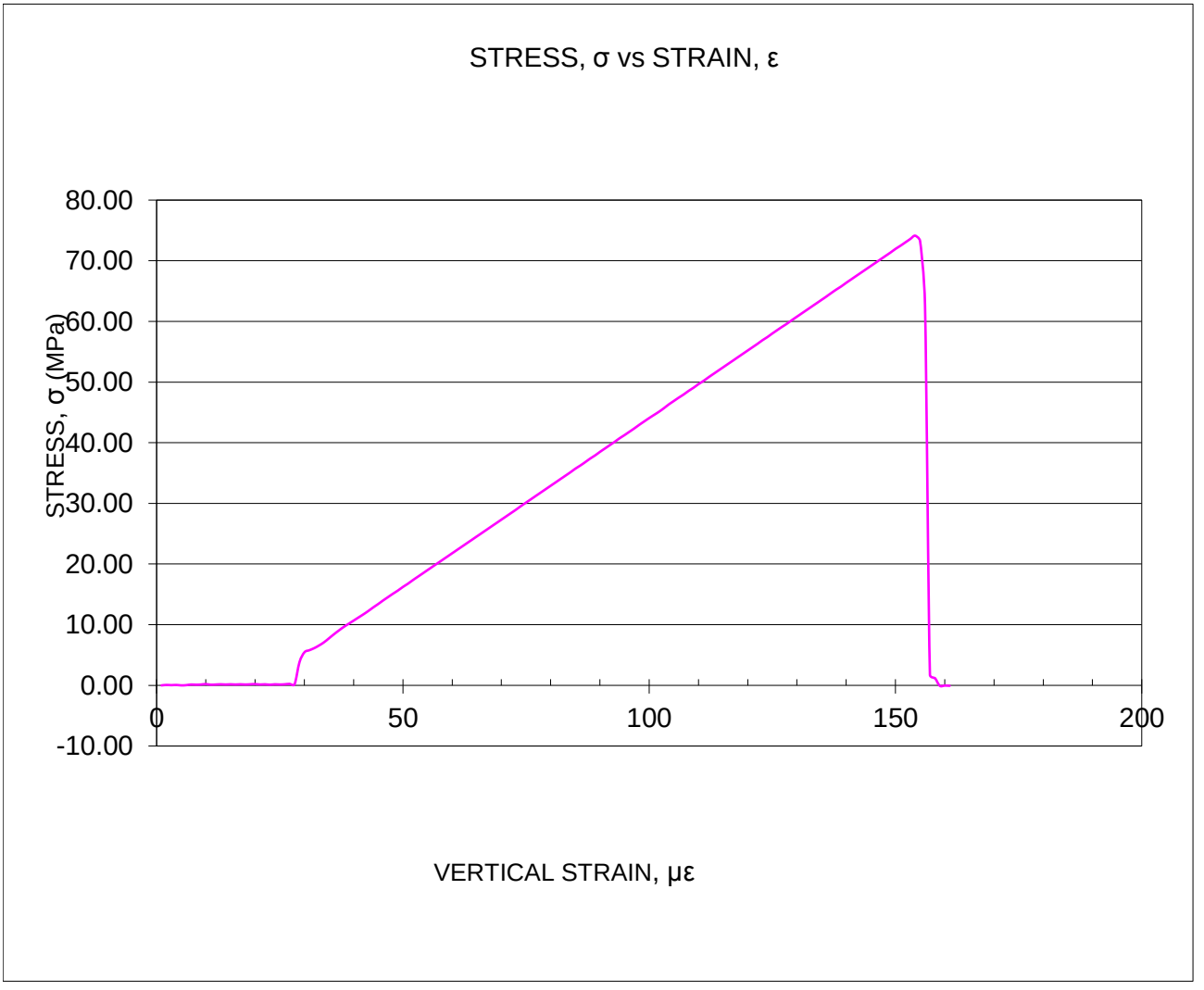
REVIEWED BY J.Noor *DATE* 2021/01/08

Peto MacCallum Ltd.
CONSULTING ENGINEERS

ELASTIC MODULI OF ROCK CORE IN UNIAXIAL COMPRESSION

ASTM D7012

CLIENT	WSP	*PML REF*	20TF017
PROJECT	HWY 401/CNR OVERPASS	*LAB NO.*	2008570C
SAMPLE IDENTIFICATION	C-3 RUN3 40.4 m - 40.59 m	*DATE SAMPLED*	2020/12/17
YOUNG'S MODULUS, E_{tan} (at 50% σ)	GPa	*DATE TESTED*	1/5/2021
YOUNG'S MODULUS, E_{sec} (at 50% σ)	GPa	*TESTED BY*	Azar Saidajan
YOUNG'S MODULUS, $E_{ave.}$ (at 50% σ)	GPa	*POISSON'S RATIO*	



REVIEWED BY J.Noor *DATE* 2021/01/08

Peto MacCallum Ltd.
CONSULTING ENGINEERS

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK CORE

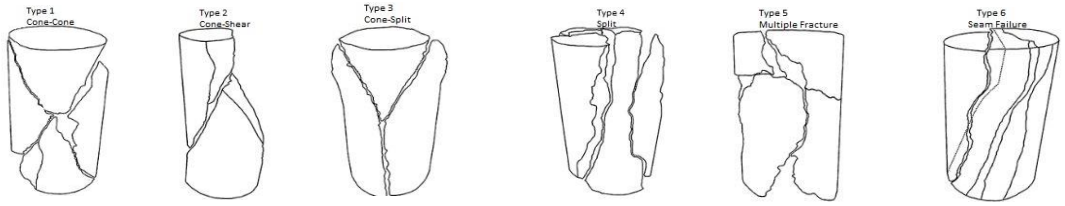
ASTM D7012

CLIENT	WSP	PML REF	2005221B
PROJECT	HWY40/CNR	LAB NO.	20TF017
SAMPLE IDENTIFICATION	CN-7 RUN1 46.65 m - 46.81 m	DATE SAMPLED	2020/08/18
		DATE TESTED	8/31/2020
		TESTED BY	A.Saidajan

CORE DIMENSIONS		COMPRESSIVE STRENGTH	
SPECIMEN DIAMETER (mm.)	31.559	**TEST TIME (min) (spec. 2 to 15)**	9:36
SPECIMEN LENGTH (mm.)	150.089	**MAXIMUM LOAD APPLIED (kN)**	263.30
	149.962		
	149.936	**COMPRESSIVE STRENGTH (MPa)**	84.1
AVE.	149.987	**TYPE OF FAILURE**	1
CROSS SECTIONAL AREA (sq mm)	3129	**LENGTH TO DIAMETER RATIO (spec 2-2.5)**	2.38

MOISTURE CONTENT		*UNIT WEIGHT*	
WEIGHT OF WET SAMPLE + TARE (g)	1270.59	**WEIGHT OF DRY SAMPLE IN AIR (g)**	1110.00
WEIGHT OF DRY SAMPLE + TARE (g)	1254.09	**VOLUME OF SAMPLE (cu m)**	0.000469
WEIGHT OF WATER (g)	16.50	**UNIT WEIGHT (kg/cu m)**	2365
WEIGHT OF TARE (g)	173.58		
WEIGHT OF DRY SAMPLE (g)	1080.51		
MOISTURE CONTENT (%)	1.5		

REMARKS 173.58



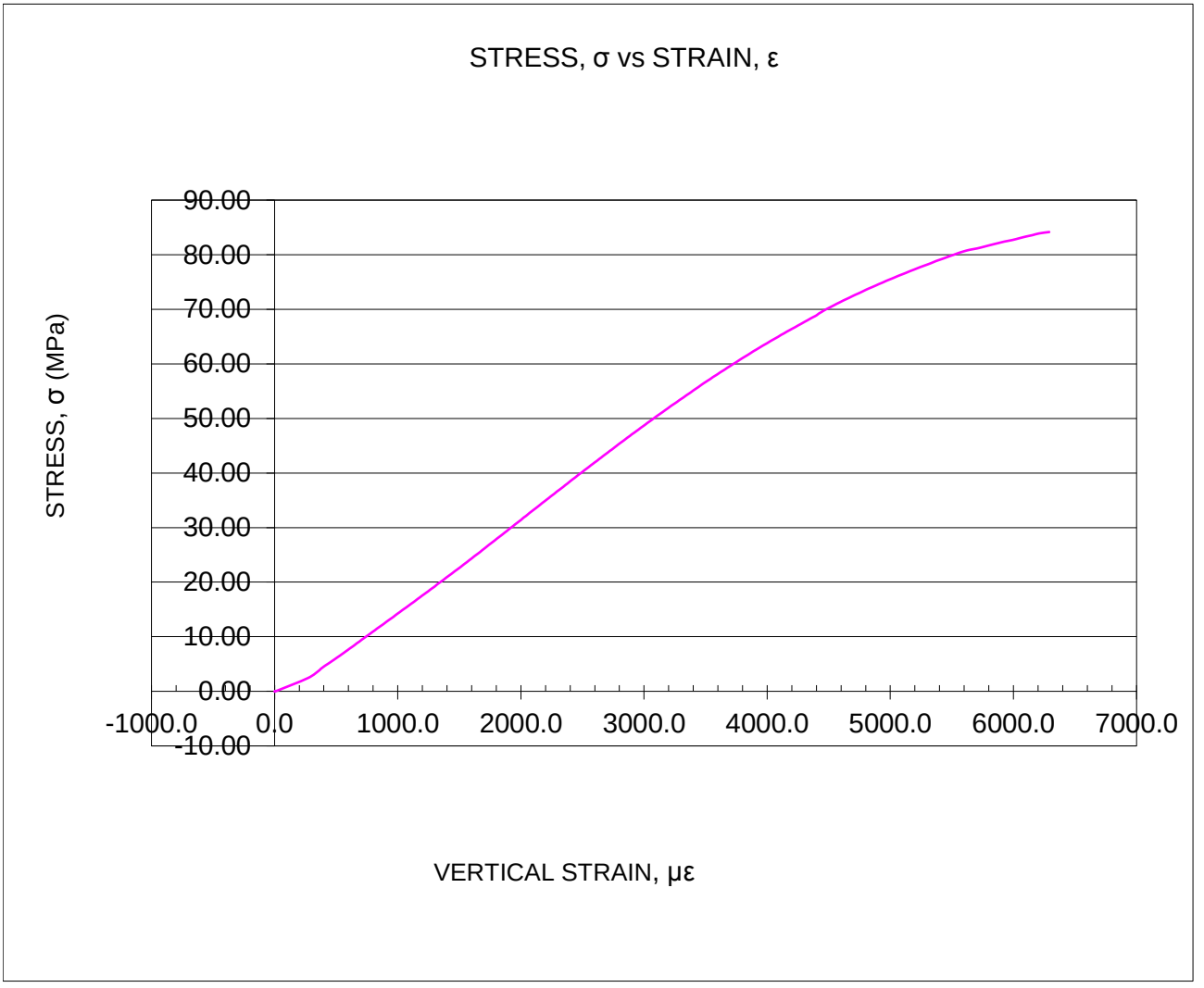
REVIEWED BY J.Noor *DATE* 2020/09/03

Peto MacCallum Ltd.
CONSULTING ENGINEERS

ELASTIC MODULI OF ROCK CORE IN UNIAXIAL COMPRESSION

ASTM D7012

CLIENT	WSP	*PML REF*	2005221B
PROJECT	HWY40/CNR	*LAB NO.*	20TF017
SAMPLE IDENTIFICATION	CN-7 RUN1 46.65 m-46.81 m	*DATE SAMPLED*	2020/08/18
YOUNG'S MODULUS, E_{tan} (at 50% σ)	17.33 GPa	*DATE TESTED*	8/31/2020
YOUNG'S MODULUS, E_{sec} (at 50% σ)	16.13 GPa	*TESTED BY*	A.Saidajan
YOUNG'S MODULUS, $E_{ave.}$ (at 50% σ)	16.73 GPa	*POISSON'S RATIO*	0.453



REVIEWED BY J.Noor *DATE* 2020/09/03

Peto MacCallum Ltd.
CONSULTING ENGINEERS

UNIAXIAL COMPRESSIVE STRENGTH OF ROCK CORE

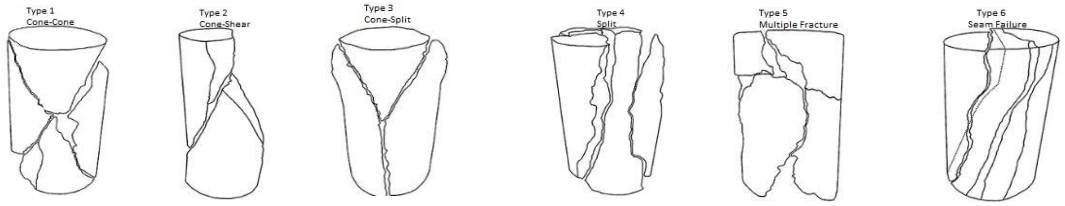
ASTM D7012

CLIENT	WSP	PML REF	20TF017
PROJECT	HWY 401/CNR OVERPASS	LAB NO.	2008570B
SAMPLE IDENTIFICATION	CN-7 RUN2 48.13 m - 48.31 m	DATE SAMPLED	2020/12/17
		DATE TESTED	12/23/2020
		TESTED BY	Azar Saidajar

CORE DIMENSIONS		COMPRESSIVE STRENGTH	
SPECIMEN DIAMETER (mm.)	63.010	**TEST TIME (min) (spec. 2 to 15)**	16:00
SPECIMEN LENGTH (mm.)	133.096	**MAXIMUM LOAD APPLIED (kN)**	189.60
	133.045		
	133.147	**COMPRESSIVE STRENGTH (MPa)**	60.8
AVE.	133.096	**TYPE OF FAILURE**	1
CROSS SECTIONAL AREA (sq mm)	3118	**LENGTH TO DIAMETER RATIO (spec 2-2.5)**	2.11

MOISTURE CONTENT		*UNIT WEIGHT*	
WEIGHT OF WET SAMPLE + TARE (g)	1074.14	**WEIGHT OF DRY SAMPLE IN AIR (g)**	960.58
WEIGHT OF DRY SAMPLE + TARE (g)	1069.00	**VOLUME OF SAMPLE (cu m)**	0.000415
WEIGHT OF WATER (g)	5.14	**UNIT WEIGHT (kg/cu m)**	2315
WEIGHT OF TARE (g)	112.65		
WEIGHT OF DRY SAMPLE (g)	956.35		
MOISTURE CONTENT (%)	0.5		

REMARKS



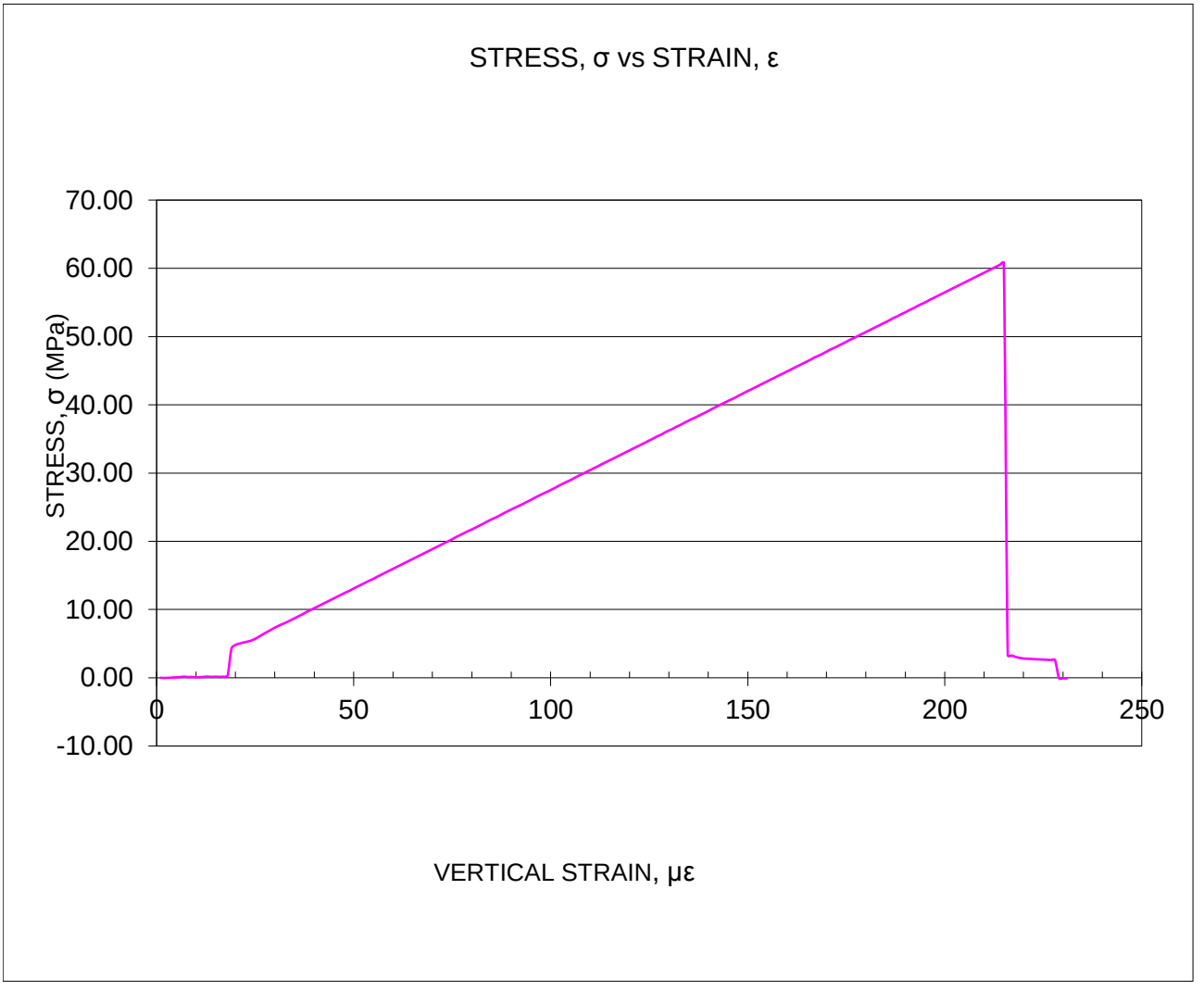
REVIEWED BY J.Noor *DATE* 2021/01/08

Peto MacCallum Ltd.
CONSULTING ENGINEERS

ELASTIC MODULI OF ROCK CORE IN UNIAXIAL COMPRESSION

ASTM D7012

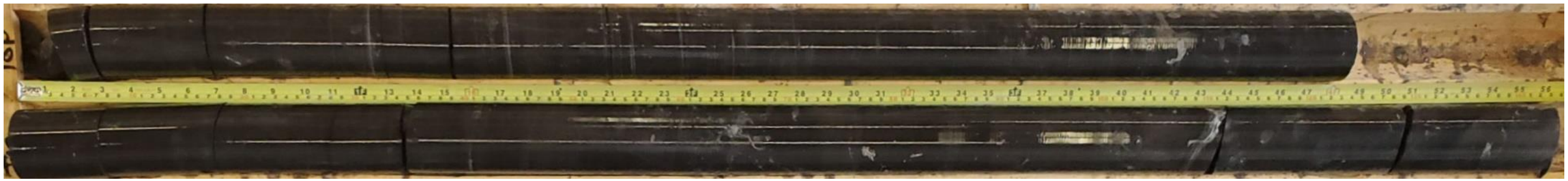
CLIENT	WSP	*PML REF*	20TF017
PROJECT	HWY 401/CNR OVERPASS	*LAB NO.*	2008570B
SAMPLE IDENTIFICATION	CN-7 RUN2 48.13 m-48.31 m	*DATE SAMPLED*	2020/12/17
YOUNG'S MODULUS, E_{tan} (at 50% σ)	GPa	*DATE TESTED*	12/23/2020
YOUNG'S MODULUS, E_{sec} (at 50% σ)	GPa	*TESTED BY*	Azar Saidajan
YOUNG'S MODULUS, $E_{ave.}$ (at 50% σ)	GPa	*POISSON'S RATIO*	



REVIEWED BY J.Noor *DATE* 2021/01/08

ROCK CORE PHOTOGRAPHS

Borehole CN-7



Borehole CN7 – RUN1 and RUN2– 45.72-48.76 m

Borehole C-3

Borehole C-3 – RUN1 and RUN2– 38.25 -39.93 m

Borehole C-3 – RUN3 – 39.93-41.45 m

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CONSULTING ENGINEERS

STRENGTH
VH = Very High = >200 MPa
H = High = 50-200 MPa
M = Medium = 15-50 MPa
L = Low = 4-15 MPa
VL = Very Low = 1-4 MPa

WEATHERING
U = Unweathered = No signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-Like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane
BR = Broken Rock

ORIENTATION
F = Flat = 0-20°
D = Dipping = 20-50°
V = Vertical >50°

SPACING
VW = Very Wide = >3 m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

CORE LOG IDENTIFICATION

BOREHOLE #:	C-3
PML REF.:	20TF017
PROJECT:	Highway 40/CNR 2019-3076 Overhead
LOCATION:	Highway 40 CNR Sarnia, Ontario
DATE:	October 2, 2020
LOGGED BY:	H. Racher, P.Geo.

Provincial Highways: A Guide to the Description of Rock for Engineering Purposes
MI-47

RUN #	DEPTH TO (m)	CORE RECOVERY (%)	RQD (%)	DEPTH TO (m)	GENERAL DESCRIPTION	STRENGTH	WEATHERING	DISCOUNTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								# OF SETS	TYPE	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
1	38.25	74% (0.13 m)	0% (0.00 m)	38.41	**KETTLE POINT FORMATION** Unweathered, fissile, thinly laminated, black, soft **SHALE**.	L	U	1	BR	-	-	-	-	-	Entire run broken rock.	
2	38.41	+100% (1.65 m)	100% (1.55 m)	39.93	**KETTLE POINT FORMATION** Unweathered, fissile, thinly laminated, black, soft **SHALE**.	L	U	1	J	F	-	SP	-	-	Occasional presence of sulphide lenses/nodules; broken rock at 39.45-39.51 m; sample taken at 38.86-39.13 m.	
								1	BR	-	-	-	-	-		
3	39.93	+100% (1.63 m)	100% (1.63 m)	41.45	**KETTLE POINT FORMATION** Unweathered, fissile, thinly laminated, black, soft **SHALE**.	L	U	1	J	F	-	SP	-	-	Occasional presence of sulphide lenses/nodules; calcite vein <3.0 mm wide; vertical fracture at 41.40-41.56 m.	
								1	J	V	-	SP	-	-		

Peto MacCallum Ltd.
CONSULTING ENGINEERS

STRENGTH
VH = Very High = >200 MPa
H = High = 50-200 MPa
M = Medium = 15-50 MPa
L = Low = 4-15 MPa
VL = Very Low = 1-4 MPa

WEATHERING
U = Unweathered = No signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-Like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane
BR = Broken Rock

ORIENTATION
F = Flat = 0-20°
D = Dipping = 20-50°
V = Vertical >50°

SPACING
VW = Very Wide = >3 m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ROUGHNESS
RU = Rough Undulating
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FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

CORE LOG IDENTIFICATION

BOREHOLE #:	CN-7
PML REF.:	20TF017
PROJECT:	Highway 40/CNR 2019-3076 Overhead
LOCATION:	Highway 40 CNR Sarnia, Ontario
DATE:	August 7, 2020
LOGGED BY:	H. Racher, P.Geo.

Provincial Highways: A Guide to the Description of Rock for Engineering Purposes
MI-47

RUN #	DEPTH TO (m)	CORE RECOVERY (%)	RQD (%)	DEPTH TO (m)	GENERAL DESCRIPTION	STRENGTH	WEATHERING	DISCOUNTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								# OF SETS	TYPE	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
1	45.72	78% (1.19 m)	75% (1.14 m)	47.24	**KETTLE POINT FORMATION** Unweathered, fissile, thinly laminated, black, soft **SHALE**.	L	U	1	J	F	-	SP	-	-	Broken rock at 45.72-45.74 m; sample taken at 46.65-46.81 m.	
2	47.24	93% (1.42 m)	93% (1.42 m)	48.76	**KETTLE POINT FORMATION** Unweathered, fissile, thinly laminated, black, soft **SHALE**.	L	U	2	J	F	M	SP	-	-	Occasional presence of sulphide stringers/nodules; white quartz vein <15.0 mm thick.	

APPENDIX C

Results of Chemical Tests Provided by SGS Canada Inc.

FINAL REPORT

CA14944-AUG20 R1

20TF017

Prepared for

Peto MacCallum Ltd

FINAL REPORT

First Page

CLIENT DETAILS

Client	Peto MacCallum Ltd
Address	165 Cartwright Ave Toronto, ON M6A 1V5. Canada
Contact	Nazibur Rahman
Telephone	416-785-5110
Facsimile	416-785-5120
Email	nrahman@petomaccallum.com
Project	20TF017
Order Number	
Samples	Soil (8)

LABORATORY DETAILS

Project Specialist	Brad Moore Hon. B.Sc
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2143
Facsimile	705-652-6365
Email	brad.moore@sgs.com
SGS Reference	CA14944-AUG20
Received	08/31/2020
Approved	09/03/2020
Report Number	CA14944-AUG20 R1
Date Reported	09/03/2020

COMMENTS

Temperature of Sample upon Receipt: 9 degrees C
Cooling Agent Present:YES
Custody Seal Present:YES

Chain of Custody Number:013261

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

SIGNATORIES

Brad Moore Hon. B.Sc

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FINAL REPORT

CA14944-AUG20 R1

Client: Peto MacCallum Ltd
Project: 20TF017
Project Manager: Nazibur Rahman
Samplers: Omar Noor

PACKAGE: **- Corrosivity Index** (SOIL)

Sample Number			5	6	7	8	9	10	11	12
Sample Name			CN-7 Sample 19 75'-77'	CN-7 Sample 25 130'-132'	CN-5 Sample 12 40'-42'	CN-5 Sample 21 110'-112'	RW-1 Sample 10 25'-27'	RW-1 Sample 16 55'-57'	RW-2 Sample 21 100'-102'	RW-2 Sample 27 140'-140'
Sample Matrix			Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date			31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Corrosivity Index										
Corrosivity Index	none	1	8	8	8	12	1	8	6	12
Soil Redox Potential	mV	-	164	218	241	157	239	84	148	218
Sulphide	%	0.04	0.44	0.40	0.13	0.43	< 0.04	0.15	0.46	0.43
pH	pH Units	0.05	8.54	8.54	8.68	8.21	8.50	8.50	8.40	8.30
Resistivity (calculated)	ohms.cm	-9999	3250	2580	4080	1600	5740	2580	2280	1590

PACKAGE: **- General Chemistry** (SOIL)

Sample Number			5	6	7	8	9	10	11	12
Sample Name			CN-7 Sample 19 75'-77'	CN-7 Sample 25 130'-132'	CN-5 Sample 12 40'-42'	CN-5 Sample 21 110'-112'	RW-1 Sample 10 25'-27'	RW-1 Sample 16 55'-57'	RW-2 Sample 21 100'-102'	RW-2 Sample 27 140'-140'
Sample Matrix			Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date			31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
General Chemistry										
Conductivity	uS/cm	2	308	387	245	624	174	387	438	628

PACKAGE: **- Metals and Inorganics** (SOIL)

Sample Number			5	6	7	8	9	10	11	12
Sample Name			CN-7 Sample 19 75'-77'	CN-7 Sample 25 130'-132'	CN-5 Sample 12 40'-42'	CN-5 Sample 21 110'-112'	RW-1 Sample 10 25'-27'	RW-1 Sample 16 55'-57'	RW-2 Sample 21 100'-102'	RW-2 Sample 27 140'-140'
Sample Matrix			Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sample Date			31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Metals and Inorganics										
Moisture Content	%	0.1	18.5	19.8	15.6	21.9	13.3	18.0	19.6	19.2

Client: Peto MacCallum Ltd
Project: 20TF017
Project Manager: Nazibur Rahman
Samplers: Omar Noor

PACKAGE: **- Metals and Inorganics** (SOIL)

			Sample Number	5	6	7	8	9	10	11	12
			Sample Name	CN-7 Sample 19 75'-77'	CN-7 Sample 25 130'-132'	CN-5 Sample 12 40'-42'	CN-5 Sample 21 110'-112'	RW-1 Sample 10 25'-27'	RW-1 Sample 16 55'-57'	RW-2 Sample 21 100'-102'	RW-2 Sample 27 140'-140'
			Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			Sample Date	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Metals and Inorganics (continued)											
Sulphate	µg/g	0.4		340	480	230	540	49	190	320	430

PACKAGE: **- Other (ORP)** (SOIL)

			Sample Number	5	6	7	8	9	10	11	12
			Sample Name	CN-7 Sample 19 75'-77'	CN-7 Sample 25 130'-132'	CN-5 Sample 12 40'-42'	CN-5 Sample 21 110'-112'	RW-1 Sample 10 25'-27'	RW-1 Sample 16 55'-57'	RW-2 Sample 21 100'-102'	RW-2 Sample 27 140'-140'
			Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			Sample Date	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020	31/08/2020
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Other (ORP)											
Chloride	µg/g	0.4		12	30	6.2	28	3.6	10	19	34

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0019-SEP20	µg/g	0.4	<0.4	0	20	94	80	120	107	75	125
Sulphate	DIO0019-SEP20	µg/g	0.4	<0.4	0	20	96	80	120	94	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	ECS0004-SEP20	%	0.04	< 0.04	1	20	104	80	120			

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0012-SEP20	uS/cm	2	< 2	2	20	100	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0012-SEP20	pH Units	0.05	NA	0		100			NA		

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

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

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

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

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

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

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

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

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

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.
RL Reporting Limit.
↑ Reporting limit raised.
↓ Reporting limit lowered.
NA The sample was not analysed for this analyte
ND Non Detect

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

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

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

-- End of Analytical Report --

FINAL REPORT

CA14840-OCT20 R1

20TF017

Prepared for

Peto MacCallum Ltd

FINAL REPORT

First Page

CLIENT DETAILS

Client	Peto MacCallum Ltd
Address	165 Cartwright Ave Toronto, ON M6A 1V5. Canada
Contact	Nazibur Rahman
Telephone	416-785-5110
Facsimile	416-785-5120
Email	nrahman@petomaccallum.com
Project	20TF017
Order Number	
Samples	Soil (8)

LABORATORY DETAILS

Project Specialist	Jill Campbell, B.Sc.,GISAS
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	2165
Facsimile	705-652-6365
Email	jill.campbell@sgs.com
SGS Reference	CA14840-OCT20
Received	10/21/2020
Approved	10/27/2020
Report Number	CA14840-OCT20 R1
Date Reported	10/27/2020

COMMENTS

Temperature of Sample upon Receipt: 7 degrees C
Cooling Agent Present:Yes
Custody Seal Present:Yes

Chain of Custody Number:004117

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

SIGNATORIES

Jill Campbell, B.Sc.,GISAS

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Client: Peto MacCallum Ltd
Project: 20TF017
Project Manager: Nazibur Rahman
Samplers: Omar Noor

PACKAGE: **- Corrosivity Index** (SOIL)

			Sample Number	5	6	7	8	9	10	11	12
			Sample Name	C-3 Sample 8, 25'-27'	C-3 Sample 12, 45'-47'	C-3 Sample 20, 105'-107'	C-3 Sample 5, 12'-14'	C-2 Sample 5, 15'-17'	C-2 Sample 7, 20'-22'	C-1 Sample 5, 12.5'-14.5'	C-1 Sample 8, 25'-27'
			Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			Sample Date	16/10/2020	16/10/2020	16/10/2020	20/10/2020	20/10/2020	21/10/2020	21/10/2020	21/10/2020
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Corrosivity Index											
Corrosivity Index	none	1		8	6	4	6	4	4	10	8
Soil Redox Potential	mV	-		149	169	151	142	161	163	152	128
Sulphide (Na2CO3)	%	0.04		0.13	0.41	0.41	< 0.04	0.10	0.13	0.10	0.12
pH	pH Units	0.05		9.05	8.37	8.41	7.75	8.35	8.20	8.55	8.51
Resistivity (calculated)	ohms.cm	-9999		5910	2480	6290	1900	7700	3650	2410	4220

PACKAGE: **- General Chemistry** (SOIL)

			Sample Number	5	6	7	8	9	10	11	12
			Sample Name	C-3 Sample 8, 25'-27'	C-3 Sample 12, 45'-47'	C-3 Sample 20, 105'-107'	C-3 Sample 5, 12'-14'	C-2 Sample 5, 15'-17'	C-2 Sample 7, 20'-22'	C-1 Sample 5, 12.5'-14.5'	C-1 Sample 8, 25'-27'
			Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			Sample Date	16/10/2020	16/10/2020	16/10/2020	20/10/2020	20/10/2020	21/10/2020	21/10/2020	21/10/2020
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
General Chemistry											
Conductivity	uS/cm	2		169	404	159	527	130	274	415	237

PACKAGE: **- Metals and Inorganics** (SOIL)

			Sample Number	5	6	7	8	9	10	11	12
			Sample Name	C-3 Sample 8, 25'-27'	C-3 Sample 12, 45'-47'	C-3 Sample 20, 105'-107'	C-3 Sample 5, 12'-14'	C-2 Sample 5, 15'-17'	C-2 Sample 7, 20'-22'	C-1 Sample 5, 12.5'-14.5'	C-1 Sample 8, 25'-27'
			Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			Sample Date	16/10/2020	16/10/2020	16/10/2020	20/10/2020	20/10/2020	21/10/2020	21/10/2020	21/10/2020
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Metals and Inorganics											
Moisture Content	%	0.1		18.7	18.2	22.3	18.8	14.8	17.3	14.2	18.5

Client: Peto MacCallum Ltd
Project: 20TF017
Project Manager: Nazibur Rahman
Samplers: Omar Noor

PACKAGE: **- Metals and Inorganics** (SOIL)

			Sample Number	5	6	7	8	9	10	11	12
			Sample Name	C-3 Sample 8, 25'-27'	C-3 Sample 12, 45'-47'	C-3 Sample 20, 105'-107'	C-3 Sample 5, 12'-14'	C-2 Sample 5, 15'-17'	C-2 Sample 7, 20'-22'	C-1 Sample 5, 12.5'-14.5'	C-1 Sample 8, 25'-27'
			Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			Sample Date	16/10/2020	16/10/2020	16/10/2020	20/10/2020	20/10/2020	21/10/2020	21/10/2020	21/10/2020
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Metals and Inorganics (continued)											
Sulphate	µg/g	0.4		220	310	420	3.1	240	230	190	200

PACKAGE: **- Other (ORP)** (SOIL)

			Sample Number	5	6	7	8	9	10	11	12
			Sample Name	C-3 Sample 8, 25'-27'	C-3 Sample 12, 45'-47'	C-3 Sample 20, 105'-107'	C-3 Sample 5, 12'-14'	C-2 Sample 5, 15'-17'	C-2 Sample 7, 20'-22'	C-1 Sample 5, 12.5'-14.5'	C-1 Sample 8, 25'-27'
			Sample Matrix	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
			Sample Date	16/10/2020	16/10/2020	16/10/2020	20/10/2020	20/10/2020	21/10/2020	21/10/2020	21/10/2020
Parameter	**Units**	**RL**		**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Other (ORP)											
Chloride	µg/g	0.4		7.6	12	32	37	13	9.1	91	9.4

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0467-OCT20	µg/g	0.4	<0.4	12	20	94	80	120	98	75	125
Sulphate	DIO0467-OCT20	µg/g	0.4	<0.4	7	20	94	80	120	110	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide (Na2CO3)	ECS0029-OCT20	%	0.04	< 0.04	18	20	109	80	120			

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0421-OCT20	uS/cm	2	< 2	0	20	100	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0421-OCT20	pH Units	0.05	NA	0		100			NA		

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

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

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

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

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

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

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

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

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

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.
RL Reporting Limit.
↑ Reporting limit raised.
↓ Reporting limit lowered.
NA The sample was not analysed for this analyte
ND Non Detect

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

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

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

-- End of Analytical Report --

Peto MacCallum Ltd.
CONSULTING ENGINEERS

PART B – FOUNDATION DESIGN REPORT

for

REPLACEMENT OF SOUTH CULVERT AT CNR OVERHEAD
SITE 14X-0290/B2
G.W.P. 3064-11-00
W.P. 3064-11-02
GEOGRAPHICAL TOWNSHIP OF SARNIA
LAMBTON COUNTY, ONTARIO
LATITUDE AND LONGITUDE: 42.955329, -82.345831

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Appendix D – List of Standard Specifications Relevant to Report

9. INTRODUCTION

This foundation investigation and design report including the interpretations and recommendations are intended for the use of WSP on behalf of the MTO, for this project, and shall not be used or relied upon for any other purposes or by any other parties. Where comments related to construction are made in this report, they are provided only to highlight those aspects that could affect the design of the project. Contractors must make their own interpretation of the factual information provided in Part A of the report for construction purposes, as it may affect equipment selection, proposed construction methods and scheduling.

10. PROJECT DESCRIPTION

10.1 General

This report provides foundation design recommendations for the replacement of the south culvert at Highway 40 and Canadian National Railway (CNR) Overhead, located in the Town of Sarnia, Ontario. A new railway overhead structure is proposed to be constructed approximately 22.0 m west of the existing CNR overhead. The existing embankments for the existing and proposed overpass structures were built over 40 years ago, and the existing south culvert is crossing beneath the existing south embankments. The recommendations are based on the interpretation of the geotechnical data presented in the factual report (Part A).

10.2 Existing Culvert

The existing culvert is crossing under the existing south embankments at Station 19+942.5. The existing box culvert is approximately 81.2 m long, with an opening size of 1.24 m in span and 1.24 m in rise, supports up to 5.9 m of overburden above the obvert.

The thickness of the concrete box culvert ranges from 0.2 m (top) to 0.25 m (bottom). The dimensions of the culverts are based on the GA drawing of the overhead structure and a preliminary drawing provided by WSP via email dated April 8, 2021 and October 25, 2019, respectively. The outlet and inlet inverts of the existing culvert are approximately EL. 185.7 and EL. 185.9, respectively, based on 1964-0307 Contract Drawings provided by WSP via email dated August 11, 2021.

The existing culvert is part of the drainage channel system along the existing embankments and across the CNR right-of-way (ROW). The drainage channel system includes ditches and drain along the embankments, and culverts crossings along the embankments and CNR ROW.

10.3 Proposed New Culvert

A culvert Detail Drawing was provided by WSP via email dated December 10, 2021. The proposed culvert Station is 19+941.4. The length of the proposed south culvert is anticipated to be 79.2 m long at a skew of 82 degrees from the centerline of the new Highway 40 alignment. The inlet and outlet invert elevations will be approximately EL. 185.8 and EL.185.5, respectively. The south culvert will be replaced 1.1 m south of the existing alignment, and will be constructed by the cut and cover method. The existing grade of the embankment at the culvert location, at Station 19+941.4, will be raised up to 6.4 m above the existing ground surface following replacement of the culvert. It is understood that prior to replacing the existing culvert, the existing embankment fill will be excavated to the bedding levels of the proposed culvert, and following construction of the replacement culvert, new fill will be placed to the proposed full height of the embankment.

10.4 Subsurface Conditions

In summary, the subsoil conditions consist of 1.5 m to 9.2 m of fill, which is underlain by approximately 36.5 m to 36.7 m of firm to very stiff silty clay/clayey silt deposit, where fully penetrated. In boreholes C-3 and CN-7, the cohesive deposit is underlain by shale bedrock to termination depths of 41.5 m (EL. 147.0), and 48.7 m (EL. 148.2), respectively. Boreholes C-1 and

C-2 were terminated in the cohesive deposit at EL. 176.2 and EL. 177.5, respectively. Borehole RW-1 was terminated on probable bedrock at 45.7 m (EL. 150.3).

Groundwater was encountered upon completion of drilling in boreholes C-2, CN-7, and RW-1 at depths of 6.1 m to 9.1 m (EL. 182.7 to EL. 187.7) below the existing ground surface. The groundwater level was not encountered or could not be established during drilling or upon completion of drilling in Boreholes C-1 and C-3. The groundwater level measured in the monitoring well installed in Borehole CN-7 was 8.9 m (EL. 187.0) as of August 17, 2020.

11. EXCAVATION

It is anticipated that staged construction with Temporary Protection System (TPS) will be required to remove the existing culvert and to install the new culvert while maintaining traffic on Highway 40.

Based on discussions with WSP, it is anticipated that the west half of the culvert will be replaced prior to the new overhead structure construction. Following replacement of the west half of the culvert, the replacement of the east half of the culvert will be completed following existing Highway 40 overhead structure is removed.

Surface water shall be diverted away from open excavations and all excavations should be carried out in accordance with the Occupational Health and Safety Act (OHSA) and MTO Regulations for Construction Projects. The TPS should be constructed in accordance with OPSS.PROV 539 and SSP 105S09. Excavation and backfilling should be carried out in accordance with OPSS.PROV 902.

The invert levels of the replacement culvert are anticipated to be between approximate EL. 185.5 and EL.185.8, and the culvert bedding between EL. 185.2 and EL. 185.5. It is anticipated that up to 7.9 m excavation of the existing overburden will be required to remove and replace the existing culvert. The excavation width should be at least 1.0 m wider than the plan area of the culvert. Where cut slope geometry in accordance with OHSA cannot be established, TPS will be required to carry out the excavation.

Based on the record of boreholes, the excavations for the culvert replacement will be advanced through existing fill material underlain by native clayey silt/silty clay deposit. In addition, it is anticipated that excavation will be carried out 1.5 m to 2.3 m depth below the observed groundwater level.

Provided adequate groundwater control is achieved, the onsite soils may be classified as Type 3 as defined in the Occupational Health and Safety Act (OHSA). Excavations within Type 3 soil that may not be steeper than one horizontal to one vertical (1H:1V) from the base. Soils below the groundwater level will take on the characteristics of Type 4 soil and will be classified as Type 4 soils, unless adequate groundwater control is provided as discussed later in this report. A Type 4 soil requires excavation at three horizontal to one vertical (3H:1V) from the base in accordance with OHSA. Workers should not enter an unprotected excavation if there is evidence of ongoing ground water seepage in the pits. The slope of excavation walls should conform to as described in Ont. Reg. 213/92, S. 234. Temporary shoring systems may be required if slopes as described in Ont. Reg. 213/92, S. 234 cannot be provided.

Any spongy or soft area observed within the base of the excavation should be removed and replaced with suitable fill material and compacted in accordance with OPSS.PROV 401.

Excavated material shall not be stockpiled in the areas immediately adjacent to the top of the excavation slopes. All excavated surfaces should be kept free of frost and water during the period of construction. Runoff shall be directed away from open excavations and should not be allowed to flow into the excavation.

12. TEMPORARY PROTECTION SYSTEM

TPS will be required along the median of the existing south embankments, between the existing Highway 40 alignment and the new alignment, to maintain traffic on the existing Highway 40. Temporary roadway protection shall be designed to meet at least a Performance Level of 2 and constructed in accordance with OPSS.PROV 539, amended by SP 105S09. The Contractor shall be responsible for the selection, detailed design and performance of the roadway protection system. OPSS.PROV 539, amended by SP 105S09, also calls for monitoring of the roadway protection system by the Contractor to check the horizontal and vertical displacements of the

roadway. The soil parameters outlined in Table 4 may be used for design of the TPS.

Table 4: Earth Pressure Coefficients

PARAMETERS	OPSS GRANULAR 'A'	OPSS GRANULAR 'B' TYPE II	FILL	CLAYEY SILT TO SILT CLAY
Internal Friction Angle, (degrees)	35°	30°	Effective Stress Value 20°	Effective Stress Value 28°(1)
Unit weight, γ (kN/m^3)	22.5± 0.3	21.5 ± 0.3	18.0 ± 0.5	20.0 ± 0.5
Coefficient of Active Earth Pressure, K_a[2]	0.27	0.33	0.49	0.36
Coefficient of Earth Pressure at Rest, K_o	0.43	0.50	0.65	0.53
Coefficient of Passive Earth Pressure, K_p[2,3]	3.69	3.00	2.04	2.77

Note(s): (1) – Based on GEOCRES No. 40J16-013.

(2) The lateral earth pressure coefficients assume an adjacent horizontal surface. For a sloped surface adjacent to the excavation, the values should be corrected.

(3) The passive pressure coefficient should be reduced by an appropriate factor to account for the fact that a large strain is needed to mobilize the full K_p (Ref. Section 6 of CHBDC (2019).

Single or Multiple-level anchor system including all anchors below level of base of excavation and existing fill into the native cohesive clayey silt/silty clay layer may be required in the median. Parameters provided in Table 5 may be used to determine the capacity of anchor. The length of anchor and penetration of the temporary retaining structure and each level of anchoring system should be checked for stability. It is recommended that the shoring design to be carried out by qualified professional with minimum of 5 years of experience in the design of similar tie back wall systems.

Table 5: Soil Parameters

ELEVATION		SOIL TYPE	SOIL PARAMETERS	
FROM	TO		UNIT WEIGHT, γ (kN/m3)	Cu, kN/m3
For TPS Along the Median of the South Embankment				
195.9	186.3	Clayey Silt Fill	18	75
186.3	170.0	Clayey Silt/ Silty Clay	20	100
170.0	160.0			90
160.0	150.2			100

A reduction factor of 0.45 for adhesion may be considered for the design.

Design tests (sacrificial anchor pull-out test) are recommended to be carried out by the contractor before the installations of working (production) anchors. Anchor pull-out tests should be carried out to verify the resistance during construction phase. Contractors should review available information and carry out as necessary survey for underground utilities and potential obstructions to avoid conflicts with tie back installations.

Non-destructive proof load test should be carried out on working servicing anchors, and should be taken to the maximum test load of 1.33 times the working service load.

13. GROUNDWATER CONTROL

Surface water flow or seepage from perched water should be directed away from the excavation areas to mitigate disturbance and weakening of the native clayey silt/silty clay soil. The groundwater level at the time of the investigation was approximately at 1.2 m to 2.0 m above the culvert invert EL. 185.7.

The existing water drainage channel has to be temporarily diverted from the culvert during the construction period by means of a temporary flow system. It is anticipated that the ends of the culvert will be dammed, and water will be diverted by means of pumps and hoses.

The contractor shall be responsible for the selection, performance and detail design of the unwatering/dewatering system, and the temporary flow system. The unwatering/dewatering scheme is required to lower the groundwater level to a minimum of 0.5 m below the lowest level of excavation. The unwatering/dewatering system, and temporary flow system should be designed to conform to the requirements of OPSS.PROV 517 and SP 517F01.

In accordance with SSP 517F01, the dewatering system should be designed by a designer with a minimum 5 years of experience in the field. A preconstruction survey of 60 m radius from the centreline of the proposed Highway 40 alignment at approximate Station 19+941.4 is required due to the presence of existing CNR tracks and utility services in the vicinity of the culvert site. The Contractor's dewatering/unwatering scheme should be submitted for the CA or Project team review, and it shall be designed and implemented in a manner not to induce adverse effect on the existing structures, rail tracks and existing underground utilities.

14. CULVERT OPTIONS

The feasibility of the following options is discussed for replacing the existing culvert along the same vertical and horizontal alignments:

- Replacement with a precast concrete box culvert, and
- Replacement with a cast-in-place concrete box culvert

Considering the subsoil conditions, the recommendations for the replacement culvert are provided below in the order of preference. A comparison of the technical advantages and disadvantages for the replacement culvert are presented in Table 6.

Table 6: Comparison of Alternate Culvert Options

Option 1: Precast Concrete Box Culvert	Option 2: Cast In-Place Concrete Box Culvert
Advantages: 1. High degree of quality and uniformity, design flexibility, superior strength and durability 2. Reduced weather dependency during installation 3. Reduced impact on traffic interruption 4. Ease of construction and installation in wet conditions is possible 5. The joints provide flexibility to accommodate differential settlement	**Advantages:** 1. Reduces uneven settlement 2. Reduces water leakage and deterioration of culvert 3. Ability to withstand differential settlements 4. Degradation of subgrade can be avoided by placing lean concrete
Disadvantages: 1. Temporary flow systems will be required 2. Installation of TPS will be required 3. Cause sediment accumulation in the upstream of the channel 4. Possibility for degradation of subgrade	**Disadvantages:** 1. Temporary flow systems will be required 2. Installation of TPS will be required 3. Cause sediments accumulation in the upstream of the channel 4. Weather dependent during construction 5. Major dewatering scheme is required to construct the floor slab under 1.3 m high groundwater level
Recommended	**Technically Feasible but Not Recommended**

The subsoil conditions below the proposed founding level of the culvert are capable of adequately support a precast box culvert or cast-in-place reinforced concrete box culvert. However, construction below 1.2 m to 2.0 m below of groundwater level will impose difficulties for construction. Adequate groundwater control will be required to provide dry conditions for the construction work to be carried out to replace the existing culvert. Refer to Section 13 of this report for groundwater control.

14.1 Option 1: Precast Concrete Box Culvert

It is assumed that the precast box culvert will be placed at about EL. 185.8 (inlet) to EL. 185.5 (outlet), on stiff cohesive soil. The subsoil conditions below the proposed founding level are capable of supporting a box culvert. Considering the dimensions of the proposed precast concrete box culvert, the soil conditions at the founding level, and the groundwater level, a factored geotechnical resistance of 230 kPa at ULS and 120 kPa at SLS may be utilized for design.

It is anticipated that the excavation during the culvert replacement will encounter groundwater level and a dewatering scheme should be implemented to keep the water level beneath the excavation and to provide a “dry” working condition.

The option of a precast box culvert will require at least 75 mm of levelling course meeting the requirement of OPSS 422.07.08 and bedding material as specified in OPSS 422.05.13. The granular bedding may comprise of OPSS Granular A, or equivalent, and have a minimum thickness of 300 mm. The bedding for the replacement culvert should be placed in accordance with Section 422.07.07 of OPSS.COMMON 422.

Based on the 1964-0307 Contract drawings, provided by WSP, it is understood that the downstream of the culvert connects to a manhole and hence, a cut-off wall is not required. Since, there is no evidence of scour at this site and a cut-off wall at the upstream inlet may not be required. However, if a cut-off wall is considered, as required by Clauses 1.9.5.6 and 1.9.11.6.5 of Canadian Highway Bridge Design (CHBDC 2019), cut-off walls shall be in accordance with OPSD 812.010 or made of precast concrete with similar dimensions to prevent washout of granular bedding. The design of cut-off wall should meet the requirements of clauses 1.9.5.6 and 1.9.11.6.5 of CHBDC 2019, to protect against scour or undermining.

The removal of the existing foundation may cause disturbance to the founding surface of the proposed culvert. In addition, the cohesive layer at the founding level will be susceptible to disturbance from construction traffic and any ponded water. In order to limit the degradation of the founding soil, it is recommended that the granular bedding be placed on the subgrade within four hours after preparation, inspection and approval of the footing subgrade.

In combination to the above measures, a minimum erosion treatment for the outlet and inlet of the culverts should also reference the standard in OPSD 810.010.

An unwatering/dewatering scheme shall be used to provide working platform for placing of precast culvert sections along the culvert alignment.

14.2 Option 2: Cast-In-Place Reinforced Concrete Box Culvert

The subsoil conditions below the proposed founding level of the culvert are capable of adequately supporting the cast-in-place concrete box culvert. However, construction under 1.2 m to 2.0 m below groundwater will impose difficulties for construction in dry conditions.

If this option is considered, the dewatering scheme shall be used to provide working platform for formwork and placing of concrete. In this case, the footing of the box culvert may be placed at about EL. 185.8 (inlet) to EL. 185.5 (outlet), and may be designed assuming geotechnical resistances as precast concrete box culvert.

The removal of the existing foundation may cause disturbance to the founding surface of the proposed culvert. In addition, the clayey silt layer at the founding level will be susceptible to disturbance from construction traffic and any ponded water. In order to limit the degradation of the founding soil, it is recommended that a 100 mm thick concrete working slab (lean concrete) to be placed on the subgrade within four hours after preparation, inspection and approval of the footing subgrade. The unwatering/dewatering to construct the cast-in-place culvert in dry condition may impose greater difficulties. In view of the construction difficulties, this option is not preferred.

14.3 Recommended Option for Culvert Replacement

From a geotechnical perspective and based on the subsurface conditions, precast concrete box culvert placed at about EL. 185.8 (inlet) to EL. 185.5 (outlet), is the preferred option for the replacement of the existing culvert.

14.4 Cover and Backfill

The existing embankment consists of clayey silt fill materials as described in Part A of this report. In case the backfill material is replaced; it should be Granular ‘A’ or ‘B’ Type II meeting the requirements of OPSS.PROV 1010, amended by SSP 110S06, to comply with the currently employed OPSD 803.010. The backfill shall be placed in layers not exceeding 200 mm in thickness before compaction and compacted in accordance with OPSS.PROV 501, amended by SSP 105S22. Backfill on each side of the culvert shall be completed simultaneously and at no time, the levels on each side of the culvert exceed more than 500 mm. Restrictions on compaction near the culvert shall be as specified in OPSS 902.07.06.02. The backfill and cover for the concrete culvert should reference to OPSD 803.010, where the span of the culvert is less than or equal to 3.0 m.

15. LATERAL EARTH PRESSURE

Earth pressure for the concrete structure should be computed as per the Clause 6.12.2 (b) of the Canadian Highway Bridge Design Code (CHBDC, 2019). Sufficient movement of the structure wall may not be permitted for both options and “at rest” conditions may be assumed for the calculation of earth pressure. The earth pressure calculation should include maximum water level expected in the drainage channel. The lateral earth and water pressure, p (kPa), may be computed using the equivalent fluid pressures presented in Section 6.12 of the CHBDC 2014 or employing the following equation assuming a triangular pressure distribution.

$$P = K(\gamma h_1 + \gamma' h_2 + q) + \gamma_w h_2 + C_p + C_s$$

Where;

- P = lateral earth pressure (kPa)
- K = Coefficient of lateral earth pressure (dimensionless)
- γ = Unit weight of backfill material above assumed water level (kN/m^3)
- γ' = Unit weight of submerged backfill ($\gamma_{sat} - \gamma_w$) material below assumed water level (kN/m^3)
- γ_w = Unit weight of water (9.8 kN/m^3)
- h_1 = Depth below final grade above design water level (m)
- h_2 = Depth below design water level (m)
- q = Surcharge load (kPa)
- C_p = Compaction pressure (kPa) (Clause 6.12.3 of CHBDC, 2019)
- C_s = Earth pressure from seismic events, (kPa) (Clause 6.14.7 of CHBDC, 2019)

Based on information provided by WSP, the ditches and culvert are generally dry.

The seismic site coefficient for the conditions at this site is provided in Section 18 of this report. Granular ‘A’ or ‘B’ should be utilized as backfill material and should be carried out in accordance with the requirements specified in the OPSS.PROV 902. The recommended granular backfill parameters are outlined in Table 4.

Backfill shall be placed simultaneously behind both sides of the culvert, maintaining the height of backfill approximately the same. At no time should the difference in backfill elevation from one side to the other be greater than 500 mm.

16. CULVERT SETTLEMENT

Refer to 'Foundation Investigation and Design Report for New Embankment on Highway 40 at CNR Overhead', prepared by PML, for the details of the embankment stability and settlement analyses and discussions.

In summary, approximately at Station 19+941.4, all existing embankment fill will be excavated to replace the existing culvert. It is estimated, based on analyses carried out at Station 19+941.18, that the primary consolidation of the cohesive layer below the culvert will be approximately up to 50 mm, following construction of the new embankment at that location. The differential settlement is estimate up to 20 mm under the proposed culvert following construction of the embankment at Station 19+941.4.

17. FOUNDATION FROST DEPTH

In accordance with OPSD 3090.101, a minimum of 1.1 m earth cover is required to protect against the frost penetration in the area where the site is located.

18. SEISMIC CONSIDERATIONS

The Spectral (Sa(T), where T is in seconds) and Peak Ground Acceleration (PGA) for the project site is 0.086 (Sa (0.2)) and 0.050 (2%/50 years), respectively, based on the longitude and latitude coordinates of the proposed structure (National Building Code of Canada, 2015). The soil below the founding level at this site for seismic design purposes is classified as Site Class D in accordance with Table 4.1, CHBDC 2019.

19. SOIL CORROSIVITY

A total of 12 samples from the fill and clayey silt to silty clay deposit were tested for soil corrosivity and potential exposure of concrete to sulphate attack. A summary of the results of chemical analyses are provided in Section 7.2.5 of Part A of this report. The sulphate concentration varied from 3.1 µg/g to 480 µg/g (0.0003% to 0.048%). Compared to the values suggested in Canadian

Standard A23.1-14, the effect on buried concrete is considered negligible. The chloride contents of the samples ranged from as low as 3.6 µg/g to 91 µg/g (0.0004% to 0.0091%). Generally, the concentration value in excess of 250 ppm (0.025%) leads to corrosive environment for buried metals or reinforcing steel. The potential for corrosive environment of this fill is assessed to be low to moderate.

Electrical resistivity less than 2000 ohm-cm generally leads to highly corrosive environment for steel elements in contact with soil. The resistivity values of samples ranged from 1900 ohm-cm to 7700 ohm-cm. The test results suggest that a corrosive environment exists at this site for steel elements in contact with soils where the resistivity was less than 2000 ohm-cm. The pH values of the samples ranged from 7.75 to 9.05.

A limited number of soil corrosivity tests was carried out and may not be representative of the corrosiveness of the full depth of the overburden soils encountered in the boreholes. Additional tests may be required during the construction period. Generally, it may be advisable to use imported backfill material selected to provide a more benign chemical environment. Otherwise, measures to mitigate the impact of the chemical environment could be considered.

20. CLOSURE

This report was prepared by Mr. Nazibur. Rahman, P.Eng., with the assistance of Ms. Natasha Leong-Sem, EIT. Mr. Robert Ng, P.Eng., Designated Principal Contact, conducted an independent review of the report.

Yours very truly,

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NLS/NR//RN: nls-nr-nk

APPENDIX D

List of Standard Specifications Relevant to Report

LIST OF STANDARD SPECIFICATIONS RELEVANT TO REPORT

DOCUMENT	TITLE
OPSS. PROV 401	Construction Specification for Trenching, Backfilling and Compacting
OPSS.COMMON 422	Construction Specification for Precast Reinforced Concrete Box Culverts in Open Cut
OPSS.PROV 517	Construction Specification for Dewatering
OPSS.PROV 501	Construction Specification for Compacting
OPSS.PROV 539	Temporary Protection System
OPSS.PROV 902	Construction Specification for Excavation and Backfilling - Structures
OPSS.PROV 1010	Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material
OPSD 803.010	Backfill and Cover for Concrete Culverts with Spans Less than or Equal to 3.0 m
OPSD 810.010	General Rip-Rap Layout for Sewer and Culvert Outlets
OPSD 812.010	Cut off Wall for Structural Plate Pipe Arch and Circular CSP
OPSD 3090.101	Foundation, Frost Penetration depths for Southern Ontario
SSP 105S22	Amendment to OPSS 501
SSP 105S09	Amendment to OPSS 539
SSP 517F01	Amendment to OPSS 517
SSP 110S06	Amendment to OPSS 1010