



Enbridge Gas Inc.

MTO HWY 17 HDD Crossing

**Geotechnical Evaluation of Site
Conditions – Highway 17
Crossing**

Report No. 3630-GO-01

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Revision:	A
Date:	2022/12/02
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2022/12/02

Enbridge Gas Inc.
500 Consumers Road
North York, Ontario
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Attention: Mr. David Monize, E.I.T. – Pipeline Engineering

RE: MTO HWY 17 HDD Crossing – Geotechnical Evaluation of Site Conditions – Highway 17 Crossing

This report presents our geotechnical evaluation to supplement the design to construct the Highway 17 crossing using Horizontal Directional Drilling (HDD) methods as part of the MTO HWY 17 HDD Crossing Project.

The evaluation was based on review of information from boreholes completed during the recent field investigation and CCI's understanding of the local geology.

Thank you for the opportunity to be of continued service. If you have any questions, please feel free to contact us.

On behalf of CCI Inc.

A handwritten signature in black ink, appearing to read 'Stefan Goerz', with a stylized flourish at the end.

Stefan Goerz, M.Sc., P.Eng.

Geotechnical Manager

Distribution: PDF – Enbridge Gas Inc., Attention: Mr. David Monize, E.I.T.

1 signed/stamped original copy – on file with CCI

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1 INTRODUCTION

Enbridge Gas Inc. (Enbridge) is proposing to construct an NPS 10 (O.D. 273.05 mm) steel pipeline approximately 30 km east of Sudbury, Ontario, as part of the MTO HWY 17 HDD Crossing Project. The Project includes the proposed trenchless crossing of Highway 17, and it is understood that Enbridge intends the installation to be completed using HDD methodology. The general location of the proposed crossing is shown in Figure 1, attached.

CCI Inc. (CCI) was requested to investigate terrain/subsurface conditions to provide a basis for evaluating the geotechnical feasibility of construction the proposed HDD crossing. Authorization to proceed with the geotechnical assignment was received from Mr. David Monize, E.I.T., Pipeline Engineer for Enbridge.

This report presents the results of the geotechnical investigation along the proposed crossing location, completed on November 17, 2022. The results will also be used in the HDD engineering design drawings.

2 SCOPE OF WORK

The Scope of the Work (SOW) for the geotechnical assignment included:

- A review of background geological/geotechnical information, including published bedrock and surficial geology maps and reports, the logs of nearby water wells and Google Earth imagery.
- Drilling/sampling of two (2) boreholes to delineate soil, bedrock and groundwater conditions at the identified crossing location.
- Visual classification and laboratory testing on selected samples.
- Preparation of a summary report.

This report details the geological setting for the project, discusses the geotechnical drilling/sampling program, and describes the subsurface conditions encountered. On that basis, it evaluates the geotechnical feasibility of constructing the Highway 17 HDD crossing.

3 GEOLOGICAL SETTING

The project area, part of the Penokean Hills, James Region in the Canadian Shield is characterized by rolling hills, in places depressional, terrain. According to Barnett, Henry and Babuin (1991) the area is underlain by sand, silt, clay and minor gravel glaciolacustrine deposits. Postglacial deposits include organics, forming wetlands in terrain depressions. Mesoproterozoic bedrock underlies the area comprising of migmatitic rocks and gneisses (Ontario Geological Survey, 1991).

4 GEOTECHNICAL INVESTIGATION

4.1 Drilling and Sampling

Two (2) boreholes were drilled and sampled to delineate soil and bedrock conditions along the HDD crossing alignment on November 17, 2022. One borehole was completed on each side of Highway 17.

A track-mounted rig owned and operated by Landcore Drilling out of Chelmsford, Ontario was used. The rig and ancillary equipment were first transported to staging/unloading areas close to the crossings, then “walked in” to the borehole locations. The soil strata being penetrated were logged from split spoon samples recovered during Standard Penetration Tests (SPTs), ASTM D1586. As well as returning relatively intact samples, the SPTs provided an indication of the *in-situ* strength of the subsurface materials. In addition, a pocket penetrometer was used in cohesive samples to measure relative density of the material. Select samples were retained and returned to Calgary for additional classification and testing.

No standpipes were installed. Rather, groundwater conditions were inferred from observations during drilling and measurements made on completion. The boreholes were backfilled to the ground surface with soil cuttings and bentonite chips.

The drilling and sampling investigation was supervised by Mr. Keith Chzyk, B.Sc., while Mr. Christian Gutierrez, P. Geo., logged the boreholes and documented site conditions. In advance of mobilizing drilling equipment to the site, right of access to the borehole locations (ground disturbance/safe work permits, road use and proximity agreements) was arranged by Enbridge. Mr. Claude Hamel, Enbridge field representative, was responsible for overall coordination of the field program.

4.2 Laboratory Testing

The laboratory testing of the soil samples returned from the field was completed by Almor Testing Services Ltd out of Calgary, Alberta. The testing consisted of a visual assessment of the sample soil type, determining natural moisture contents and sieve analyses on selected samples.

5 PRESENTATION OF RESULTS

Photographs of the site and drilling program are presented in Appendix A. Detailed descriptions of the soil, bedrock, and groundwater conditions encountered in the boreholes are presented on the logs contained in Appendix B. An Explanation of Terms and Symbols used on the logs is also enclosed.

Borehole locations along the proposed crossing alignment are shown in Figure 2, as well as in plan and profile on Drawing No. 3630-GO-01, included in Appendix C. Elevations noted in this report, estimated from the drawing, reference geodetic datum.

6 SUBSURFACE CONDITIONS

6.1 General

Subsurface conditions have been determined using information from Boreholes 3630-01 and 3630-02, which were drilled to depths of 7.9 and 9.3 m, respectively, at the locations shown on the attached Figure 2 and CCI's understanding of the local geology.

6.2 Soil Conditions

Similar subsurface soils were encountered at both borehole locations. Both boreholes exhibited 0.2 m of surficial organic material with the major underlying sections being clay, silt, sand, and gneiss (bedrock), in order with increasing depth. Differences between, and specifics of, the boreholes are noted below.

6.2.1 Borehole 3630-01

Under the 0.2 m of organics from surface, 0.4 m of poorly graded sand was encountered. Low plastic, stiff clay underlies the sand, extending 4.9 m with occasional fine grained sand lenses below 2.4 m. Very dense, poorly graded, wet silty sand with little to some gravel was present beneath the clay section. The borehole was terminated at 7.9 m after auger refusal 0.3 m into bedrock.

6.2.2 Borehole 3630-02

Damp, stiff, low plastic clay was encountered beneath the 0.2 m organic layer at surface with a boulder at 2.3 m bordering the underlying silt and sand. The boulder is believed to be a rafted piece of Gneiss (bedrock). Compact to dense silt with little amounts of sand and gravel was encountered from 2.3 to 6.7 m, while dirty sand with trace gravel was found to be underlain by bedrock at 9.0 m. Approximately 0.3 m of bedrock was drilled prior to auger refusal, terminating the borehole.

6.3 Bedrock Conditions

As discussed, the bedrock encountered at both borehole locations comprised of fresh, medium strong gneiss (bedrock) at depths of 7.6 and 9.0 m in Boreholes 3630-01 and 3630-02, respectively.

6.4 Groundwater Conditions

As noted, no standpipes were installed; rather groundwater conditions were inferred from observations during drilling. Boreholes 3630-01 and 3630-02 encountered water at 5.5 m and 2.3 m, respectively, within the silty sand layers.

It should be noted that groundwater conditions may not have stabilized and could fluctuate based on seasonal and climatic conditions. Higher groundwater could be encountered, particularly during spring thaw or following precipitation events.

7 HORIZONTAL DIRECTIONAL DRILL CONSIDERATIONS

7.1 General

Construction of an HDD crossing at Highway 17 is expected to be geotechnically feasible, subject to the limitations discussed below. Issues to be addressed in final design and which may affect the contractor's independent assessment of the risks associated with completing the crossing are presented below.

7.2 Minimum Depth of Cover

A "No Drill Zone" was not provided for the crossing. To satisfy regulatory requirements specified by the Ontario Provincial Standard Specifications 416 (OPSS) – Pipeline and Utility Installation by Jacking and Boring, at least 3.0 m of cover must be maintained below the lowest point of the road right of way. It is also recommended that the HDD maintains at least 5.0 m cover under the highway to reduce the risk of heave or inadvertent release near the road surface.

7.3 Settlement Monitoring

Settlement monitoring is recommended to be completed during construction. A detailed settlement monitoring plan should be prepared prior to construction outlining how any potential loss of ground will be captured at the earliest possible stage. This monitoring plan is recommended to include field survey as well as visual observations or mass balance of cuttings volume for the duration of construction.

7.4 Entry and Exit Considerations

The near surface soils in the crossing area are cohesive and the use of casing on entry should not be required. Due to the presence of shallow cohesive soil on both sides of the road, it should be feasible to extend the bore to ground surface at the exit.

A small pit could be excavated in the latter area to contain fluids during drilling and assist with pipe pullback. In addition, space requirements for making up and testing the pipe sections prior to pullback at the proposed HDD exit area should be evaluated by the designer.

7.5 Drilling Considerations

A bore passing beneath the minimum depth of cover along Highway 17 is expected to pass mainly through compact to very dense silt and sand along the entirety of its path with clay near surface on both sides. If the HDD extends below the sand, bedrock would also be encountered along the drill path, however it is understood that the HDD design is expected to remain above this interface.

Although sensitive to disturbance, the sand is described as dirty and very dense and occurs at an elevation below the HDD entry, allowing drilling fluid to help maintain sidewall stability through positive hydrostatic pressure. As such, it should be feasible for construction of the proposed pipeline crossing. In order to reduce the risk of washout within the sand, the bore should pass through this material as quickly as possible. In addition, an Engineered Drilling Fluid Management Plan (EDFP) is recommended to be prepared in order to control infiltration of fluid through the sand and help maintain borehole stability.

The low to medium plastic nature of the clay at this site should be noted, however, because of its shallow and near surface nature, it should not have a large impact on the drilling fluids used.

It is recommended that an Annular Pressure (AP) analysis be conducted by the HDD designer to assess the risk of inadvertent release as the bore passes beneath the Highway. The contractor should adhere to the drilling fluid pressure limits specified by the HDD designer.

8 CLOSURE

Available data suggest it should be feasible, from a geotechnical perspective, to construct the Highway 17 trenchless crossing as part of the MTO Highway 17 HDD Crossing Project. Proper planning during final design to address the issues described above, as well as good workmanship during construction, are required elements in the successful completion of the crossings.

Although subsurface conditions are not expected to vary significantly from those shown in the Borehole Logs, it should be noted that extrapolation of subsurface conditions beyond the borehole locations and explored depth is subject to interpretation and could be at variance with actual field conditions encountered. If there are changes to the proposed crossing alignment or if subsurface conditions are encountered during construction that appear to be at variance with those provided in this report, CCI shall be notified in order to re-examine conditions in the field and reassess recommendations.

This report has been prepared in accordance with generally accepted geotechnical principles and practice for the exclusive use of Enbridge in the design and construction of the proposed MTO Highway 17 HDD Crossing Project. No other warranty is expressed or implied.

On behalf of CCI Inc.

Prepared by:

A handwritten signature in black ink, appearing to read 'Christian Gutierrez'.

Christian Gutierrez, MBA, P.Geo.
Project Geologist

Reviewed by:

A handwritten signature in black ink, appearing to read 'Keith Chzyk'.

Keith Chzyk, B.Sc.
Geotechnical Operations lead

Approved by:

Landon Cels, P.Eng,
Geotechnical Engineer

REFERENCES

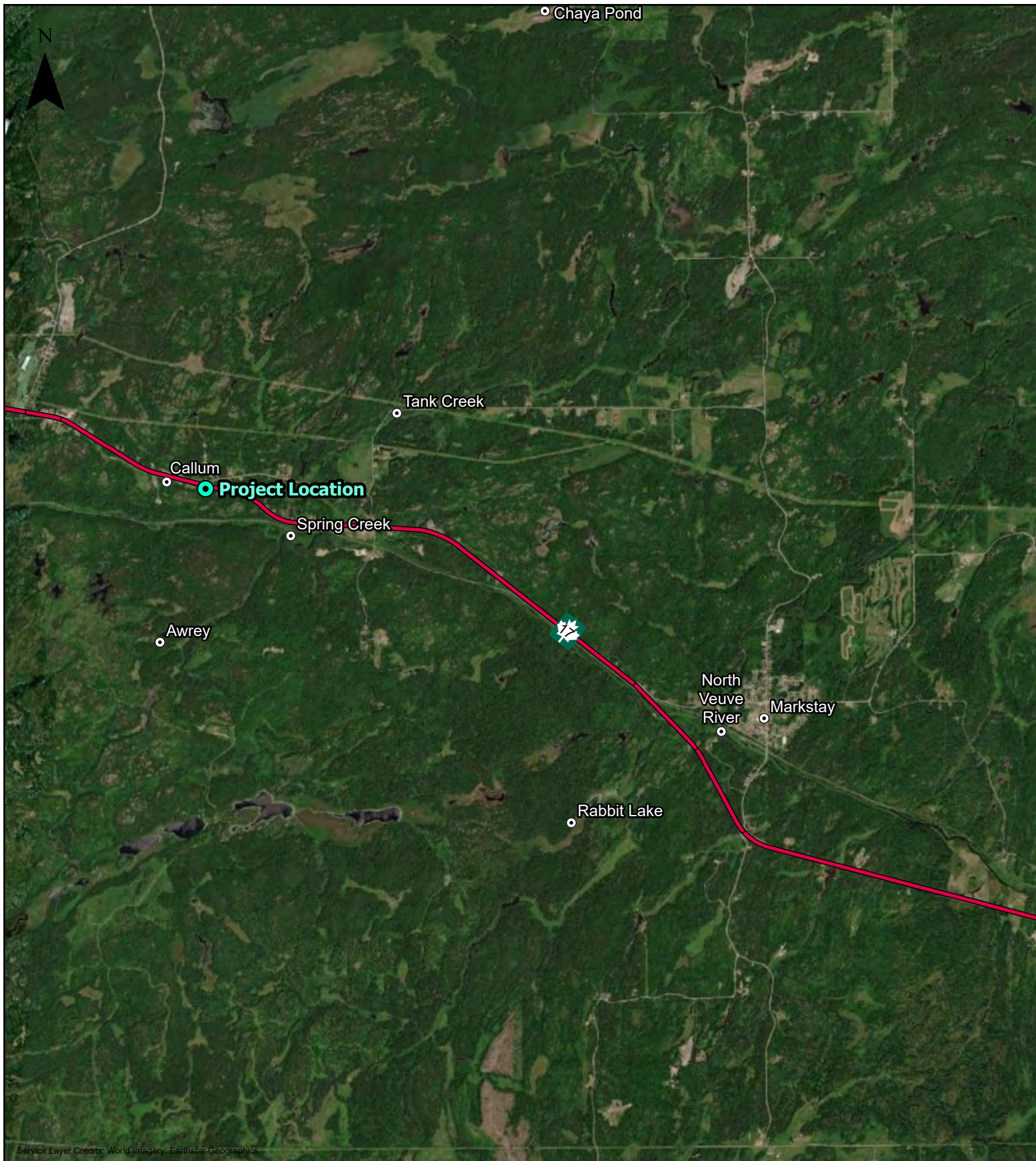
Barnett, P.J., Henry A.P. and Babuin, D. 1991. Quaternary Geology of Ontario, East-Central sheet; Ontario Geological Survey, Map 2555, 1:1 000 000 scale map.

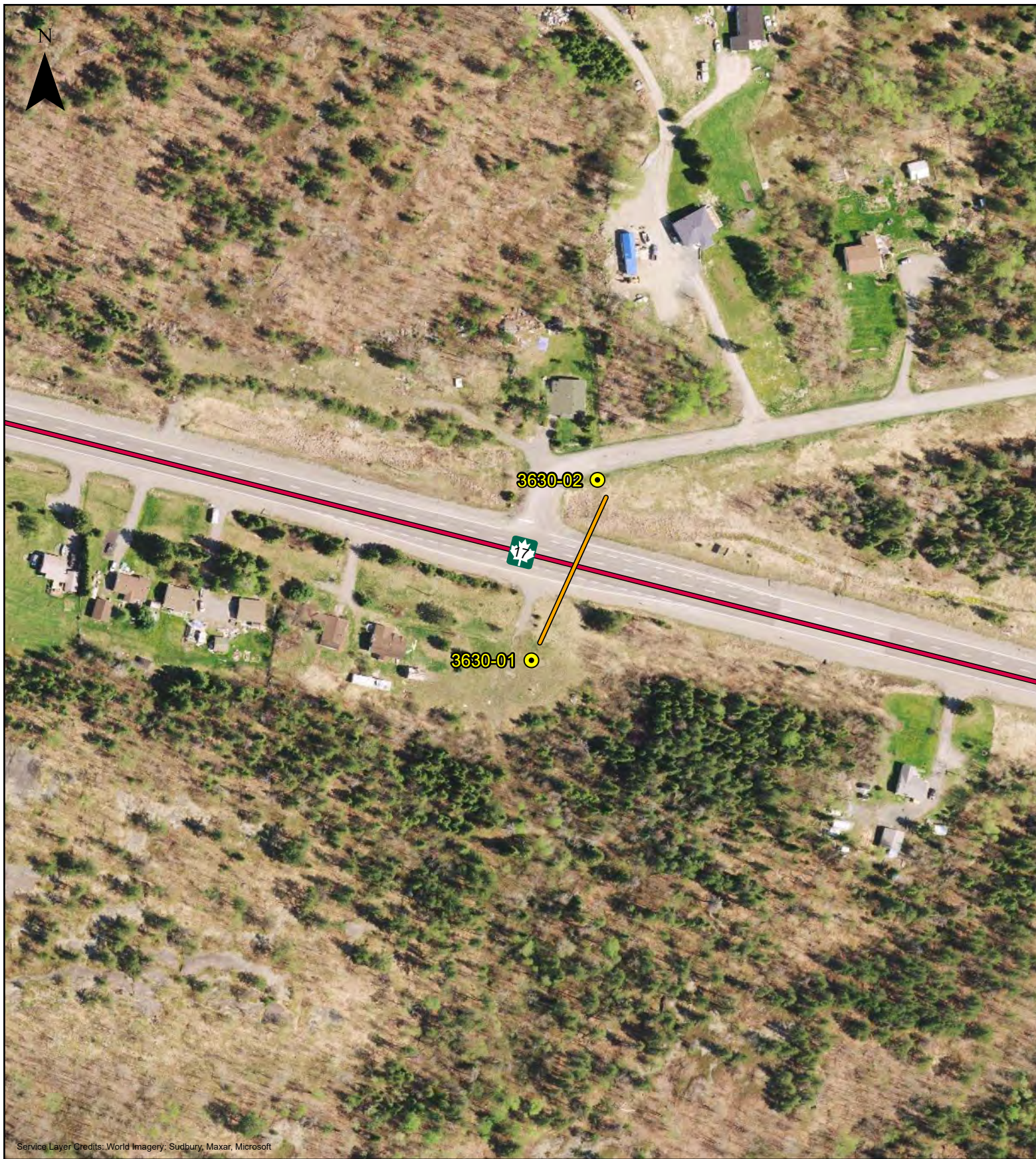
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Robertson A. J. 1963. Geology of the Iron Bridge Area, District of Algoma, Geological Report No. 17. Ontario Department of Mines.

Ontario Geological Survey. 1991. Bedrock Geology of Ontario, East-Central sheet; Ontario Geological Survey, Map 2543, 1:1 000 000 scale map.

Figures








Service Layer Credits: World Imagery, Sudbury, Maxar, Microsoft

Project Location



-  Borehole Locations
-  Approximate Alignment
-  Highways



Enbridge Gas Inc.

MTO HWY 17 HDD

Figure 2 - Detailed Location Plan

0 0.06 0.11

Kilometres

1:1,977

CCI Project #3630
Date: December 1, 2022

NAD 1983 UTM Zone 17N
File: GeotechOView_Nov28_2022

Appendix A

Site Photographs



Photo 1: Vehicles and support equipment used for the project facing east (November 17, 2022).



Photo 2: The borehole location, rig, and crew on Borehole 3630-02 (November 17, 2022).

Date & Time: Thu, Nov 17, 2022 at 14:09:27 EST
Position: +046.514733° / -080.622034° (± 11.6 ft)
Altitude: 809ft (± 9.8 ft)
Datum: WGS-84
Azimuth/Bearing: 025° N25E 0444mils True ($\pm 13^\circ$)
Elevation Angle: +03.5°
Horizon Angle: -01.9°
Zoom: 0.5X



Photo 3: Looking north at gas lines and ROW near Borehole 3630-01 (November 17, 2022).

Date & Time: Thu, Nov 17, 2022 at 14:09:35 EST
Position: +046.514729° / -080.621959° (± 15.1 ft)
Altitude: 804ft (± 11.7 ft)
Datum: WGS-84
Azimuth/Bearing: 279° N81W 4960mils True ($\pm 13^\circ$)
Elevation Angle: +10.9°
Horizon Angle: +00.1°
Zoom: 0.5X



Photo 4: Looking west at setup for drilling operations on Borehole 3630-01 (November 17, 2022).

Appendix B

Explanation of Terms & Symbols

Borehole Logs

EXPLANATION OF TERMS AND SYMBOLS

The borehole logs summarize the results of the field investigations and, where practicable, laboratory test data. It should be appreciated that conditions established at the borehole location may not be representative of subsurface conditions across the investigated site.

SOIL CLASSIFICATION AND DESCRIPTION

Soils are described according to their appearance, lithological composition, and probable mode of deposition (generic type). Expected engineering properties and behavior of the materials are interpreted relative to the soil type and laboratory test results. The soils are classified according to the modified UNIFIED SOIL CLASSIFICATION SYSTEM (USCS). The soil classification system is shown on Page 2.

ROCK CLASSIFICATION AND DESCRIPTION

The following factors are usually incorporated into a log for adequate engineering geological description:

Rock Name: Established names for igneous, metamorphic and sedimentary rocks are used. This could include established local names rather than the actual rock name. It is believed that, for engineering purposes, classification by mechanical properties is more significant than classification by mineralogy and texture.

Alteration and Weathering State: The following grades are used: **fresh, slightly weathered, moderately weathered, highly weathered, and decomposed.** In some cases of decomposed rocks, the material may exhibit plasticity and soil mechanics classifications could be used.

Structure and Discontinuities: This includes comments on discontinuities (bedding planes or separation along foliation planes and fissures in igneous and sedimentary rocks) and veins in relation to their type, orientation, frequency, infilling and surface features. The Rock Quality Designation (RQD), defined by Deere et al. as the percentage of core fractions greater than 100 mm (4 in.) in length relative to the length of the core run, is considered indicative of the fracture state.

Assessment of Strength: The field assessment of rock strength can be aided by simple tests such as the use of a hammer or a penknife and supplemented by laboratory testing. Any rock with an unconfined compressive strength significantly less than 1.25 MPa (185 psi) is described with reference to Soil Mechanics practice.

Ancillary Geological Information: This might include dip, identification of infill, etc..

TEST DATA

Data obtained from laboratory or field testing are shown on the logs in the appropriate columns at the corresponding depth interval. Abbreviations and graphic symbols are as follows:

LL = Liquid Limit (ASTM D423)	UCS = Unconfined Compressive Strength (in units noted)
PL = Plastic Limit (ASTM D424)	PP = UCS, as determined by Pocket Penetrometer
PI = LL-PL	MC = Water Content (Weight of Water/Weight of Solids)

DEFINITION OF PARTICLE SIZE (GRANULAR SOIL COMPONENTS)

SAND - Fine (0.076 mm to 0.425 mm), Medium (0.425 mm to 2 mm), Coarse (2 mm to 4.76 mm)

GRAVEL - Fine (4.76 mm to 19 mm), Coarse (19 mm to 75 mm)

COBBLE - 75 mm to 300 mm

BOULDER - larger than 300 mm

DEFINITIONS FOR QUALITATIVE FIELD OBSERVATIONS

MOISTURE

Dry - No obvious sign of moisture

Damp - Moisture is evident but does not leave soil markings when handled

Moist - Moisture is evident and leaves soil markings when handled

Wet - Water evident in soil

Water-bearing (Bedrock) - Water evident in bedrock

FREQUENCY OF OCCURRENCE

Few - Occurring on a small number of occasions at irregular intervals

Occasional - Occurring on some occasions at irregular intervals

Frequent - Occurring on many occasions at regular intervals

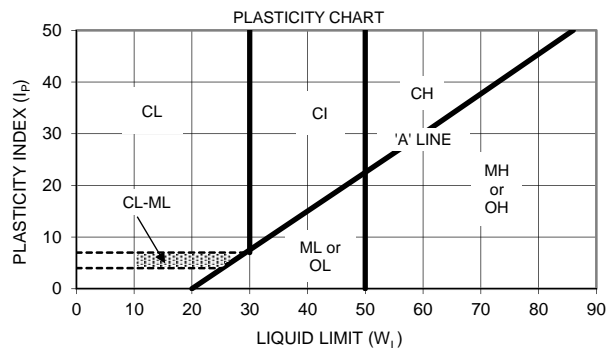
SOIL CLASSIFICATION SYSTEM (MODIFIED U.S.C.)

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
HIGHLY ORGANIC SOILS			PT	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE
COARSE-GRAINED SOILS MORE THAN HALF BY WEIGHT LARGER THAN # 200 SIEVE (0.076 mm)	GRAVELS MORE THAN HALF COARSE FRACTION LARGER THAN # 4 SIEVE (4.76 mm)	CLEAN GRAVELS	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES <5% FINES	$C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$
			GP	POORLY-GRADED GRAVELS, AND GRAVEL-SAND MIXTURES, <5% FINES	NOT MEETING ALL OF ABOVE REQUIREMENTS
		DIRTY GRAVELS	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES >12% FINES	ATTERBERG LIMITS BELOW 'A' LINE or $I_p < 4$
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES >12% FINES	ATTERBERG LIMITS ABOVE 'A' LINE or $I_p > 7$
	SANDS MORE THAN HALF COARSE FRACTION SMALLER THAN # 4 SIEVE (4.76 mm)	CLEAN SANDS	SW	WELL-GRADED SANDS, OR GRAVELLY SAND, <5% FINES	$C_U = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$
			SP	POORLY-GRADED SANDS, OR GRAVELLY SAND, <5% FINES	NOT MEETING ALL OF ABOVE REQUIREMENTS
		DIRTY SANDS	SM	SILTY SANDS, SAND-SILT MIXTURES >12% FINES	ATTERBERG LIMITS BELOW 'A' LINE or $I_p < 4$
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES >12% FINES	ATTERBERG LIMITS ABOVE 'A' LINE or $I_p > 7$

FINE-GRAINED SOILS MORE THAN HALF BY WEIGHT PASSES # 200 SIEVE (0.076 mm)	SILTS BELOW 'A' LINE ON PLASTICITY CHART; NEGLECTIBLE ORGANIC CONTENT	ML	INORGANIC SILTS & VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	$W_L < 50$	SEE CHART BELOW
		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	$W_L > 50$	
	CLAYS ABOVE 'A' LINE ON PLASTICITY CHART; NEGLECTIBLE ORGANIC CONTENT	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS	$W_L < 30$	
		CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS	$W_L > 30, < 50$	
		CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	$W_L > 50$	
	ORGANIC SILTS & CLAYS BELOW 'A' LINE ON PLASTICITY CHART	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	$W_L < 50$	
		OH	ORGANIC CLAYS OF HIGH PLASTICITY	$W_L > 50$	

- All sieve sizes mentioned on this chart are U.S. Standards, ASTM E11.
- Boundary classifications possessing characteristics of two groups are given combined group symbols, e.g., GW-GC is a well-graded gravel-sand mixture with clay binder between 5% and 12%.
- Soil fractions and limiting textural boundaries are in accordance with the Unified Soil Classification System, except that an inorganic clay of medium plasticity (CI) is recognized.
- The following adjectives may be employed to define percentage ranges by weight of minor components.

and	50 - 36%
some	35 - 21%
little	20 - 11%
trace	10 - 1%



Definitions of Soil Descriptors Used on Borehole Logs



RELATIVE DENSITY OF COARSE-GRAINED SOILS

Density is a qualitative term describing the compactness of the soil, and is often interpreted from the results of a Standard Penetration Test. The relative density of sand and gravel is related according to the following table:

Descriptive Term	Relative Density (%)	Standard Penetration Test Blows/0.3m
Very Loose	0 – 20	0 – 4
Loose	20 – 40	4 – 10
Compact	40 – 70	10 – 30
Dense	70 – 90	30 – 50
Very Dense	90 – 100	More than 50

CONSISTENCY OF FINE-GRAINED SOILS

Consistency varies mainly with moisture content and density and is described as follows:

Consistency	Field Identification	Approximate Undrained Shear Strength* kPa	Standard Penetration Test Blows/0.3 m
Very Soft	Easily penetrated several centimetres by the fist	12	2
Soft	Easily penetrated several centimetres by the thumb	12 – 25	2 – 4
Firm	Can be penetrated several centimeters by the thumb with moderate effort	25 – 50	4 – 8
Stiff	Readily indented by the thumb but penetrated only with great effort	50 – 100	8 – 15
Very Stiff	Readily indented by the thumbnail	100 – 200	15 – 30
Hard	Indented with difficulty by the thumbnail	200	30

*The undrained shear strength is taken as $\frac{1}{2}$ of the unconfined compressive strength.

DESCRIPTIVE LEGEND - ROCK SAMPLES AND/OR CORE LOGS

WEATHERING¹

Code	Description
F	Fresh: No visible sign of weathering.
FW	Faintly Weathered: Weathering limited to the surface of major discontinuities.
SW	Slightly Weathered: Penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.
MW	Moderately Weathered: Weathering extends through the rock mass but the rock material is not friable
HW	Highly Weathered: Weathering extends throughout the rock mass and the rock material is partly friable.
CW	Completely Weathered: Rock is fully decomposed and in a friable condition, but the rock texture and structure are preserved.
RS	Residual Soil: A soil material with the original texture, structure and mineralogy of the completely destroyed rock.

STRENGTH²

CODE	ROCK DESCRIPTION	FIELD IDENTIFICATION	APPROX. RANGE OF UNIAXIAL COMPRESSIVE STRENGTH (MPa)
R0	Extremely Weak	Indented by thumbnail	0.25-1.0
R1	Very Weak	Crumbles under firm blows with point of geological hammer; can be peeled with a pocket knife	1.0-5.0
R2	Weak	Can be peeled with a pocket knife with difficulty, shallow indentations can be made with firm blow using the point of a geological hammer	5.0-25
R3	Medium Strong	Cannot be scraped or peeled with a pocket knife; can be fractured with a single firm blow of geological hammer	25-50
R4	Strong	Requires more than one blow of geological hammer to fracture specimen	50-100
R5	Very Strong	Specimen fractured by many blows of geological hammer	100-250

Note ¹ Geological Society, Engineering Group Working Party Report (1970). "The Logging of Rock Cores for Engineering Purposes" Quarterly Journal - Engineering Geology, Vol 3, pp 1-24

Note ² - International Society for Rock Mechanics (I.S.R.M.). Commission on Standardization of Laboratory and Field Tests (1978) "Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses" Int. J. Rock Mech. Min. Sci. and Geomech. Abstr. Vol. 15 . pp 319 To 368



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BOREHOLE NUMBER 3630-01

PAGE 1 OF 1

PROJECT NUMBER 3630

PROJECT MTO Highway 17 HDD

SITE Highway 17 Crossing

LEGAL LOCATION

GROUND ELEVATION 799 m, Geodetic Datum

CLIENT Enbridge Gas Inc.

DATE STARTED 17-11-22 COMPLETED 17-11-22

DRILLING CONTRACTOR Landcore Drilling

DRILLING METHOD Hollow Stem Auger

NOTES 6m W of pipeline, 50m E of house

GROUND WATER LEVEL(S): Encountered at 5.5 m below ground surface

UTM 17T

N 5151308

E 528995

LOGGED BY CG

CHECKED BY KC

DEPTH (m)	▲ SPT N VALUE ▲		GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	COMMENTS	ELEVATION (m)
	PL	MC							
	20 40 60 80	20 40 60 80							
	□ FINES CONTENT (%) □								
	20 40 60 80	20 40 60 80							
1				TOPSOIL organic rich, trace rootlets, dark brown					798
2				SAND (SP) fine grained, loose, grey, damp					797
3				CLAY (CL) low to medium plastic, stiff, dark grey, damp, weakly layered, occasional silt lenses	SPT 1	5-7-7 (14)	150		796
4				- occasional fine grained sand lenses below 2.1m	SPT 2	2-4-5 (9)	150		795
5					SPT 3	4-5-8 (13)			794
6				SAND (SM) fine to medium grained, very dense, dirty, little to some gravel, dark grey, wet	SPT 4	8-39-41 (80)		Gravel = 20.4% Sand = 56.5% Fines = 23.1%	793
7									792
8				GNEISS (BEDROCK) fresh, medium strong, dark grey, dry	SPT 5	32-50/0.05		Auger refusal at 7.9m total depth. Hole backfilled from total depth to surface with bentonite chips and cuttings.	791
9				Bottom of hole at 7.9 m.					790
10									789
11									788
12									787



CCI Inc.
2600, 520 - 5 Ave SW
Calgary, AB T2P 3R7
Telephone: (403) 932-0560

BOREHOLE NUMBER 3630-02

PAGE 1 OF 1

PROJECT NUMBER 3630

PROJECT MTO Highway 17 HDD

SITE Highway 17 Crossing

LEGAL LOCATION

GROUND ELEVATION 798 m, Geodetic Datum

CLIENT Enbridge Gas Inc.

DATE STARTED 17-11-22 COMPLETED 17-11-22

DRILLING CONTRACTOR Landcore Drilling

DRILLING METHOD Hollow Stem Auger

NOTES 20m N of Highway 17, 15m E of OHPP

GROUND WATER LEVEL(S): Encountered at 2.3 m below ground surface

UTM 17T

N 5151379

E 529021

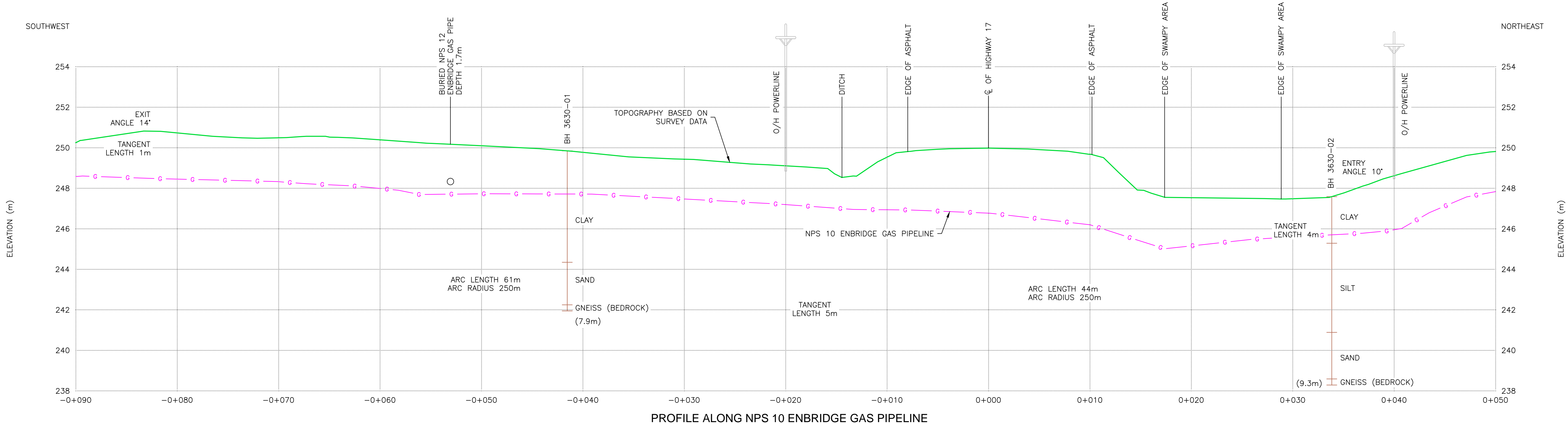
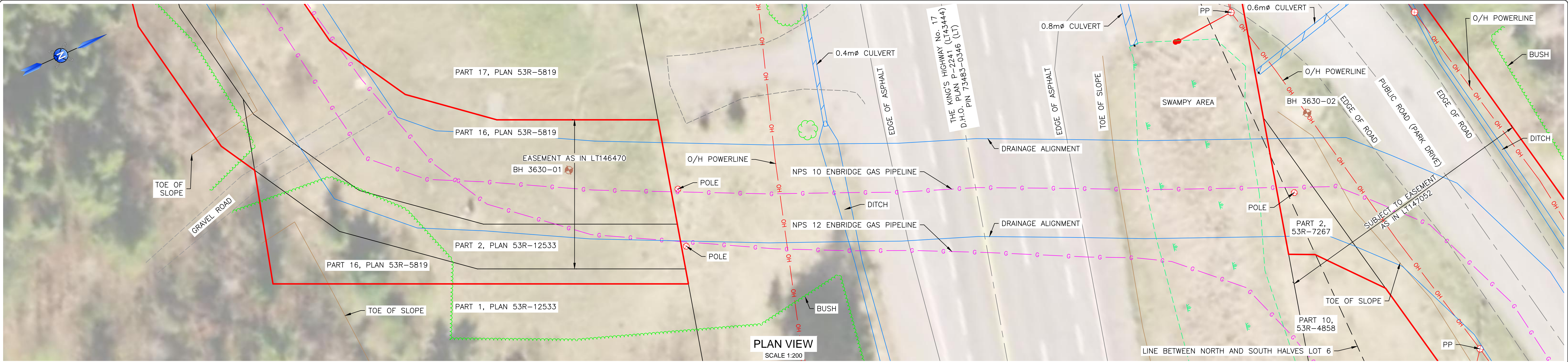
LOGGED BY CG

CHECKED BY KC

DEPTH (m)	▲ SPT N VALUE ▲		GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	COMMENTS	ELEVATION (m)
	PL	MC							
	20	40	60	80					
	20	40	60	80					
	□ FINES CONTENT (%) □								
	20	40	60	80					
1									797
2					SPT 1	2-4-3 (7)	100		796
3					SPT 2	4-7-8 (15)			795
4									794
5					SPT 3	3-16-12 (28)		Gravel = 19.6% Sand = 18.5% Silt = 57.0% Clay = 4.9%	793
6									792
7					SPT 4	10-16-17 (33)			791
8					SPT 5	37-41-50 (91)			790
9					SPT 6	30-50		Backfilled hole from total depth to surface with bentonite chips and cuttings.	789
10									788
11									787
12									786

Appendix C

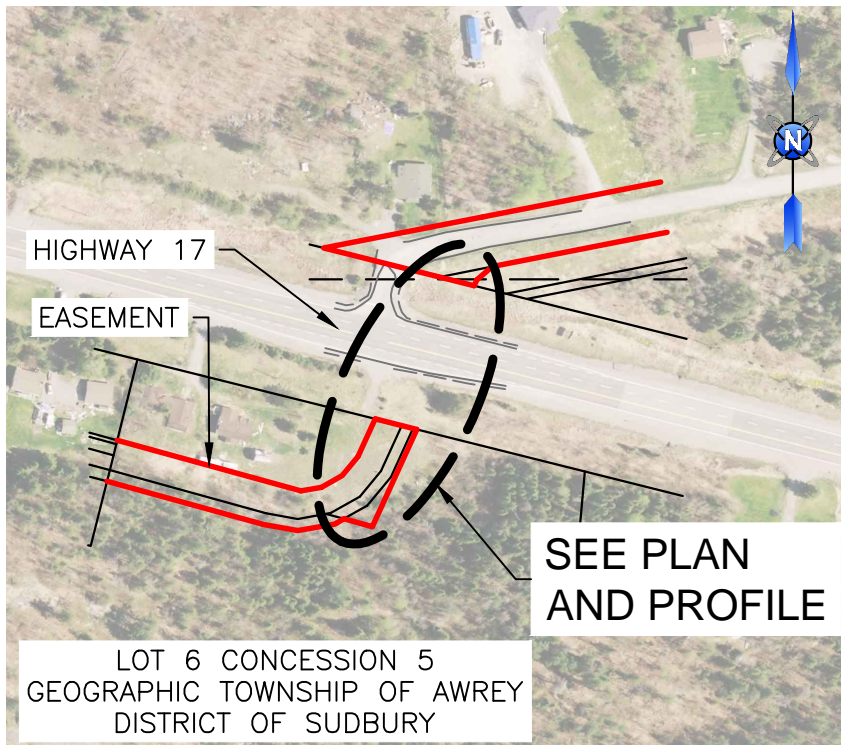

Geotechnical Drawing – 3630-GO-01



GEOTECHNICAL NOTES

- Subsurface conditions are believed to be suitable for the construction of the proposed directionally drilled crossing based on the data available.
- Soil and bedrock stratigraphy shown is based on interpretation of data from two (2) boreholes, drilled at the locations shown and CCI's understanding of the local geology. Due to natural variations in subsurface conditions and inherent uncertainties associated with the interpretation of subsurface data, some variation in stratigraphy between boreholes and along the length of the bore should be expected.
- Although a "No Drill Zone" has not been provided for this crossing, it is recommended that the HDD path be a minimum of 5 m depth as it passes under the road surface. In addition, it is recommended that the HDD design be completed to ensure adequate depth of cover to meet annular pressure and pipe stress requirements for the crossing.
- It is also recommended that the directional drilling contractor independently evaluate the feasibility of drilling the crossing, giving due consideration to the suitability of his proposed equipment and construction procedures.

THIS DRAWING, PREPARED BY CCI, ACCOMPANIES REPORT NO. 3630-GO-01, DATED DECEMBER 2022.

REFERENCE DOCUMENT NO.		DATE	ENGINEER AND PERMIT STAMPS						LOCATION PLAN (1:3,000)		UTM - ZONE 17 - NAD 83 (CSRS)			
1. 222799 Hwy 17 Crossing Survey		2022-10-04	PRELIMINARY NOT FOR CONSTRUCTION								 HIGHWAY 17 NPS 10 PIPELINE REPLACEMENT PROJECT HIGHWAY 17 HDD CROSSING GEOTECHNICAL DRAWING DISTRICT OF SUDBURY			

Appendix D

Lab Testing Results



7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Aggregate Analysis Report

ASTM C-136

Client Complete Crossings Inc.
9-214 Grande Blvd W
Cochrane AB, T4C 2G4
Attention Mr. Keith Chzyk
Project CCI# 3630 Highway 17

Job No. 020-01-22
Date Sampled N/A
Date Received Nov 24/22
Date Tested Nov 28/22

By Client
By AB
By PS

Aggregate Type SAND
Aggregate Source

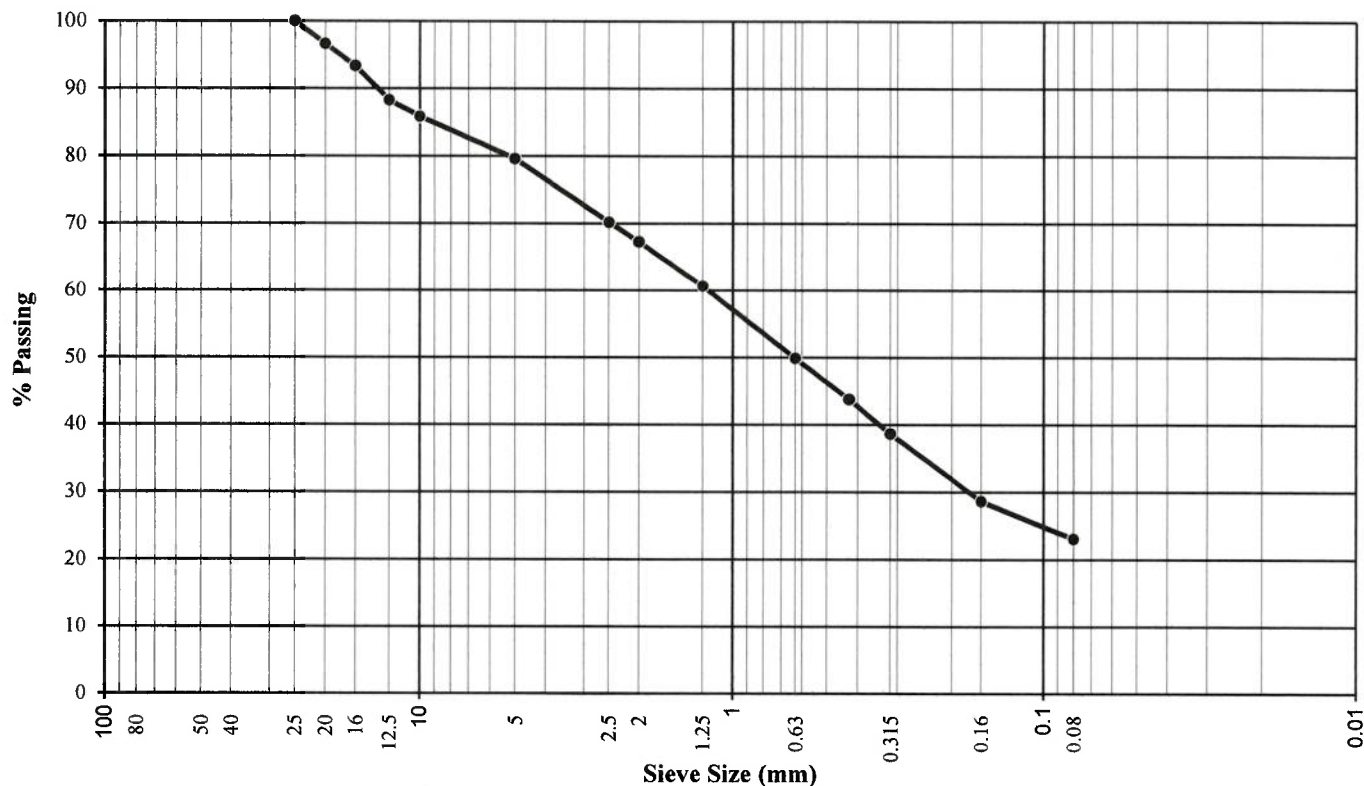
Classification SM or SC
 $C_c =$ 0.3
 $C_u =$ 15.1

Specification

Comments Gravel 20.4%
Sand 56.5%
Silt/Clay 23.1%

BH 3630-1, 20ft

Sieve Size (mm)	Percent Passing by Weight		
		Min.	Max.
100			
80			
50			
40			
25	100.0		
20	96.6		
16	93.3		
12.5	88.3		
10	85.8		
5	79.6		
2.5	70.2		
2	67.3		
1.25	60.7		
0.63	49.9		
0.425	43.7		
0.315	38.6		
0.16	28.6		
0.08	23.1		





7505 - 40 Street SE
Calgary, Alberta T2C 2H5
Telephone: (403) 236-8880

Grain Size Distribution

ASTM D-422

Project CCI #3630
Client CCI Inc.
Almor Job # 020-01-22
Date Recieved Nov 24/22
Date Tested Nov 29/22

Test Hole # BH3630-2
Depth 15 ft
Technician AB

Soil Classification

Gravel 19.6%
Sand 18.5%
Silt 57.0%
Clay 4.9%

Soil Description

SILT, some Gravel, some Sand, trace Clay

Soil Properties

Natural Moisture Content 19.9 %
Liquid Limit %
Plastic Limit %
Plasticity Index %
Specific Gravity 2.65

Sieve Size (mm)	% Passing
150	
100	
80	
50	
40	
25	100.0
20	91.4
10	85.4
5	80.4
2	79.4
0.425	72.5
0.080	61.9
0.005	10.5
0.002	4.9

Comments

Gravel		Sand			Silt	Clay
Coarse	Fine	Coarse	Medium	Fine		

