

# Subsurface Investigation Report

Enbridge Line 5 Reroute  
MP 38 HDD Crossing – Potato River  
Location 75-C, East of WI-169, South of Potato River  
Location 77-C, East of WI-169, South of Potato River  
Location 79-C-1, East of WI-169, South of Potato River  
Location 81-C, South West of Curry Road, North of Potato River  
Town of Gurney, Iron County, Wisconsin

*Prepared for*

## Enbridge Energy

### Professional Certification:

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Wisconsin.



Joseph C. Butler, PE  
Business Unit Manager / Senior Engineer  
License Number: E-43286-6  
September 17, 2020



Project B2001991

Braun Intertec Corporation

September 17, 2020

Project B2001991

Mr. Adam Erickson  
Enbridge Energy, Limited Partnership  
Manulife Place, 10180-101 Street  
Edmonton, AB T5J 3S4

Re: Subsurface Investigation  
Enbridge Line 5 Reroute  
MP 38 HDD Crossing – Potato River  
Location 75-C, East of WI-169, South of Potato River  
Location 77-C, East of WI-169, South of Potato River  
Location 79-C-1, East of WI-169, South of Potato River  
Location 81-C, South West of Curry Road, North of Potato River  
Gurney Town, Iron County, Wisconsin

Dear Mr. Erickson:

We are pleased to present this Subsurface Investigation Report for the Line 5 Reroute Project at the MP 38 HDD Crossing under Potato River in Gurney Town, Iron County, Wisconsin.

Thank you for making Braun Intertec your geotechnical consultant for this project. If you have questions about this report, or if there are other services that we can provide in support of our work to date, please contact Kyle Warmuth ([kwarmuth@brauninterte.com](mailto:kwarmuth@brauninterte.com)) or David Morrison ([dmorrison@braunintertec.com](mailto:dmorrison@braunintertec.com)) at 218.624.4967.

Sincerely,

BRAUN INTERTEC CORPORATION



Kyle P. Warmuth  
Staff Consultant



David E. Morrison  
Project Consultant



Joseph C. Butler, PE  
Business Unit Manager / Senior Engineer

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### Appendix

Log of Boring Sheets 75-C, 77-C, 79-C-1, and 81-C

HDD Alignment Profile

Descriptive Terminology of Soil

Descriptive Terminology of Rock

Sieve Analysis Reports: 326707, 326710, 326712, 318772, 319401, 319405, 315520, 315521, 324771

Moisture Content Reports: 326707, 326710, 326712, 318772, 319401, 319405, 315520, 315521, 324771

Hydrometer and Sieve Analysis Reports: 328877

Compressive Strength of Cores Report: 75-C-1, 77-C (Set 7 & 7B), 79-C-1

## **A. Introduction**

### **A.1. Project Description**

Enbridge Energy plans to relocate Line 5 around the Bad River Indian Reservation, as part of that project, a geotechnical investigation and evaluation is being completed. We are providing subsurface investigation services as part of this effort.

This report provides a factual data obtained at Borehole Locations 75-C, 77-C, 79-C-1, and 81-C for the HDD crossing under Potato River which is located at MP 38 in the proposed pipeline alignment in Gurney Town, Iron County, Wisconsin.

### **A.2. Purpose**

The purpose of our subsurface investigation is to characterize subsurface geologic conditions at the selected exploration location.

### **A.3. Background Information and Reference Documents**

We reviewed the following information:

- Wisconsin Geologic Map, "Soils of Wisconsin", prepared by F. D. Hole, M.T Beatty, C.J. Milfred, G.B. Lee, and A.J Klingelhoets, dated 1968.
- "Bedrock Geologic Map of Wisconsin", prepared by M.G. Mudrey, Jr., B.A. Brown, and J.K. Greenberg, dated 1982.
- "Rock Mechanics Properties of Typical Foundation Rock Types", prepared by J.R. Brandon, dated July 1974.
- Aerial photos from Google Earth Pro®.

## **A.4. Scope of Services**

We performed our scope of services for the project in accordance with our Quote to Mr. Jonathan Underland of Enbridge Energy, under the terms of the Work Order (132013839) provided by Enbridge Energy. The following list describes the geotechnical tasks completed in accordance with our authorized scope of services.

- Reviewing the background information and reference documents previously cited.
- Lake Superior Consulting selected and staked the boring location and we cleared the exploration location of underground utilities. The Soil Boring Location Sketch included in the Appendix shows the approximate location of the boring.
- Performing four (4) standard penetration test (SPT) borings with coring denoted as 75-C, 77-C, 79-C-1, and 81-C to nominal depths ranging from 144 to 219 feet below grade across the site.
- Performing laboratory testing on select samples as selected by Lake Superior Consulting.
- Preparing this report containing a boring location sketch, an exploration log, laboratory tests, a summary of the geologic materials encountered.

Our scope of services did not include environmental services or testing and our geotechnical personnel performing this evaluation are not trained to provide environmental services or testing. We can provide environmental services or testing at your request.

## **B. Results**

### **B.1. Geologic Overview**

We based the geologic origins used in this report on the soil types, in-situ and laboratory testing, and available common knowledge of the geological history of the site. Because of the complex depositional history, geologic origins can be difficult to ascertain. We did not perform a detailed investigation of the geologic history for the site.

## **B.2. Geologic Materials**

### **B.2.a. Soil Encountered**

The general geologic profile of the soils encountered between the four (4) borings consisted (proceeding down from the ground surface) of 1 foot of topsoil over 6 feet of fill in boring 79-C-1 and 4 feet of peat encountered in boring 75-C, the fill, topsoil, and peat are underlain by alternating layers of lacustrine (lake deposited) and glacial deposits. The soils contained in the layers consisted of peat, silty sands, poorly graded sands, fat clay, lean clay with sand, silty clay, silty clayey sand, poorly graded gravel with silt, and silt to the termination depth of each boring or refusal on bedrock, the encountered soils contained variable amounts of gravel. Table 1 in section B.3 contains more information on each material encountered.

### **B.2.b. Bedrock Encountered**

Below the glacial deposits, the boring encountered bedrock extending from an approximate elevation ranging between of 1074 to 1047 feet to the termination depth of the boring.

The bedrock generally consisted of grayish pink with white rhyolite associated with the Kallander Creek Volcanics and gray with white basalt, and gray with whitish red andesite associated with the Portage Lake Volcanics.

The rhyolite was generally classified as “moderately fractured” to “intensely fractured”. The rock was deemed as “hard” in terms of the rock hardness scale and ranged from “slightly weathered” to “moderately weathered”

The basalt was generally classified as “moderately fractured” to “highly fractured”. The rock was deemed as “moderately hard” to “hard” in terms of the rock hardness scale and was deemed “slightly weathered” to “moderately weathered”.

The andesite was generally classified as “highly fractured”. The rock was deemed as “moderately hard” to “hard” in terms of the rock hardness scale and was deemed “slightly weathered” to “moderately weathered”.

### **B.2.c. Altered Bedrock**

In boring 81-C, we encountered poorly consolidated conglomerate from a depth of 123 feet to the termination of the boring. The drill crew made several failed attempts to collect a sample using coring methods to a depth of 157 feet. These attempts were not successful due to the bedrock behaving more

like a soil than bedrock. At 157 feet they changed to a smaller tri-cone bit to drill through the material and attempt to collect samples using split spoon but could not penetrate through the material using standard split spoon sampling and the core barrel was too large to continue coring. Due to the difficulty of sampling using standard methods of coring and split-spoon the driller collected samples from the auger cuttings.

### B.3. Estimated Soil Properties

Estimated soil properties for each significant strata change are presented below in Table 1.

**Table 1: Estimated Soil Properties**

Soil Strata and Elevations (ft)	Soil Type	Blow Count per foot Range (BPF)	Dry Unit Weight Range (pcf)	Undrained Unit Weight Range (pcf)	Drained Friction Angle Range (degrees)	Undrained Friction Angle (degrees)	Undrained Cohesion Range (ksf)	Drained Cohesion Range (ksf)	Modulus of Elasticity Range* (tsf)
Upper Soils (1163 to 1110)	Silty Sand (SM)	5 - 27	110 - 120	115 - 125	28 - 34	10 - 25	0.75 - 2.0	0.4 - 4.0	29- 189
	Silty Clayey Sand (SC-SM)	14 - 20	105 - 115	118 - 122	30 - 31	15 - 20	1.0 - 1.25	0.9 - 1.9	56- 86
	Sandy Lean Clay (CL)	19	100 - 125	125 - 130	29 - 30	10	2.5 - 4.5	1.6 - 3.0	76 - 109
Middle Soils (1110 to 1046)	Silty Sand (SM)	1 - 50 blows per 1 inch of penetration	92 - 116	110 - 130	27 - 37	5 - 25	0.5 - 2.5	0.1 - 4.1+	6 - 490
	Silt (ML)	9 - 67	99 - 112	112 - 127	30 - 36	30 - 35	0	0	36 - 289
	Fat Clay (CH)	12	90 - 110	112 - 117	22 - 25	0	1.0 - 3.6	0.6 - 2.1	48 - 69
	Peat (PT)	11	80	80	15	0	0.15	0.1	32 - 44



Soil Strata and Elevations (ft)	Soil Type	Blow Count per foot Range (BPF)	Dry Unit Weight Range (pcf)	Undrained Unit Weight Range (pcf)	Drained Friction Angle Range (degrees)	Undrained Friction Angle (degrees)	Undrained Cohesion Range (ksf)	Drained Cohesion Range (ksf)	Modulus of Elasticity Range* (tsf)
	Poorly Graded Sand with Silt (SP-SM)	5 - 80	91 - 114	105 - 127	30 - 40	30 - 36	0	0	35 - 576
	Silty Clay (CL-ML)	9	100 - 120	122 - 125	27 - 28	5	1.5 - 2.5	0.9 - 1.5	36 - 39
	Poorly Graded Gravel with Silt (GP-GM)	19 - 22	119 - 121	125 - 127	37 - 38	34	0	0	219 - 264
	Lean Clay (CL)	15 - 66	100 - 125	125 - 135	29 - 35	10	2.5 - 10.0	1.6 - 6.0+	60 - 380
Lower Soils (1110 to 944)	Poorly Graded Gravel with Silt (GP-GM)	50 blows per 1 inch of penetration - 60 blows per 0 inches of penetration	120 - 130	130 - 135	42 - 45	36	0	0	806 - 840
	Silty Sand (SM)	50 blows per 1 inch of penetration - 50 blows per 0 inches of penetration	120 - 125	125 - 130	35 - 37	25	2.5	4.1+	403 - 490
	Lean Clay (CL)	50 blows per 1 inch of penetration - 50 blows per 0 inches of penetration	100 - 125	133 - 135	33 - 35	10	10.0	6.1+	280 - 403

Soil Strata and Elevations (ft)	Soil Type	Blow Count per foot Range (BPF)	Dry Unit Weight Range (pcf)	Undrained Unit Weight Range (pcf)	Drained Friction Angle Range (degrees)	Undrained Friction Angle Range (degrees)	Undrained Cohesion Range (ksf)	Drained Cohesion Range (ksf)	Modulus of Elasticity Range* (tsf)
Bedrock (1074 to 943 1/2)	Rhyolite	N/A	161-167	161-167	35 - 38	31 - 36	0	0	327,080 – 513,000
	Basalt	N/A	169 - 206	169 - 206	35 - 38	31 - 36	0	0	446,400 – 597,600
	Andesite	N/A	157 - 175	157 - 175	35 - 38	31 - 36	0	0	381,600 – 388,800

\*Sustained Young's Modulus values

## B.4. Groundwater

We encountered groundwater at a depths ranging between 6 1/2 to 11 feet below the ground surface in borings 77-C and 79-C-1 while advancing the borings.

We did not observe groundwater while advancing borings 75-C and 81-C. Groundwater may take days or longer to reach equilibrium in the boreholes and we immediately backfilled the boreholes, in accordance with our scope of work.

Project planning should anticipate seasonal and annual fluctuations of groundwater. Mud-rotary drilling techniques were used to advance the borings, hindering the ability to observe groundwater.

## B.5. Laboratory Test Results

The boring logs show the results of the sieve analysis, moisture testing, hydrometer with sieve analysis, and compressive strength of cores that were requested. The Appendix contains the results of these tests.

## C. Procedures

### C.1. Penetration Test Borings

We drilled the penetration test borings with a float tire-mounted core and auger drill equipped with hollow-stem auger. We performed the borings in general accordance with ASTM D6151 taking

penetration test samples at 2 1/2- or 5-foot intervals in general accordance to ASTM D1586. We collected thin-walled tube samples in general accordance with ASTM D1587 at selected depths. The boring logs show the actual sample intervals and corresponding depths. We also collected bulk samples of auger cuttings at selected locations for laboratory testing.

## **C.2. Rock Cores**

We performed rock cores with an NQ-3 core barrel. First, we lowered the bit and casing to the bottom of the previously advanced borehole. Then we lowered the core barrel into the casing with a wire line, and locked into place. We advanced the bit and barrel by rotating the assembly while applying crowd pressure. We used bentonite-drilling mud to cool the bit and wash cuttings to the surface. Our drillers noted bit pressure, rate of advance, fluid pressure and fluid return as coring progressed. They also noted intervals with a rapid rate of advance, a sudden loss of fluid pressure or return and intervals with a loss of bit pressure.

After completing each 5-foot core run, the drillers unlocked the core barrel from the bit and brought the barrel to the surface. They then extruded the split inner tube from the barrel and opened the tube to reveal the core sample. After field classification and logging, the drillers packed the core into a cardboard storage box, arranged into 2-foot long sections.

## **C.3. Exploration Logs**

### **C.3.a. Log of Boring Sheets**

The Appendix includes Log of Boring sheets for our penetration test borings. The logs identify and describe the penetrated geologic materials, and present the results of penetration resistance and other in-situ tests performed. The logs also present the results of laboratory tests performed on penetration test samples, and groundwater measurements. The Appendix also includes a Fence Diagram intended to provide a summarized cross-sectional view of the soil profile across the site.

We inferred strata boundaries from changes in the penetration test samples and the auger cuttings. Because we did not perform continuous sampling, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may occur as gradual rather than abrupt transitions.

### **C.3.b. Logs of Coring**

Log of Coring sheets follow the logs of the penetration test borings through which we performed rock coring. The logs identify and describe rock lithology, weathering, hardness, bedding and fracture characteristics, and other features. The logs also report the bit pressure, rate of advance, and water pressure and return (if applicable) recorded during the coring process. The percent recovery and rock quality designation (RQD) for each 5-foot core run is also shown.

We inferred strata boundaries from changes in lithology along the length of the core sample. Due to natural and mechanical fractures, destruction of the rock fabric during coring, and limited recovery, it is difficult to place the core sample in the geologic profile; the strata boundary depths in the rock are also approximate, and likely vary from the core locations.

### **C.3.c. Geologic Origins**

We assigned geologic origins to the materials shown on the logs and referenced within this report, based on: (1) a review of the background information and reference documents cited above, (2) visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, (3) penetration resistance and other in-situ testing performed for the project, (4) laboratory test results, and (5) available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

## **C.4. Material Classification and Testing**

### **C.4.a. Visual and Manual Classification**

We visually and manually classified the geologic materials encountered based on ASTM D2488. When we performed laboratory classification tests, we used the results to classify the geologic materials in accordance with ASTM D2487. The Appendix includes a chart explaining the classification system we used.

### **C.4.b. Laboratory Testing**

The exploration logs in the Appendix note most of the results of the laboratory tests performed on geologic material samples. The remaining laboratory test results follow the exploration logs. We performed the tests in general accordance with ASTM or AASHTO procedures.

## **C.5. Groundwater Measurements**

The drillers checked for groundwater while advancing the penetration test borings, and again after auger withdrawal. We then filled the boreholes, as noted on the boring logs.

## **D. Qualifications**

### **D.1. Variations in Subsurface Conditions**

#### **D.1.a. Material Strata**

We developed our evaluation, analyses and recommendations from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth. Therefore, we must infer strata boundaries and thicknesses to some extent. Strata boundaries may also be gradual transitions, and project planning should expect the strata to vary in depth, elevation and thickness, away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until performing additional exploration work, or starting construction. If future activity for this project reveals any such variations, you should notify us so that we may reevaluate our recommendations. Such variations could increase construction costs, and we recommend including a contingency to accommodate them.

#### **D.1.b. Groundwater Levels**

We made groundwater measurements under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. Note that the observation periods were relatively short, and project planning can expect groundwater levels to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

### **D.2. Continuity of Professional Responsibility**

#### **D.2.a. Plan Review**

We based this report on a limited amount of information, and we made a number of assumptions to help us develop our recommendations. We should be retained to review the geotechnical aspects of the

designs and specifications. This review will allow us to evaluate whether we anticipated the design correctly, if any design changes affect the validity of our recommendations, and if the design and specifications correctly interpret and implement our recommendations.

#### **D.2.b. Construction Observations and Testing**

We recommend retaining us to perform the required observations and testing during construction as part of the ongoing geotechnical evaluation. This will allow us to correlate the subsurface conditions exposed during construction with those encountered by the borings and provide professional continuity from the design phase to the construction phase. If we do not perform observations and testing during construction, it becomes the responsibility of others to validate the assumption made during the preparation of this report and to accept the construction-related geotechnical engineer-of-record responsibilities.

#### **D.3. Use of Report**

This report is for the exclusive use of the addressed parties. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

#### **D.4. Standard of Care**

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

## **Appendix**

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B2001991 Geotechnical Evaluation Enbridge Line 5 Re-Route Various Locations Ashland and Iron Counties, Wisconsin					BORING: 75-C							
					LOCATION: See attached sketch							
					LATITUDE: 46.46354	LONGITUDE: -90.48130						
DRILLER: C. Gorman		LOGGED BY:			START DATE: 06/09/20		END DATE: 06/17/20					
SURFACE ELEVATION: 1093.6 ft		RIG: 8502		METHOD: 4 1/4" HSA		SURFACING:		WEATHER: sunny				
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)			Sample	Blows (N-Value) Recovery		q <sub>p</sub> tsf	MC %	Tests or Remarks		
1089.6		PEAT (PT), black, wet (SWAMP DEPOSIT)				2-4-7 (11) 4"			12	Test results are in the attached lab report		
4.0		FAT CLAY with SAND (CH), brown, moist, stiff (LACUSTRINE)			5	3-5-7 (12) 22"						
1087.0		SILTY SAND (SM), fine to medium-grained, brown, wet, medium dense to dense (GLACIAL TILL)				7-7-8 (15) 12"						
6.5						17-19-23 (42) 12"						
1083.0		SILTY SAND (SM), fine to medium-grained, with Gravel, brown, moist, very dense (GLACIAL TILL)				33-50/2" (REF) 6"						
10.5						50/1" (REF) 2"				Drilling method switched to rock coring at 20 feet		
1073.6		KALLANDER CREEK VOLCANICS, RHYOLITE, grayish pink with white, slightly weathered, hard, fine-grained to medium-grained, massive, moderately fractured			20	50	100	3	6510	100	75	Run 1 MOHs 7 Run 2 MOHs 7
20.0		Test results are in the attached lab report				65	100	2	6510	150	75	
					25	70		2		80	75	Run 3 MOHs 7 MOHs 7
1066.0		KALLANDER CREEK VOLCANICS, RHYOLITE, grayish pink with white, moderately weathered, hard, fine-grained to medium-grained, massive, highly fractured				15	100	2	6510	100		
27.5					30	80		4		150		Run 4 MOHs 7 MOHs 7
1062.0												
31.5												
Continued on next page						RQD %	Recovery %	Drilling Rate (mip/ft)	Bit Pressure (nsi)	Water Pressure (nsi)	Water Return %	Remarks




<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>						BORING: <b>75-C</b>					
						LOCATION: See attached sketch					
						LATITUDE: 46.46354			LONGITUDE: -90.48130		
DRILLER: C. Gorman		LOGGED BY:				START DATE: 06/09/20		END DATE: 06/17/20			
SURFACE ELEVATION: 1093.6 ft		RIG: 8502		METHOD: 4 1/4" HSA		SURFACING:		WEATHER: sunny			
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %	Remarks	
1060.0		KALLANDER CREEK VOLCANICS, RHYOLITE, grayish pink with white, moderately weathered, hard, fine-grained to medium- grained, massive, intensely fractured <i>Test results are in the attached lab report</i>	35	0	100	2	5580	200	90	Run 5 MOHs 7	
33.5			40	60	4	5580	120	90			
			KALLANDER CREEK VOLCANICS, RHYOLITE, grayish pink with white, slightly weathered, hard, fine-grained to medium- grained, massive, highly fractured	40	40	90	3	4880	150	100	Plugged barrel at 36 1/2 feet Run 6 MOHs 7
1051.0		45		75	90	2	4650	120	75		
42.5			KALLANDER CREEK VOLCANICS, RHYOLITE, grayish pink with white, slightly weathered, hard, fine-grained to medium- grained, massive, moderately fractured <i>Test results are in the attached lab report</i>	50							Run 8 MOHs 7
	55	60		100	3	5120	100	90			
1033.6		KALLANDER CREEK VOLCANICS, RHYOLITE, grayish pink with white, slightly weathered, hard, fine-grained to medium- grained, massive, highly fractured	60							Run 9 MOHs 7	
60.0											
Continued on next page											

<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>						BORING: <b>75-C</b>					
						LOCATION: See attached sketch					
						LATITUDE: 46.46354			LONGITUDE: -90.48130		
DRILLER: C. Gorman		LOGGED BY:		START DATE: 06/09/20		END DATE: 06/17/20					
SURFACE ELEVATION: 1093.6 ft		RIG: 8502		METHOD: 4 1/4" HSA		SURFACING:		WEATHER: sunny			
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %	Remarks	
1025.6		KALLANDER CREEK VOLCANICS, RHYOLITE, grayish pink with white, slightly weathered, hard, fine-grained to medium- grained, massive, highly fractured <i>Test results are in the attached lab report</i>	65	55	95	5	4880	200	75	Plugged barrel at 68 feet Run 10 MOHs 7	
68.0		KALLANDER CREEK VOLCANICS, RHYOLITE, grayish pink with white, slightly weathered, hard, fine-grained to medium- grained, massive, moderately fractured  <i>Test results are in the attached lab report</i>	70	85	100	4	5580	100	90		
			75							Run 11 MOHs 7	
1010.6			80	65	90	4	4880	100	90		
83.0		KALLANDER CREEK VOLCANICS, RHYOLITE, grayish pink with white, moderately weathered, hard, fine-grained to medium- grained, massive, highly fractured <i>Test results are in the attached lab report</i>	85	30	90	4	5580	100	90	Run 12 MOHs 7	
			90	60	100	4	5120	100	90	Run 13 MOHs 7	
998.6			95							Run 14 MOHs 7	
95.0		KALLANDER CREEK VOLCANICS,									
Continued on next page											

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<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>75-C</b>					
					LOCATION: See attached sketch					
					LATITUDE: 46.46354		LONGITUDE: -90.48130			
DRILLER: C. Gorman		LOGGED BY:			START DATE: 06/09/20		END DATE: 06/17/20			
SURFACE ELEVATION: 1093.6 ft		RIG: 8502		METHOD: 4 1/4" HSA		SURFACING:		WEATHER: sunny		
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %	Remarks
		KALLANDER CREEK VOLCANICS, RHYOLITE, grayish pink with white, slightly weathered, hard, fine-grained to medium- grained, massive, highly fractured	130	55	100	2	5580	150	90	
			135							Run 19 MOHs 7
			140	60	95	2	5580	100	90	
			145							Run 20 MOHs 7
946.6		KALLANDER CREEK VOLCANICS, RHYOLITE, grayish pink with white, moderately weathered, hard, fine-grained to medium- grained, massive, highly fractured		35	80	3	5580		80	
147.0										
943.6		END OF CORING	150							
150.0		Boring then backfilled with cement/bentonite grout								
			155							

<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>77-C</b>		
					LOCATION: See attached sketch		
					LATITUDE: 46.46545	LONGITUDE: -90.48187	
DRILLER: EPC		LOGGED BY: A. Hillerud		START DATE: 05/26/20	END DATE: 05/27/20		
SURFACE ELEVATION: 1089.2 ft		RIG: Subcontractor	METHOD: 4 1/4" HSA	SURFACING:		WEATHER:	
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q <sub>p</sub> tsf	MC %	Tests or Remarks
1084.7		SILTY SAND (SM), fine-grained, brown, moist, very loose (GLACIAL TILL)		1-0-1-1 (1) 18"			
4.5				1-1-2-3 (3) 24"			
		SILTY SAND (SM), fine to medium-grained, with Gravel, with Boulders, brown, moist, medium dense (GLACIAL TILL)	5	7-7-8-14 (15) 2"		19	Minimal recovery
				4-10-10-10 (20) 6"			Test results are in the attached lab report
1079.2				2-3-6-9 (9) 10"			
10.0		SILTY CLAY (CL-ML), with Sand lenses, brown, moist, stiff (GLACIAL TILL)	10	2-2-3-4 (5) 12"		12	Test results are in the attached lab report
1077.2				6-5-6-6 (11) 2"			Drilling method switched to mud rotary at 15 feet
12.0		POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, with Gravel, brown, wet, loose to medium dense (GLACIAL OUTWASH)	15				
			20				
1066.2				1-5-10-12 (15) 8"			
23.0	LEAN CLAY with SAND (CL), with Gravel, brown, moist, hard (GLACIAL TILL)	25	13-29-37 (66) 18"				
1061.2							
28.0	SILTY SAND (SM), fine to medium-grained, with Gravel, brown, wet, very dense (GLACIAL TILL)	30	45-40-50/4" (REF) 18"			Auger met refusal at 31.3 feet. Drilling method switched to rock coring at 33 feet.	
1057.9							
31.3							

Continued on next page

<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>77-C</b>				
					LOCATION: See attached sketch				
					LATITUDE: 46.46545		LONGITUDE: -90.48187		
DRILLER: EPC		LOGGED BY: A. Hillerud			START DATE: 05/26/20		END DATE: 05/27/20		
SURFACE ELEVATION: 1089.2 ft		RIG: Subcontractor		METHOD: 4 1/4" HSA		SURFACING:		WEATHER:	
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery		q <sub>p</sub> tsf	MC %	Tests or Remarks	
		PORTAGE LAKE VOLCANICS, ANDESITE, gray with red, slightly weathered, moderately hard, fine-grained to medium-grained, massive, highly fractured <i>Test results are in the attached lab report</i>	35	75	100				Run 1 MOH's 4 Run 2 MOH's 4
				45	75				
			40	40	100				Run 3 MOH's 4 Run 4 MOH's 4
				70	90				
			45	40	100				Run 5 MOH's 4
		<i>Test results are in the attached lab report</i>		60	100				Run 6 MOH's 4
1040.2									Run 7 MOH's 4
49.0		PORTAGE LAKE VOLCANICS, ANDESITE, gray with red, moderately weathered, moderately hard, fine-grained to medium- grained, massive, highly fractured	50	10	100				
			55	10	100				Run 8 MOH's 4
		<i>Test results are in the attached lab report</i>		35	95				Run 9 MOH's 4
			60	35	90				Run 10 MOH's 4
Continued on next page				RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %
									Remarks

<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>77-C</b>					
					LOCATION: See attached sketch					
					LATITUDE: 46.46545	LONGITUDE: -90.48187				
DRILLER: EPC		LOGGED BY: A. Hillerud		START DATE: 05/26/20		END DATE: 05/27/20				
SURFACE ELEVATION: 1089.2 ft		RIG: Subcontractor		METHOD: 4 1/4" HSA		SURFACING:		WEATHER:		
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %	Remarks
1020.2		PORTAGE LAKE VOLCANICS, ANDESITE, gray with red, moderately weathered, moderately hard, fine-grained to medium- grained, massive, highly fractured  <i>Test results are in the attached lab report</i>	65	45	100					Run 11 MOH's 4
69.0		PORTAGE LAKE VOLCANICS, ANDESITE, gray with red, slightly weathered, moderately hard, fine-grained to medium-grained, massive, highly fractured	70	75	100					Run 12 MOH's 4
1015.2		PORTAGE LAKE VOLCANICS, ANDESITE, gray with red, moderately weathered, moderately hard, fine-grained to medium- grained, thick bedded, highly fractured	75	65	100					Run 13 MOH's 4
74.0		PORTAGE LAKE VOLCANICS, ANDESITE, gray with red, moderately weathered, moderately hard, fine-grained to medium- grained, thick bedded, highly fractured  <i>Test results are in the attached lab report</i>	80	40	100					Run 14 MOH's 4
1010.2		PORTAGE LAKE VOLCANICS, ANDESITE, gray with red, moderately weathered, moderately hard, fine-grained to medium- grained, thick bedded, highly fractured  <i>Test results are in the attached lab report</i>	85	60	100					Run 15 MOH's 4
79.0		PORTAGE LAKE VOLCANICS, ANDESITE, gray with red, moderately weathered, moderately hard, fine-grained to medium- grained, thick bedded, highly fractured  <i>Test results are in the attached lab report</i>	90	10	100					Run 16 MOH's 4
1000.2		PORTAGE LAKE VOLCANICS, ANDESITE, gray with red, moderately weathered, moderately hard, fine-grained to medium- grained, massive, highly fractured	95	30	100					Run 17 MOH's 4 Run 18 MOH's 4
89.0		PORTAGE LAKE VOLCANICS, ANDESITE, gray with red, slightly weathered, hard, fine- grained to medium-grained, thick bedded, highly fractured								
996.2										
93.0										
995.2										
94.0										
Continued on next page										

<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>77-C</b>					
					LOCATION: See attached sketch					
					LATITUDE: 46.46545	LONGITUDE: -90.48187				
DRILLER: EPC		LOGGED BY: A. Hillerud		START DATE: 05/26/20		END DATE: 05/27/20				
SURFACE ELEVATION: 1089.2 ft		RIG: Subcontractor		METHOD: 4 1/4" HSA		SURFACING:		WEATHER:		
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %	Remarks
990.2		PORTAGE LAKE VOLCANICS, ANDESITE, gray with red, moderately weathered, hard, fine-grained to medium-grained, massive, highly fractured		70	100					
99.0		<i>Test results are in the attached lab report</i>								Run 19 MOH's 4
985.2		PORTAGE LAKE VOLCANICS, ANDESITE, gray with red, slightly weathered, hard, fine-grained to medium-grained, massive, highly fractured	100	55	100					
104.0		PORTAGE LAKE VOLCANICS, ANDESITE, gray with red, moderately weathered, hard, fine-grained to medium-grained, massive, highly fractured		40	70					Run 20 MOH's 4
980.2		PORTAGE LAKE VOLCANICS, BASALT, gray with reddish white, moderately weathered, moderately hard, fine-grained to medium-grained, thick bedded, highly fractured	110	40	100					Run 21 MOH's 3
109.0		<i>Test results are in the attached lab report</i>								
975.2		PORTAGE LAKE VOLCANICS, BASALT, gray with white, slightly weathered, hard, fine-grained to medium-grained, massive, moderately fractured	115	85	100					Run 22 MOH's 4
114.0										
970.2		PORTAGE LAKE VOLCANICS, ANDESITE, gray with whitish red, slightly weathered, hard, fine-grained to medium-grained, massive, highly fractured	120	75	100					Run 23 MOH's 4
119.0										
		<i>Test results are in the attached lab report</i>	125	35	100					Run 24 MOH's 4
Continued on next page										



See Descriptive Terminology sheet for explanation of abbreviations

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<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>79-C-1</b>	
					LOCATION: See attached sketch	
					LATITUDE: 46.46723	LONGITUDE: -90.48094
DRILLER: EPC		LOGGED BY: A. Hillerud		START DATE: 06/05/20	END DATE: 06/18/20	
SURFACE ELEVATION: 1087.9 ft		RIG: Subcontractor	METHOD: 4 1/4" HSA	SURFACING:		WEATHER:

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q <sub>p</sub> tsf	MC %	Tests or Remarks	
1086.9		SILTY SAND (SM), fine to medium-grained, with organic, roots, brown, moist (TOPSOIL) FILL: SILTY SAND (SM), fine to medium-grained, brown, moist	0-1-1-1 (2) WOH/6" 6"	5	5	Test results are in the attached lab report		
1.0							2-2-2-3 (4) 20"	
1081.9		POORLY GRADED GRAVEL with SILT (GP-GM), fine to medium-grained, brown, moist, medium dense (GLACIAL TILL)	2-3-4-14 (7) 18"					
6.0							8-10-12-12 (22) 18"	
1076.9		SILTY SAND (SM), fine to medium-grained, trace Gravel, brown, wet, loose (GLACIAL TILL)	8-10-9-5 (19) 16"				13	Test results are in the attached lab report
11.0								
1075.9		SANDY SILT (ML), fine to medium-grained, trace Gravel, brown, moist, stiff to very stiff (GLACIAL TILL)	1-5-8-7 (13) 4"					
12.0								
		12-11-7-7 (18) 16"						
			31-34-42-38 (76) 24"					
1062.9	SILTY SAND (SM), fine to medium-grained, trace Gravel, rock fragments, brown, moist, very dense (GLACIAL TILL)	25						
25.0			30					

Continued on next page

<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>79-C-1</b>					
					LOCATION: See attached sketch					
					LATITUDE: 46.46723	LONGITUDE: -90.48094				
DRILLER: EPC		LOGGED BY: A. Hillerud		START DATE: 06/05/20		END DATE: 06/18/20				
SURFACE ELEVATION: 1087.9 ft		RIG: Subcontractor		METHOD: 4 1/4" HSA		SURFACING:		WEATHER:		
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q <sub>p</sub> tsf	MC %	Tests or Remarks			
		SILTY SAND (SM), fine to medium-grained, trace Gravel, rock fragments, brown, moist, very dense (GLACIAL TILL)	35	50/5" (REF) 5"			Auger met refusal at 41 feet. Drilling method switched to rock coring at 41 feet.			
			40	32-40-40-50/ 5" (80) 16"						
1046.9 41.0		PORTAGE LAKE VOLCANICS, ANDESITE, dark gray with white, moderately weathered, moderately hard, fine-grained to medium- grained, massive, highly fractured		50/0" (REF) 0" 40			Run 1 MOHs 3			
		Test results are in the attached lab report	45	27 100			Run 2 MOHs 3			
			50	29 100			Run 3 MOHs 3			
		Test results are in the attached lab report	55	23 100			Run 4 MOHs 3			
			60	22 100			Run 5 MOHs 3			
							Run 6 MOHs 3			
Continued on next page				RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %	Remarks

<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>79-C-1</b>							
					LOCATION: See attached sketch							
					LATITUDE: 46.46723		LONGITUDE: -90.48094					
DRILLER: EPC		LOGGED BY: A. Hillerud		START DATE: 06/05/20		END DATE: 06/18/20						
SURFACE ELEVATION: 1087.9 ft		RIG: Subcontractor		METHOD: 4 1/4" HSA		SURFACING:		WEATHER:				
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %	Remarks		
1011.9 76.0		PORTAGE LAKE VOLCANICS, ANDESITE, dark gray with white, moderately weathered, moderately hard, fine-grained to medium-grained, massive, highly fractured	65	10	100					Run 7 MOHs 3		
			70	7	100							
			75	0	20						Run 8 MOHs 3	
				PORTAGE LAKE VOLCANICS, BASALT, dark gray with white, moderately weathered, moderately hard, fine-grained to medium-grained, massive, highly fractured <i>Test results are in the attached lab report</i>	80	0	100					Run 9 MOHs 3
					85	13	100					Run 10 MOHs 3
					90	15	100					Run 11 MOHs 3
				<i>Test results are in the attached lab report</i>	95	7	100					Run 12 MOHs 3
Continued on next page												

<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>79-C-1</b>					
					LOCATION: See attached sketch					
					LATITUDE: 46.46723		LONGITUDE: -90.48094			
DRILLER: EPC		LOGGED BY: A. Hillerud		START DATE: 06/05/20		END DATE: 06/18/20				
SURFACE ELEVATION: 1087.9 ft		RIG: Subcontractor		METHOD: 4 1/4" HSA		SURFACING:		WEATHER:		
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %	Remarks
974.9 113.0		PORTAGE LAKE VOLCANICS, BASALT, dark gray with white, moderately weathered, moderately hard, fine-grained to medium-grained, massive, highly fractured	100	8	100					Run 14 MOHs 3
		<i>Test results are in the attached lab report</i>	105	18	100					Run 15 MOHs 3
			110	10	100					Run 16 MOHs 3
		PORTAGE LAKE VOLCANICS, ANDESITE, dark gray with white, moderately weathered, moderately hard, fine-grained to medium-grained, massive, highly fractured	115	15	100					Run 17 MOHs 3
		<i>Test results are in the attached lab report</i>	120	20	100					Run 18 MOHs 3
			125	33	100					Run 19 MOHs 3
Continued on next page										

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					LOCATION: See attached sketch					
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DRILLER: EPC		LOGGED BY: A. Hillerud		START DATE: 06/05/20		END DATE: 06/18/20				
SURFACE ELEVATION: 1087.9 ft		RIG: Subcontractor		METHOD: 4 1/4" HSA		SURFACING:		WEATHER:		
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %	Remarks
954.9		PORTAGE LAKE VOLCANICS, ANDESITE, dark gray with white, moderately weathered, moderately hard, fine-grained to medium- grained, massive, highly fractured <i>Test results are in the attached lab report</i>	130	47	100					Run 20 MOHs 3
133.0		PORTAGE LAKE VOLCANICS, ANDESITE, dark gray with white, slightly weathered, hard, fine-grained to medium-grained, massive, highly fractured	135	75	100					Run 21 MOHs 3.5
		<i>Test results are in the attached lab report</i>	140	89	100					Run 22 MOHs 3.5
943.9				100	100					Run 23 MOHs 3.5
144.0		END OF CORING	145							Water observed at 11.0 feet while drilling.
		Boring then backfilled with cement/bentonite grout	150							
			155							

<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>81-C</b>	
					LOCATION: See attached sketch	
					LATITUDE: 46.47087	LONGITUDE: -90.48258
DRILLER: EPC		LOGGED BY: S. Sullivan		START DATE: 04/09/20	END DATE: 04/09/20	
SURFACE ELEVATION: 1162.9 ft		RIG: Subcontractor	METHOD: 3 1/4" HSA	SURFACING:		WEATHER:

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q <sub>p</sub> tsf	MC %	Tests or Remarks
1153.4		SILTY SAND (SM), fine to medium-grained, brown, moist, loose to medium dense (GLACIAL TILL)	5	3-2-3-6 (5) 12" 7-6-6-10 (12) 18" 3-6-9-7 (15) 24" 4-4-6-7 (10) 12"			Test results are in the attached lab report
9.5		SILTY SAND (SM), fine to medium-grained Sand, with Gravel, brown, moist, medium dense (GLACIAL TILL)	10	3-4-6-6 (10) 18"		4	
				3-5-11-12 (16) 24"			
			15	4-7-8-9 (15) 24"			
			20	4-11-15-13 (26) 24"			
			25	15-11-9-11 (20) 24"			
			30	7-12-15 (27) 18"			
1129.9		SANDY LEAN CLAY with GRAVEL (CL),					
33.0							

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<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>81-C</b>		
					LOCATION: See attached sketch		
					LATITUDE: 46.47087	LONGITUDE: -90.48258	
DRILLER: EPC		LOGGED BY: S. Sullivan		START DATE: 04/09/20		END DATE: 04/09/20	
SURFACE ELEVATION: 1162.9 ft		RIG: Subcontractor	METHOD: 3 1/4" HSA		SURFACING:		WEATHER:

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q <sub>p</sub> tsf	MC %	Tests or Remarks
1124.9		SANDY LEAN CLAY with GRAVEL (CL), brown, moist, very stiff (GLACIAL TILL)	35	6-9-10 (19) 18"			
38.0		SILTY, CLAYEY SAND (SC-SM), fine to medium-grained, reddish brown, moist, stiff to very stiff (GLACIAL TILL)	40	4-8-9 (17) 18"			
			45	4-6-8 (14) 18"			
			50	5-9-11 (20) 18"			
1109.9		SILTY SAND (SM), fine to medium-grained Sand, brown, moist, dense to very dense (GLACIAL TILL)	55	11-18-24 (42) 12"			
53.0			60	18-20-22 (42) 18"			
			65	10-18-39 (57) 18"			

Continued on next page



<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>81-C</b>	
					LOCATION: See attached sketch	
					LATITUDE: 46.47087	LONGITUDE: -90.48258
DRILLER: EPC		LOGGED BY: S. Sullivan		START DATE: 04/09/20	END DATE: 04/09/20	
SURFACE ELEVATION: 1162.9 ft		RIG: Subcontractor	METHOD: 3 1/4" HSA	SURFACING:		WEATHER:

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q <sub>p</sub> tsf	MC %	Tests or Remarks
1089.9		SILTY SAND (SM), fine to medium-grained Sand, brown, moist, dense to very dense (GLACIAL TILL)	70	15-21-24 (45) 18"		12	Test results are in the attached lab report
73.0		SANDY SILT (ML), brown, moist, dense to very dense (GLACIAL TILL)	75	20-16-24 (40) 18"			
			80	19-26-41 (67) 18"			
1079.9		POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, brown, moist, dense to very dense (GLACIAL OUTWASH)	85	20-31-43 (74) 18"			
83.0			90	15-20-30 (50) 18"			Test results are in the attached lab report
			95	17-23-24 (47) 18"		15	
			100	30-40-40 (80)			

Continued on next page

<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>81-C</b>		
					LOCATION: See attached sketch		
					LATITUDE: 46.47087	LONGITUDE: -90.48258	
DRILLER: EPC		LOGGED BY: S. Sullivan		START DATE: 04/09/20	END DATE: 04/09/20		
SURFACE ELEVATION: 1162.9 ft		RIG: Subcontractor	METHOD: 3 1/4" HSA	SURFACING:		WEATHER:	
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q <sub>p</sub> tsf	MC %	Tests or Remarks
		POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, brown, moist, dense to very dense (GLACIAL OUTWASH)					Probable Bedrock at 102 feet
			105				
			110				
			115	12-20-18 (38) 18"		11	Test results are in the attached lab report
1045.9							
117.0		Rock fragments, brownish black, very dense, (BOULDER)		50/2" (REF) 2"			
			120				
1041.9				5"			
121.0		Boulders, gray, (BOULDER)					
1039.9							
123.0		POORLY GRADED GRAVEL with SILT (GP- GM), fine-grained, with Sand, brown, wet, very dense, (ALTERED BEDROCK)		60/0" (REF) 0"			No recovery
		<i>Samples taken from auger cuttings, not from split spoon</i>	125				
				50/1" (REF) 1"			
			130				
				50/1" (REF) 1"			
1027.9							
135.0		SILTY SAND (SM), fine to medium-grained,	135				
Continued on next page							

<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>81-C</b>	
					LOCATION: See attached sketch	
					LATITUDE: 46.47087	LONGITUDE: -90.48258
DRILLER: EPC		LOGGED BY: S. Sullivan		START DATE: 04/09/20	END DATE: 04/09/20	
SURFACE ELEVATION: 1162.9 ft		RIG: Subcontractor	METHOD: 3 1/4" HSA	SURFACING:		WEATHER:

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q <sub>p</sub> tsf	MC %	Tests or Remarks
		SILTY SAND (SM), fine to medium-grained, with Gravel, brown, moist, very dense, (ALTERED BEDROCK) <i>Samples taken from auger cuttings, not from split spoon</i>					
			140				
				50/0" (REF) 0"			No recovery
			145				
				50/1" (REF) 1"			No recovery
			150				
				50/0" (REF) 0"			No recovery
1007.9			155				
155.0		LEAN CLAY (CL), trace Sand, reddish brown, moist, hard, (ALTERED BEDROCK) <i>Samples taken from auger cuttings, not from split spoon</i>		50/0" (REF) 0"			No recovery
			160				
				50/0" (REF) 0"			No recovery
			165				
				50/0" (REF) 0"			No recovery

Continued on next page

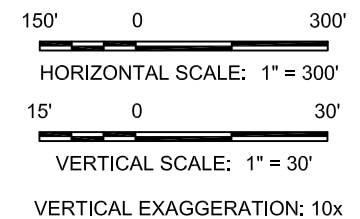
<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>81-C</b>	
					LOCATION: See attached sketch	
					LATITUDE: 46.47087	LONGITUDE: -90.48258
DRILLER: EPC		LOGGED BY: S. Sullivan		START DATE: 04/09/20	END DATE: 04/09/20	
SURFACE ELEVATION: 1162.9 ft		RIG: Subcontractor	METHOD: 3 1/4" HSA	SURFACING:		WEATHER:

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q <sub>p</sub> tsf	MC %	Tests or Remarks
		LEAN CLAY (CL), trace Sand, reddish brown, moist, hard, (ALTERED BEDROCK)		50/0" (REF) 0"			No recovery
			175				
				50/1" (REF) 1"			No recovery
			180				
980.9		SILTY SAND (SM), fine to medium-grained, with Gravel, brown, wet, very dense, (ALTERED BEDROCK)		50/1" (REF) 1"			No recovery
182.0							
		<i>Samples taken from auger cuttings, not from split spoon</i>	185				
				50/0" (REF) 0"			No recovery
			190				
				50/0" (REF) 0"			No recovery
			195				
				50/0" (REF) 0"			No recovery
			200				
				50/0" (REF) 0"			No recovery

Continued on next page

<b>Project Number B2001991</b> <b>Geotechnical Evaluation</b> <b>Enbridge Line 5 Re-Route</b> <b>Various Locations</b> <b>Ashland and Iron Counties, Wisconsin</b>					BORING: <b>81-C</b>		
					LOCATION: See attached sketch		
					LATITUDE: 46.47087	LONGITUDE: -90.48258	
DRILLER: EPC		LOGGED BY: S. Sullivan		START DATE: 04/09/20	END DATE: 04/09/20		
SURFACE ELEVATION: 1162.9 ft		RIG: Subcontractor	METHOD: 3 1/4" HSA	SURFACING:		WEATHER:	
Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q <sub>p</sub> tsf	MC %	Tests or Remarks
		SILTY SAND (SM), fine to medium-grained, with Gravel, brown, wet, very dense, (ALTERED BEDROCK)	205				
				50/0" (REF) 0"			No recovery
			210				
				50/0" (REF) 0"			No recovery
			215				
943.9							
219.0		END OF BORING		50/0" (REF) 0"			No recovery
		Boring then backfilled with cement/bentonite grout	220				Water not observed while drilling.
			225				
			230				
			235				



Project No:  
32001991

Drawing No:  
B2001991\_MP38\_POTATO-RIVER

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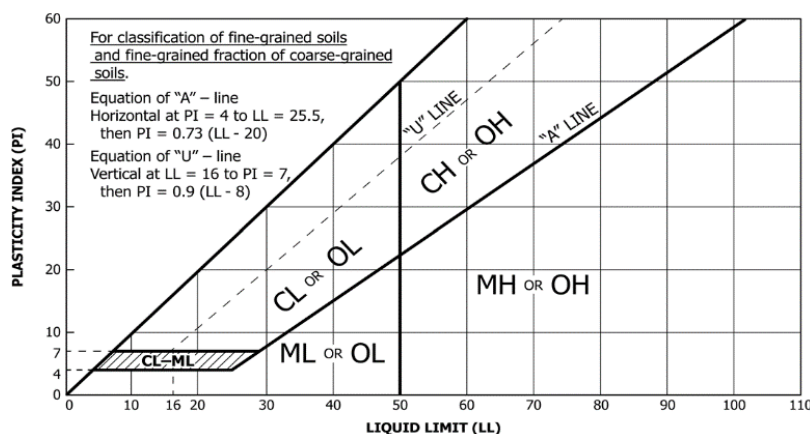
Drawn By: BJB  
Date Drawn: 7/22/20  
Checked By: DM  
Last Modified: 8/24/20

## Enbridge Line 5 Re-route

## MP 38 - Potato River Crossing

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests <sup>A</sup>				Soil Classification	
				Group Symbol	Group Name <sup>B</sup>
Coarse-grained Soils (more than 50% retained on No. 200 sieve)	Gravels (More than 50% of coarse fraction retained on No. 4 sieve)	Clean Gravels (Less than 5% fines <sup>C</sup> )	$C_u \geq 4$ and $1 \leq C_c \leq 3^D$	GW	Well-graded gravel <sup>E</sup>
			$C_u < 4$ and/or ( $C_c < 1$ or $C_c > 3$ ) <sup>D</sup>	GP	Poorly graded gravel <sup>E</sup>
		Gravels with Fines (More than 12% fines <sup>C</sup> )	Fines classify as ML or MH	GM	Silty gravel <sup>EFG</sup>
			Fines Classify as CL or CH	GC	Clayey gravel <sup>EFG</sup>
	Sands (50% or more coarse fraction passes No. 4 sieve)	Clean Sands (Less than 5% fines <sup>H</sup> )	$C_u \geq 6$ and $1 \leq C_c \leq 3^D$	SW	Well-graded sand <sup>I</sup>
			$C_u < 6$ and/or ( $C_c < 1$ or $C_c > 3$ ) <sup>D</sup>	SP	Poorly graded sand <sup>I</sup>
		Sands with Fines (More than 12% fines <sup>H</sup> )	Fines classify as ML or MH	SM	Silty sand <sup>FGI</sup>
			Fines classify as CL or CH	SC	Clayey sand <sup>FGI</sup>
Fine-grained Soils (50% or more passes the No. 200 sieve)	Silts and Clays (Liquid limit less than 50)	Inorganic	PI > 7 and plots on or above "A" line <sup>J</sup>	CL	Lean clay <sup>KLM</sup>
			PI < 4 or plots below "A" line <sup>J</sup>	ML	Silt <sup>KLM</sup>
		Organic	Liquid Limit – oven dried Liquid Limit – not dried <0.75	OL	Organic clay <sup>KLMN</sup> Organic silt <sup>KLMQ</sup>
	Silts and Clays (Liquid limit 50 or more)	Inorganic	PI plots on or above "A" line	CH	Fat clay <sup>KLM</sup>
			PI plots below "A" line	MH	Elastic silt <sup>KLM</sup>
		Organic	Liquid Limit – oven dried Liquid Limit – not dried <0.75	OH	Organic clay <sup>KLMP</sup> Organic silt <sup>KLMQ</sup>
Highly Organic Soils		Primarily organic matter, dark in color, and organic odor		PT	Peat

- Based on the material passing the 3-inch (75-mm) sieve.
- If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
- Gravels with 5 to 12% fines require dual symbols:  
GW-GM well-graded gravel with silt  
GW-GC well-graded gravel with clay  
GP-GM poorly graded gravel with silt  
GP-GC poorly graded gravel with clay
- $C_u = D_{60} / D_{10}$        $C_c = (D_{30})^2 / (D_{10} \times D_{60})$
- If soil contains  $\geq 15\%$  sand, add "with sand" to group name.
- If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
- If fines are organic, add "with organic fines" to group name.
- Sands with 5 to 12% fines require dual symbols:  
SW-SM well-graded sand with silt  
SW-SC well-graded sand with clay  
SP-SM poorly graded sand with silt  
SP-SC poorly graded sand with clay
- If soil contains  $\geq 15\%$  gravel, add "with gravel" to group name.
- If Atterberg limits plot in hatched area, soil is CL-ML, silty clay.
- If soil contains 15 to < 30% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
- If soil contains  $\geq 30\%$  plus No. 200, predominantly sand, add "sandy" to group name.
- If soil contains  $\geq 30\%$  plus No. 200 predominantly gravel, add "gravelly" to group name.
- PI  $\geq 4$  and plots on or above "A" line.
- PI plots on or above "A" line.
- PI plots below "A" line.



**DD** Dry density, pcf  
**WD** Wet density, pcf  
**P200** % Passing #200 sieve

**Laboratory Tests**  
**OC** Organic content, %  
**q<sub>p</sub>** Pocket penetrometer strength, tsf  
**MC** Moisture content, %  
**q<sub>u</sub>** Unconfined compression test, tsf

**LL** Liquid limit  
**PL** Plastic limit  
**PI** Plasticity index

## Particle Size Identification

Boulders..... over 12"  
Cobbles..... 3" to 12"  
Gravel  
Coarse..... 3/4" to 3" (19.00 mm to 75.00 mm)  
Fine..... No. 4 to 3/4" (4.75 mm to 19.00 mm)  
Sand  
Coarse..... No. 10 to No. 4 (2.00 mm to 4.75 mm)  
Medium..... No. 40 to No. 10 (0.425 mm to 2.00 mm)  
Fine..... No. 200 to No. 40 (0.075 mm to 0.425 mm)  
Silt..... No. 200 (0.075 mm) to .005 mm  
Clay..... < .005 mm

## Relative Proportions<sup>L, M</sup>

trace..... 0 to 5%  
little..... 6 to 14%  
with.....  $\geq 15\%$

## Inclusion Thicknesses

lens..... 0 to 1/8"  
seam..... 1/8" to 1"  
layer..... over 1"

## Apparent Relative Density of Cohesionless Soils

Very loose ..... 0 to 4 BPF  
Loose ..... 5 to 10 BPF  
Medium dense..... 11 to 30 BPF  
Dense..... 31 to 50 BPF  
Very dense..... over 50 BPF

## Consistency of Cohesive Soils      Blows Per Foot      Approximate Unconfined Compressive Strength

Very soft..... 0 to 1 BPF..... < 0.25 tsf  
Soft..... 2 to 4 BPF..... 0.25 to 0.5 tsf  
Medium..... 5 to 8 BPF ..... 0.5 to 1 tsf  
Stiff..... 9 to 15 BPF..... 1 to 2 tsf  
Very Stiff..... 16 to 30 BPF..... 2 to 4 tsf  
Hard..... over 30 BPF..... > 4 tsf

## Moisture Content:

**Dry:** Absence of moisture, dusty, dry to the touch.  
**Moist:** Damp but no visible water.  
**Wet:** Visible free water, usually soil is below water table.

## Drilling Notes:




**Blows/N-value:** Blows indicate the driving resistance recorded for each 6-inch interval. The reported N-value is the blows per foot recorded by summing the second and third interval in accordance with the Standard Penetration Test, ASTM D1586.

**Partial Penetration:** If the sampler could not be driven through a full 6-inch interval, the number of blows for that partial penetration is shown as #/x" (i.e. 50/2"). The N-value is reported as "REF" indicating refusal.

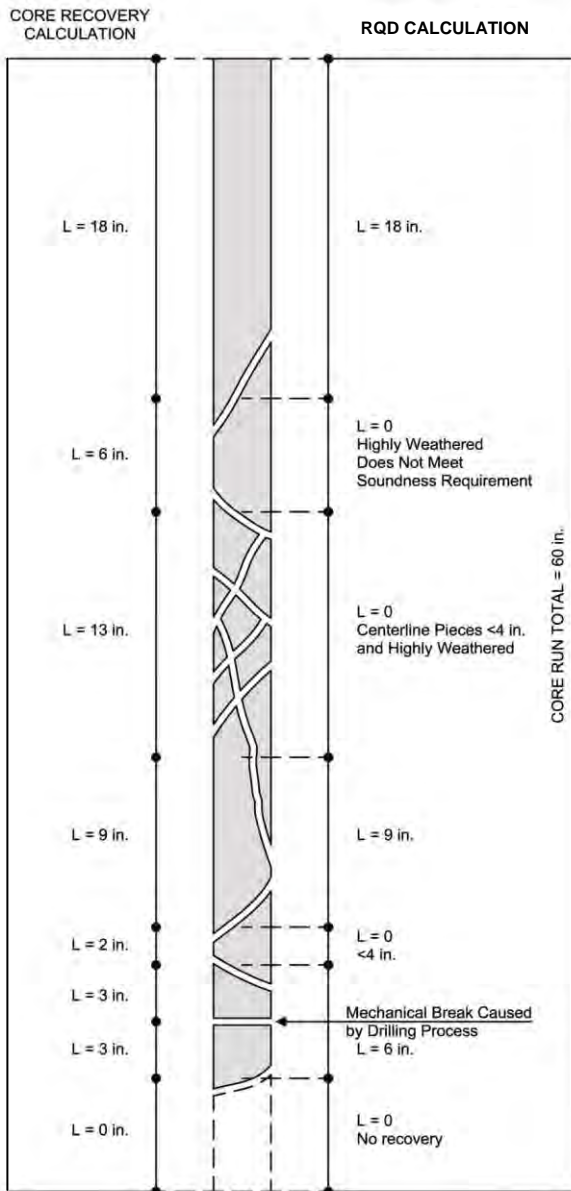
**Recovery:** Indicates the inches of sample recovered from the sampled interval. For a standard penetration test, full recovery is 18", and is 24" for a thinwall/shelby tube sample.

**WOH:** Indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

**WOR:** Indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

**Water Level:** Indicates the water level measured by the drillers either while drilling (  ), at the end of drilling (  ), or at some time after drilling (  ).





### Example Calculations

Core Recovery, CR =  $\frac{\text{Total length of rock recovered}}{\text{Total core run length}}$

$$\text{Example: CR} = \frac{(18 + 6 + 13 + 9 + 2 + 3 + 3)}{(60)}$$

CR = 90%

RQD =  $\frac{\text{Sum of sound pieces 4 inches or larger}}{\text{Total core run length}}$

RQD Percent	Rock Quality
< 25	very poor
25 < 50	poor
50 < 75	fair
75 < 90	good
90 < 100	excellent

$$\text{Example: RQD} = \frac{(18 + 9 + 6)}{(60)}$$

RQD = 55%

### Weathering

*Unweathered:* No evidence of chemical or mechanical alteration.

*Slightly weathered:* Slight discoloration on surface, slight alteration along discontinuities, less than 10% of rock volume altered.

*Moderately Weathered:* Discoloration evident, surface pitted and altered with alteration penetrating well below rock surfaces, weathering halos evident, 10% to 50% of the rock altered.

*Highly Weathered:* Entire mass discolored, alteration pervading nearly all of the rock, with some pockets of slightly weathered rock noticeable, some mineral leached away.

*Decomposed:* Rock reduced to a soil consistency with relict rock texture, generally molded and crumbled by hand.

### Hardness

<i>Very soft:</i>	Can be deformed by hand
<i>Soft:</i>	Can be scratched with a fingernail
<i>Moderately hard:</i>	Can be scratched easily with a knife
<i>Hard:</i>	Can be scratched with difficulty with a knife
<i>Very hard:</i>	Cannot be scratched with a knife

### Texture

Sedimentary Rocks:	Grain Size
Coarse grained	2 – 5 mm
Medium grained	0.4 – 2 mm
Fine grained	0.1 – 0.4 mm
Very fine grained	< 0.1 mm

### Igneous and Metamorphic Rocks:

Coarse grained	5 mm
Medium grained	1 – 5 mm
Fine grained	0.1 – 1 mm
Aphanitic	< 0.1 mm

### Thickness of Bedding

<i>Massive:</i>	3 ft. thick or greater
<i>Thick bedded:</i>	1 to 3 ft. thick
<i>Medium bedded:</i>	4 in. to 1 ft. thick
<i>Thin bedded:</i>	4 in. thick or less

### Degree of Fracturing (Jointing)

<i>Unfractured:</i>	Fracture spacing 6 ft. or more
<i>Slightly fractured:</i>	Fracture spacing 2 to 6 ft.
<i>Moderately fractured:</i>	Fracture spacing 8 in. to 2 ft.
<i>Highly fractured:</i>	Fracture spacing 2 in. to 8 in.
<i>Intensely fractured:</i>	Fracture spacing 2 in. or less



4511 West First Street  
Suite 4  
Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

**Sample Information**

<b>Sample Number:</b>	326707	<b>Alternate ID:</b>	81-C 6 12'-14'
<b>Sampling Method:</b>	Auger Boring ASTM D1452	<b>Depth (ft):</b>	12-14
<b>Boring Number:</b>	81-C	<b>Sampled By:</b>	Drill Crew
<b>Location:</b>	In-place		
<b>Location Details:</b>	Boring 81-C Sample 6 12'-14'		
<b>Sample Date:</b>	04/09/2020		
<b>Received Date:</b>	08/03/2020	<b>Lab:</b>	4511 West First Street, Suite 4, Duluth, MN
<b>Tested Date:</b>	08/04/2020	<b>Tested By:</b>	Nelson, Brennan

**Laboratory Data**

Sieve Size	Passing (%)	Specification
19 mm (3/4 inch)	95.6	
12.5 mm (1/2 inch)	85.7	
9.5 mm (3/8 inch)	83.1	
4.75 mm (No. 4)	77.7	
2 mm (No. 10)	72.5	
850 µm (No. 20)	68.0	
425 µm (No. 40)	62.7	
150 µm (No. 100)	46.0	
75 µm (No. 200)	35.8	

**Gravel (%)**

22.3

**Sand (%)**

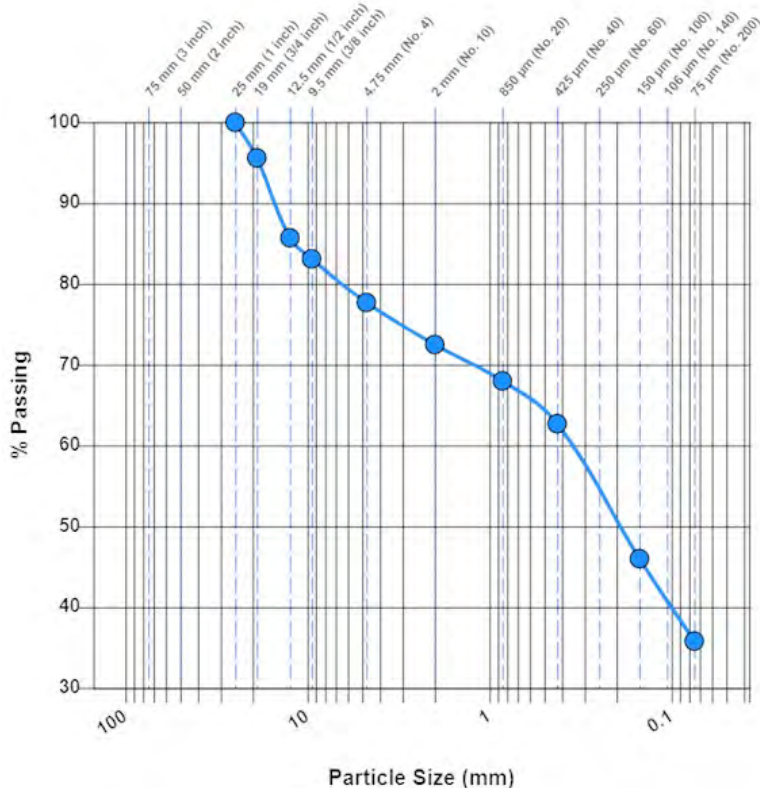
41.9

**Silt & Clay (%)**

35.8

**D60**

0.234



**Classification:** SM Silty sand with gravel

**Specimen Obtained:** Oven Dry

**Test Method:** Method A (Composite Sieving)

**Dispersion Apparatus:** Shaking

**General**

**Results:** The test is for informational purposes.

**Remarks:** Total dry weight of sample is 244.1 grams.

*[Signature]*

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Suite 4  
Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

**Sample Information**

<b>Sample Number:</b>	326710	<b>Alternate ID:</b>	81-C 18 69.5'-71'
<b>Sampling Method:</b>	Auger Boring ASTM D1452	<b>Depth (ft):</b>	69.5-71
<b>Boring Number:</b>	81-C	<b>Sampled By:</b>	Drill Crew
<b>Location:</b>	In-place		
<b>Location Details:</b>	Boring 81-C Sample 18 69.5'-71'		
<b>Sample Date:</b>	04/10/2020		
<b>Received Date:</b>	08/03/2020	<b>Lab:</b>	4511 West First Street, Suite 4, Duluth, MN
<b>Tested Date:</b>	08/04/2020	<b>Tested By:</b>	Nelson, Brennan

**Laboratory Data**

Sieve Size	Passing (%)	Specification
4.75 mm (No. 4)	100.0	
2 mm (No. 10)	100.0	
850 µm (No. 20)	99.7	
425 µm (No. 40)	98.2	
150 µm (No. 100)	66.3	
75 µm (No. 200)	27.4	

**Sand (%)**

72.6

**Silt & Clay (%)**

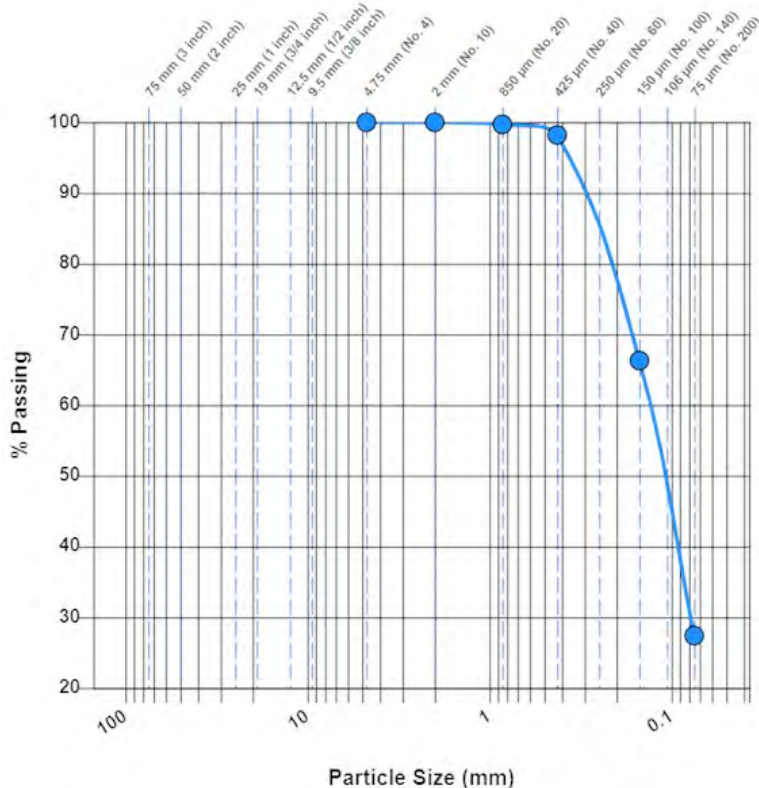
27.4

**D30**

0.077

**D60**

0.101



**Classification:** SM Silty sand

**Specimen Obtained:** Oven Dry

**Test Method:** Method A (Composite Sieving)

**Dispersion Apparatus:** Shaking

**General**

**Results:** The test is for informational purposes.

**Remarks:** Total dry weight of sample is 195.7 grams.

*[Signature]*

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Suite 4  
Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable 5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

**Sample Information**

<b>Sample Number:</b>	326712	<b>Alternate ID:</b>	81-C 23 94.5'-96'
<b>Sampling Method:</b>	Auger Boring ASTM D1452	<b>Depth (ft):</b>	94.5-96
<b>Boring Number:</b>	81-C	<b>Sampled By:</b>	Drill Crew
<b>Location:</b>	In-place		
<b>Location Details:</b>	Boring 81-C Sample 23 94.5'-96'		
<b>Sample Date:</b>	04/10/2020		
<b>Received Date:</b>	08/03/2020	<b>Lab:</b>	4511 West First Street, Suite 4, Duluth, MN
<b>Tested Date:</b>	08/04/2020	<b>Tested By:</b>	Nelson, Brennan

**Laboratory Data**

Sieve Size	Passing (%)	Specification
9.5 mm (3/8 inch)	100.0	
4.75 mm (No. 4)	98.8	
2 mm (No. 10)	96.9	
850 µm (No. 20)	91.2	
425 µm (No. 40)	65.7	
150 µm (No. 100)	16.9	
75 µm (No. 200)	11.0	

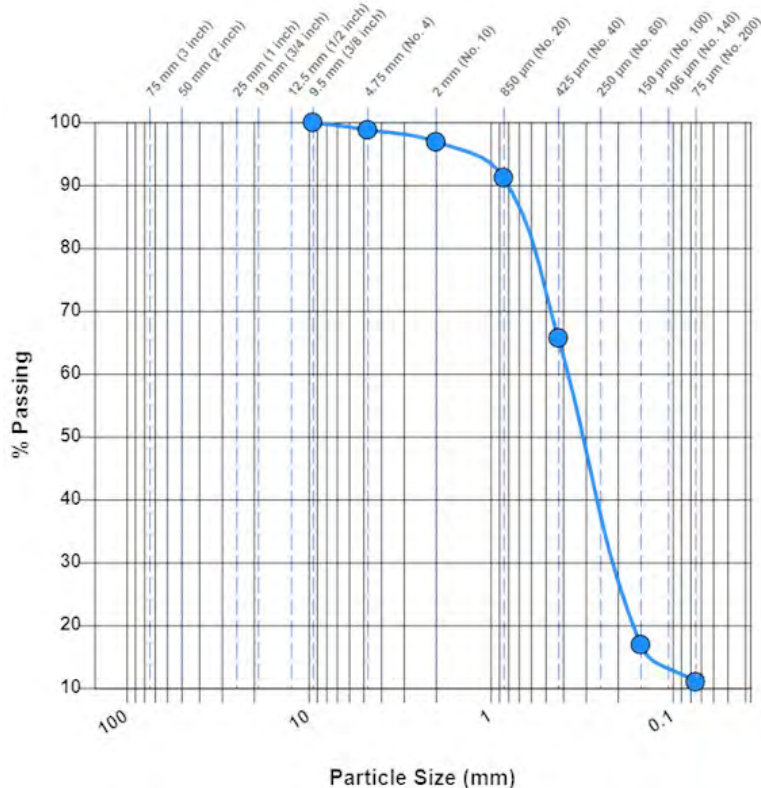
**Gravel (%)**  
1.2

**Sand (%)**  
87.8

**Silt & Clay (%)**  
11.0

**D30**  
0.177

**D60**  
0.238



**Classification:** SP-SM Poorly graded sand with silt

**Specimen Obtained:** Oven Dry

**Test Method:** Method A (Composite Sieving)

**Dispersion Apparatus:** Shaking

**General**

**Results:** The test is for informational purposes.

**Remarks:** Total dry weight of sample is 223.6 grams.

*[Signature]*

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Suite 4  
Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

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Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

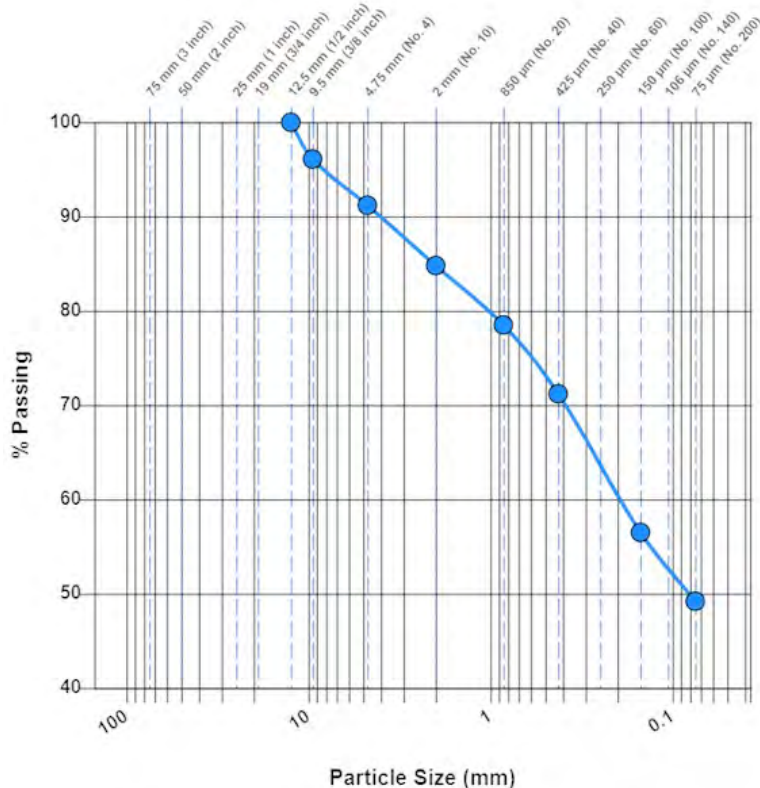
**Sample Information**

<b>Sample Number:</b>	318772	<b>Alternate ID:</b>	81-C 25 112'
<b>Sampling Method:</b>	Auger Boring ASTM D1452	<b>Depth (ft):</b>	112
<b>Boring Number:</b>	81-C	<b>Sampled By:</b>	Drill Crew
<b>Location:</b>	In-place		
<b>Location Details:</b>	Boring 81-C Sample 25 112'		
<b>Sample Date:</b>	04/14/2020		
<b>Received Date:</b>	06/29/2020	<b>Lab:</b>	4511 West First Street, Suite 4, Duluth, MN
<b>Tested Date:</b>	06/29/2020	<b>Tested By:</b>	Nelson, Brennan

**Laboratory Data**

Sieve Size	Passing (%)	Specification
12.5 mm (1/2 inch)	100.0	
9.5 mm (3/8 inch)	96.1	
4.75 mm (No. 4)	91.2	
2 mm (No. 10)	84.8	
850 µm (No. 20)	78.5	
425 µm (No. 40)	71.2	
150 µm (No. 100)	56.5	
75 µm (No. 200)	49.2	

<b>Gravel (%)</b>	<b>Sand (%)</b>	<b>Silt &amp; Clay (%)</b>
8.8	42.0	49.2
<b>D60</b>		
0.174		



**Classification:** SM Silty sand  
**Specimen Obtained:** Oven Dry  
**Dispersion Apparatus:** Shaking

**Test Method:** Method A (Composite Sieving)

**General**

**Results:** The test is for informational purposes.  
**Remarks:** Total dry weight of sample 241.5 grams

*[Signature]*

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Suite 4  
Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

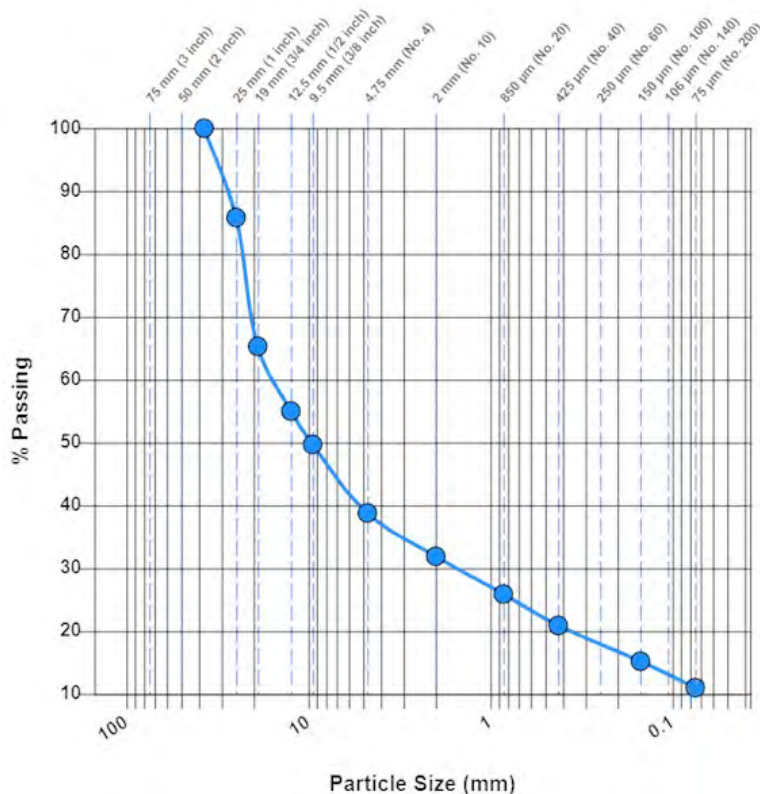
**Sample Information**

<b>Sample Number:</b>	319401	<b>Alternate ID:</b>	79-C-1 4 7'
<b>Sampling Method:</b>	Aggregate ASTM D75/AASHTO T2	<b>Depth (ft):</b>	7
<b>Boring Number:</b>	79-C-1	<b>Sampled By:</b>	Drill Crew
<b>Location:</b>	In-place		
<b>Location Details:</b>	Boring 79-C-1 Sample 4 7'		
<b>Sample Date:</b>	06/05/2020		
<b>Received Date:</b>	07/01/2020	<b>Lab:</b>	4511 West First Street, Suite 4, Duluth, MN
<b>Tested Date:</b>	07/07/2020	<b>Tested By:</b>	Nelson, Brennan

**Laboratory Data**

Sieve Size	Passing (%)	Specification
37.5 mm (1.5 inch)	100.0	
25 mm (1 inch)	85.8	
19 mm (3/4 inch)	65.3	
12.5 mm (1/2 inch)	55.0	
9.5 mm (3/8 inch)	49.7	
4.75 mm (No. 4)	38.8	
2 mm (No. 10)	31.9	
850 µm (No. 20)	25.9	
425 µm (No. 40)	20.9	
150 µm (No. 100)	15.2	
75 µm (No. 200)	11.0	

<b>Gravel (%)</b>	<b>Sand (%)</b>	<b>Silt &amp; Clay (%)</b>
61.2	27.8	11.0
<b>D30</b>	<b>D60</b>	
1.636	15.655	



<b>Classification:</b>	GP-GM Poorly graded gravel with silt and sand		
<b>Specimen Obtained:</b>	Oven Dry	<b>Test Method:</b>	Method A (Composite Sieving)
<b>Dispersion Apparatus:</b>	Shaking		

**General**

**Results:** The test is for informational purposes.  
**Remarks:** Total dry weight of sample is 275.6 grams.

*[Signature]*



4511 West First Street  
Suite 4  
Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

**Sample Information**

<b>Sample Number:</b>	319405	<b>Alternate ID:</b>	79-C-1 8 20'
<b>Sampling Method:</b>	Aggregate ASTM D75/AASHTO T2	<b>Depth (ft):</b>	20
<b>Boring Number:</b>	79-C-1	<b>Sampled By:</b>	Drill Crew
<b>Location:</b>	In-place		
<b>Location Details:</b>	Boring 79-C-1 Sample 8 20'		
<b>Sample Date:</b>	06/08/2020		
<b>Received Date:</b>	07/01/2020	<b>Lab:</b>	4511 West First Street, Suite 4, Duluth, MN
<b>Tested Date:</b>	07/07/2020	<b>Tested By:</b>	Nelson, Brennan

**Laboratory Data**

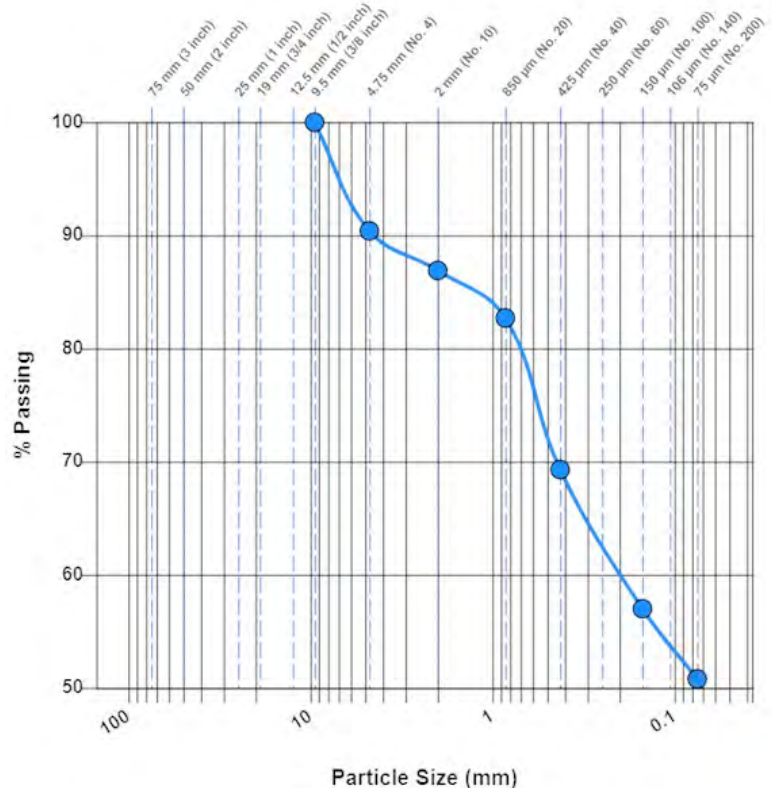
Sieve Size	Passing (%)	Specification
9.5 mm (3/8 inch)	100.0	
4.75 mm (No. 4)	90.4	
2 mm (No. 10)	86.9	
850 µm (No. 20)	82.7	
425 µm (No. 40)	69.3	
150 µm (No. 100)	57.0	
75 µm (No. 200)	50.8	

**Gravel (%)**  
9.6

**Sand (%)**  
39.6

**Silt & Clay (%)**  
50.8

**D60**  
0.174



**Classification:** ML Sandy silt

**Specimen Obtained:** Oven Dry

**Test Method:** Method A (Composite Sieving)

**Dispersion Apparatus:** Shaking

**General**

**Results:** The test is for informational purposes.

**Remarks:** Total dry weight of sample is 267.9 grams.

*[Signature]*

4511 West First Street  
Suite 4  
Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

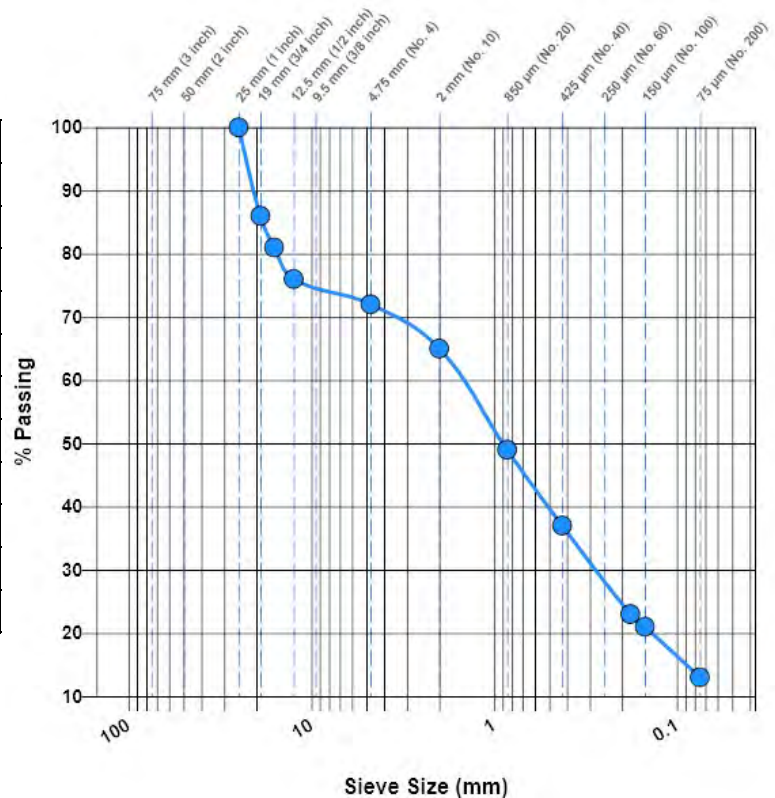
**Sample Information**

**Sample Number:** 315520 **Alternate ID:** 77-C Sample 4 7'-9'  
**Sampling Method:** Auger Boring ASTM D1452 **Depth (ft):** 7'  
**Boring Number:** 77-C **Sampled By:** Drill Crew  
**Location:** In-place  
**Location Details:** Boring 77-C Sample 4 7'-9'  
**Sample Date:** 05/26/2020  
**Received Date:** 06/15/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN  
**Tested Date:** 06/17/2020

**Laboratory Data**

Sieve Size	% Passing	Specification
25 mm (1 inch)	100	
19 mm (3/4 inch)	86	
16 mm (5/8 inch)	81	
12.5 mm (1/2 inch)	76	
4.75 mm (No. 4)	72	
2 mm (No. 10)	65	
850 µm (No. 20)	49	
425 µm (No. 40)	37	
180 µm (No. 80)	23	
150 µm (No. 100)	21	
75 µm (No. 200)	13.0	

**Test Method:** Method A (Composite Sieving)  
**Dispersion Apparatus:** Shaking  
**Specimen Obtained:** Oven Dry



**Classification:** SM Silty sand with gravel

**General**

**Results:** The test is for informational purposes.

**Remarks:** Total dry weight of sample 111.9 grams

*[Signature]*

4511 West First Street  
Suite 4  
Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable 5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

**Sample Information**

**Sample Number:** 315521 **Alternate ID:** 77-C 6 & 7 12'-16.5'  
**Sampling Method:** Auger Boring ASTM D1452 **Depth (ft):** 12  
**Boring Number:** 77-C **Sampled By:** Drill Crew  
**Location:** In-place  
**Location Details:** Boring 77-C Sample 6 & 7 12'-16.5'  
**Sample Date:** 05/26/2020  
**Received Date:** 06/15/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN  
**Tested Date:** 06/17/2020

**Laboratory Data**

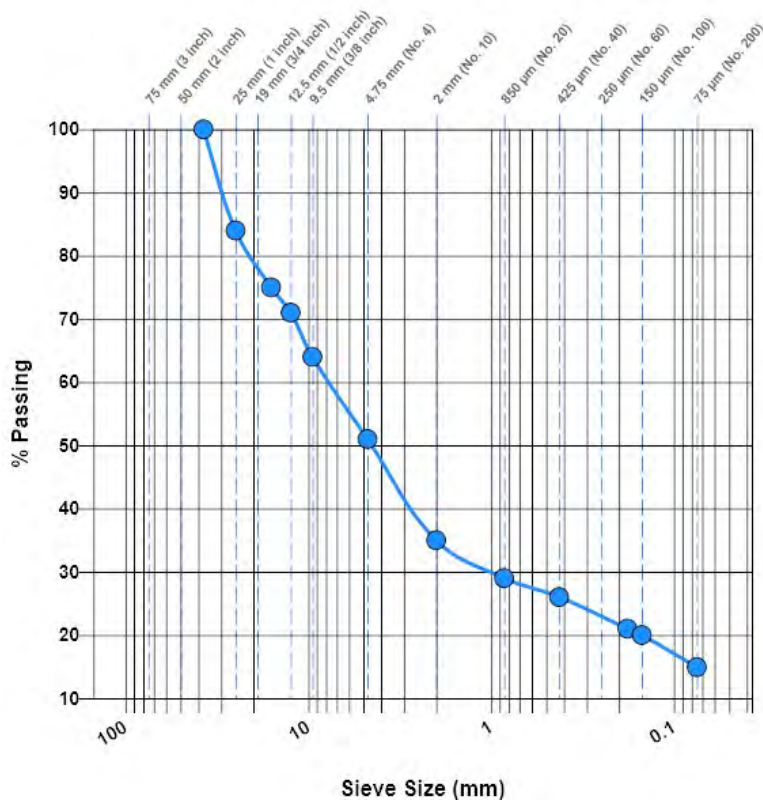
Sieve Size	% Passing	Specification
37.5 mm (1.5 inch)	100	
25 mm (1 inch)	84	
16 mm (5/8 inch)	75	
12.5 mm (1/2 inch)	71	
9.5 mm (3/8 inch)	64	
4.75 mm (No. 4)	51	
2 mm (No. 10)	35	
850 µm (No. 20)	29	
425 µm (No. 40)	26	
180 µm (No. 80)	21	
150 µm (No. 100)	20	
75 µm (No. 200)	14.9	

**Test Method:** Method A (Composite Sieving)

**Dispersion Apparatus:** Shaking

**Specimen Obtained:** Oven Dry

**Classification:** SP-SM Poorly graded sand with silt and gravel



**General**

**Results:** The test is for informational purposes.

**Remarks:** Total weight of dry sample 355.8 grams

*[Signature]*



4511 West First Street  
Suite 4  
Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

**Sample Information**

<b>Sample Number:</b>	324771	<b>Alternate ID:</b>	75-C Sample 303 7.5'
<b>Sampling Method:</b>	Auger Boring ASTM D1452	<b>Depth (ft):</b>	7.5
<b>Boring Number:</b>	75-C	<b>Sampled By:</b>	Drill Crew
<b>Location:</b>	In-place		
<b>Location Details:</b>	Boring 75-C Sample 303 7.5'		
<b>Sample Date:</b>	07/27/2020		
<b>Received Date:</b>	07/27/2020	<b>Lab:</b>	4511 West First Street, Suite 4, Duluth, MN
<b>Tested Date:</b>	07/27/2020	<b>Tested By:</b>	Patterson, Gregg

**Laboratory Data**

Sieve Size	Passing (%)	Specification
12.5 mm (1/2 inch)	100.0	
9.5 mm (3/8 inch)	96.9	
4.75 mm (No. 4)	94.0	
2 mm (No. 10)	90.5	
850 µm (No. 20)	86.6	
425 µm (No. 40)	79.5	
150 µm (No. 100)	41.2	
75 µm (No. 200)	26.2	

**Gravel (%)**

6.0

**Sand (%)**

67.8

**Silt & Clay (%)**

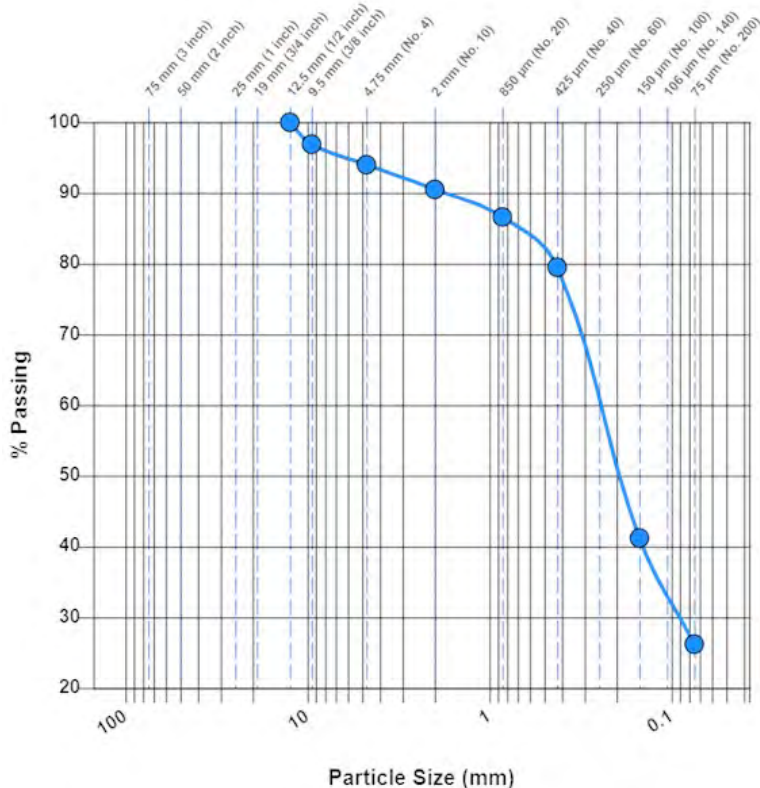
26.2

**D30**

0.094

**D60**

0.285



**Classification:**

SM Silty sand

**Specimen Obtained:**

Air Dry

**Test Method:**

Method A (Composite Sieving)

**Dispersion Apparatus:**

Shaking

**General**

**Results:** The test is for informational purposes.

**Remarks:** Total dry weight of sample 319.0 grams

*David Morrison*

David Morrison

4511 West First Street  
Suite 4  
Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

**Sample Information**

**Sample Number:** 326707 **Alternate ID:** 81-C 6 12'-14'  
**Sampling Method:** Auger Boring ASTM D1452 **Sampled By:** Drill Crew  
**Location:** In-place  
**Location Details:** Boring 81-C Sample 6 12'-14'  
**Sample Date:** 04/09/2020  
**Received Date:** 08/03/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN  
**Tested Date:** 08/04/2020 **Tested By:** Nelson, Brennan

**Laboratory Data**

Boring #	Sample #	Depth (ft)	Moisture Content (%)
81-C	6	13.0	3.6

**General**

**Results:** The test is for informational purposes.



4511 West First Street  
Suite 4  
Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

**Sample Information**

**Sample Number:** 326710 **Alternate ID:** 81-C 18 69.5'-71'  
**Sampling Method:** Auger Boring ASTM D1452 **Sampled By:** Drill Crew  
**Location:** In-place  
**Location Details:** Boring 81-C Sample 18 69.5'-71'  
**Sample Date:** 04/10/2020  
**Received Date:** 08/03/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN  
**Tested Date:** 08/04/2020 **Tested By:** Nelson, Brennan

**Laboratory Data**

Boring #	Sample #	Depth (ft)	Moisture Content (%)
81-C	18	70.0	11.7

**General**

**Results:** The test is for informational purposes.



4511 West First Street  
Suite 4  
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Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

**Sample Information**

**Sample Number:** 326712 **Alternate ID:** 81-C 23 94.5'-96'  
**Sampling Method:** Auger Boring ASTM D1452 **Sampled By:** Drill Crew  
**Location:** In-place  
**Location Details:** Boring 81-C Sample 23 94.5'-96'  
**Sample Date:** 04/10/2020  
**Received Date:** 08/03/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN  
**Tested Date:** 08/04/2020 **Tested By:** Nelson, Brennan

**Laboratory Data**

Boring #	Sample #	Depth (ft)	Moisture Content (%)
81-C	23	95.0	14.7

**General**

**Results:** The test is for informational purposes.



4511 West First Street  
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Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

**Sample Information**

**Sample Number:** 318772 **Alternate ID:** 81-C 25 112'  
**Sampling Method:** Auger Boring ASTM D1452 **Sampled By:** Drill Crew  
**Location:** In-place  
**Location Details:** Boring 81-C Sample 25 112'  
**Sample Date:** 04/14/2020  
**Received Date:** 06/29/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN  
**Tested Date:** 06/29/2020 **Tested By:** Nelson, Brennan

**Laboratory Data**

Boring #	Sample #	Depth (ft)	Moisture Content (%)
81-C	25	112.0	11.1

**General**

**Results:** The test is for informational purposes.



4511 West First Street  
Suite 4  
Duluth, MN 55807  
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**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

**Sample Information**

**Sample Number:** 319401 **Alternate ID:** 79-C 4 7'  
**Sampling Method:** Aggregate ASTM D75/AASHTO T2 **Sampled By:** Drill Crew  
**Location:** In-place  
**Location Details:** Boring 79-C Sample 4 7'  
**Sample Date:** 06/05/2020  
**Received Date:** 07/01/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN  
**Tested Date:** 07/07/2020 **Tested By:** Nelson, Brennan

**Laboratory Data**

Boring #	Sample #	Depth (ft)	Moisture Content (%)
79-C-1	4	7.0	5.0

**General**

**Results:** The test is for informational purposes.



4511 West First Street  
Suite 4  
Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

**Sample Information**

**Sample Number:** 319405 **Alternate ID:** 79-C-1 8 20'  
**Sampling Method:** Aggregate ASTM D75/AASHTO T2 **Sampled By:** Drill Crew  
**Location:** In-place  
**Location Details:** Boring 79-C-1 Sample 8 20'  
**Sample Date:** 06/08/2020  
**Received Date:** 07/01/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN  
**Tested Date:** 07/07/2020 **Tested By:** Nelson, Brennan

**Laboratory Data**

Boring #	Sample #	Depth (ft)	Moisture Content (%)
79-C-1	8	20.0	12.5

**General**

**Results:** The test is for informational purposes.



4511 West First Street  
Suite 4  
Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

**Sample Information**

**Sample Number:** 315520 **Alternate ID:** 77-C Sample 4 7'-9'

**Sampling Method:** Auger Boring ASTM D1452 **Sampled By:** Drill Crew

**Location:** In-place

**Location Details:** Boring 77-C Sample 4 7'-9'

**Sample Date:** 05/26/2020

**Received Date:** 06/15/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN

**Tested Date:** 06/17/2020 **Tested By:** Nelson, Brennan

**Laboratory Data**

Boring #	Sample #	Depth (ft)	Moisture Content (%)
77-C	4	8.0	18.6

**General**

**Results:** The test is for informational purposes.





4511 West First Street  
Suite 4  
Duluth, MN 55807  
Phone: 218-624-4967

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

**Sample Information**

**Sample Number:** 315521 **Alternate ID:** 77-C 6 & 7 12'-16.5'  
**Sampling Method:** Auger Boring ASTM D1452 **Sampled By:** Drill Crew  
**Location:** In-place  
**Location Details:** Boring 77-C Sample 6 & 7 12'-16.5'  
**Sample Date:** 05/26/2020  
**Received Date:** 06/15/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN  
**Tested Date:** 06/17/2020 **Tested By:** Nelson, Brennan

**Laboratory Data**

Boring #	Sample #	Depth (ft)	Moisture Content (%)
77-C	6 and 7	14.5	12.1

**General**

**Results:** The test is for informational purposes.



11001 Hampshire Avenue S  
Minneapolis, MN 55438  
Phone: 952-995-2000

**Client:**

Enbridge Energy, Limited Partnership  
Attn: Accounts Payable5400 Westheimer Ct  
Houston, TX 77056

**Project:**

B2001991  
Enbridge Line 5 Re-route  
Enbridge Line 5  
near Mellen, WI

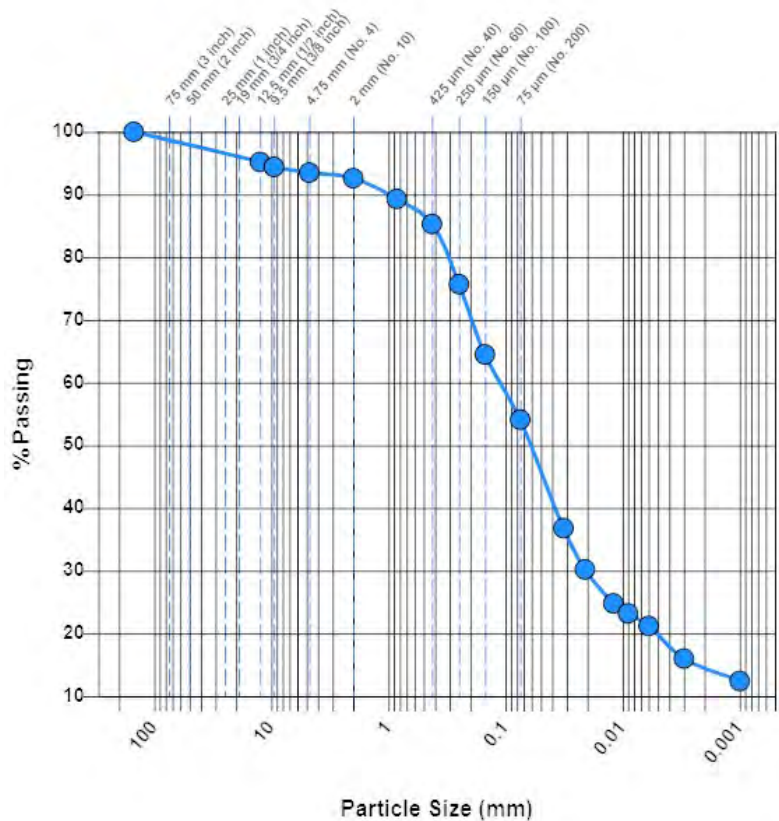
## Sample Information

<b>Sample Number:</b>	328877	<b>Depth (ft):</b>	35
<b>Boring Number:</b>	81-C	<b>Sampled By:</b>	Drill Crew
<b>Sample Date:</b>	08/05/2020		
<b>Received Date:</b>	08/12/2020	<b>Lab:</b>	11001 Hampshire Ave S, Bloomington, MN
<b>Tested Date:</b>	08/12/2020	<b>Tested By:</b>	Streier, Jim

## Laboratory Data

### Sieve-Hydrometer Analysis

Particle Size	% Passing	Specification
19 mm (3/4 inch)	100.0	-
12.5 mm (1/2 inch)	95.2	-
9.5 mm (3/8 inch)	94.4	-
4.75 mm (No. 4)	93.5	-
2 mm (No. 10)	92.6	-
850 µm (No. 20)	89.3	-
425 µm (No. 40)	85.3	-
250 µm (No. 60)	75.7	-
150 µm (No. 100)	64.5	-
75 µm (No. 200)	54.1	-
32.0 (µm)	36.8	-
20.7 (µm)	30.2	-
12.2 (µm)	24.8	-
8.7 (µm)	23.2	-
6.2 (µm)	21.2	-
3.1 (µm)	16.0	-
1.4 (µm)	12.4	-



**Soil Classification:** CL Sandy lean clay

<b>Gravel (%):</b>	6.5	<b>Sand (%):</b>	39.4	<b>Silt (%):</b>	34.6	<b>Clay (%):</b>	19.5
<b>D<sub>60</sub> (µm):</b>	117.5	<b>D<sub>30</sub> (µm):</b>	20.7				

## General



Braun Intertec Corporation  
4511 West First Street, Suite 4  
Duluth, MN 55807

Phone: 218.624.4967  
Fax: 218.624.0196  
Web: braunintertec.com

**Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core  
Specimens under Varying States of Stress and Temperatures (Method C)  
ASTM D 7012**

**Date:** July 29, 2020

**Project Number:** B2001991

**Client:** Accounts Payable  
Enbridge Energy, Limited Partnership  
5400 Westheimer Ct  
Houston, TX 77056

**Project Description:**  
Enbridge Line 5 Re-route

---

**Sample Data**

Date Sampled: Not Given  
Samples Obtained By: Braun  
Date Received: 7/10/2020  
Sample Preparation: Trim and Polished

---

**Laboratory Data**

ASTM D4543 Limits

Sample Number:	23-24	33-34	43-44	54-55	
Date Tested:	7/16/2020	7/16/2020	7/16/2020	7/16/2020	
Rock Type:	Felsite	Felsite	Felsite	Felsite	
Moisture Condition During Testing:	Dry	Dry	Dry	Dry	
Diameter (in.):	1.76	1.76	1.76	1.77	
Length (in.):	4.11	3.75	3.22	4.41	
Length-to-Diameter Ratio (L/D):	2.3	2.1	1.8	2.5	$2.0 \leq L/D \leq 2.5$
Side Tolerance, Maximum (in.)	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$ in.
End Tolerance, Maximum (in.)	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in.
Perpendicularity Deviation ( $^{\circ}$ )	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.250^{\circ}$
Parallelism Deviation ( $^{\circ}$ )	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.25^{\circ}$
Maximum Load (lbs):	21,969	47,438	34,312	41,584	
Area (in <sup>2</sup> ):	2.43	2.43	2.43	2.46	
Compressive Strength (psi):	9,040	19,520	14,120	16,900	
Compressive Strength (MPa):	61	133	96	115	

---

**Remarks:**

Location 75-C-1

---

Reviewed By:  
David Morrison

Project Manager



Braun Intertec Corporation  
4511 West First Street, Suite 4  
Duluth, MN 55807

Phone: 218.624.4967  
Fax: 218.624.0196  
Web: braunintertec.com

**Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core  
Specimens under Varying States of Stress and Temperatures (Method C)  
ASTM D 7012**

**Date:** August 3, 2020

**Project Number:** B2001991

**Client:** Accounts Payable  
Enbridge Energy, Limited Partnership  
5400 Westheimer Ct  
Houston, TX 77056

**Project Description:**  
Enbridge Line 5 Re-route

---

**Sample Data**

Date Sampled: Not Given  
Samples Obtained By: Braun  
Date Received: 7/10/2020  
Sample Preparation: Trim and Polished

---

**Laboratory Data**

ASTM D4543 Limits

Sample Number:	64-65	74-75	86-87	96-97	
Date Tested:	7/16/2020	7/16/2020	7/16/2020	7/16/2020	
Rock Type:	Felsite	Felsite	Felsite	Felsite	
Moisture Condition During Testing:	Dry	Dry	Dry	Dry	
Diameter (in.):	1.76	1.76	1.76	1.76	
Length (in.):		4.47	3.99	3.60	
Length-to-Diameter Ratio (L/D):		2.5	2.3	2.0	$2.0 \leq L/D \leq 2.5$
Side Tolerance, Maximum (in.)	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$ in.
End Tolerance, Maximum (in.)	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in.
Perpendicularity Deviation ( $^{\circ}$ )	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.250^{\circ}$
Parallelism Deviation ( $^{\circ}$ )	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.25^{\circ}$
Maximum Load (lbs):	21,868	52,176	38,583	58,347	
Area (in <sup>2</sup> ):	2.43	2.43	2.43	2.43	
Compressive Strength (psi):	9,000	21,470	15,880	24,010	
Compressive Strength (MPa):	61	146	108	163	

---

**Remarks:**

Location 75-C-1

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Reviewed By:  
David Morrison

Project Manager



Braun Intertec Corporation  
4511 West First Street, Suite 4  
Duluth, MN 55807

Phone: 218.624.4967  
Fax: 218.624.0196  
Web: braunintertec.com

**Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core  
Specimens under Varying States of Stress and Temperatures (Method C)  
ASTM D 7012**

**Date:** August 3, 2020  
**Client:** Accounts Payable  
Enbridge Energy, Limited Partnership  
5400 Westheimer Ct  
Houston, TX 77056  
**Project Number:** B2001991  
**Project Description:**  
Enbridge Line 5 Re-route

**Sample Data**

Date Sampled: Not Given  
Samples Obtained By: Braun  
Date Received: 7/10/2020  
Sample Preparation: Trim and Polished

**Laboratory Data**

ASTM D4543 Limits

Sample Number:	117-118	129-130	139-140	149-150	
Date Tested:	7/16/2020	7/16/2020	7/16/2020	7/16/2020	
Rock Type:	Rhyolite	Rhyolite	Rhyolite	Rhyolite	
Moisture Condition During Testing:	Dry	Dry	Dry	Dry	
Diameter (in.):	1.76	1.76	1.76	1.76	
Length (in.):	4.20	4.02	4.11	4.35	
Length-to-Diameter Ratio (L/D):	2.4	2.3	2.3	2.5	$2.0 \leq L/D \leq 2.5$
Side Tolerance, Maximum (in.)	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$ in.
End Tolerance, Maximum (in.)	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in.
Perpendicularity Deviation (°)	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.250^\circ$
Parallelism Deviation (°)	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.25^\circ$
Maximum Load (lbs):	40,891	39,150	45,924	53,005	
Area (in <sup>2</sup> ):	2.43	2.43	2.43	2.43	
Compressive Strength (psi):	16,830	16,110	18,900	21,810	
Compressive Strength (MPa):	114	109	128	148	

**Remarks:**

Location 75-C-1

Reviewed By:  
David Morrison

Project Manager



Braun Intertec Corporation  
4511 West First Street, Suite 4  
Duluth, MN 55807

Phone: 218.624.4967  
Fax: 218.624.0196  
Web: braunintertec.com

**Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core  
Specimens under Varying States of Stress and Temperatures (Method C)  
ASTM D 7012**

**Date:** June 26, 2020

**Project Number:** B2001991

**Client:** Accounts Payable  
Enbridge Energy, Limited Partnership  
5400 Westheimer Ct  
Houston, TX 77056

**Project Description:**  
Enbridge Line 5 Re-route

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**Sample Data**

Date Sampled: Not Given  
Samples Obtained By: Braun  
Date Received: 6/17/2020  
Sample Preparation: Trim and Polished

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**Laboratory Data**

ASTM D4543 Limits

Sample Number:	35-36	47-48	58-59	67-68	
Date Tested:					
Rock Type:	Gabbro	Gabbro	Basalt	Basalt	
Moisture Condition During Testing:	Dry	Dry	Dry	Dry	
Diameter (in.):	1.98	1.99	1.98	1.98	
Length (in.):	4.58	3.99	4.42	4.39	
Length-to-Diameter Ratio (L/D):	2.3	2.0	2.2	2.2	$2.0 \leq L/D \leq 2.5$
Side Tolerance, Maximum (in.)	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$ in.
End Tolerance, Maximum (in.)	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in.
Perpendicularity Deviation (°)	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.250^\circ$
Parallelism Deviation (°)	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.25^\circ$
Maximum Load (lbs):	43,284	42,743	28,297	30,697	
Area (in <sup>2</sup> ):	3.08	3.11	3.08	3.08	
Compressive Strength (psi):	14,050	13,740	9,190	9,970	
Compressive Strength (MPa):	95	93	62	68	

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**Remarks:**

Location 77-C

Reviewed By:  
David Morrison

Project Manager



Braun Intertec Corporation  
4511 West First Street, Suite 4  
Duluth, MN 55807

Phone: 218.624.4967  
Fax: 218.624.0196  
Web: braunintertec.com

**Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core  
Specimens under Varying States of Stress and Temperatures (Method C)  
ASTM D 7012**

**Date:** June 26, 2020

**Project Number:** B2001991

**Client:** Accounts Payable  
Enbridge Energy, Limited Partnership  
5400 Westheimer Ct  
Houston, TX 77056

**Project Description:**  
Enbridge Line 5 Re-route

---

**Sample Data**

Date Sampled: Not Given  
Samples Obtained By: Braun  
Date Received: 6/17/2020  
Sample Preparation: Trim and Polished

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**Laboratory Data**

ASTM D4543 Limits

Sample Number:	81-82	95-96	112-113	125-126	
Date Tested:					
Rock Type:	Basalt	Gabbro	Basalt	Andesite	
Moisture Condition During Testing:	Dry	Dry	Dry	Dry	
Diameter (in.):	1.97	1.99	1.98	1.98	
Length (in.):	3.26	4.37	3.25	4.11	
Length-to-Diameter Ratio (L/D):	1.7	2.2	1.6	2.1	$2.0 \leq L/D \leq 2.5$
Side Tolerance, Maximum (in.)	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$ in.
End Tolerance, Maximum (in.)	$\leq 0.001$ in.	$\leq 0.001$ in.	$\leq 0.001$ in.	$\leq 0.001$ in.	$\leq 0.001$ in.
Perpendicularity Deviation (°)	$\leq 0.001$ in.	$\leq 0.001$ in.	$\leq 0.001$ in.	$\leq 0.001$ in.	$\leq 0.250^\circ$
Parallelism Deviation (°)	$\leq 0.001$ in.	$\leq 0.001$ in.	$\leq 0.001$ in.	$\leq 0.001$ in.	$\leq 0.25^\circ$
Maximum Load (lbs):	16,938	39,704	15,844	11,941	
Area (in <sup>2</sup> ):	3.05	3.11	3.08	3.08	
Compressive Strength (psi):	5,550	12,770	5,140	3,880	
Compressive Strength (MPa):	38	87	35	26	

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**Remarks:**

Location 77-C  
Sample 112-113 was sulfur capped for testing purposes

Reviewed By:  
David Morrison

Project Manager



Braun Intertec Corporation  
4511 West First Street, Suite 4  
Duluth, MN 55807

Phone: 218.624.4967  
Fax: 218.624.0196  
Web: braunintertec.com

**Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core  
Specimens under Varying States of Stress and Temperatures (Method C)  
ASTM D 7012**

**Date:** July 16, 2020

**Project Number:** B2001991

**Client:** Accounts Payable  
Enbridge Energy, Limited Partnership  
5400 Westheimer Ct  
Houston, TX 77056

**Project Description:**  
Enbridge Line 5 Re-route

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**Sample Data**

Date Sampled: Not Given  
Samples Obtained By: Braun  
Date Received: 7/10/2020  
Sample Preparation: Trim and Polished

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**Laboratory Data**

ASTM D4543 Limits

Sample Number:	45-46	55-56	78-79	92-93	
Date Tested:					
Rock Type:	Andesite	Andesite	Basalt	Basalt	
Moisture Condition During Testing:	Dry	Dry	Dry	Dry	
Diameter (in.):	1.86	1.86	1.87	1.86	
Length (in.):	3.60	3.79	3.00	3.76	
Length-to-Diameter Ratio (L/D):	1.9	2.0	1.6	2.0	$2.0 \leq L/D \leq 2.5$
Side Tolerance, Maximum (in.)	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$ in.
End Tolerance, Maximum (in.)	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in.
Perpendicularity Deviation (°)	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.250^\circ$
Parallelism Deviation (°)	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.25^\circ$
Maximum Load (lbs):	42,156	47,618	5,224	12,079	
Area (in <sup>2</sup> ):	2.72	2.72	2.75	2.72	
Compressive Strength (psi):	15,500	17,510	1,900	4,440	
Compressive Strength (MPa):	105	119	13	30	

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**Remarks:**

Location 79-C-1

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Reviewed By:  
David Morrison

Project Manager





Braun Intertec Corporation  
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Duluth, MN 55807

Phone: 218.624.4967  
Fax: 218.624.0196  
Web: braunintertec.com

**Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core  
Specimens under Varying States of Stress and Temperatures (Method C)  
ASTM D 7012**

**Date:** July 29, 2020  
**Project Number:** B2001991  
**Client:** Accounts Payable  
Enbridge Energy, Limited Partnership  
5400 Westheimer Ct  
Houston, TX 77056  
**Project Description:**  
Enbridge Line 5 Re-route

**Sample Data**

Date Sampled: Not Given  
Samples Obtained By: Braun  
Date Received: 7/10/2020  
Sample Preparation: Trim and Polished

**Laboratory Data**

ASTM D4543 Limits

Sample Number:	102-103	115-116	128-129	139-140	
Date Tested:	7/16/2020	7/16/2020	7/16/2020	7/16/2020	
Rock Type:	Basalt	Andesite	Andesite	Andesite	
Moisture Condition During Testing:	Dry	Dry	Dry	Dry	
Diameter (in.):	1.86	1.87	1.87	1.96	
Length (in.):	3.60	3.79	4.16	4.11	
Length-to-Diameter Ratio (L/D):	1.9	2.0	2.2	2.1	$2.0 \leq L/D \leq 2.5$
Side Tolerance, Maximum (in.)	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$	$\leq 0.020$ in.
End Tolerance, Maximum (in.)	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in.
Perpendicularity Deviation (°)	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.250^\circ$
Parallelism Deviation (°)	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.001$ in	$\leq 0.25^\circ$
Maximum Load (lbs):	Untestable	30,046	75,003	45,924	
Area (in <sup>2</sup> ):	2.72	2.75	2.75	3.02	
Compressive Strength (psi):		10,930	27,270	15,210	
Compressive Strength (MPa):		74	185	103	

**Remarks:**

Location 79-C-1

Reviewed By:  
David Morrison

Project Manager