

Subsurface Investigation Report

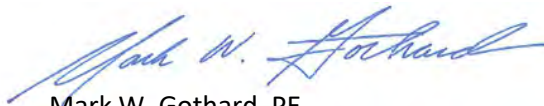
Enbridge Line 5 Reroute
MP 22 HDD Crossing – Krause Creek
Location 50-C-1, South of County Road C, North of Krause Creek
Location 52-C, West of Golf Course Road, South of Krause Creek
Ashland Town, Ashland County, Wisconsin

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.



Mark W. Gothard, PE
Senior Engineer
License Number: E-38488-6
August 19, 2020



Project B2001991

Braun Intertec Corporation

August 19, 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 22 HDD Crossing – Krause Creek
Location 50-C-1, South of County Road C, North of Krause Creek
Location 52-C, West of Golf Course Road, South of Krause Creek
Ashland Town, Ashland County, Wisconsin

Dear Mr. Erickson:

We are pleased to present this Subsurface Investigation Report for the Line 5 Reroute Project at the MP 22 HDD Crossing under Krause Creek in Ashland Town, Ashland 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) or David Morrison (dmorrison@braunintertec.com) at 218.624.4967.

Sincerely,

BRAUN INTERTEC CORPORATION



Kyle P. Warmuth
Staff Consultant



David E. Morrison
Project Consultant



Mark W. Gothard, PE
Senior Engineer

Table of Contents

Description	Page
A. Introduction.....	1
A.1. Project Description	1
A.2. Purpose.....	1
A.3. Background Information and Reference Documents.....	1
A.4. Scope of Services	2
B. Results	2
B.1. Geologic Overview	2
B.2. Geologic Materials.....	3
B.2.a. Soil and Bedrock Encountered	3
B.2.b. Bedrock.....	3
B.3. Estimated Soil Properties	3
B.4. Groundwater	4
B.5. Laboratory Test Results.....	4
C. Procedures.....	5
C.1. Penetration Test Borings	5
C.2. Rock Cores	5
C.3. Exploration Logs	5
C.3.a. Log of Boring Sheets.....	5
C.3.b. Logs of Coring.....	6
C.3.c. Geologic Origins	6
C.4. Material Classification and Testing	6
C.4.a. Visual and Manual Classification	6
C.4.b. Laboratory Testing	7
C.5. Groundwater Measurements.....	7
D. Qualifications.....	7
D.1. Variations in Subsurface Conditions.....	7
D.1.a. Material Strata	7
D.1.b. Groundwater Levels	7
D.2. Continuity of Professional Responsibility.....	8
D.2.a. Plan Review	8
D.2.b. Construction Observations and Testing	8
D.3. Use of Report.....	8
D.4. Standard of Care.....	8

Table of Contents (continued)

Appendix

Log of Boring Sheets 50-C-1 and 52-C

HDD Alignment Profile

Descriptive Terminology of Soil

Descriptive Terminology of Rock

Sieve Analysis Reports: 299989, 299992, 321588 through 321590

Moisture Content Reports: 299989, 299992, 321588 through 321590

Compressive Strength of Cores Reports: 50-C-1 Set 1(A&B), 52-C

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 factual data obtained at Borehole Locations 50-C-1 and 52-C for the HDD crossing under Krause Creek which is located at MP 22 in the proposed pipeline alignment in Ashland Town, Ashland County, Wisconsin.

A.2. Purpose

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

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 locations and we cleared the exploration locations of underground utilities. The Soil Boring Location Sketch included in the Appendix shows the approximate locations of the borings.
- Performing two (2) standard penetration test (SPT) borings with coring denoted as 50-C-1 and 52-C to nominal depths ranging from 124 1/2 to 126 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, exploration logs, laboratory tests, and 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 and Bedrock Encountered

The general geologic profile of the soils encountered between the two (2) borings consisted (proceeding down from the ground surface) of 1 foot of silty sand topsoil in both borings and 6 feet of fill in boring 52-C, underlain by layers of glacial deposits. The soils contained in the layers consisted of silty sands and poorly graded sands with silt to refusal on bedrock in each boring, 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

Below the glacial deposits, the borings encountered bedrock at approximate elevations ranging from 1247 to 1218 feet extending to the termination depths of the borings. The bedrock generally consisted of reddish brown with gray and white or grayish white granite associated with the Mellen Intrusive Complex.

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

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 (1263 1/2 to 1218)	Silty Sand (SM)	14	115 - 120	118 - 120	31	20	1.25	1.4 – 1.9	81 - 98
	Poorly Graded Sand with Silt (SP-SM)	7 - 55	87 - 120	105 - 127	32 - 40	32 - 36	0	0	49 - 396
Bedrock (1247 to 1145)	Granite	N/A	159 - 166	159 - 166	35 - 38	31 - 36	0	0	532,800 – 583,200

*Sustained Young's Modulus values

B.4. Groundwater

We encountered groundwater at a depth of 30 feet below the ground surface in Boring 52-C while advancing the borings.

We did not observe groundwater while advancing Boring 50-C-1. 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, 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

Project Number B2001991 Geotechnical Evaluation Enbridge Line 5 Re-Route Various Locations Ashland and Iron Counties, Wisconsin					BORING: 50-C-1					
					LOCATION: See attached sketch					
					LATITUDE: 46.35331		LONGITUDE: -90.68216			
DRILLER: M. Heinzen		LOGGED BY: S. Sullivan		START DATE: 02/19/20		END DATE:				
SURFACE ELEVATION: 1263.3 ft		RIG: 7505		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 _p tsf	MC %	Tests or Remarks			
1262.3		SILTY SAND (SM), fine to medium-grained Sand, with organic, black, moist (TOPSOIL)								
1.0		SILTY SAND (SM), fine to medium-grained Sand, brown, moist (GLACIAL TILL)								
1260.8		POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, with Gravel, brown, moist to wet, loose to very dense (GLACIAL OUTWASH)								
2.5			3-4-10 (14) 6"							
			10-14-41 (55) 13"							
			6-11-12 (23) 14"			21			Test results are in the attached lab report	
			4-8-11 (19) 13"							
			3-9-10 (19) 12"			15			Test results are in the attached lab report	
			4-4-3 (7) 4"						Drilling method switched to rock coring at 16 1/2 feet	
1246.8		MELLEN COMPLEX, GRANITE, grayish white with black, slightly weathered, medium-grained to coarse-grained, massive, moderately fractured							Run 1 MOH's = 8.5	
16.5		<i>Test results are in the attached lab report</i>								
			85	100	3	4650	20	100		
					3					
					2					
					2					
					2					
			85	100	2	4650	20	100	Run 2 MOH's = 8.5	
					2					
					2					
					2					
1238.8		MELLEN COMPLEX, GRANITE, grayish white with black, slightly weathered, hard, medium-grained to coarse-grained, massive, moderately fractured							Run 3 MOH's = 8.5	
24.5			88	96	3	4650	20	100		
					3					
					3					
			88	96	3	4650	20	100		
					3					
					3					
					2					
Continued on next page				RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %	Remarks

Project Number B2001991 Geotechnical Evaluation Enbridge Line 5 Re-Route Various Locations Ashland and Iron Counties, Wisconsin					BORING: 50-C-1					
					LOCATION: See attached sketch					
					LATITUDE: 46.35331		LONGITUDE: -90.68216			
DRILLER: M. Heinzen		LOGGED BY: S. Sullivan		START DATE: 02/19/20		END DATE:				
SURFACE ELEVATION: 1263.3 ft		RIG: 7505		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	RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %	Remarks
1228.8 34.5		MELLEN COMPLEX, GRANITE, grayish white with black, slightly weathered, hard, medium- grained to coarse-grained, massive, moderately fractured <i>Test results are in the attached lab report</i>	35	88	96	3	4650	20	100	Run 4 MOH's = 8.5
						2				
						2				
						2				
1218.8 44.5		MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, hard, medium-grained to coarse-grained, massive, slightly fractured	40	100	100	2	4650	20	100	Run 5 MOH's = 8.5
						2				
						2				
						1				
1208.8 54.5		MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, hard, medium-grained to coarse-grained, massive, slightly fractured <i>Test results are in the attached lab report</i>	45	92	99	2	4650	20	100	Run 6 MOH's = 8.5
						3				
						4				
						4				
1208.8 54.5		MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, hard, medium-grained to coarse-grained, massive, slightly fractured <i>Test results are in the attached lab report</i>	50	92	99	5	4650	20	100	Run 7 MOH's = 8.5
						5				
						5				
						8				
1208.8 54.5		MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, hard, medium-grained to coarse-grained, massive, slightly fractured <i>Test results are in the attached lab report</i>	55	89	96	3	4650	20	100	Run 8 MOH's = 8.5
						2				
						3				
						3				
1208.8 54.5		MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, hard, medium-grained to coarse-grained, massive, slightly fractured <i>Test results are in the attached lab report</i>	60	89	96	3	5580	20	100	Run 9 MOH's = 8.5
						3				
						3				
						3				
1208.8 54.5		MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, hard, medium-grained to coarse-grained, massive, slightly fractured <i>Test results are in the attached lab report</i>	60	89	96	3	5580	20	100	Run 10 MOH's = 8.5
						3				
						3				
						3				
Continued on next page										

Project Number B2001991 Geotechnical Evaluation Enbridge Line 5 Re-Route Various Locations Ashland and Iron Counties, Wisconsin					BORING: 50-C-1					
					LOCATION: See attached sketch					
					LATITUDE: 46.35331		LONGITUDE: -90.68216			
DRILLER: M. Heinzen		LOGGED BY: S. Sullivan		START DATE: 02/19/20		END DATE:				
SURFACE ELEVATION: 1263.3 ft		RIG: 7505		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	RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %	Remarks
1188.8		MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, hard, medium-grained to coarse-grained, massive, slightly fractured	65	95	95	4	7900	20	100	Run 11 MOH's = 8.5
						4				
						4				
						1				
						2				
						2				
						3				
						2				
						1				
						2				
74.5		MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, hard, medium-grained to coarse-grained, massive, slightly fractured	70	95	95	3	7900	20	100	Run 12 MOH's = 8.5
						2				
						1				
						1				
						2				
						2				
						2				
						2				
						2				
						2				
1178.8		MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, hard, medium-grained to coarse-grained, massive, slightly fractured	75	96	99	2	7900	20	100	Run 13 MOH's = 8.5
						1				
						1				
						1				
						2				
						2				
						2				
						2				
						2				
						2				
84.5		MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, hard, medium-grained to coarse-grained, massive, slightly fractured	80	96	99	2	7900	20	100	Run 14 MOH's = 8.5
						2				
						2				
						2				
						2				
						2				
						2				
						2				
						2				
						2				
1168.8		MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, hard, medium-grained to coarse-grained, massive, slightly fractured	85	91	100	2	7900	20	100	Run 15 MOH's = 8.5
						1				
						1				
						1				
						2				
						2				
						2				
						2				
						2				
						2				
94.5		MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, moderately hard,	90	91	100	2	7900	20	100	Run 16 MOH's = 8.5
						2				
						2				
						2				
						1				
						2				
						2				
						2				
						2				
						2				
		MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, moderately hard,	95			2				Run 17 MOH's = 8.5
Continued on next page										

Project Number B2001991 Geotechnical Evaluation Enbridge Line 5 Re-Route Various Locations Ashland and Iron Counties, Wisconsin					BORING: 50-C-1					
					LOCATION: See attached sketch					
					LATITUDE: 46.35331		LONGITUDE: -90.68216			
DRILLER: M. Heinzen		LOGGED BY: S. Sullivan			START DATE: 02/19/20		END DATE:			
SURFACE ELEVATION: 1263.3 ft		RIG: 7505		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	RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %	Remarks
1158.8 104.5		MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, moderately hard, medium-grained to coarse-grained, massive, slightly fractured		92	96	1	7900	20	100	Run 18 MOH's = 8.5
						1				
						2				
						2				
				92	96	2	7900	20	100	
						2				
						1				
						2				
		97	98	2	7900	20	100			
				1						
				2						
				2						
MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, hard, medium-grained to fine-grained, massive, slightly fractured		97	98	2	7900	20	100	Run 19 MOH's = 8.5		
				1						
				2						
				2						
		97	98	3	7900	20	100			
				2						
				2						
				1						
MELLEN COMPLEX, GRANITE, grayish white with black, unweathered, hard, medium-grained to fine-grained, massive, slightly fractured		91	99	2	7900	20	100	Run 21 MOH's = 8.5		
				2						
				2						
				2						
		91	99	2	7900	20	100			
				2						
				2						
				3						
END OF CORING		125								
Boring immediately backfilled with bentonite grout										

Project Number B2001991 Geotechnical Evaluation Enbridge Line 5 Re-Route Various Locations Ashland and Iron Counties, Wisconsin					BORING: 52-C	
					LOCATION: See attached sketch	
					LATITUDE: 46.35153	LONGITUDE: -90.68057
DRILLER: EPC		LOGGED BY: P. Moe		START DATE: 06/19/20	END DATE: 07/01/20	
SURFACE ELEVATION: 1261.2 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 _p tsf	MC %	Tests or Remarks
1260.2		SILTY SAND with GRAVEL (SM), fine to medium-grained, trace organic, brown, moist (TOPSOIL) FILL: SILTY SAND with GRAVEL (SM), fine to medium-grained, brown, moist		1-2-3-7 (5) 12"			Test results are in the attached lab report Drilling method switched to mud rotary at 12 feet, switched to 4 1/4 inch auger at 20 feet due to rocks and then mud rotary at 30 feet
1.0				3-7-8-6 (15) 14"			
			5	6-11-14-12 (25) 10"			
1255.2		POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, with Gravel, brown, moist, medium dense to very dense (GLACIAL OUTWASH)		12-17-25-11 (42) 12"		6	
6.0			10	15-12-9-8 (21) 14"			
				7-10-11-11 (21) 12"			
			15	8-9-8-5 (17) 10"			
				4-7-10-7 (17) 10"			
			20	13-16-15-14 (31) 3"			
			25	6-8-9-11 (17) 12"			
			30	5-7-8-8 (15) 12"		15	
							Test results are in the attached lab report

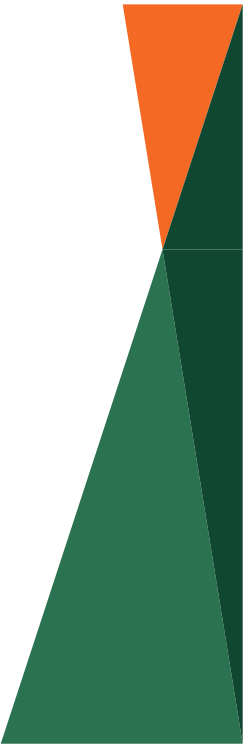
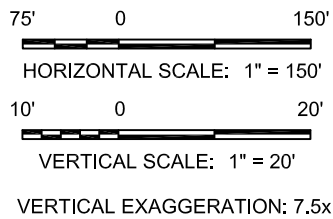
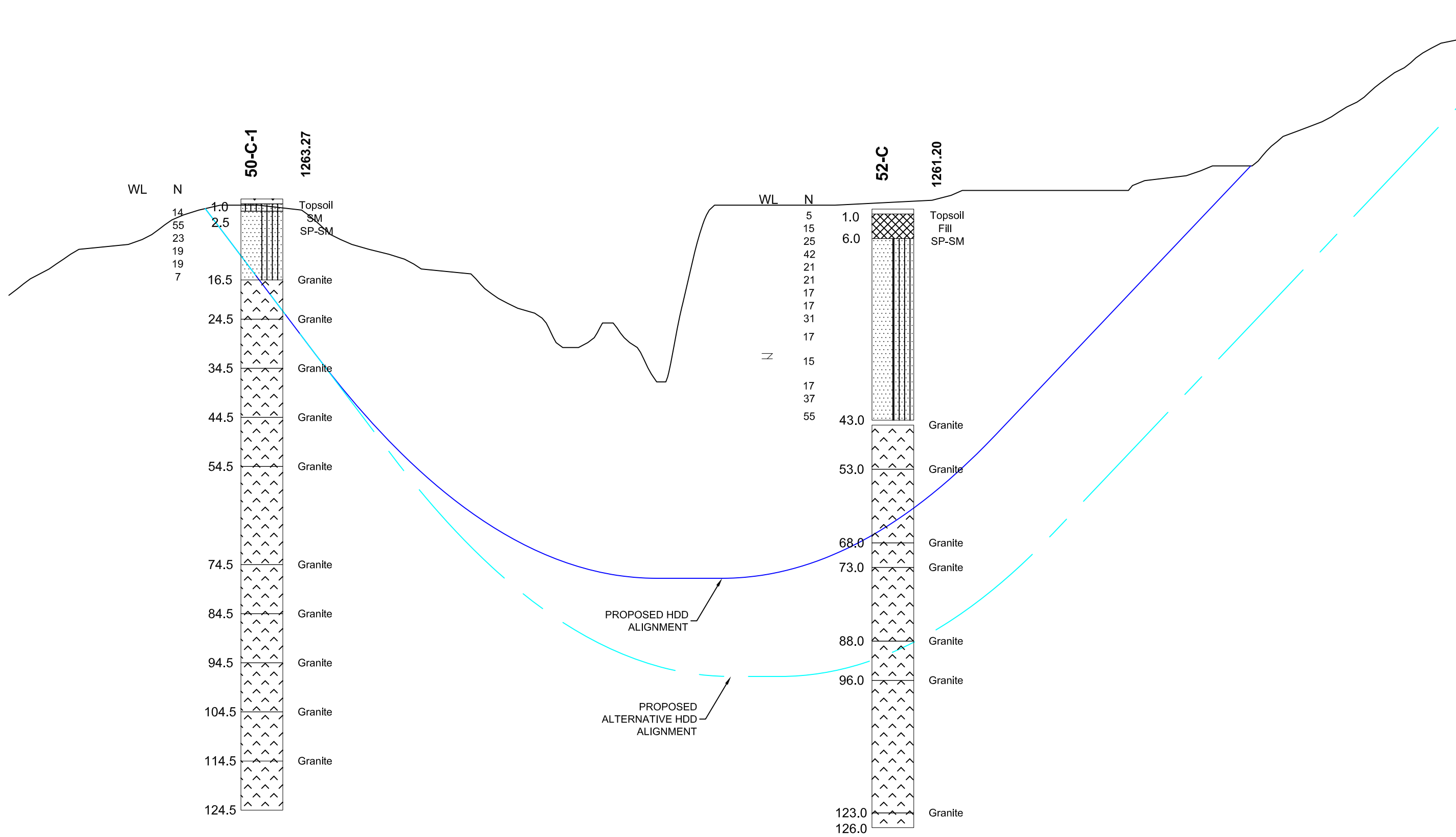
Continued on next page

Project Number B2001991 Geotechnical Evaluation Enbridge Line 5 Re-Route Various Locations Ashland and Iron Counties, Wisconsin					BORING: 52-C					
					LOCATION: See attached sketch					
					LATITUDE: 46.35153		LONGITUDE: -90.68057			
DRILLER: EPC		LOGGED BY: P. Moe		START DATE: 06/19/20		END DATE: 07/01/20				
SURFACE ELEVATION: 1261.2 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 _p tsf	MC %	Tests or Remarks			
1218.2 43.0		POORLY GRADED SAND with SILT (SP-SM), fine to medium-grained, with Gravel, brown, moist, medium dense to very dense (GLACIAL OUTWASH)	35 40	12-9-8-7 (17) 10" 4-18-19-19 (37) 14" 12-18-37-50/ 1" (55) 12"		15	Test results are in the attached lab report Auger met refusal at 43 feet. Drilling method switched to rock coring at 44 feet.			
1208.2 53.0		MELLEN INTRUSIVE COMPLEX, GRANITE, reddish brown with gray, moderately weathered, hard, fine-grained to medium-grained, massive, highly fractured	45 50	45 80 45 100			Run 1 MOHs 5 Run 2 MOHs 5			
1193.2 68.0		MELLEN INTRUSIVE COMPLEX, GRANITE, reddish brown with gray, moderately weathered, hard, fine-grained to medium-grained, massive, moderately fractured	55 60 65	100 100 80 100 100 100 100 100			Run 3 MOHs 5 Run 4 MOHs 5 Run 5 MOHs 5 Run 6 MOHs 5			
Continued on next page				RQD %	Recovery %	Drilling Rate (min/ft)	Bit Pressure (psi)	Water Pressure (psi)	Water Return %	Remarks

Project Number B2001991 Geotechnical Evaluation Enbridge Line 5 Re-Route Various Locations Ashland and Iron Counties, Wisconsin					BORING: 52-C					
					LOCATION: See attached sketch					
					LATITUDE: 46.35153		LONGITUDE: -90.68057			
DRILLER: EPC		LOGGED BY: P. Moe			START DATE: 06/19/20		END DATE: 07/01/20			
SURFACE ELEVATION: 1261.2 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
1188.2		MELLEN INTRUSIVE COMPLEX, GRANITE, reddish brown with gray, moderately weathered, hard, fine-grained to medium-grained, massive, highly fractured	70	55	100					Run 7 MOHs 5.5
73.0		MELLEN INTRUSIVE COMPLEX, GRANITE, reddish gray with whitish black, slightly weathered, hard, fine-grained to medium- grained, massive, highly fractured	75	100	100					Run 8 MOHs 5.5
			80	100	100					Run 9 MOHs 5.5
				90	100					Run 10 MOHs 5.5
				85	100					Run 11 MOHs 5.5
1173.2			85	85	100					Run 12 MOHs 5.5
88.0		MELLEN INTRUSIVE COMPLEX, GRANITE, dark gray with white, slightly weathered, moderately hard, fine-grained to medium- grained, massive, highly fractured	90	40	100					Run 13 MOHs 3.5
			95	90	100					Run 14 MOHs 3.5
1165.2		MELLEN INTRUSIVE COMPLEX, GRANITE, reddish gray with whitish black, slightly weathered, hard, fine-grained to medium- grained, massive, highly fractured	100	95	100					Run 15 MOHs 5.5
96.0										
Continued on next page										

Project Number B2001991 Geotechnical Evaluation Enbridge Line 5 Re-Route Various Locations Ashland and Iron Counties, Wisconsin					BORING: 52-C					
					LOCATION: See attached sketch					
					LATITUDE: 46.35153		LONGITUDE: -90.68057			
DRILLER: EPC		LOGGED BY: P. Moe			START DATE: 06/19/20		END DATE: 07/01/20			
SURFACE ELEVATION: 1261.2 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
		MELLEN INTRUSIVE COMPLEX, GRANITE, reddish gray with whitish black, slightly weathered, hard, fine-grained to medium- grained, massive, highly fractured	105	100	100					Run 16 MOHs 5.5
				85	100					Run 17 MOHs 5.5
				110	85	100				Run 18 MOHs 5.5
					95	100				Run 19 MOHs 5.5
				115	100	100				Run 20 MOHs 5.5
1138.2			120	75	100					Run 21 MOHs 5.5
123.0		MELLEN INTRUSIVE COMPLEX, GRANITE, reddish gray with white, slightly weathered, moderately hard, fine-grained to medium- grained, massive, moderately fractured	125	100	100					Run 22 MOHs 5.5
1135.2		END OF CORING								Water observed at 30.0 feet while drilling.
126.0		Boring then backfilled with cement/bentonite grout								

F:\2020\B2001991\CAD\MP 22 Krause Creek\B2001991_MP22_KRAUSE-CREEK.dwg, Bland, 8/11/2020 5:10:29 PM



Drawing Information

Project No:
B2001991

Drawing No:
B2001991_MP22_KRAUSE-CREEK
Drawn By: BJB
Date Drawn: 7/22/20
Checked By: DM
Last Modified: 8/11/20

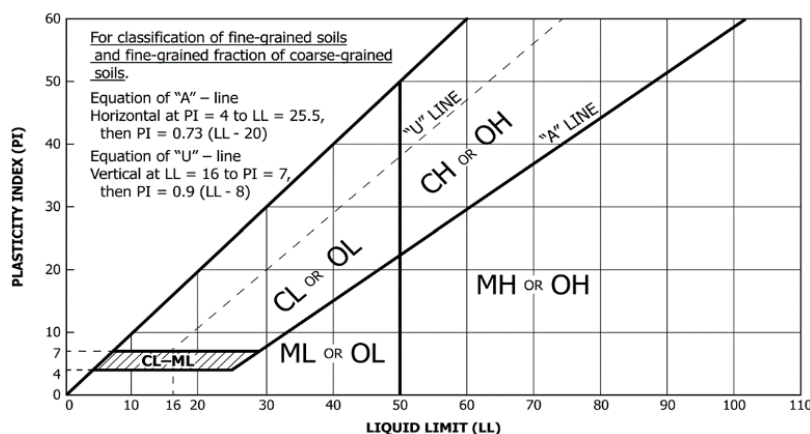
Project Information

Enbridge Line 5 Re-route

**MP 22 - Krause
Creek Crossing**

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



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^{L, M}

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.

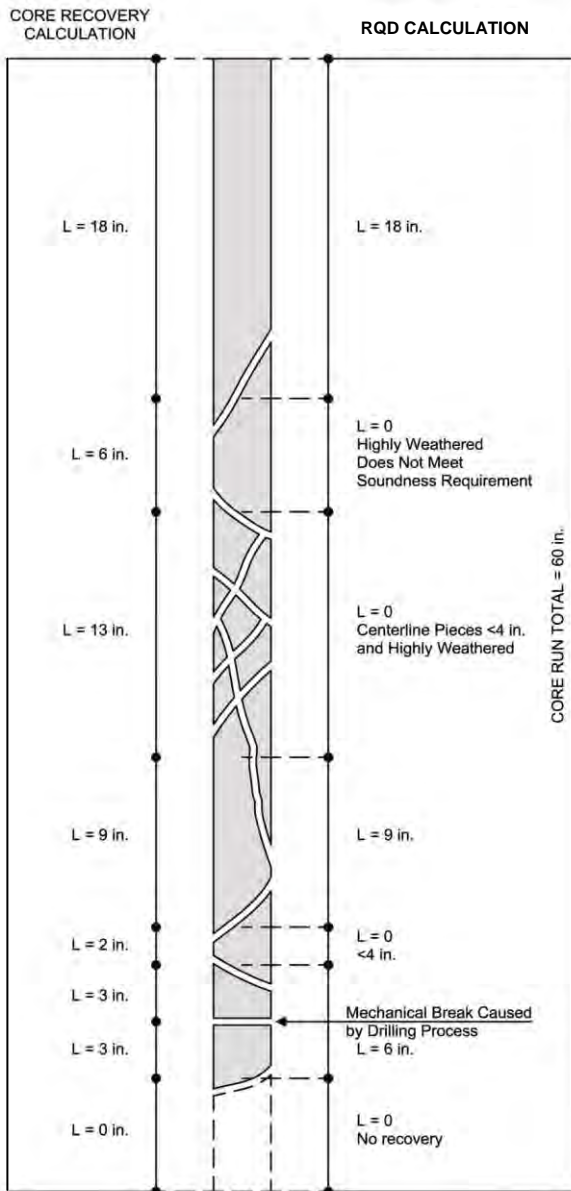
Partial Penetration: If the sampler could not be driven through a full 6-inch interval, the number of blows for that partial penetration is shown as #/x" (i.e. 50/2"). The N-value is reported as "REF" indicating refusal.

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
<Blank>, <Blank>

Sample Information

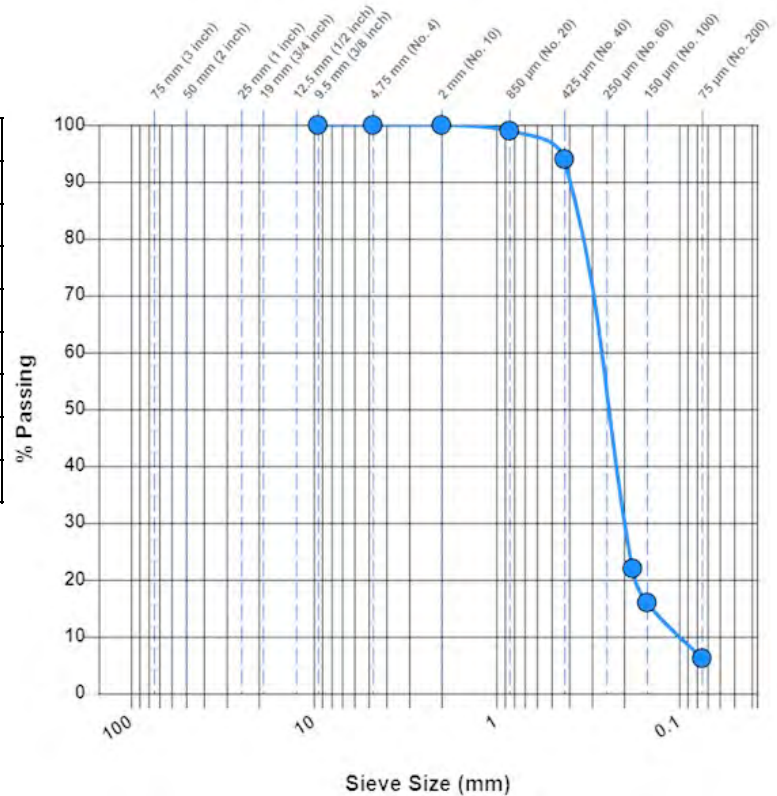
Sample Number: 299989 **Alternate ID:** 50-C-1 7.5'-10'
Sampling Method: Auger Boring ASTM D1452 **Depth (ft):** 7.5-10
Boring Number: 50-C-1 **Sampled By:** Patterson, Gregg
Location: In-place
Location Details: Boring 50-C-1 7.5' - 10'
Sample Date: 03/31/2020
Received Date: 03/31/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN
Tested Date: 04/01/2020

Laboratory Data

Sieve Size	% Passing	Specification
9.5 mm (3/8 inch)	100	
4.75 mm (No. 4)	100	
2 mm (No. 10)	100	
850 µm (No. 20)	99	
425 µm (No. 40)	94	
180 µm (No. 80)	22	
150 µm (No. 100)	16	
75 µm (No. 200)	6.2	

Test Method: Method A (Composite Sieving)

Specimen Obtained: Oven Dry



Classification: SP-SM Poorly graded sand with silt

General

Results: The test is for informational purposes.

[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
<Blank>, <Blank>

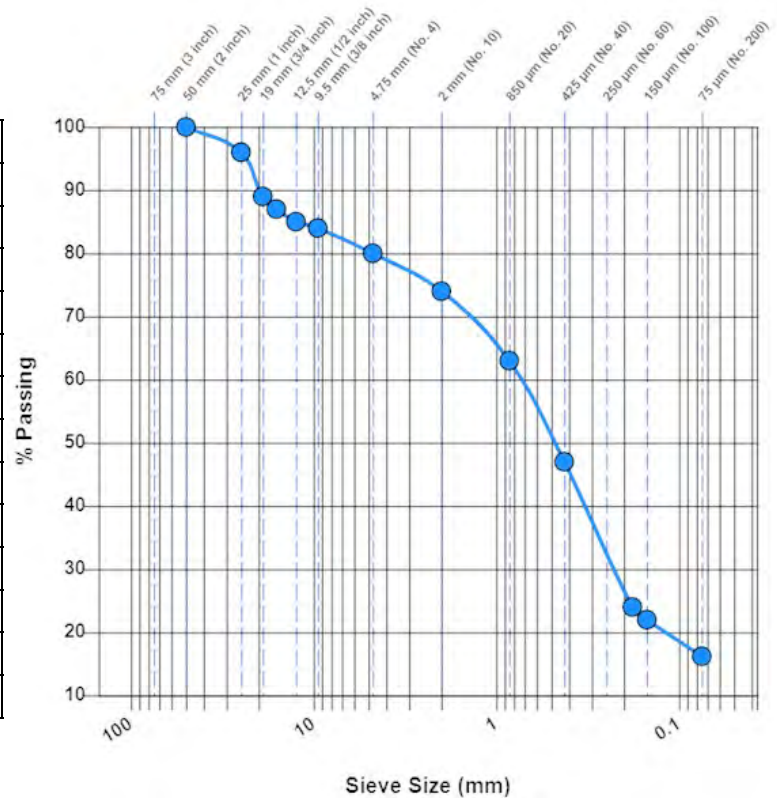
Sample Information

Sample Number: 299992 **Alternate ID:** 50-C-1 12.5' - 15'
Sampling Method: Auger Boring ASTM D1452 **Depth (ft):** 12.5'-15'
Boring Number: 50-C-1 **Sampled By:** Patterson, Gregg
Location: In-place
Location Details: Boring 50-C-1 12.5'-15'
Sample Date: 03/31/2020
Received Date: 03/31/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN
Tested Date: 04/01/2020

Laboratory Data

Sieve Size	% Passing	Specification
50 mm (2 inch)	100	
25 mm (1 inch)	96	
19 mm (3/4 inch)	89	
16 mm (5/8 inch)	87	
12.5 mm (1/2 inch)	85	
9.5 mm (3/8 inch)	84	
4.75 mm (No. 4)	80	
2 mm (No. 10)	74	
850 µm (No. 20)	63	
425 µm (No. 40)	47	
180 µm (No. 80)	24	
150 µm (No. 100)	22	
75 µm (No. 200)	16.2	

Test Method: Method A (Composite Sieving)
Specimen Obtained: Oven Dry
Classification: SM Silty sand with gravel



General

Results: The test is for informational purposes.

[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:	321588	Alternate ID:	52-C 5 9.5'
Sampling Method:	Auger Boring ASTM D1452	Depth (ft):	9.5
Boring Number:	52-C	Sampled By:	Drill Crew
Location:	In-place		
Location Details:	Boring 52-C Sample 5 9.5'		
Sample Date:	06/19/2020		
Received Date:	07/13/2020	Lab:	4511 West First Street, Suite 4, Duluth, MN
Tested Date:	07/15/2020	Tested By:	Nelson, Brennan

Laboratory Data

Sieve Size	Passing (%)	Specification
19 mm (3/4 inch)	100.0	
12.5 mm (1/2 inch)	94.2	
9.5 mm (3/8 inch)	91.3	
4.75 mm (No. 4)	80.1	
2 mm (No. 10)	68.1	
850 µm (No. 20)	52.8	
425 µm (No. 40)	26.4	
150 µm (No. 100)	14.1	
75 µm (No. 200)	10.7	

Gravel (%)

19.9

Sand (%)

69.4

Silt & Clay (%)

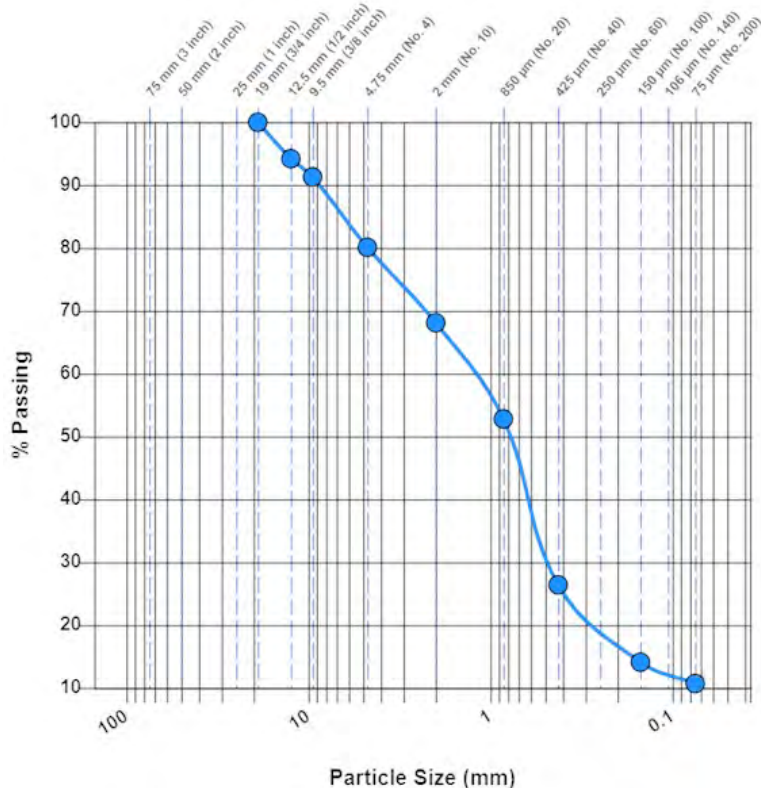
10.7

D30

0.483

D60

1.391



Classification: SP-SM Poorly graded sand with silt and 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 292.4 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:	321589	Alternate ID:	52-C 11 30'
Sampling Method:	Auger Boring ASTM D1452	Depth (ft):	30
Boring Number:	52-C	Sampled By:	Drill Crew
Location:	In-place		
Location Details:	Boring 52-C Sample 11 30'		
Sample Date:	06/19/2020		
Received Date:	07/13/2020	Lab:	4511 West First Street, Suite 4, Duluth, MN
Tested Date:	07/15/2020	Tested By:	Nelson, Brennan

Laboratory Data

Sieve Size	Passing (%)	Specification
19 mm (3/4 inch)	100.0	
12.5 mm (1/2 inch)	84.9	
9.5 mm (3/8 inch)	81.3	
4.75 mm (No. 4)	71.2	
2 mm (No. 10)	57.7	
850 µm (No. 20)	39.3	
425 µm (No. 40)	21.2	
150 µm (No. 100)	13.5	
75 µm (No. 200)	9.7	

Gravel (%)

28.8

Sand (%)

61.5

Silt & Clay (%)

9.7

D10

0.077

D30

0.632

D60

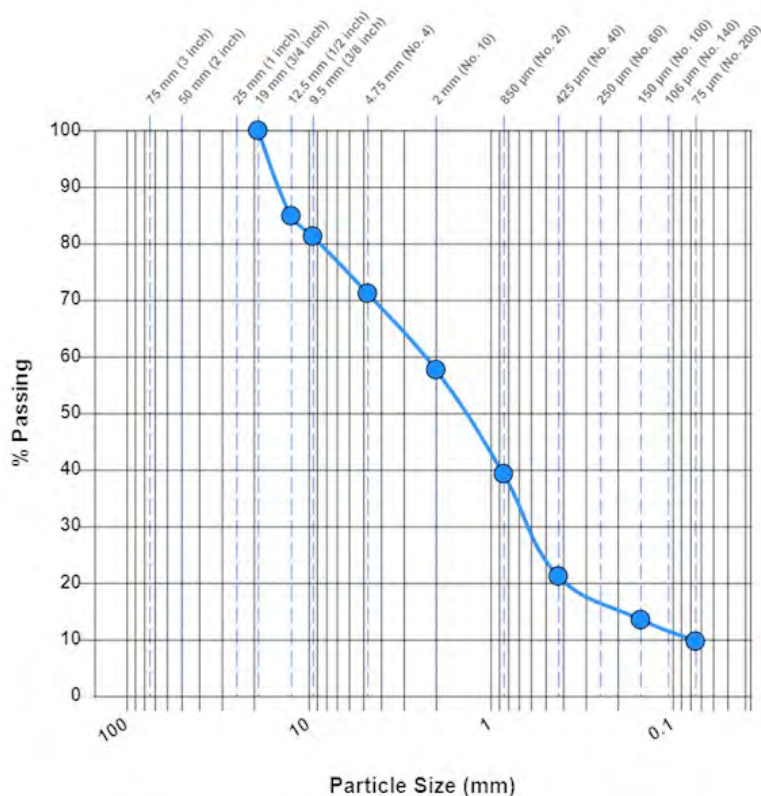
2.469

C_u

32.06

C_c

2.10



Classification: SP-SM Poorly graded sand with silt and 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 316.6 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

Sample Number:	321590	Alternate ID:	52-C 12 37'
Sampling Method:	Auger Boring ASTM D1452	Depth (ft):	37
Boring Number:	52-C	Sampled By:	Drill Crew
Location:	In-place		
Location Details:	Boring 52-C Sample 12 37'		
Sample Date:	06/19/2020		
Received Date:	07/13/2020	Lab:	4511 West First Street, Suite 4, Duluth, MN
Tested Date:	07/15/2020	Tested By:	Nelson, Brennan

Laboratory Data

Sieve Size	Passing (%)	Specification
19 mm (3/4 inch)	100.0	
12.5 mm (1/2 inch)	95.5	
9.5 mm (3/8 inch)	90.9	
4.75 mm (No. 4)	84.9	
2 mm (No. 10)	76.0	
850 µm (No. 20)	65.6	
425 µm (No. 40)	50.6	
150 µm (No. 100)	19.9	
75 µm (No. 200)	14.9	

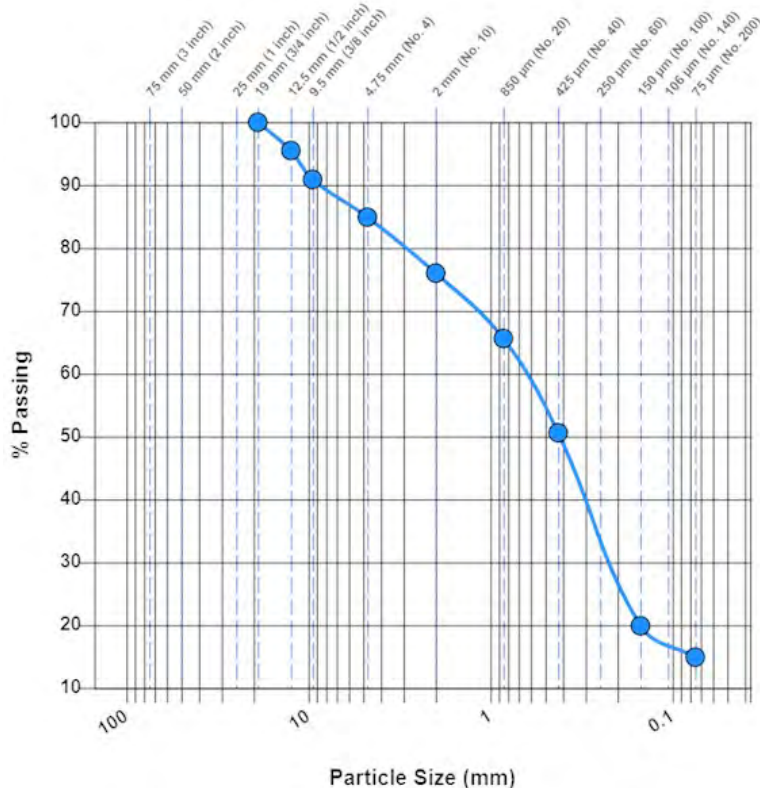
Gravel (%)
15.1

Sand (%)
70.0

Silt & Clay (%)
14.9

D30
0.183

D60
0.691



Classification: SP-SM Poorly graded sand with silt and 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 330.1 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
<Blank>, <Blank>

Sample Information

Sample Number: 299992 **Alternate ID:** 50-C-1 12.5' - 15'
Sampling Method: Auger Boring ASTM D1452 **Sampled By:** Patterson, Gregg
Location: In-place
Location Details: Boring 50-C-1 12.5'-15'
Sample Date: 03/31/2020
Received Date: 03/31/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN
Tested Date: 04/01/2020 **Tested By:** Patterson, Gregg

Laboratory Data

Boring #	Sample #	Depth (ft)	Moisture Content (%)
50-C-1		14.0	15.0

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
<Blank>, <Blank>

Sample Information

Sample Number: 299989 **Alternate ID:** 50-C-1 7.5'-10'
Sampling Method: Auger Boring ASTM D1452 **Sampled By:** Patterson, Gregg
Location: In-place
Location Details: Boring 50-C-1 7.5' - 10'
Sample Date: 03/31/2020
Received Date: 03/31/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN
Tested Date: 04/01/2020 **Tested By:** Patterson, Gregg

Laboratory Data

Boring #	Sample #	Depth (ft)	Moisture Content (%)
50-C-1		9.0	21.4

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: 321589 **Alternate ID:** 52-C 11 30'
Sampling Method: Auger Boring ASTM D1452 **Sampled By:** Drill Crew
Location: In-place
Location Details: Boring 52-C Sample 11 30'
Sample Date: 06/19/2020
Received Date: 07/13/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN
Tested Date: 07/14/2020 **Tested By:** Nelson, Brennan

Laboratory Data

Boring #	Sample #	Depth (ft)	Moisture Content (%)
52-C	11	30.0	14.6

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: 321590 **Alternate ID:** 52-C 12 37'
Sampling Method: Auger Boring ASTM D1452 **Sampled By:** Drill Crew
Location: In-place
Location Details: Boring 52-C Sample 12 37'
Sample Date: 06/19/2020
Received Date: 07/13/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN
Tested Date: 07/14/2020 **Tested By:** Nelson, Brennan

Laboratory Data

Boring #	Sample #	Depth (ft)	Moisture Content (%)
52-C	12	37.0	15.1

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: 321588 **Alternate ID:** 52-C 5 9.5'
Sampling Method: Auger Boring ASTM D1452 **Sampled By:** Drill Crew
Location: In-place
Location Details: Boring 52-C Sample 5 9.5'
Sample Date: 06/19/2020
Received Date: 07/13/2020 **Lab:** 4511 West First Street, Suite 4, Duluth, MN
Tested Date: 07/14/2020 **Tested By:** Nelson, Brennan

Laboratory Data

Boring #	Sample #	Depth (ft)	Moisture Content (%)
52-C	5	9.5	5.7

General

Results: The test is for informational purposes.





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: April 8, 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: 2/19/2020
Samples Obtained By: Braun
Date Received: 4/6/2020
Sample Preparation: Trim and Polished

Laboratory Data

ASTM D4543 Limits

Location: 50-C-1						
Sample Number:	17'-18'	33'-34'	54'-53'	73'-74'	93'-94'	
Date Tested:	4/7/2020	4/7/2020	4/7/2020	4/7/2020	4/7/2020	
Rock Type:	Granite	Granite	Granite	Granite	Granite	
Moisture Condition During Testing:	As Received	As Received	As Received	As Received	As Received	
Diameter (in.):	1.77	1.77	1.77	1.77	1.77	
Length (in.):	4.38	4.39	4.35	4.41	4.37	
Length-to-Diameter Ratio (L/D):	2.5	2.5	2.5	2.5	2.5	$2.0 \leq L/D \leq 2.5$
Side Tolerance, Maximum (in.)	≤ 0.020	≤ 0.020	≤ 0.020	≤ 0.020	≤ 0.020	≤ 0.020 in.
End Tolerance, Maximum (in.)	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in.
Perpendicularity Deviation (°)	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	$\leq 0.250^\circ$
Parallelism Deviation (°)	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	$\leq 0.25^\circ$
Maximum Load (lbs):	61,160	59,920	69,560	61,030	60,130	
Area (in ²):	2.46	2.46	2.46	2.46	2.46	
Compressive Strength (psi):	24,860	24,360	28,280	24,810	24,440	
Compressive Strength (MPa):	169	165	192	168	166	

Remarks:

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: April 8, 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: 2/19/2020
Samples Obtained By: Braun
Date Received: 4/6/2020
Sample Preparation: Trim and Polished

Laboratory Data

ASTM D4543 Limits

Location:	50-C-1	
Sample Number:	112'-113'	121'-122'
Date Tested:	4/7/2020	4/7/2020
Rock Type:	Granite	Granite
Moisture Condition During Testing:	As Received	As Received
Diameter (in.):	1.77	1.76
Length (in.):	4.38	4.44
Length-to-Diameter Ratio (L/D):	2.5	2.5
Side Tolerance, Maximum (in.)	≤ 0.020	≤ 0.020
End Tolerance, Maximum (in.)	≤ 0.001 in	≤ 0.001 in
Perpendicularity Deviation (°)	≤ 0.001 in	≤ 0.001 in
Parallelism Deviation (°)	≤ 0.001 in	≤ 0.001 in
Maximum Load (lbs):	31,560	61,450
Area (in ²):	2.46	2.43
Compressive Strength (psi):	12,830	25,290
Compressive Strength (MPa):	87	172

Remarks: Sampe 112-113: Fracture occurred along an existing vein.

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:	44-45	57-58	70-71	82-83	
Date Tested:	7/16/2020	7/16/2020	7/16/2020	7/16/2020	
Rock Type:	Granite	Granite	Granite	Granite	
Moisture Condition During Testing:	Dry	Dry	Dry	Dry	
Diameter (in.):	1.96	1.98	1.97	1.96	
Length (in.):	4.59	4.61	4.43	4.95	
Length-to-Diameter Ratio (L/D):	2.3	2.3	2.2	2.5	$2.0 \leq L/D \leq 2.5$
Side Tolerance, Maximum (in.)	≤ 0.020	≤ 0.020	≤ 0.020	≤ 0.020	≤ 0.020 in.
End Tolerance, Maximum (in.)	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in.
Perpendicularity Deviation (°)	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	$\leq 0.250^\circ$
Parallelism Deviation (°)	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	$\leq 0.25^\circ$
Maximum Load (lbs):	60,731	43,024	42,071	112,059	
Area (in ²):	3.02	3.08	3.05	3.02	
Compressive Strength (psi):	20,110	13,970	13,790	37,110	
Compressive Strength (MPa):	137	95	94	252	

Remarks:

Location 52-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: 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:	94-95	106-107	116-117	125-126	
Date Tested:	7/16/2020	7/16/2020	7/16/2020	7/16/2020	
Rock Type:	Granite	Granite	Granite	Granite	
Moisture Condition During Testing:	Dry	Dry	Dry	Dry	
Diameter (in.):	1.98	1.97	1.98	1.97	
Length (in.):	3.28	3.86	4.07	4.20	
Length-to-Diameter Ratio (L/D):	1.7	2.0	2.1	2.1	$2.0 \leq L/D \leq 2.5$
Side Tolerance, Maximum (in.)	≤ 0.020	≤ 0.020	≤ 0.020	≤ 0.020	≤ 0.020 in.
End Tolerance, Maximum (in.)	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in.
Perpendicularity Deviation (°)	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	$\leq 0.250^\circ$
Parallelism Deviation (°)	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	≤ 0.001 in	$\leq 0.25^\circ$
Maximum Load (lbs):	18,401	49,058	52,625	74,179	
Area (in ²):	3.08	3.05	3.08	3.05	
Compressive Strength (psi):	5,970	16,080	17,090	24,320	
Compressive Strength (MPa):	41	109	116	165	

Remarks:

Location 52-C

Reviewed By:
David Morrison

Project Manager