Date: December 22, 2021 (Revision 4)

To: Minnesota Department of Natural Resources, Minnesota Department of Health

From: Enbridge Line 3 Replacement Team

Re: **MP1102.5 Revised Groundwater Investigation Plan**

This revised Groundwater Investigation Plan (GIP) outlines the completed and proposed work at nine (9) test boring locations for subsurface evaluation, groundwater pressure monitoring instrumentation installation, and perform test pumping along the alignment of the Line 3 Replacement Project (L3R or Project) near MP 1102.5, which is located south of US Highway 2 and east of Minnesota Highway 73 in St. Louis County, Minnesota. Five (5) of the test borings were previously advanced by Barr Engineering Co. in October and November 2021. The results of the investigation were submitted in a Groundwater Investigation Data Submittal dated November 7, 2021. Four (4) additional test borings are currently proposed.

This revised GIP is provided as a response to:

- conditions encountered in the field during initial plan implementation
- agency comments made after the November 7, 2021 data submittal
- subsequent correspondence with the Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, and the Minnesota Department of Health

The purpose of this memorandum is to provide an overview of the revised GIP goals and the additional investigation work proposed as a result of agency comments and correspondence.

Background

MP 1102.5 was a hydrostatic test break location and the trench remained open for several months. Sheet piling was necessary in this area to stabilize the trench during pipeline installation and safely complete testing and tie-in activities. Portions of the sheet piling through the area were installed in the winter months of 2020 and 2021 and were left in place until September 14, 2021. The depth of the trench was approximately 7 to 8 feet and the sheet piling near the seep locations was installed to a depth of approximately 22 to 23 feet. The extents of the sheet piling that was installed for L3R construction and removed on September 14, 2021 is shown on Figure 1.

Prior to the removal of the sheet piling, a total of 69,140 gallons of groundwater was pumped from this location between July 13, 2021 and September 7, 2021. There was no significant groundwater seepage noted at this location. During sheetpiling removal on September 14, 2021, groundwater flow was observed. To manage the groundwater flow, Enbridge has installed a temporary geotechnical fabric-lined and rock-filled channel in the approved workspace and along the location of the seeps.

A weir box was installed on September 26, 2021 and the measured flow was approximately 215 gallons per minute (GPM) and the flow since installation has been steadily declining. Enbridge has been reporting discharge quantities regularly since September 2021. The fluctuation in flow has been attributed to the

currently installed test borings, of which one has been completed as a dewatering well with an installed screen (MP1102-GIP-21-3), and another consists of an open casing which is being pumped (MP1102-GIP-21-2). Investigation at these locations was conducted as part of the GIP.

On September 29, 2021, the first geotechnical boring penetrated the confining layer of a gravelly aquifer at a depth of approximately 34.5 feet at boring location MP-1102.5-21-2. The boring was terminated at a depth of 39 feet due to high artesian flow rates within the installed 8-inch casing. The flow rate was initially estimated to be between 450 and 550 GPM and flowed for a period of about 90 minutes in which approximately 42,000 gallons of water was transferred to onsite tanks through pumps.

Borings MP1102-GIP-21-1 and MP1102-GIP-21-5 were terminated in the confining layer and did not penetrate the confining layer into the confined aquifer due to challenges encountered at the other borings with maintaining well casing seal integrity. Boring MP1102-GIP-21-4 was completed through the confining layer to a total depth of 50 feet. The confined aquifer was encountered between a depth of 30 to 34 feet. The boring was completed as a 6-inch diameter well. The flow rate was estimated at 150 GPM. Due to concerns with well casing integrity, MP1102-GIP-21-4 was abandoned by means of grouting and complete removal in accordance with Minnesota Department of Health requirements. Boring MP1102-GIP-21-3 was completed to a depth of 60 feet with the confined aquifer encountered between a depth of 35 to 49 feet. The boring was completed as a 6-inch diameter screened well. A 25-horsepower submersible pump was installed to reduce local head pressure with initial pumped flow rates measured at about 400-450 GPM.

Investigation scope

Enbridge's proposed scope of work includes the advancement of a minimum of four (4) additional borings in addition to the five (5) previously advanced borings near the L3R pipeline alignment. The five previously advanced borings were conducted near the seeps observed at sheet pile installations that were made as part of the L3R construction, as shown in Figure 1. The proposed borings are further from the seep area with the intention of evaluating groundwater and subsurface conditions in the general area and to perform pump tests to evaluate aquifer characteristics.

One additional boring (MP1102-GIP-21-6) is proposed north of the sheet pile seep area to better evaluate groundwater flow. Three other investigation locations, MP1102-GIP-21-2A, MP1102-CAP-6, and MP1102-CAP-9 are proposed to be completed as wells for the purpose of test pumping in areas where potential dewatering may be required to implement the Corrective Action Plan.

To accomplish this work, a revised geotechnical drilling approach is required to manage the encountered head and potential flow conditions. This revised approach has been developed through conversations with Traut Companies, a licensed well drilling firm that has extensive experience drilling in artesian conditions, and the Minnesota Department of Health Well Management Section.

As described in subsequent sections, each of the additional borings are planned to collect subsurface stratigraphy information and be constructed to install instrumentation to allow groundwater pressures to be measured and recorded. Additionally, the four additional borings will be constructed as wells to allow a temporary dewatering pump test to be performed for water management planning during the remediation process.

The instrumentation will be installed on the casing and well screen prior to any dewatering and will be placed in each boring when head conditions allow, to evaluate sealing options and to monitor groundwater pressure over time.

Soil Boring and Pressure Monitoring Locations

The existing and proposed soil boring locations and depths are outlined in Table 1 and are shown on the attached Figure 1.

Table 1 Soil Boring Location Summary

Borehole ID	Borehole Status	Boring Depth* (ft)	Boring Use	Sampling
MP1102-GIP-21-1	Completed	15.0	Define soil type and lithology, and install instrumentation for groundwater pressure measurements, perform temporary pump testing for dewatering design	Continuous, minimally disturbed samples using rotosonic drilling methods
MP1102-GIP-21-2	Completed	40.0		
MP1102-GIP-21-3	Completed	60.0		
MP1102-GIP-21-4	Completed	50.0		
MP1102-GIP-21-5	Completed	11.0		
MP1102-GIP-21-6	Proposed	60.0 (Approx)		
MP1102-GIP-21-2A	Proposed	50.0 (Approx)		
MP1102-CAP-6	Proposed	50.0 (Approx)		
MP1102-CAP-9	Proposed	50.0 (Approx)		

*the termination depth will be to the depth required to fully penetrate the confined aquifer

Revised Drilling Approach

Based on a review of the existing boring logs and observations made during construction, there is a high probability that there will be pressurized flow at each proposed boring location. The soil boring logs for the completed work are included in Attachment 1.

Traut, a licensed contractor with experience managing artesian conditions will continue to be retained to complete the borings in accordance with Minnesota Rules, part 4725.3450 (Flowing Well or Boring). Any additives used during the boring construction will be products that are currently approved for use on L3R and approved by the Minnesota Department of Health.

The locations of the four proposed borings were selected based on comments received from the agencies during their review of the Corrective Action Plan, email correspondence, phone conversations, as well as considering spatial distribution and relative position to the groundwater expressions and selecting locations that are physically able to be accessed for the investigative work. Investigation location MP1102-GIP-21-2A is proposed to allow abandonment of existing well MP1102-GIP-21-2, as that well is showing signs of leakage around the well casing. The locations of the five completed borings and the four proposed borings are shown on Figure 1.

Due to the fact that drilling fluids cannot be mixed to a weight that can be effectively used in a mud-rotary drill to penetrate the confining layer to overcome the encountered head, this revised plan utilizes fully grouted cased holes set with a large rotary rig into the top of the confining layer and with rotosonic

drilling techniques into and through the confined aquifer. The confining layer above the confined aquifer is predominately made up of silt and sandy silt which is susceptible to liquefaction and has a lower undrained shear strength than a clay confining layer. To mitigate the risk of disturbance to the confining layer, the confining layer will be improved/replaced with concrete grout prior to the installation of the proposed borings. The improvement process will include drilling a 6.5-foot diameter shaft at each boring location. The shaft will be constructed by a specialty contractor under the review of a licensed well driller using a specialty-built drill rig such as a Liebherr LB45, which is shown in Photo 1. The specialty caisson drill rig can auger downwards while also advancing a large diameter temporary steel casing to maintain hole stability. This temporary steel casing will extend upwards of 10 to 20 feet above ground level and will be filled with drilling fluid to overcome the hydrostatic pressures of the artesian formation should it be encountered while drilling the temporary casing into place.

Photo 1 Liebherr LB45 Caisson Drill Rig (sample photograph)

The caisson drill rig will advance the 6.5-foot diameter auger and temporary steel casing to a depth of about 18 to 20 feet. The actual depth will be adjusted in the field based on observations of soil cuttings during advancement. The auger will remove soil and mix the soil with a weighted drilling fluid. Once the drilled excavation is cleaned and prepared (while always filled with drilling fluid), an 18-inch diameter steel casing will be installed down the center of the excavation and stabilized by pressing it approximately 6 inches into the undisturbed soil at the base of the excavation. The 18-inch casing will have a flanged base to minimize bearing penetration. The 18-inch steel casing will be filled with drilling fluid and sealed to prevent concrete or sand-cement grout from entering. A specialized stabilization jig attached to the large caisson rig will be inserted into the 18-inch casing to prevent the casing from shifting during the tremie operation.

A sand-cement grout, or if approved through a MDH variance, a concrete mix, will then be pumped by tremie to the bottom of the excavation. The significant difference in density between the drilling fluid and the sand-cement grout or the concrete mix will cause displacement of the drilling fluid to the surface. The sand-cement grout or concrete will be lightly vibrated to reduce the potential for any drilling fluid entrapment. Displaced drill fluid will be collected at the ground surface in either a sump and pumped or directly pumped from the temporary 6.5-foot diameter casing to temporary onsite storage for off-site disposal.

The 6.5-foot diameter temporary steel casing will be removed as the sand-cement grout or concrete is placed by tremie in a manner that retracts the casing prior to cement gelling to utilize internal head within the casing to press the grout or concrete to the excavation base and sidewalls to form a seal. The sand-cement grout or concrete will be allowed to cure for a minimum of 24 hours prior to continuation of the boring. Figure 3 provides a plot of the applied pressures during each phase of construction of the caisson and shows the pressures at each depth during caisson construction. The resulting change in effective stress at a depth of 20 feet is the difference in unit weight of soil and concrete, which were assumed to be 120 and 145 pounds per cubic foot, respectively, for a net increase in effective stress at the base of the caisson of 500 psf. If the confining layer is assumed to be at least 10 feet thick below the caisson, the stress is reduced to 15% of the applied stress at the base of the caisson, or 75 psf.

Activities to complete the installation of the four proposed borings are included in this plan revision. A cross section of the proposed well construction is included in Figure 2.

Completion of the four proposed borings will be performed in the following sequence for each location:

1. The top of the confining layer will be estimated by reviewing logs from the previously completed borings on site with consideration made for the closest boring(s).

    a. Due to the location of proposed boring MP1102-GIP-21-6 being quite distant from any other borings, the top of the confining layer will be first verified in field through advancement of a soil boring.

    b. The soil boring at location MP1102-GIP-21-6 will be terminated once the top of the confining layer is identified.

2. At each of the proposed boring locations, a 6.5-foot diameter sand-cement grout or concrete column will be installed to a depth of about 20-25 feet to improve the top of the confining layer and to provide a seal for the subsequent casings.

    a. The column would be excavated to depth by soil auguring and slurry mixing with a head of 10 or more feet of fluid above grade.

    b. An 18-inch steel liner will be set in the center of the column and stabilized with an internal jig attached to the drill rig.

    c. The 18-inch casing will temporarily extend approximately 30 inches above grade to allow drilling of subsequent casing.

    d. The drilling fluid mixture between the 18-inch casing and 6.5-foot diameter casing will be removed by tremie placing sand-cement grout or concrete at the base of the large casing and continuing the tremie process to the surface.

    e. This grout or concrete column will be allowed to cure for a minimum of 24 hours.

3. A mud-rotary drill rig will drill an 18-inch diameter hole within the previously placed 18-inch casing (set in the center of the concrete or grout column) and will extend the 12-inch casing to a minimum of 5 feet beyond the bottom of the 18-inch casing.

    a. The 18-inch casing will be cut approximately 3 to 6 inches above grade.

    b. A 12-inch casing will then be placed in the 18-inch hole and pressure grouted and allowed to cure for a minimum of 24 hours.

    c. The annulus between the 12-inch and 18-inch casings will be cement grouted to near the surface while the 12-inch casing is filled with weighted drilling fluid

    d. The 12-inch casing will be threaded or flanged at the top of the hole and project approximately 12 inches above grade.

    e. The 12-inch and 18-inch casings will be allowed to cure for 24 hours with high early strength cement grout to achieve a seal.

4. The rotosonic drilling process will then be conducted inside the 12-inch casing to penetrate the confining layer by advancing a 10-inch sonic liner with a modified bit.

    a. Crews will attempt to advance the liner with maximum downforce and minimal vibratory effort to minimize disturbance to the confining layer.

    b. Turbid water and drilling fluids coming up through the 12-inch casing and muddied water coming up the liner will be transferred to onsite tanks via pumps for off-site disposal.

c. Rotosonic drilling with 10-inch, 8-inch, and 6-inch liners and 4-inch sampling core will continue to a depth that penetrates the confined aquifer. This depth will be known by no longer observing flow up the 6-inch or 8-inch liner and/or by the core sample material.

5. The licensed well driller will then install a 6-inch diameter slotted metal well screen through the aquifer and solid metal riser to the ground surface.

    a. Due to the formation expected to be gravel and cobble, and anticipated groundwater pressures, installation of a sand pack around the screen is not likely possible. As a result, the screens will naturally pack.

    b. The screen size will be selected by the licensed well driller based on the encountered formation.

    c. The annulus between the riser and the 12-inch casing will be grouted.

    d. Following setting of the grout, an electric submersible pump will be installed in each well.

6. Upon construction, each well will be observed weekly to inspect the surface for seepage outside of the 6.5-foot diameter caisson and the 18-inch casing. Observations will be recorded and provided in a weekly inspection report to the Minnesota Department of Natural Resources and the Minnesota Department of Health.

Instrumentation

At each of the additional four proposed boring locations, vibrating wire (VW) piezometers will be installed to monitor the head pressures before, during, and after any pumping activity. One VW will be installed on the exterior near the tip of the 6-inch well screen. An additional VW piezometer will be installed on the exterior of the 12-inch casing within the confining layer. An additional VW will be installed on the drop pipe immediately above the submersible pump and one piezometer. These VW piezometers will be connected to a central data monitoring system.

In addition to the VWs, a manual pressure gage will be installed at each boring to measure piezometric head. Data will be recorded as raw measurements and converted to groundwater elevation. The data will be compared to the VW data in weekly data submittals.

A weather station has been installed to provide barometric corrections. The piezometers will be monitored with near-real-time collection of pressure head via cellular telephone modems powered by a solar panel array installed near the borings. The VWs and weather station will be connected to a fully automated monitoring system with telemetry to provide remote monitoring of all instrumentation at a 15-minute interval after installation and setup. This frequency may be increased for critical tasks, such as during pump tests, sealing activities, or decreased for longer-term monitoring.

Table 2 Instrumentation Summary

Borehole ID	Instrumentation Depth	Instrumentation Goal
MP1102-GIP-21-1 MP1102-GIP-21-2 MP1102-GIP-21-3 MP1102-GIP-21-4 MP1102-GIP-21-5 MP1102-GIP-21-6 MP1102-GIP-21-2A MP1102-CAP-6 MP1102-CAP-9	Manual pressure gages at the top of each casing, initially. Up to 3 locations in each boring to be determined based on where water is encountered during drilling	Groundwater pressure data, pump testing measurements

The goal of the instrumentation installation is to:

- Evaluate the pressure in the confined layer
- Provide data for pump test purposes in dewatering assessment
- Evaluate the gradient within the confining layer
- Evaluate the differences in confining layer presence along the length of observed seepage
- Evaluate the effectiveness of future remediation
- Provide data necessary to develop a sealing plan

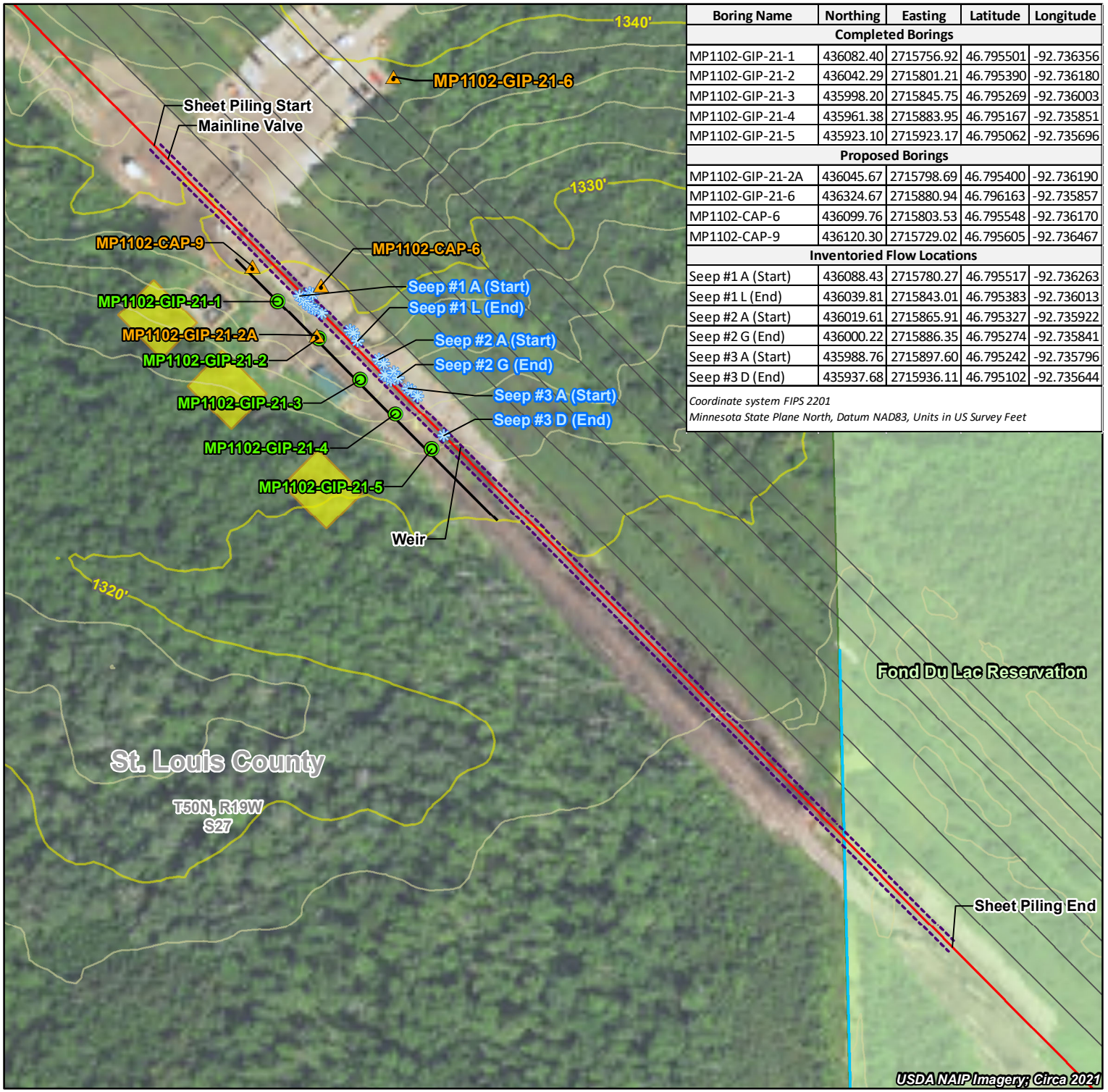
Figures

Figure 1 MP1102.5 Site Location and Proposed Boring Locations
Figure 2 Typical Dewatering Well Detail
Figure 3 MP 1102 Caisson Construction Pressures

Attachments

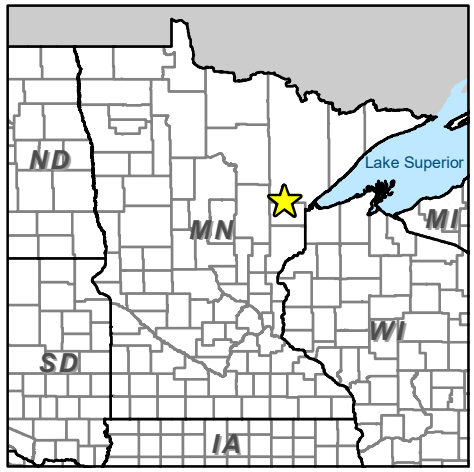
Attachment 1 Soil Boring Logs

Figures



Boring Name	Northing	Easting	Latitude	Longitude
Completed Borings				
MP1102-GIP-21-1	436082.40	2715756.92	46.795501	-92.736356
MP1102-GIP-21-2	436042.29	2715801.21	46.795390	-92.736180
MP1102-GIP-21-3	435998.20	2715845.75	46.795269	-92.736003
MP1102-GIP-21-4	435961.38	2715883.95	46.795167	-92.735851
MP1102-GIP-21-5	435923.10	2715923.17	46.795062	-92.735696
Proposed Borings				
MP1102-GIP-21-2A	436045.67	2715798.69	46.795400	-92.736190
MP1102-GIP-21-6	436324.67	2715880.94	46.796163	-92.735857
MP1102-CAP-6	436099.76	2715803.53	46.795548	-92.736170
MP1102-CAP-9	436120.30	2715729.02	46.795605	-92.736467
Inventoried Flow Locations				
Seep #1 A (Start)	436088.43	2715780.27	46.795517	-92.736263
Seep #1 L (End)	436039.81	2715843.01	46.795383	-92.736013
Seep #2 A (Start)	436019.61	2715865.91	46.795327	-92.735922
Seep #2 G (End)	436000.22	2715886.35	46.795274	-92.735841
Seep #3 A (Start)	435988.76	2715897.60	46.795242	-92.735796
Seep #3 D (End)	435937.68	2715936.11	46.795102	-92.735644

Coordinate system FIPS 2201
Minnesota State Plane North, Datum NAD83, Units in US Survey Feet



- Completed Borings
- Proposed Borings
- Inventoried Flow Locations
- Cross Sections
- Constructed Line 3 Replacement
- Enbridge Pipelines
- Rivers & Streams
- Approximate Previously Installed Sheet Pile
- Approximate Dewatering Structure Locations
- Fond Du Lac Reservation Boundary

2012 Post-Flood Lidar Contours

- Index (10-Foot)
- Intermediate (2-Foot)

N

0 150 300

Feet

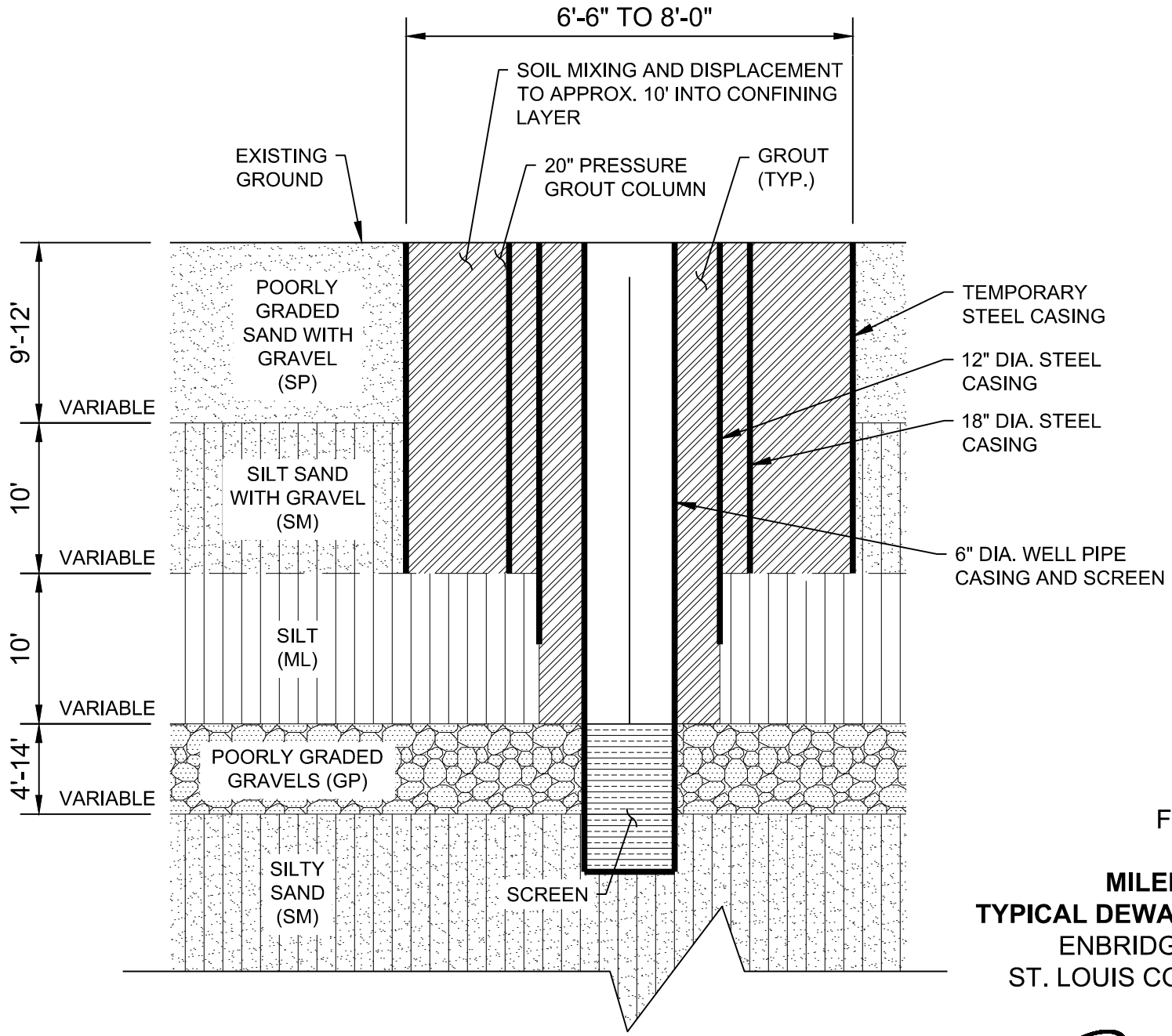
1 Inch = 150 Feet

Figure 1

MILEPOST 1102.5
BORING LOCATIONS
Enbridge Energy, L.P.
St. Louis County, Minnesota

ENBRIDGE®

Barr Footer: ArcGIS 10.8.1, 2021-12-08 15:32 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\49161299\Work_Orders\Line3_MP1102_5_20210916\Maps\Reports\Groundwater_Investigation_Plan\Figure1_MP1102_5_Boring_Locations.mxd User: jwk



1 DETAIL: TYPICAL WELL

NOT TO SCALE

FIGURE 2

MILEPOST 1102.5
TYPICAL DEWATERING WELL DETAIL
ENBRIDGE ENERGY, L.P.
ST. LOUIS COUNTY, MINNESOTA

ENBRIDGE®

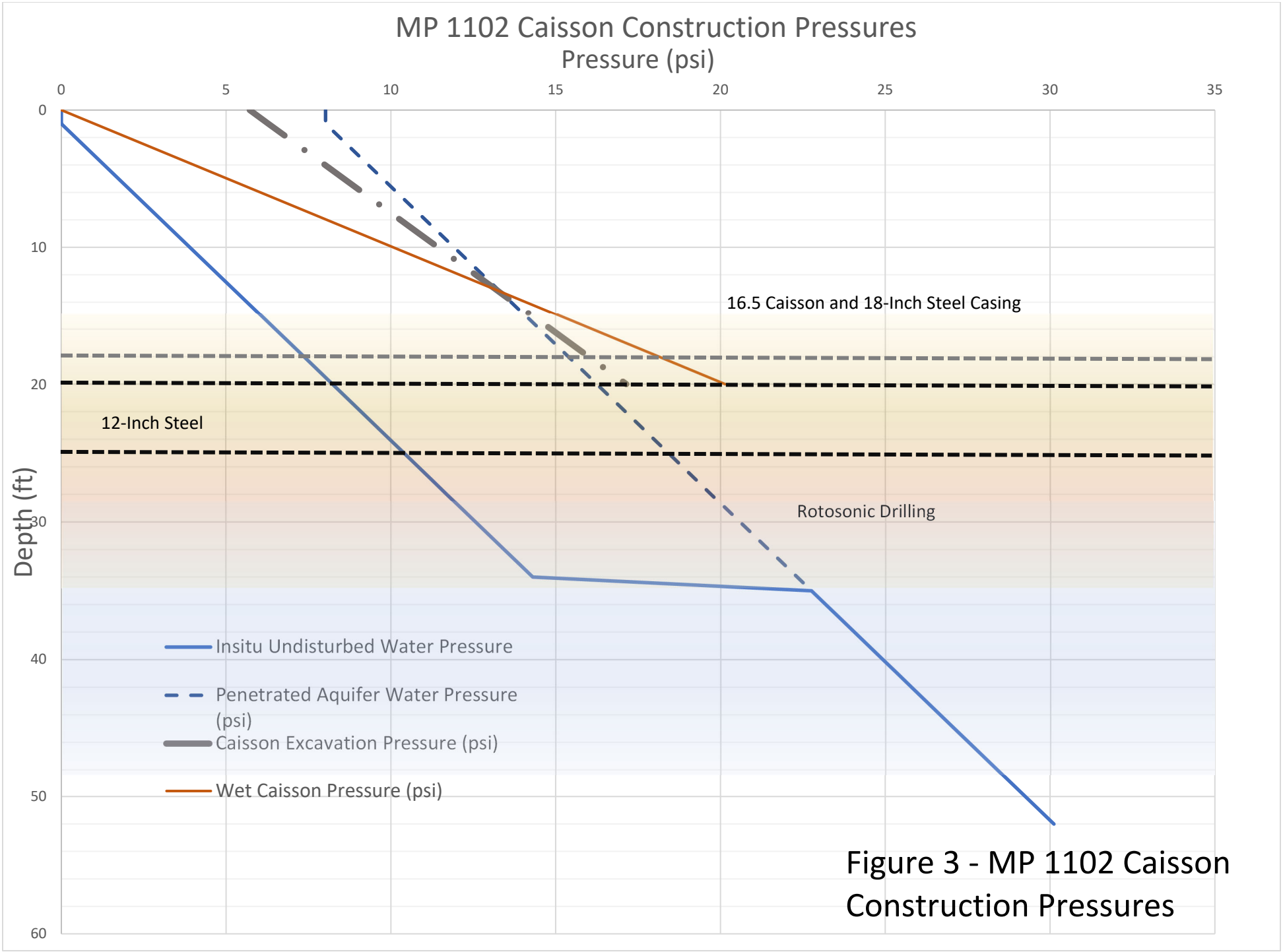


Figure 3 - MP 1102 Caisson Construction Pressures

Attachment 1

Soil Boring Logs

Barr Engineering Company
325 South Lake Avenue, Suite 700
Duluth, MN 55802
Telephone: 218-529-8200

LOG OF BORING MP1102-GIP-21-1

Project: L3 Replacement - MP1102 GIP | Location: MP 1102, St. Louis County, Minnesota | Client: Enbridge

Barr Project Number: 49161299.14

Surface Elev.: 1329.7 ft

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)
1328.7	0.0	TOPSOIL: dark brown; silty clay with organics; forest mat.
	1.0	SAND WITH SILT (SP-SM): dark brown; wet; little gravel.
1327.5	2.5	
1325.0	5.0	
1323.7	6.0	GRAVEL WITH SAND AND SILT (GP-GM): gray; wet.
1322.7	7.0	SAND WITH SILT (SP-SM): fine to medium grained; brown to dark brown; wet.
1322.5	7.5	
1320.0	10.0	
1317.7	12.0	POORLY GRADED GRAVEL (GP): gray; wet.
1316.2	13.5	SILTY SAND (SM): gray; wet; little gravel, trace cobbles.
1317.5	12.5	
1315.0	15.0	
1314.7	15.0	Bottom of Boring at 15.0 feet
	17.5	
	20.0	

Graphic Log | Sample Type & Rec.

STANDARD PENETRATION TEST DATA — N in blows/ft: 10 20 30 40

WATER CONTENT % — PL ⊢×⊣ LL: 20 40 60

SIEVE ANALYSIS — GRAVEL SAND SILT CLAY; FINES: 20 40 60 80

Physical Properties	WC %	γ_d pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
SIEVE ANALYSIS: 7.7 – 94.5	16						
SIEVE ANALYSIS: 50 – 93.9	10						
WATER CONTENT: 11 12; SIEVE ANALYSIS: 8.6 – 52.4	9						

Completion Depth:	15.0
Date Boring Started:	10/12/21
Date Boring Completed:	10/12/21
Logged By:	RWO
Drilling Contractor:	Traut
Drilling Method:	Rotosonic
Ground Surface Elevation:	1329.7
Coordinates:	N 436,082.4 ft E 2,715,757.0 ft
Datum:	MN State Plane N, NAD83, NAVD88

Remarks: Boring was advanced from 0' to 15' with a 4" diameter rotosonic core barrel and 6" diameter override casing; then advanced to 15.5' with an 18-inch diameter roller bit and then cased to 15.5' with 12" diameter steel casing and tremie grouted; then advanced with 10" diameter rotosonic core barrel to 19'. An 8" diameter steel casing was set at a depth of 19' and pressure grouted.

SAMPLE TYPES

ROTOSONIC SOIL CORE | GRAB SAMPLE

WATER LEVELS (ft)

At Time of Drilling 4.0

LEGEND

MC Moisture Content
γ Dry Unit Weight
ϕ Friction Angle
Q_u Unconfined Compression
Q_p Hand Penetrometer UC
Gs Specific Gravity
RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

Barr Engineering Company
325 South Lake Avenue, Suite 700
Duluth, MN 55802
Telephone: 218-529-8200

LOG OF BORING MP1102-GIP-21-2

Project: L3 Replacement - MP1102 GIP | Location: MP 1102, St. Louis County, Minnesota | Client: Enbridge

Barr Project Number: 49161299.14

Surface Elev.: 1328.3 ft

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	
1326.2	0	SAND (SP): fine to coarse grained; brown; moist to wet; trace gravel and cobles and rootlets.	2.1
1325	5	SAND (SP): fine to coarse grained; brown; moist to wet; trace gravel and cobles.	
1320	10		
1315	15		
1312.3		SILTY SAND (SM): gray; moist; trace gravel.	16.0
1310	20		
1305	25		
1301.8			
1300.3		SILT (ML): fine grained; gray; moist to wet; trace sand.	26.5
1300	30		28.0
		SAND (SP): fine grained; gray; dry to moist; trace silt.	
1295			
1293.8	35		
		SAND (SP): fine to medium grained; gray; wet; with gravel.	34.5
1290			
1289.8			
1288.3	40	POORLY GRADED GRAVEL (GP): fine to coarse grained; gray; wet; with sand, trace cobbles.	38.5
			40.0
	45	Bottom of Boring at 40.0 feet packer and multi-valve piping installed for monitoring	

Graphic Log | Sample Type & Rec. | STANDARD PENETRATION TEST DATA (N in blows/ft: 10 20 30 40) | WATER CONTENT % (PL — LL; 20 40 60) | SIEVE ANALYSIS (GRAVEL SAND SILT CLAY; FINES; 20 40 60 80)

Physical Properties

WC %	γ_d pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %

Completion Depth:	40.0
Date Boring Started:	9/29/21
Date Boring Completed:	9/30/21
Logged By:	SDB2
Drilling Contractor:	Traut
Drilling Method:	Rotosonic
Ground Surface Elevation:	1328.3
Coordinates:	N 436,042.3 ft E 2,715,801.0 ft
Datum:	MN State Plane N, NAD83, NAVD88

Remarks: Boring was advanced from 0' to 20' with a 4" diameter rotosonic core barrel and 6" diameter override casing. The boring was then cased to 21' with 8" diameter steel casing.

SAMPLE TYPES

ROTOSONIC SOIL CORE

WATER LEVELS (ft)

At Time of Drilling 38.5

LEGEND

MC Moisture Content
γ Dry Unit Weight
ϕ Friction Angle
Q_u Unconfined Compression
Q_p Hand Penetrometer UC
Gs Specific Gravity
RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

O:\GINT\PROJECTS\49161299 LINE 3 REPLACEMENT GEOTECH SURVEY\49161299.14 L3 MP1102 GIP.GPJ BARRLIBRARY.GLB HORIZONTAL LOG REPORT BARR GEOTECH TEMPLATE.GDT

Barr Engineering Company
325 South Lake Avenue, Suite 700
Duluth, MN 55802
Telephone: 218-529-8200

LOG OF BORING MP1102-GIP-21-3

Project: L3 Replacement - MP1102 GIP | Location: MP 1102, St. Louis County, Minnesota | Client: Enbridge

Barr Project Number: 49161299.14

Surface Elev.: 1327.8 ft

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)
1327.8	0	SAND (SP): fine to medium grained; brown; moist; trace gravel and cobble.
1312.8	15	SILT (ML): brow; moist; trace gravel and cobble.
	15.0	
	25	Cement grout recovered in liner (25-27').
1292.8	35	POORLY GRADED GRAVEL (GP): fine to coarse grained; gray; wet; cobbles; pressurized ground water encountered (about 75 - 150 gpm).
	35.0	
1278.8	49	SILTY SAND (SM): red/brown; moist; trace gravel. Dense; with gravel; few cobbles.
	49.0	
1273.8	54	SAND WITH SILT (SP-SM): fine to coarse grained; red/brown; moist; dense; little gravel.
1270.8	54.0	
	57.0	
1267.8	60	SILTY, CLAYEY SAND (SM-SC): fine to medium grained; red/brown; moist; dense.
	60.0	
		Bottom of Boring at 60.0 feet

Graphic Log | Sample Type & Rec.

STANDARD PENETRATION TEST DATA — N in blows/ft (10, 20, 30, 40)

WATER CONTENT % — PL, LL (20, 40, 60)

SIEVE ANALYSIS — GRAVEL, SAND, SILT, CLAY, FINES (20, 40, 60, 80)

Physical Properties	WC %	γ_d pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
35.0							
19 21 H							
3.9							
69 95.5							
12 15 H							
4.8 66.6 88.8							
6.7 91.4							
12 16 H							
14.7 64.8 88.1							

Completion Depth:	60.0
Date Boring Started:	11/2/21
Date Boring Completed:	11/2/21
Logged By:	RWO/SDB2
Drilling Contractor:	Traut
Drilling Method:	Rotosonic
Ground Surface Elevation:	1327.8
Coordinates:	N 436,001.4 ft E 2,715,844.0 ft
Datum:	MN State Plane N, NAD83, NAVD88

Remarks: Boring was advanced from 0' to 60' with a 4" diameter rotosonic core barrel and 6" diameter override casing. The boring was then cased to 17.5 feet with 16" casing installed with 24" diameter roller bit; then to 25' with 8" diameter steel casing. Completed as 6" well. The screened section was 35' to 55'.

SAMPLE TYPES

ROTOSONIC SOIL CORE

WATER LEVELS (ft)

At Time of Drilling 0.0
Artesian flow (200-300 GMP)

LEGEND

MC Moisture Content
γ Dry Unit Weight
ϕ Friction Angle
Q_u Unconfined Compression
Q_p Hand Penetrometer UC
Gs Specific Gravity
RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

Barr Engineering Company
325 South Lake Avenue, Suite 700
Duluth, MN 55802
Telephone: 218-529-8200

LOG OF BORING MP1102-GIP-21-4

Project: L3 Replacement - MP1102 GIP | Location: MP 1102, St. Louis County, Minnesota | Client: Enbridge

Barr Project Number: 49161299.14

Surface Elev.: 1325.0 ft

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)
1325	0	SAND (SP): fine to medium grained; brown; moist; trace gravel and cobble.
1320	5	
1315	10	
1312.0		
1310	15	SANDY SILT (ML): brown; moist; trace gravel and cobble.
1305	13.0	
1305.0		
1305	20	SILTY SAND WITH GRAVEL (SM): gray; moist; some cobbles.
1300	20.0	
1295.0	25	
1295	30	GRAVEL WITH SAND AND SILT (GP-GM): gray; saturated; few cobbles.
1291.0	30.0	
1290	35	SILTY SAND WITH GRAVEL (SM): gray; moist.
1285	34.0	Light brown.
1280	40	
1275.0	45	
1275	50	Bottom of Boring at 50.0 feet 8" flanged gate valve installed
	50.0	
	55	

Graphic Log | Sample Type & Rec.

STANDARD PENETRATION TEST DATA — N in blows/ft (10, 20, 30, 40)

WATER CONTENT % — PL, LL (20, 40, 60)

SIEVE ANALYSIS — GRAVEL, SAND, SILT, CLAY, FINES (20, 40, 60, 80)

Depth, feet	WC %	Sieve: GRAVEL	Sieve: SAND	Sieve: FINES
20	12.14	20	66.2	91.5
25	12.14	10	56.7	89.8
30			53.4	88
40		19.3	69	

Physical Properties: WC %, γ_d pcf, ϕ °, Q_u tsf, Q_p tsf, Gs, RQD %

Completion Depth:	50.0
Date Boring Started:	9/29/21
Date Boring Completed:	10/15/21
Logged By:	RWO
Drilling Contractor:	Traut
Drilling Method:	Rotosonic
Ground Surface Elevation:	1325
Coordinates:	N 435,961.4 ft E 2,715,884.0 ft
Datum:	MN State Plane N, NAD83, NAVD88

Remarks: Boring was advanced from 0' to 15' with a 18" diameter roller bit. The boring was then cased with 12" diameter steel casing and tremie grouted; then advanced with 10" diameter rotosonic core barrel to a depth of 18'; then cased with 8" diameter steel casing and tremie grouted; then advanced with 4" diameter rotosonic core barrel and 6" diameter override casing to a depth of 50'.

SAMPLE TYPES

ROTOSONIC SOIL CORE | GRAB SAMPLE

WATER LEVELS (ft)

At Time of Drilling 0.0
50 GPM of flow encountered at 30'

LEGEND

MC Moisture Content
γ Dry Unit Weight
ϕ Friction Angle
Q_u Unconfined Compression
Q_p Hand Penetrometer UC
Gs Specific Gravity
RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

O:\GINT\PROJECTS\49161299 LINE 3 REPLACEMENT GEOTECH SURVEY\49161299.14 L3 MP1102 GIP.GPJ BARRLIBRARY.GLB HORIZONTAL LOG REPORT BARR GEOTECH TEMPLATE.GDT

Barr Engineering Company
325 South Lake Avenue, Suite 700
Duluth, MN 55802
Telephone: 218-529-8200

LOG OF BORING MP1102-GIP-21-5

Project: L3 Replacement - MP1102 GIP | Location: MP 1102, St. Louis County, Minnesota | Client: Enbridge

Barr Project Number: 49161299.14

Surface Elev.: 1324.1 ft

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)
1322.5	0.0	ORGANIC SILTY CLAY (OL): black; moist; with cobbles and boulder at 1-2'.
	1322.1	
	2.5	SILTY SAND WITH GRAVEL (SM): brown; moist. 2.0
1320.0	5.0	
1317.5	1317.1	
	7.5	POORLY GRADED SAND (SP): gray; moist. 7.0
	1315.1	
1315.0		SILTY GRAVEL WITH SAND (GM): gray; moist; some gravel. 9.0
	10.0	
	1313.1	
		Bottom of Boring at 11.0 feet 11.0
	12.5	
	15.0	

Graphic Log; Sample Type & Rec.

STANDARD PENETRATION TEST DATA — N in blows/ft: 10 20 30 40

WATER CONTENT % — PL LL; 20 40 60

SIEVE ANALYSIS — GRAVEL SAND SILT CLAY; FINES; 20 40 60 80

Physical Properties	WC %	γ_d pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
7.8 95.2	17						
50.5 83.6	6						

Completion Depth:	11.0
Date Boring Started:	10/13/21
Date Boring Completed:	10/13/21
Logged By:	RWO
Drilling Contractor:	Traut
Drilling Method:	Rotosonic
Ground Surface Elevation:	1324.1
Coordinates:	N 435,923.1 ft E 2,715,923.0 ft
Datum:	MN State Plane N, NAD83, NAVD88

Remarks: Boring was advanced from 0' to 11' with a 4" diameter rotosonic core barrel and 6" diameter override casing. The boring was then drilled to a depth of 11 feet with a 18" diameter roller bit and 12" steel casing installed and pressure grouted.

SAMPLE TYPES: ROTOSONIC SOIL CORE

WATER LEVELS (ft): At Time of Drilling — Dry

LEGEND: MC Moisture Content; γ Dry Unit Weight; ϕ Friction Angle; Q_u Unconfined Compression; Q_p Hand Penetrometer UC; Gs Specific Gravity; RQD Rock Quality Designation

The stratification lines represent approximate boundaries. The transition may be gradual.

O:\GINT\PROJECTS\49161299 LINE 3 REPLACEMENT GEOTECH SURVEY\49161299.14 L3_MP1102_GIP.GPJ BARRLIBRARY.GLB HORIZONTAL LOG REPORT BARR GEOTECH TEMPLATE.GDT