MEMO

Date:

September 25, 2021

To:
Randall Doneen, Minnesota Department of Natural Resources
Cheryl Kelley-Dobie, Minnesota Department of Natural Resources
Michele Walker, Minnesota Department of Natural Resources
Melissa Kuskie, Minnesota Pollution Control Agency
Kevin Molloy, Minnesota Pollution Control Agency

From:

Bobby Hahn, Enbridge Energy, Limited Partnership

Subject:

Line 3 Replacement Project LaSalle Creek Corrective Action Plan

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The attached technical memo prepared by Barr Engineering ("Barr") on behalf of Enbridge Energy, Limited Partnership ("Enbridge") incorporates revisions requested by the Minnesota Department of Natural Resources ("MDNR") and Minnesota Pollution Control Agency ("MPCA") on September 1, 2, 17, 19, and 22, 2021 regarding the corrective actions proposed to stop the seepage flow in the vicinity of LaSalle Creek between mileposts ("MPs") 946.1 and 946.5 on the Line 3 Replacement Project ("L3R" or "Project"). It also provides contingency planning for groundwater management, describes filtration that will be maintained on-site for dewatering activities, and the installation of slash/coarse woody debris after final grading is complete. A comment response matrix is enclosed responding to comments received on September 17, 19 and 22, 2021.

Consistent with Enbridge's email provided on September 20, 2021, Enbridge will have an Environmental Inspector ("EI") stationed continuously at LaSalle Creek (24 hours day/7 days a week) until the LaSalle Creek Corrective Action Plan is implemented. Further, an Independent Environmental Monitor ("IEM") will also be continuously stationed at LaSalle Creek. Lighting has been reinstalled in this area to facilitate monitoring and inspections.

Enbridge will also comply with the procedures described in the LaSalle Creek Construction and Restoration Plan, and requirements found in the applicable environmental plans, permits, authorizations and certifications.

Please note that Enbridge's revised Site-Specific Restoration Plan ("SSRP") for the LaSalle Creek submitted to the MDNR and MPCA on Enbridge on August 27, 2021, and approved by both agencies on August 27, 2021, addresses the MDNR and MPCA request regarding restoration of the original placement of the bridge.

Enbridge is developing a Groundwater Monitoring Plan for this area to be provided by October 1, 2021 and will address both MDNR and MPCA comments received September 17 and 22, 2021, respectively.

Enbridge Line 3 Replacement Project
LaSalle Creek Corrective Action Plan - Comment Response

Comment ID No.	Source	Date	AGENCY COMMENTS	ENBRIDGE RESPONSE
1	DNR Nathan Kestner	9/17/2021	Until the CAP is completed and flowing conditions cease, EI's or IEM's are to walk just west of the construction ROW a minimum of once daily to check that there are no discharges going into surrounding wetlands. Lighting needs to be re-installed (especially around pumps and dewatering structures) to ensure nighttime monitoring will be successful.	Response provided 9/20/21; see memo cover page.
2	DNR Nathan Kestner	9/17/2021	Memo page 4 -3rd paragraph alludes to the potential of sheet piling remaining in place indefinitely in the event pulling out sheet piling damages the TAMs or presents a safety concern. This would be a bigger concern for us regarding impacts to the wetland hydrology of the terraced wetlands, blocking lateral flow from higher wetlands flowing down to LaSalle Creek. Please clarify if our interpretation of this language is accurate and sheet piling is proposed to remain in place due to construction complications.	Please refer to pages 3-5. Groundwater monitoring indicates that hydraulic gradients, and therefore, groundwater flow direction, is overwhelmingly vertical - not horizontal - through the peat. This is supported by the observations identified during pipe installation which are documented on pages 3-4. If alternative methods presented on pages 4-5 are not successful and sheet piling must remain in place, Enbridge would not anticipate impacts to lateral flow for these short sections based on hydrology observed on site.
4	DNR Nathan Kestner	9/17/2021	DNR will require alternatives to leaving the sheet pile in place in the event of construction difficulties such as: replace the TAMs in a different location or angle if they get damaged during sheet pile removal, using equipment with a longer reach to eliminate safety concerns.	Alternatives have been proposed on pages 4-5.
5	DNR Nathan Kestner	9/17/2021	DNR prefers TAMs be made of steel but realize that this may not be possible. The reasoning for this is that if a large number are needed to be in this area, that is a lot of PVC to be left in the wetland as fill.	TAMs will be made from steel; addressed on page 4.
6	DNR Nathan Kestner	9/17/2021	From recent photos taken by MPCA on site, it appears additional sheet piling was installed in the process of pipeline construction. These area must be documented and submitted as part of the corrective action report along with any additional areas of upwelling that were created from these sheet piles.	No additional sheeting was installed during pipeline installation. As documented on page 3, no additional seeps were identified within the construction workspace during excavation activities.
7	DNR Nathan Kestner	9/17/2021	In the corrective action report, also provide a report of the pipeline installation. Describe soil and groundwater observations during construction with regards to groundwater discharge; did the groundwater flow increase or decrease with the construction. Provide any data collected during construction. Describe if there was additional sediment within the groundwater discharge, which could indicate more soil piping. Document additional seeps forming from this work outside of the construction area. How the groundwater discharge reacted to construction may be able to tell us how the discharge will react to the proposed work.	Observations recorded during construction are documented on pages 3-4.
8	DNR Nathan Kestner	9/17/2021	(Preliminary Assessment of Seepage Conditions) it states that the flow is low and estimated to be 5-20 gpm. We believe this to be an oversight since the updated information in red is more recent but this should be clarified.	Comment addressed. Sentence was deleted to remove redundant data reporting and inconsistency. Flow is accurately reported in the last paragraph on page 2.
9	DNR Nathan Kestner	9/17/2021	The cross section in Figure 2 of the Barr September 14, 2021 GW Investigation Data submittal should be revised to include the water levels found in the borings and vibe wire piezometers. For example GIP2 has a hydraulic head of -12.5 ft (above land surface) 0.75 hours after drilling.	Figure 2 has been updated.
10	DNR Nathan Kestner	9/17/2021	Groundwater levels must be monitored for 2 additional years to ensure water levels stabilize. Provide a groundwater monitoring plan for approval. Commit to monthly water level data submittals-electronic spreadsheet format. The data should contain: a. An explanation of all abbreviations used including: Thead_Corr, Tip Elev etc. b. Dates of work construction events such as dewatering, sheet pile removal and construction (excavation and backfilling). For work over a time period, the date and time started and ended should be included. c. Pumping events with date/times started and ended along with flow rates and volumes. How the flow is measured should also be documented.	Enbridge is currently preparing a Groundwater Monitoring Plan which will be provided to the agencies for review by October 1, 2021.
11	MPCA Kevin Molloy	9/19/2021	Enbridge must ensure the company and its contractors are continuously inspecting and monitoring all pumping activities and treatment systems at this location to ensure they are functioning correctly and fully compliant with applicable water quality standards. This includes providing 24-hour a day staff coverage to ensure no pumps are inexplicably shut down, either manually or due to mechanical failure, and to maintain and/or adjust dewatering treatment systems to ensure dewatering discharges must not be allowed to result in a future violation of applicable WQS outside of the authorized working space. It has been reported to the MPCA that Enbridge staff have told our IEMs the company will continuously monitor this site for this purpose; however, it is unclear what that specifically means, in terms of number of staff the company is requiring (and validating) to be on-site for this purpose.	Response provided 9/20/21; see memo cover page.

Enbridge Line 3 Replacement Project
LaSalle Creek Corrective Action Plan - Comment Response

Comment ID No.	Source	Date	AGENCY COMMENTS	ENBRIDGE RESPONSE
12	MPCA Kevin Molloy	9/19/2021	Report how many staff the company is providing for this purpose, together with an explanation regarding why that is considered sufficient in light of the situation at this sensitive resource? Please also be specific in terms of the frequency at which your staff are inspecting and monitoring the areas, and please remember your response does not presume the 24-hour IEM coverage, which the resource agencies have required of our IEMs, does not substitute as any part of Enbridge's staffing responsibility. In addition, if the company is relying on its contractors to do this work, please identify how often Enbridge is inspecting/monitoring their contractors' performance to ensure they are, in fact, doing the job correctly (unlike last weekend). The MPCA expects a qualified EI and/or LEI to get to this site multiple times a day to check up on any contractors performing the work. Further, we expect the company to walk and inspect the entire western side of this site at least 4 times per shift, possibly more, depending on the circumstances, to ensure no noncompliant discharges are occurring to state waters. Lastly, we expect Enbridge to provide adequate lighting at this location to ensure any non-compliant activity can be detected and reported immediately during the night shifts, instead of waiting for daylight hours to discover it.	Response provided 9/20/21; see memo cover page.
13	MPCA Kevin Molloy	9/19/2021	As communicated to Tim last week, an IEM must remain at this location 24 hours a day to monitor and ensure all pumping and dewater activities are functioning correctly, and that all other applicable regulatory requirements are being followed. Since the IEMs are not expected to do the work the company must provide, I've instructed Tim to ensure, moving forward, that the IEM daily reports identify: (a) the number of staff Enbridge is providing to ensure compliance at this location throughout the entire shift; (b) the frequency at which Enbridge's EIs are on-site, if not continuously, to monitor their contractor's work; (c) whether Enbridge's staff are walking and inspecting the entire site at least 4 times per shift; and (d) whether sufficient lighting is on-site. On this last point, the IEMs have been told to require additional lighting, if necessary, in which case Enbridge is expected to provide it ASAP.	Response provided 9/20/21; see memo cover page.
14	MPCA Mark Gernes	9/22/2021	The CAP notes (document page 2) that seeps are natural features that have been observed in this area during previous investigations. Seep faces are frequently important ecological habitats that support slope wetland features. The CAP needs to consider how preconstruction wetland seep conditions are anticipated to be affected into the future by grouting and sheet pile removal. On document page 4 the CAP discusses potential excavation of grout material removal down 2 to 3 foot following stabilization of the current seepage conditions. It is not clear if this action will proceed regardless whether complete sheeting removal occurs or not. Clarification in this regard is needed. Also, elaborate on how previous observed surface seeps may be affected by the proposed grouting action and potential subsequent grout surface excavation.	Please refer to pages 3-5. Groundwater monitoring indicates that hydraulic gradients, and therefore, groundwater flow direction, is overwhelmingly vertical - not horizontal - through the peat. This is supported by the observations identified during pipe installation which are documented on pages 3-4. If alternative methods presented on pages 4-5 are not successful and sheet piling must remain in place, Enbridge would not anticipate impacts to lateral flow for these short sections based on hydrology observed on site. As discuss on Page 5, if sheet piling remains in place, the top 2-3 feet of grout/sheet pile will be removed to restore flow to surface seeps.
15	MPCA Mark Gernes	9/22/2021	Provide updated lineal feet of sheet pile removal and proposed course (direction and pace) of	This discussion has been added to page 4.
16	MPCA Mark Gernes	9/22/2021	Please address apparent inconsistencies in reported seep flow rates presented on document pages 2 and 3.	Comment addressed. Sentence was deleted to remove redundant data reporting and inconsistency. Flow is accurately reported in the last paragraph on page 2.
17	MPCA Mark Gernes	9/22/2021	The MPCA expects that qualified EI and/or LEI will physically review this area multiple times a day to check and assure necessary oversight over contractors work progress. Further, we expect company representatives to walk and inspect the entire western side of this site at least 4 times per shift, possibly more, depending on the circumstances, to ensure no noncompliant discharges are occurring to state waters.	Response provided 9/20/21; see memo cover page.
18	MPCA Mark Gernes	9/22/2021	Assure that agency directed IEM are to remain at this location 24 hours a day to monitor and ensure all sheet pile removal, grouting, pumping and dewater activities are functioning correctly, and that all applicable regulatory requirements are being followed	Response provided 9/20/21; see memo cover page.
19	MPCA Mark Gernes	9/22/2021	Provide assurance that Enbridge and or their contractors will provide adequate lighting construction and monitoring throughout this location to ensure any non-compliant activity can be detected and reported immediately during night shifts.	Response provided 9/20/21; see memo cover page.

Enbridge Line 3 Replacement Project
LaSalle Creek Corrective Action Plan - Comment Response

Comment ID No.	Source	Date	AGENCY COMMENTS	ENBRIDGE RESPONSE
20	MPCA Mark Gernes	9/22/2021	A clear process for field decision making needs more specifics, detail explicit monitoring actions that will be taken during sheet piling removal and grouting to inform field decisions regarding, For example: a. Corrective action pace •Grout injection pace and effectiveness to judge injection pressure and volume •Pace of sheet pile removal and grout deployment b. Who will be chiefly responsible for managing these actions and decisions: •Barr or other geo-tech consultants •Specialized sheet piling removal contractor(s) •Enbridge construction supervisors •Other onsite expertise oJoint decision-making •Agency input c. Data sources •Existing vibrating wire (VW) piezometer are installed at different depths for the two nested VW. Discuss how differential probe depths as well as data from other instrumented piezometers data will be accessed and utilized for decision-making including over what time period and measurement frequency. •What data analysis steps will be used to guide decision making? •Field observations, nature of where and what. Timing and spatial frequency •Grout injection rates •How will drawdown pump rates, and volume data be used as needed •Potential need for additional hand or mechanical observation borings. Availability of this equipment to assist assessments •Specific actions and extent to detect any inadvertent short-circuit grout releases within the construction vicinity or down gradient locations d. Contingencies •What results or thresholds are anticipated to trigger contingency engagement? Agencies should be notified when contingency actions are needed. Presenting this detailed content in a tabular or bulleted format may be an effective communication approach as much of this is alluded to or implied in various parts of the CAP body.	Addressed a) Corrective action pace, including grout injection pace and effectiveness and sheet pile removal and grout deployment is addressed on page 4. b) Decision making and responsibility is addressed on page 5. c) Data Sources - Vibrating wires will be used to monitor long-term effectiveness, which will be described in the forthcoming Groundwater Monitoring Plan (see page 4); however, one would not expect immediate nor significant changes to the piezometer data that would be useful to the short-term decision making processes during grouting. Similarly, additional borings or drawdown pump rates data would not apply to this process. As described on page 4, the efficacy of the grouting effort will be based on visual observations - based on the lack of seeps observed at the surface. Grout injection rates, pressures, and volumes will be determined and adjusted appropriate to field conditions by the specialty grouting contractor. Should grout return to the surface, Enbridge would contact the EI and IEM and initiate clean-up immediately. d. Contingencies - performance criteria for triggering alternatives or contingencies are described on page 5, including commitment to notify agencies if contingency actions required.
21	MPCA Mark Gernes	9/22/2021	Post corrective action monitoring: •What, where, who, and or how frequent. Relate this to the planned restoration actions. May need to reference and/or integrate monitoring actions into the post construction monitoring plan (PCMP) or other standing documents.	Enbridge is currently preparing a Groundwater Monitoring Plan which will be provided to the agencies for review by October 1, 2021.

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Technical Work Plan – Revision 2

To: Bobby Hahn, Enbridge, Kristin Lenz, Merjent
From: Ray W. Wuolo, PE, PG; Peter M. Demshar, PE, Kevin Eisen, PE, Travis A. Davidsavor, PE
Subject: Work Plan for Controlling and Sealing Groundwater Seepage – LaSalle Creek
Date: September 24, 2021

Introduction

This Work Plan discusses the proposed steps for sealing surface seepage of groundwater flow along the Line 3 Replacement project east and south of the LaSalle Creek crossing with the least environmental impact. This Work Plan was prepared at the request of Enbridge and is based on currently available data and information regarding measured groundwater pressures, documented stratigraphy, and flow location and rates. This Work Plan has been revised to address comments received from the Minnesota Department of Natural Resources (MDNR) and Minnesota Pollution Control Agency (MPCA) on:

- September 1, 2021 – MDNR
- September 2, 2021 – MPCA
- September 17, 2021 – MDNR
- September 22, 2021 – MPCA

Background

LaSalle Creek and its topographic valley are a regional groundwater discharge area because they are at a lower elevation than much of the surrounding region. Regional groundwater flow is toward LaSalle Creek, and where the potentiometric surface intersects the ground surface, seeps and springs can be expected. Groundwater flow also contributes to the baseflow of LaSalle Creek. Finer grained deposits, such as silts, clays, and wetland muck/peat have formed a confining layer over the more permeable valley-fill deposits, resulting in the development of artesian conditions.

Sheet piling depths of installation for construction of the Line 3 Replacement project ranged from 28 feet to 30 feet below ground surface (bgs) near the LaSalle Creek crossing. During the installation of the sheet piling, seepage to the ground surface was observed between the sheet piles and the adjacent soils. Four seep areas have been identified and the location of each seep is shown on Figure 1. The approximate length of each seep is shown below:

- Seep 1 – 15 feet
- Seep 2 – 100 feet

- Seep 3 – 59 feet
- Seep 4 – 48 feet

Monitoring data (described below) shows that this seepage has resulted in a localized drop in the potentiometric surface, similar to the response that would be observed if wells were pumping.

Monitoring Data and Hydrogeologic Conditions

Vibrating wire piezometers (VWPs) were installed at locations shown on Figure 1. The installation details are presented in Attachment 1. The purpose of these piezometers is to collect groundwater pressure data under current conditions (i.e., uncontrolled artesian flow) and to monitor pressures during and after sealing efforts of the flowing conditions. Boring logs and groundwater level data from the piezometers are summarized in Attachment 1. The depths and elevations of the piezometers are tabulated in Table 2 of Attachment 1.

Previous investigations indicated that flowing artesian conditions did exist at depths significantly deeper than the planned open cut trench. In addition, previous site visits also encountered groundwater seeps along the eastern hillslope of the LaSalle Creek valley that are consistent with a phreatic surface that intersects the ground surface topography near LaSalle Creek. In the area of the seeps, hand auger borings from these investigations identified saturated soil conditions in shallow subsurface (1-foot bgs and 1.5-foot bgs in LS-20-HA-9 and LS-20-HA-10, respectively).

A geologic cross section is presented in Attachment 1, using data collected from installation of the VWPs and from existing wells and borings installed during previous investigations. These data are interpreted to show a lower permeability layer of clay 31 to 40 feet along the eastern hillslope. It is important to note that the confining layer does not appear to be homogenously comprised of low permeability materials – it is likely variable in thickness and both grain size and hydraulic conductivity characteristics because of the glacial and glacio-fluvial environments in which the materials were deposited. Thin layers of permeable sand may be present within the confining layer and may be connected with other sand or layers of higher hydraulic conductivity to varying degrees.

Soil samples and observation of the boring installations in the seep area indicates that the surficial soils are saturated, which was anticipated based on the preconstruction conditions identified at the site and documented in the LaSalle Creek Construction and Restoration Plan dated October 2020.

Below the confining unit is a more permeable sand and gravel aquifer that is generally under artesian pressure (i.e., the hydraulic head is above the ground surface). Artesian flow at the excavation was measured by channeling flow through a V-notch weir. Flows from Seeps 1-3 were channeled into a single flow path and the total measured flowrate was approximately 10 gallons per minute (gpm). However, the weir is likely not capturing the seep flow that is conveyed beneath the wetland surface vegetation mat. Flow from Seep 4 was measured separately, and the flowrate was estimated to be 90 gpm.

Preliminary Assessment of Seepage Conditions

Groundwater seepage to the ground surface is presently visible immediately adjacent to some temporary sheet piles. Groundwater monitoring indicates that hydraulic gradients and, therefore, groundwater flow direction, is overwhelmingly vertical - not horizontal - through the peat. The surficial soils are comprised of mainly low-permeability peat deposits. At the locations of seepage, the sheet piling is reported to have been installed to an approximate depth of 28 feet below ground surface. This penetration length may have intersected more permeable zones at depth with sufficient pressure to induce upward flow to the ground surface adjacent to the sheets.

The contact between the steel sheet piles and the native deposits has likely formed preferential flow paths for pressurized groundwater to flow to the ground surface. Because of the cohesive nature of the peat and the relatively low water velocities, soil piping along these preferential flow paths appears to be negligible, and rapid enlargement of preferential flow-path conduits is likely a much slower process than would be observed in cohesionless deposits, such as silt and sand. These conditions are likely conducive to a sealing approach that uses injection of grout into the preferential flow paths (i.e., along the interface between the sheeting and the soil) without the need to reduce pressures (and flow rates) through groundwater pumping. Contingency plans for pumping are included in this Plan if dewatering is required to temporarily reduce the confined aquifer pressures to allow for more successful grout injection.

Proposed Method for Controlling Artesian Flow

Prior to initiation of work activities designed to control the artesian flow, the remaining section of the pipeline will be installed as described in Enbridge's September 3, 2021 memo. Enbridge received concurrence to proceed with the pipe installation on September 3, 2021 and initiated these activities on September 4, 2021.

Once the line is installed, backfilled and final grading is complete, Enbridge will also install slash/coarse woody debris along the sloped areas within the wetland to provide additional erosion control, as described in Enbridge's September 3, 2021 memo to the MDNR and MPCA.

During pipeline installation, Enbridge utility inspectors and environmental inspectors observed the following conditions:

- The depth of the interface between the organic and subsoil ranged from 9 inches to 26 inches bgs and generally increased in depth from north to south.
- Groundwater flow did not change during construction.
- No additional sediment within the groundwater discharge were identified during ditching activities.
- No additional seeps were identified within the construction workplace during excavation activities.

- Significant continuous coarse-grained layers were not encountered during trenching activities that would serve as preferential horizontal flow paths.

The proposed plan for sealing the groundwater seepage uses Tube-a-Manchette (TAM) grouting method to inject grout into the flow channels associated with the uncontrolled flow. The perforated TAMs will be installed directly adjacent to sheet sections where seepage is observed, to a depth approximately equal to the installed depth of the sheet. The spacing of the TAMs will vary, with initial spacing on the order of 2 to 10 feet. These TAMs are equipped with short sections of rubber sleeve (Manchette) on the outer part of the pipe that acts as a one-way valve. Grout is pumped into the hole between confining packers by applying pressure. Pressure pushes the grout past the small rubber sleeves to open the cover perforation, rupture the sleeve grout and enter the soil. Grout injection rates, pressures and volumes will be determined by the specialty grouting contractor. Sheet pile will be removed without grouting in areas where seeps are not identified. The preliminary grouting locations are shown in Attachment 2.

The initial method of grouting will attempt to remove the sheets as grouting commences, which will allow the pressurized grout to fill void spaces left by the sheet and adjacent soils. Grouting will begin at the bottom and as the sheeting is lifted, grout injection will follow behind, filling the void areas with pressurized grout to the ground surface. Sheet pile removal pace will be determined by grout injection rate and sealing efficacy. Sealing efficacy will be determined by a lack of seeps observed at the surface. If additional seeps are identified after initial grouting, additional grouting efforts will be made to mitigate the remaining seeps and repeated as necessary. Existing vibrating wire piezometers will be used to monitor long-term effectiveness in accordance with the Groundwater Monitoring Plan. In the event grout comes to the surface outside of the construction vicinity, grouting activities will be stopped at that location. Environmental Inspectors and Independent Environmental Monitors will be notified, and cleanup activities will immediately commence if required.

The TAMs that will be specified will be made of steel and will be incased in grout upon completion of the grouting and will be isolated from the surrounding soil and pore water by the grout (i.e., they will be encapsulated). As such, they will not be a potential source to negatively affect water quality. Grouting with the TAMs will be completed with the intention to minimize the lateral length of the grout placed and to limit the amount of grout used to that which is required to seal the uncontrolled flow.

The TAMs will be permanently left in place following grouting, and the near surface portion of the TAMs will be cut off upon completion. Completely removing the TAMs may cause a break in the grout seal which could cause the uncontrolled flow to resume.

If removing the sheet piles as grouting commences negatively affects the uncontrolled flow, grouting efficacy or presents constructability issues, such as causing the TAM's to be damaged or pulled out during sheet pile removal, or if the specialty contractor identifies safety concerns that will prevent the execution of the grouting plan, the following alternatives will be implemented:

- Repositioning of the TAM's.

- Use of alternative construction equipment.
- If alternatives fail, sheet piles will remain in place at the location of each seep and the grout will be pumped until the flow path along each sheet pile is filled with grout and flow is stopped.

Decisions on correction action implementation will be primarily made by the specialty grouting contractor, in consultation with Enbridge, Barr, and onsite Agency staff. If additional contingency actions are required as described in the Contingency Measures for Controlling Seepage section, the Agencies will be notified.

After grouting and sealing of the uncontrolled flow, the top 2-3 feet of sheet pile or grout will be removed regardless of if the sheet piles are removed, and the stockpiled organics will be used to backfill the remaining trench with the intention of restoring the flow and surface seeps to pre-construction conditions in the upper organic layer.

Currently there are seeps present that are not adjacent to the sheet piles. Those seeps are likely attributed to the flow following seams of higher hydraulic conductivity through the surficial organic material above the confining layer. These seeps will likely cease to flow when the grout is injected, as the higher hydraulic conductivity will increase the radius of grout injection. If these seeps do not stop flowing during the initial round of grouting, the spot treatment will be used to seal these seepage locations as described below.

For seep locations that continue to flow after sheet pile removal, spot injection grouting will be performed. Additional injection grouting will continue until seepage has been stopped. When injecting grout, staff will inspect the area to identify any grout that is observed to be short-circuiting and flowing to the surface. If observed, grouting operations will be modified (e.g., reduced injection pressure, reduced flow rate, increased depth of injection) or ceased in the areas. Measures to avoid grout flowing off the workspace include placement of erosion control measures, such as sandbags, filter socks, silt fence, and other common approaches. A vacuum truck will also be staged on site to be used to collect the grout and prevent migration, as needed.

Options Assessment

Groundwater seepage upward along the interface between the sheet piles and the soils is currently not as great as has been observed at other similar artesian flow settings in northern Minnesota. The preferential vertical flow paths that have developed between the sheets and the soils appear to be narrow and stable, with minimal amounts of soil piping. Soil piping is caused by the upward flowing groundwater reducing the effective stress of the soil in the surrounding apertures and carrying the loosened soil grains to the ground surface. The result of soil piping is to further increase the size of the flow path apertures, increase seepage to the ground surface, and make sealing more difficult and invasive.

It is our professional opinion that the proposed sealing plan described herein has the best chance of successfully sealing the groundwater seepage because it allows for the preferential flow path apertures to be sealed and grouted directly from the bottom up. Other sealing alternatives that involve attempting to seal these flow paths after the sheets have been removed will likely result in much more ground disturbance, more seepage flow to the surface, and be more difficult to successfully seal the seepage zones. Experience with artesian flow conditions has shown that quickly moving to seal preferential flow zones is imperative because if left to continue to flow to the surface, new zones of seepage will begin to develop farther from the original locations of seepage, making sealing much more difficult and require on-site grouting for a much longer period of time (perhaps several months). If grouting takes place only after sheet removal, we anticipate that a much larger volume of soil will need to be grouted and the likelihood that the underlying aquifer will need to be depressurized with high-capacity wells in order to inject grout will be greater.

In the absence of addressing the flows, it is anticipated that increased upward flow would result from removing the sheet piles. It is difficult to predict how or if increased upward flow from sheet pile removal would affect the wetland but the seepage to the ground surface that is taking place along the sheet-soil interfaces is resulting in more water at the ground surface than was present before construction. It is anticipated that the localized hydrogeologic characteristics would be slightly modified in this scenario, resulting in lower confined pressures in the lower aquifer.

Contingency Measures for Controlling Seepage

Grouting is a reliable remedy if the seepage flow rates are manageable and the seepage flow velocities are not great, as they appear to be in these locations. If the grouting plan, described above, is not successful at stopping seepage in some locations, localized pumping may be required to lower hydrostatic pressures to allow the injected grout an opportunity to set. In this situation, the Minnesota DNR will be notified that a drilling contractor with experience in drilling and pumping in artesian conditions will be engaged for the purpose of installing temporary pumping well(s) to lower the hydrostatic pressures so that additional grouting can be performed in conditions with a reduced upward vertical groundwater gradient.

If this condition is encountered, one or more multi-cased, temporary high-capacity wells, completed in the underlying confined aquifer adjacent to the seepage area(s), will be installed and pumped at a rate sufficient to temporarily stop flow at the ground surface and to reduce upward pressures in the confined aquifer to a level that will facilitate grout injection (i.e., at or near non-confined hydrogeologic conditions).

The temporary high-capacity well(s) are proposed to have the following general characteristics:

- Installed through two casings. The outer casing will be drilled to approximately 5 feet above the top of the confined aquifer and grouted in place. An inner casing will then be advanced into the confined aquifer. The borehole will be advanced approximately 20 feet into the confined aquifer and a 20-foot screen will be installed. The screen and inner casing will have a diameter of 6-12 inches to accommodate a temporary high-capacity submersible pump.

- The temporary submersible pump will be capable of pumping at a sustained rate sufficient to lower the piezometric head in the confined aquifer to the bottom of the confining unit in the immediate vicinity of the well.

- The well and pump system will be designed to prevent flow up the casing to the ground surface when not pumped.

- Pumped water will be discharged via a temporary discharge line to dewatering structure(s) sited and designed in accordance with Enbridge's Environmental Protection Plan and applicable permits and certifications. Proposed dewatering locations are shown on Figure 1. Enbridge will maintain sand filters on-site to be used to maintain compliance with Minnesota water quality standards, as needed.

- Final well construction details will be determined in consultation with the licensed well drilling contractor, who will be selected on the basis of their experience in undertaking similar projects. The drilling contractor may opt for different casing widths, depths, etc., but the overarching goals will not change: 1) installing a well that will not, itself, become a conduit for flow, and 2) depressurizing the confined aquifer at the excavation.

Surface flows should cease soon after pumping begins. Pressure grouting through injection points will commence while pumping continues using a quick-set grout. Grouting will focus on the areas of observed surface flows. Grouting will take place through the entire thickness of the confined unit in order to fill connected sand seams (if present). When the grout has had sufficient time to set up, the pumping rate of the well will be reduced and areas of flowing conditions will be identified and marked. The well's pumping rate will subsequently be increased and these additionally-identified areas will be grouted. This process will be repeated until all flow at the surface is stopped. The pumping of the well will cease. A 48-hour period will begin and conditions at the surface will be observed. If surface seepage is identified, pumping will recommence, and those areas will be grouted.

After a 48-hour period has elapsed without any visible surface flows, the temporary pump will be removed, and the well will be shut-in. It will not be abandoned for a period of at least one year in the event that seepage is observed at a later date.

Following successful grout injection and cessation of surface flows, site restoration will be completed in accordance with the LaSalle Creek Construction and Restoration Plan and SSRP, and Enbridge's September 3, 2021 memo.

Monitoring and Reporting

Flow rates of the high-capacity pump will be recorded using a totalizing flow meter. Water levels and water pressures will be monitored in the existing monitoring wells and vibrating wire piezometers during pumping and sealing of the surface seeps. Inadvertent returns of grout, if any, will be noted during grouting and will be contained. Quantities of grout used will be recorded.

A memo on the sealing will be prepared and submitted to the MDNR upon completion and will include water pressure/elevation monitoring data and estimates of dewatering efforts associated with grouting, if utilized.

A monitoring plan will be developed and submitted following the corrective action(s) taken at the site. The monitoring plan will include information on how, where, and how often the area will be visually monitored for breakthrough groundwater discharges. Additionally, the monitoring plan will identify how frequently the vibrating wire data from the piezometers will processed, analyzed, and reported to the Minnesota DNR.

Sincerely,

Ray W. Wuolo

Ray W. Wuolo, PE, PG
Vice President/Senior Hydrogeologist

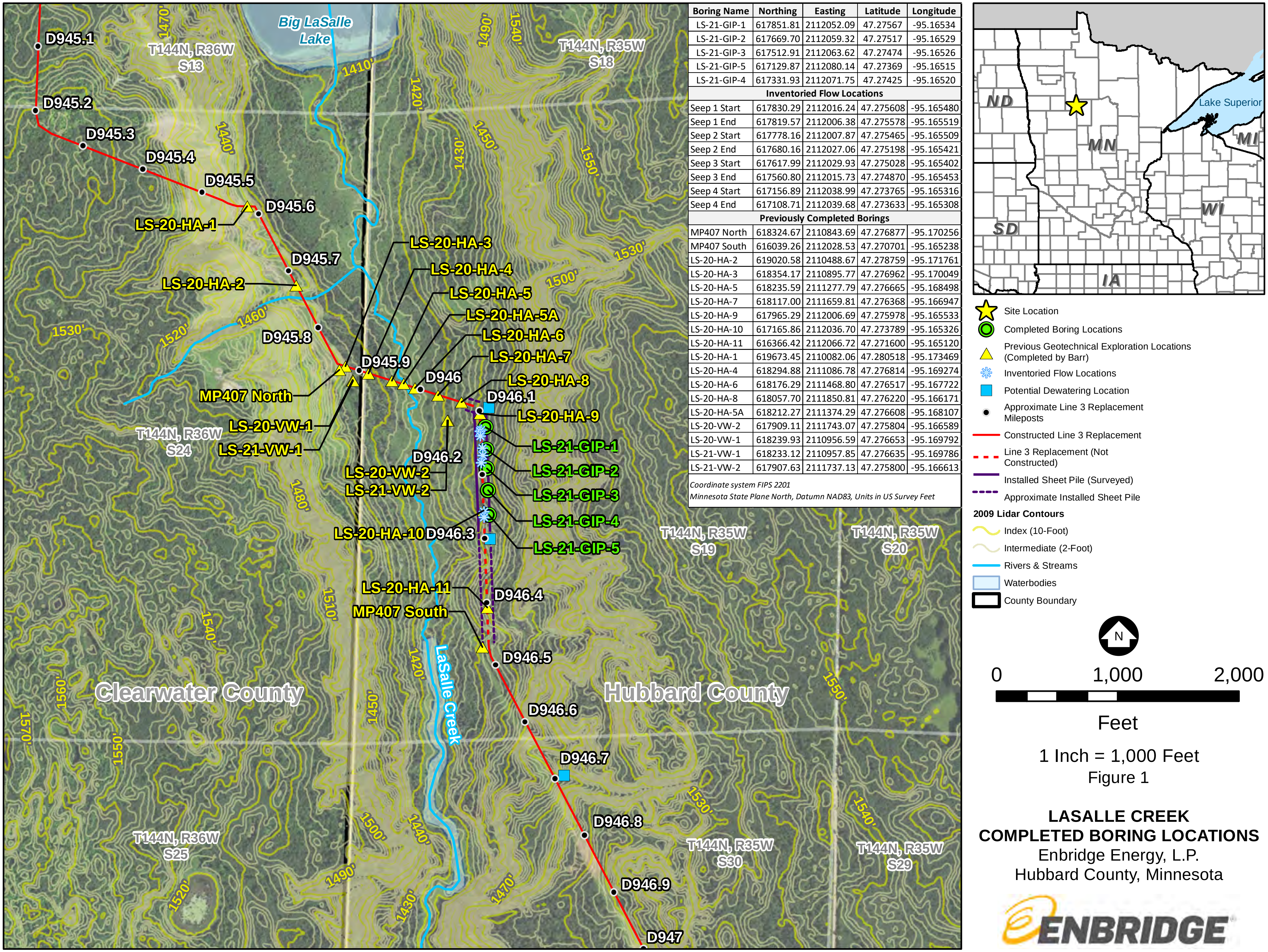
Figures

Figure 1	Completed Boring Locations

Attachments

Attachment 1	LaSalle Groundwater Investigation Data Submittal
Attachment 2	Preliminary Grouting Plan

Figures



Boring Name	Northing	Easting	Latitude	Longitude
LS-21-GIP-1	617851.81	2112052.09	47.27567	-95.16534
LS-21-GIP-2	617669.70	2112059.32	47.27517	-95.16529
LS-21-GIP-3	617512.91	2112063.62	47.27474	-95.16526
LS-21-GIP-5	617129.87	2112080.14	47.27369	-95.16515
LS-21-GIP-4	617331.93	2112071.75	47.27425	-95.16520
Inventoried Flow Locations				
Seep 1 Start	617830.29	2112016.24	47.275608	-95.165480
Seep 1 End	617819.57	2112006.38	47.275578	-95.165519
Seep 2 Start	617778.16	2112007.87	47.275465	-95.165509
Seep 2 End	617680.16	2112027.06	47.275198	-95.165421
Seep 3 Start	617617.99	2112029.93	47.275028	-95.165402
Seep 3 End	617560.80	2112015.73	47.274870	-95.165453
Seep 4 Start	617156.89	2112038.99	47.273765	-95.165316
Seep 4 End	617108.71	2112039.68	47.273633	-95.165308
Previously Completed Borings				
MP407 North	618324.67	2110843.69	47.276877	-95.170256
MP407 South	616039.26	2112028.53	47.270701	-95.165238
LS-20-HA-2	619020.58	2110488.67	47.278759	-95.171761
LS-20-HA-3	618354.17	2110895.77	47.276962	-95.170049
LS-20-HA-5	618235.59	2111277.79	47.276665	-95.168498
LS-20-HA-7	618117.00	2111659.81	47.276368	-95.166947
LS-20-HA-9	617965.29	2112006.69	47.275978	-95.165533
LS-20-HA-10	617165.86	2112036.70	47.273789	-95.165326
LS-20-HA-11	616366.42	2112066.72	47.271600	-95.165120
LS-20-HA-1	619673.45	2110082.06	47.280518	-95.173469
LS-20-HA-4	618294.88	2111086.78	47.276814	-95.169274
LS-20-HA-6	618176.29	2111468.80	47.276517	-95.167722
LS-20-HA-8	618057.70	2111850.81	47.276220	-95.166171
LS-20-HA-5A	618212.27	2111374.29	47.276608	-95.168107
LS-20-VW-2	617909.11	2111743.07	47.275804	-95.166589
LS-20-VW-1	618239.93	2110956.59	47.276653	-95.169792
LS-21-VW-1	618233.12	2110957.85	47.276635	-95.169786
LS-21-VW-2	617907.63	2111737.13	47.275800	-95.166613

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

1 Inch = 1,000 Feet

Figure 1

LASALLE CREEK
COMPLETED BORING LOCATIONS
Enbridge Energy, L.P.
Hubbard County, Minnesota

ENBRIDGE

Attachments

Attachment 1

LaSalle Groundwater Investigation Data Submittal

resourceful. naturally.
engineering and environmental consultants
BARR

Memorandum

To: Minnesota Department of Natural Resources
From: Peter Demshar (PE) and Ray Wuolo, PE, PG
Subject: LaSalle Groundwater Investigation Data Submittal – Revision 2
Date: September 24, 2021
Project: Line 3 Replacement Project

Barr Engineering Co. (Barr), under contract with Enbridge Energy, Limited Partnership (Enbridge), completed a geotechnical investigation to evaluate soil conditions and install groundwater pressure monitoring instrumentation at the proposed Line 3 Replacement (L3R) pipeline near the LaSalle River Crossing MP 946.2. The purpose of this memorandum is to provide the results of the recently completed investigation and our interpretation of the subsurface soil and groundwater conditions.

Revision 2 of this memorandum updates the vibrating wire piezometer data provided in Attachment 3.

Five borings were performed to investigate the subsurface soil and groundwater conditions (Figure 1). The boring locations were submitted to the MDNR on August 12, 2021 and August 17, 2021 and the MDNR approved these locations on August 18, 2021. The coordinates and elevations for the boring locations, provided by the project surveyor Northwestern Surveying & Engineering, Inc. of Bemidji, Minnesota, are shown in Table 1 below:

Table 1 Boring Summary

Borehole ID	Northing (ft)	Easting (ft)	Elevation (ft)
LS-21-GIP-1	617851.8	2112052.1	1433.6
LS-21-GIP-2	617669.7	2112059.3	1435.6
LS-21-GIP-3	617512.9	2112063.6	1440.4
LS-21-GIP-4	617331.9	2112071.7	1436.2
LS-21-GIP-5	617129.9	2112080.1	1431.3

Coordinate system FIPS 2201
Minnesota State Plane North, Datum NAD83

Qualified drillers, licensed in Minnesota, with experience in drilling in Minnesota artesian conditions were retained for these investigation activities. Borings LS-21-GIP-2 and LS-21-GIP-4 were completed by Traut Companies (Traut) of Waite Park, Minnesota using a truck mounted rotosonic rig to depths of 40 and 50 feet, respectively. Borings LS-21-GIP-1, LS-21-GIP-3 and LS-21-GIP-5 were completed to a depth of 20 feet by Traut, with installation of the 10-inch-diameter surficial valved casing, and subsequently completed to termination depths by Coleman Engineering Inc. of Iron Mountain, Michigan. The borings were advanced using a variety of drilling techniques described in the Work Plan, including rotosonic drilling where a 21-foot long, 10-inch diameter surface casing was installed into the confining unit, and a 6-inch outer casing with a 4-inch diameter sampler was used to advance the boring beyond the depth of the surface casing, into the confined soils. In addition, borings LS-21-GIP-1, LS-21-GIP-3 and LS-21-GIP-5 were advanced using 4 7/8-inch and 3 7/8-inch tricone mud rotary techniques with standard split spoon (SPT) sampling for depths below the surface casing (i.e., greater than 20 feet bgs). Because of the potential for pressurized groundwater conditions, the mud rotary borings were completed using high density drilling mud. To evaluate the lithology and document the presence of confining layers, rotosonic and SPT sampling was completed continuously throughout the depths of all borings.

Subsurface Conditions

The results of the geotechnical soil borings were compiled to obtain an understanding of the lithology and groundwater hydrogeology of the study area. Boring logs can be found in Attachment 1. The observed soil conditions generally consist of silty sand and clayey sands, to depths of 10-15' bgs (elevation 1427.4 – 1417.8), with shallower upper clay elevations observed in the more northern borings. This more granular surface material is underlain by gray lean clay, to depths of 31 to 35.5 to 2.5 to 13 feet (elevation 1400.6 to 1409.4 feet). Silty sand and sand with silt and gravel were noted underlying the lower contact of the confining unit. A geologic cross section representing the stratigraphy in the region is shown in Figure 2.

Groundwater was observed in borings LS-21-GIP-2 and LS-21-GIP-4 while drilling with rotosonic drilling techniques. Pressures during drilling were observed at 12.5 and 8 feet above casing elevation, respectively.

Instrumentation

Vibrating wire piezometers were installed in all borings at various depths as indicated in Table 2.

Table 2 Vibrating Wire Piezometer Summary

Piezometer ID	Serial Number	Installation Depth (ft)	Installation Elevation (ft)	Data Location
LS-21-GIP-1-A[1]	1706253	39.3	1394.3	Attachment 3A
LS-21-GIP-1-B[1]	2123058	46.3	1387.3	Attachment 3A
LS-21-GIP-2-A[1]	2134208	38.7	1396.8	Attachment 3B
LS-21-GIP-3-A[2]	2123035	35.2	1405.3	Attachment 3C
LS-21-GIP-4-A[2]	2123062	48.8	1387.5	Attachment 3D
LS-21-GIP-5-A[2]	2134210	22.3	1409.0	Attachment 3E
LS-21-GIP-5-B[2]	2108129	33.3	1398.0	Attachment 3E

1. Vibrating wire piezometer connected to automated logger
2. Vibrating wire piezometer connected to Geokon LC2x4 logger for manual data collection

Nested vibrating wire piezometers were installed in in LS-21-GIP-1 and LS-21-GIP-5 prior to abandonment while single vibrating wire piezometers were installed in LS-21-GIP-2, LS-21-GIP-3 and LS-21-GIP-4. All boreholes were backfilled with neat cement grout and bentonite slurry upon completion of drilling, in accordance with Minnesota Department of Health (MDH) requirements. Piezometer locations and associated depths/elevations are also shown on the attached Instrumentation Logs provided in Attachment 2.

A data logger system logging at 15-minute intervals was installed for the piezometers indicated in Table 2. Geokon LC2x4 dataloggers were installed at locations identified in Table 2 to provide data collection on 15-minute intervals with data collected manually from the logger at regular intervals. The previously-installed onsite weather station was utilized to correct the vibrating wire piezometer data for barometric pressure changes.

Results of the vibrating wire piezometer data indicate that pressurized groundwater conditions are present at the site. The vibrating piezometers installed LS-21-GIP-1A and B, LS-21-GIP-3A, and LS-21-GIP-5-A and B all show piezometric heads above the ground surface at the boring locations. LS-21- GIP-2A and LS-21-GIP-4A showed piezometric heads above the ground surface initially but have declined to below the ground surface since installation. This response appears to be consistent with drawdown of the potentiometric surface in response to seepage and is similar to the response from a pumping well. Data from all installed piezometers are shown in Attachment 3.

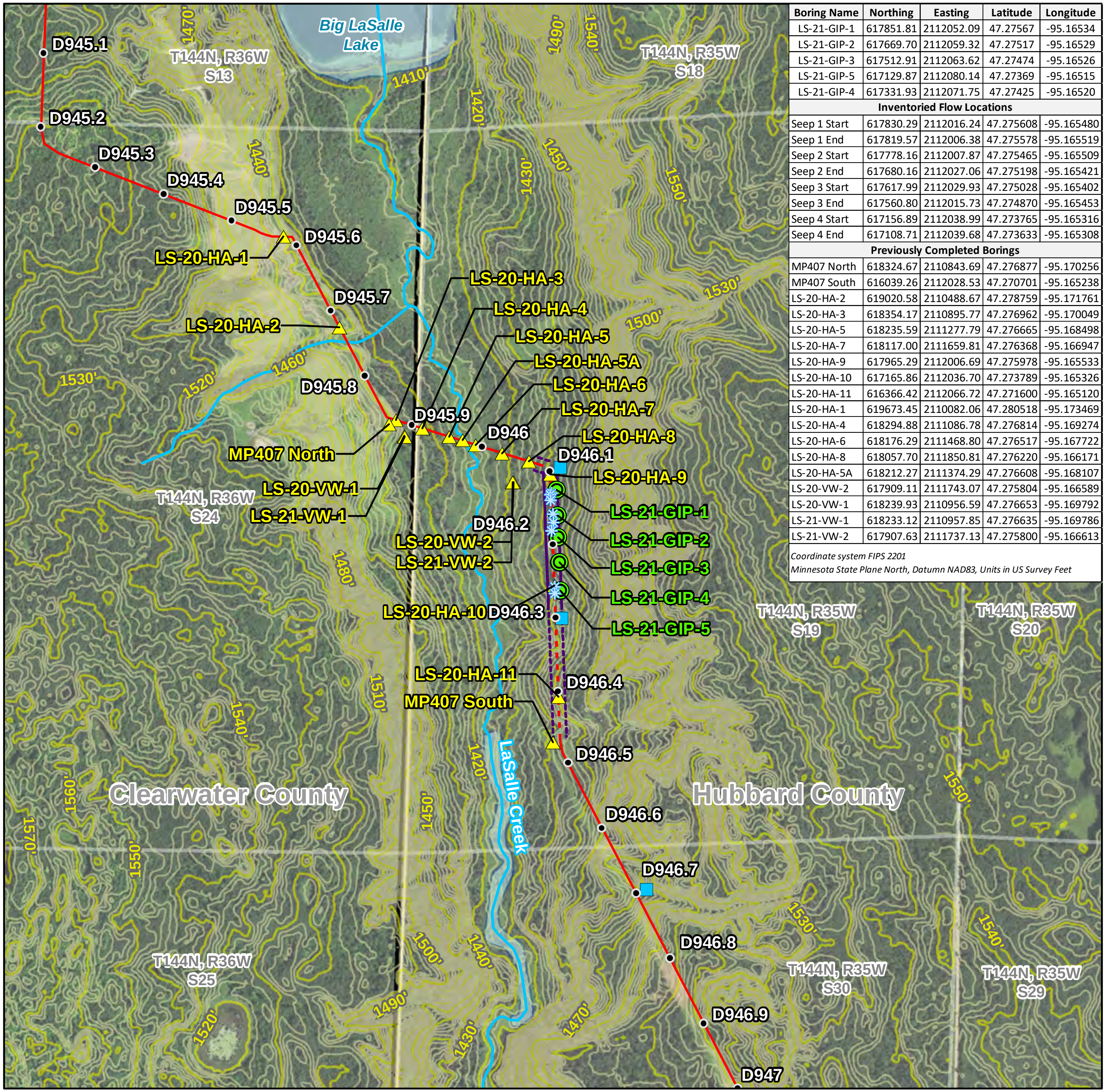
Figures

Figure 1	LaSalle Completed Boring Locations
Figure 2	LaSalle Geologic Cross Section

Attachments

Attachment 1	Soil Boring Logs
Attachment 2	Laboratory Data
Attachment 3	Vibrating Wire Piezometer Data

Figures



Boring Name	Northing	Easting	Latitude	Longitude
LS-21-GIP-1	617851.81	2112052.09	47.27567	-95.16534
LS-21-GIP-2	617669.70	2112059.32	47.27517	-95.16529
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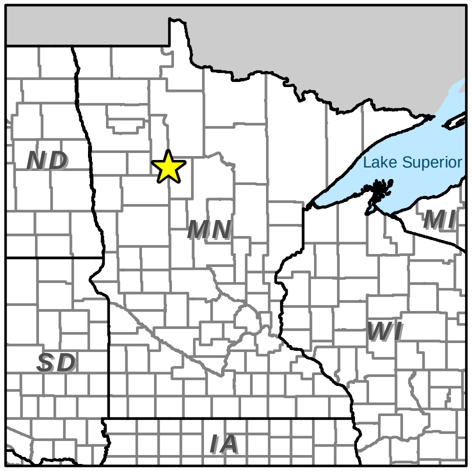
Coordinate system FIPS 2201
Minnesota State Plane North, Datumn NAD83, Units in US Survey Feet



★	Site Location
◎	Completed Boring Locations
△	Previous Geotechnical Exploration Locations (Completed by Barr)
❄	Inventoried Flow Locations
■	Potential Dewatering Location
●	Approximate Line 3 Replacement Mileposts
—	Constructed Line 3 Replacement
- -	Line 3 Replacement (Not Constructed)
—	Installed Sheet Pile (Surveyed)
- -	Approximate Installed Sheet Pile

2009 Lidar Contours

⌒	Index (10-Foot)
⌒	Intermediate (2-Foot)
—	Rivers & Streams
▭	Waterbodies
▭	County Boundary

N

0 1,000 2,000

Feet

1 Inch = 1,000 Feet

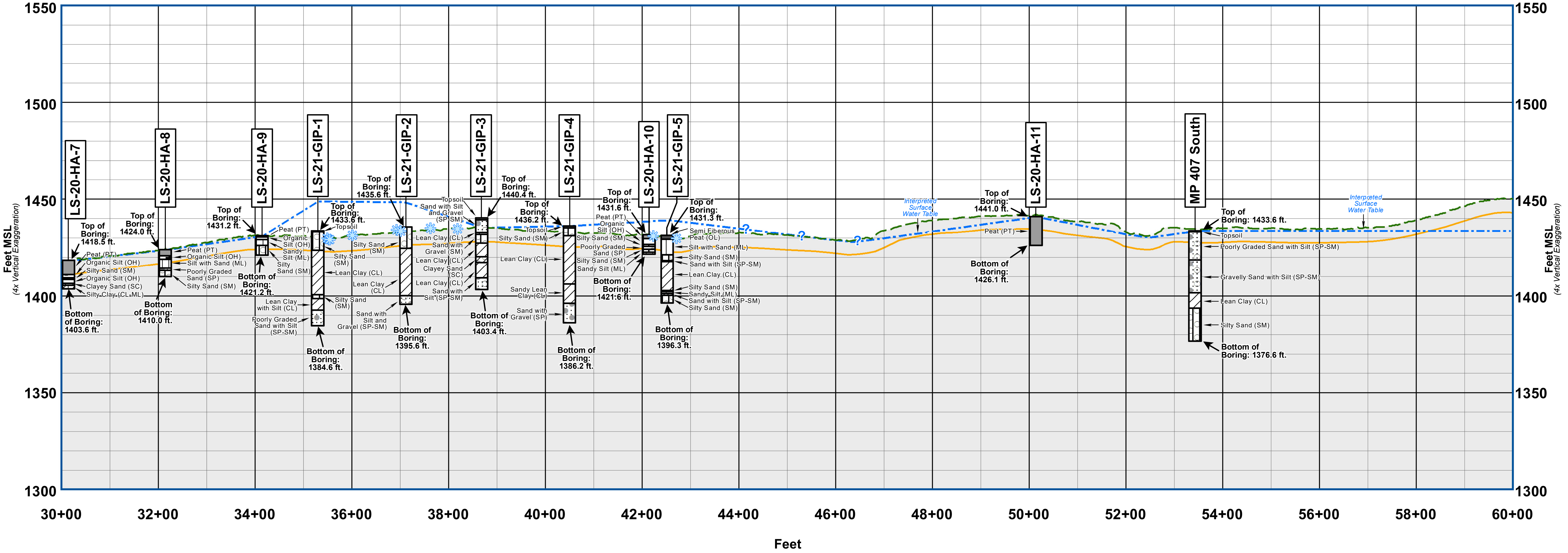
Figure 1

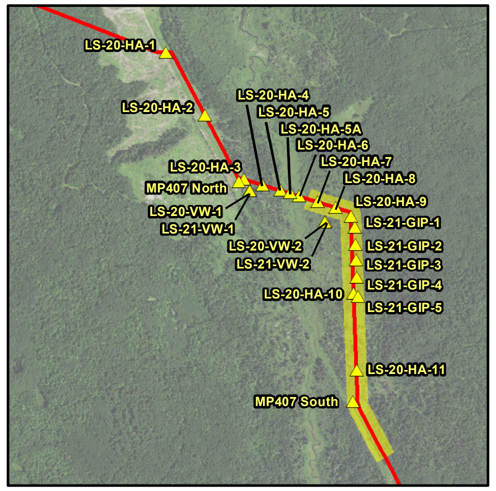
LASALLE CREEK
COMPLETED BORING LOCATIONS

Enbridge Energy, L.P.
Hubbard County, Minnesota

ENBRIDGE

Barr Footer: ArcGIS 10.8.1, 2021-09-03 03:05 File: I:\Client\Enbridge_Energy\Work_Orders\Mainline_Permitting\49161299\Work_Orders\Line3_LaSalle_Aquifer_20210810\Maps\Reports\Remedial_Action_Plan\Figure1_LaSalle_Completed_Boring_Locations.mxd User: jwk





- - - Approximate Ground Surface

-·-· Interpreted Surface Water Table

— Proposed L3R Estimated Trench Depth

❊ Approximate Artesian Seepage Location

▯ Completed Geotechnical Exploration Location (by Barr)

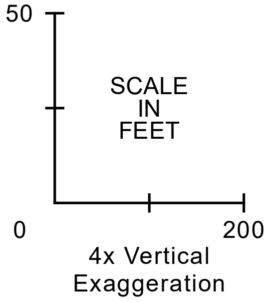


Figure 2
CROSS SECTION
LaSalle Creek
Line 3 Mainline Replacement
Clearwater & Hubbard Counties, MN

ENBRIDGE

NOTE:
Topographic information depicted based on MnTOPO LiDAR elevation data.

Attachments

Attachment 1

Soil Boring Logs

BARR

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

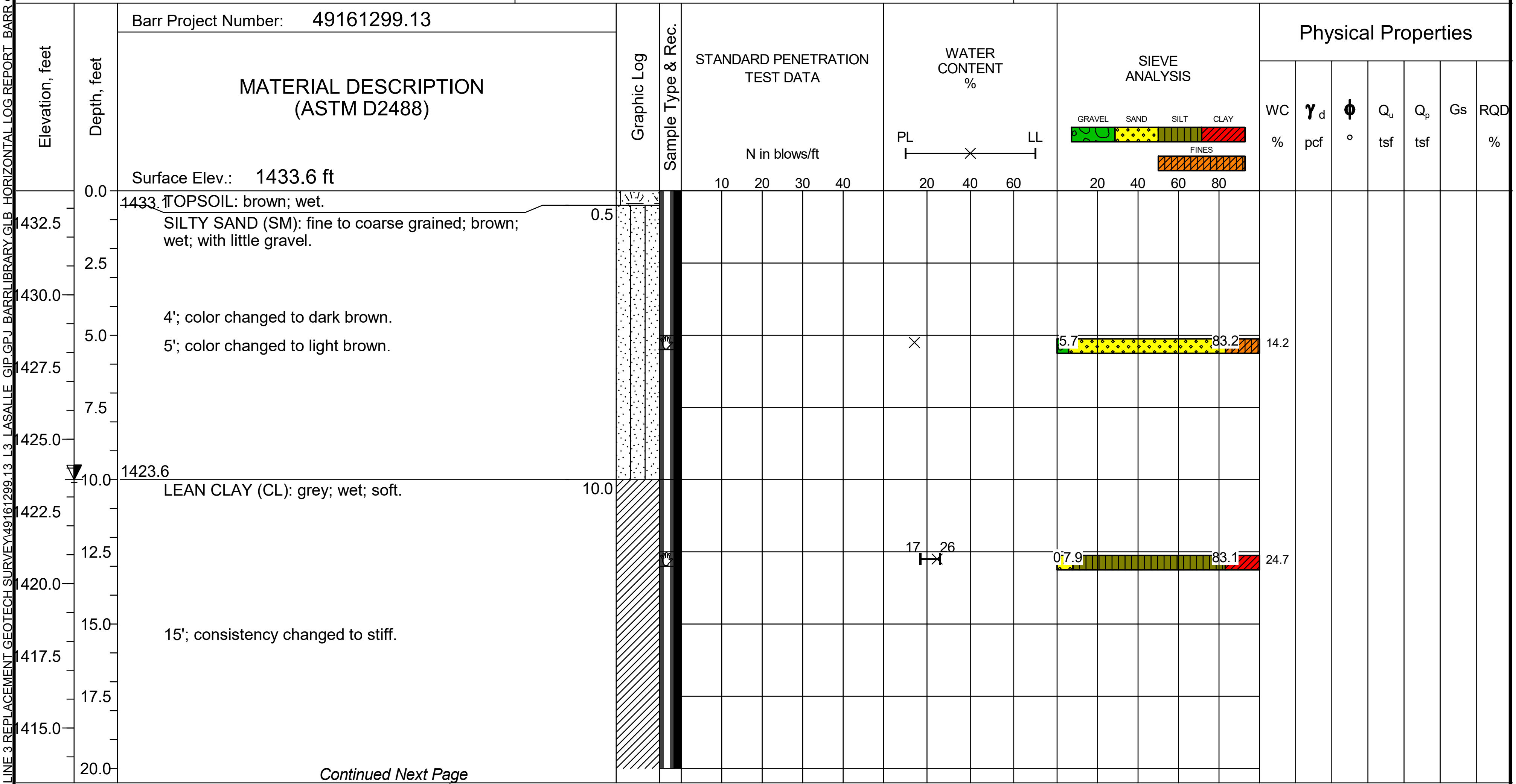
DRAFT
LOG OF BORING LS-21-GIP-1

Sheet 1 of 3

Project: L3 Replacement - LaSalle Creek GIP	Location: LaSalle Creek - MN	Client: Enbridge

Barr Project Number: 49161299.13

Surface Elev.: 1433.6 ft



MATERIAL DESCRIPTION (ASTM D2488)

Elevation, feet	Depth, feet	Material Description
1433.1	0.5	TOPSOIL: brown; wet.
		SILTY SAND (SM): fine to coarse grained; brown; wet; with little gravel.
		4'; color changed to dark brown.
		5'; color changed to light brown.
1423.6	10.0	LEAN CLAY (CL): grey; wet; soft.
		15'; consistency changed to stiff.

Continued Next Page

Depth, feet	Water Content (PL / WC / LL)	Sieve Analysis (Gravel / Sand / Fines)	WC %
5.0	✕	5.7 / 83.2	14.2
12.5	17 / 26	0 / 7.9 / 83.1	24.7

Completion Depth:	49.0
Date Boring Started:	8/17/21
Date Boring Completed:	8/19/21
Logged By:	RWO
Drilling Contractor:	Traut/Coleman
Drilling Method:	Rotosonic/Mud rotary
Ground Surface Elevation:	1433.6
Coordinates:	N 617,851.8 ft E 2,112,052.1 ft
Datum:	NAD83, NAVD88

Remarks: Rotosonic drilling method used from 0'- 20'. 21' casing set and grouted with neat cement grout. Boring completed from 20' to 49' using mud rotary.

SAMPLE TYPES

- ▯ ROCK CORE
- GRAB SAMPLE
- ☒ SPLIT SPOON
- ■ 3-inch Shelby Tube
- ⧗ MODIFIED CALIFORNIA SAMPLER

WATER LEVELS (ft)

▼ At Time of Drilling	10.0

LEGEND

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

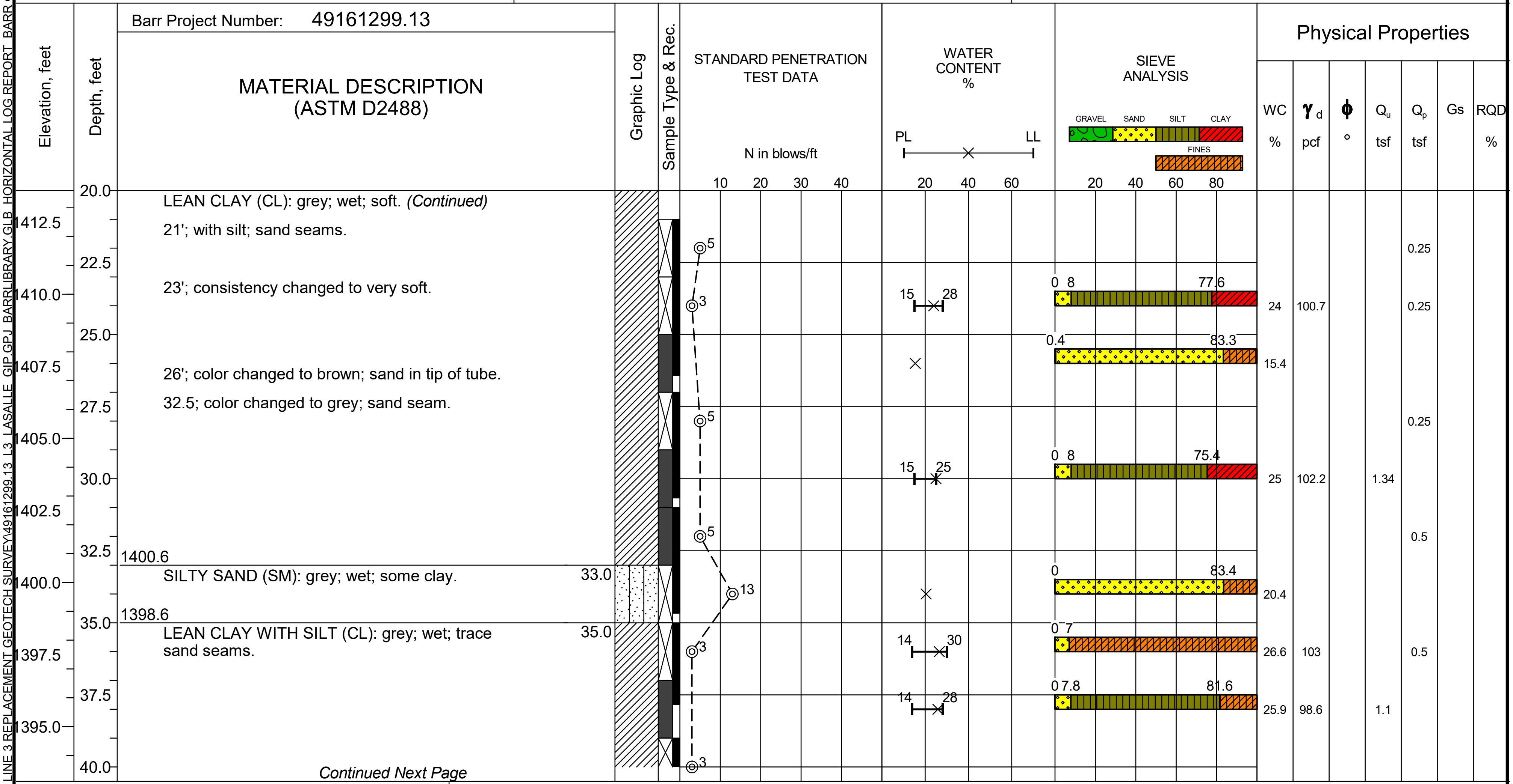
The stratification lines represent approximate boundaries. The transition may be gradual.

DRAFT
LOG OF BORING LS-21-GIP-1

Sheet 2 of 3

Project: L3 Replacement - LaSalle Creek GIP	Location: LaSalle Creek - MN	Client: Enbridge

Barr Project Number: 49161299.13



LEAN CLAY (CL): grey; wet; soft. *(Continued)*

21'; with silt; sand seams.

23'; consistency changed to very soft.

26'; color changed to brown; sand in tip of tube.

32.5; color changed to grey; sand seam.

1400.6

SILTY SAND (SM): grey; wet; some clay. 33.0

1398.6

LEAN CLAY WITH SILT (CL): grey; wet; trace sand seams. 35.0

Physical Properties

WC %	γd pcf	ϕ °	Qu tsf	Qp tsf	Gs	RQD %
				0.25		
24	100.7			0.25		
15.4						
				0.25		
25	102.2		1.34			
				0.5		
20.4						
26.6	103			0.5		
25.9	98.6		1.1			

Continued Next Page

Completion Depth:	49.0
Date Boring Started:	8/17/21
Date Boring Completed:	8/19/21
Logged By:	RWO
Drilling Contractor:	Traut/Coleman
Drilling Method:	Rotosonic/Mud rotary
Ground Surface Elevation:	1433.6
Coordinates:	N 617,851.8 ft E 2,112,052.1 ft
Datum:	NAD83, NAVD88

Remarks: Rotosonic drilling method used from 0'- 20'. 21' casing set and grouted with neat cement grout. Boring completed from 20' to 49' using mud rotary.

SAMPLE TYPES

- ROCK CORE
- GRAB SAMPLE
- SPLIT SPOON
- 3-inch Shelby Tube
- MODIFIED CALIFORNIA SAMPLER

WATER LEVELS (ft)

▼ At Time of Drilling	10.0

LEGEND

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

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

BARR

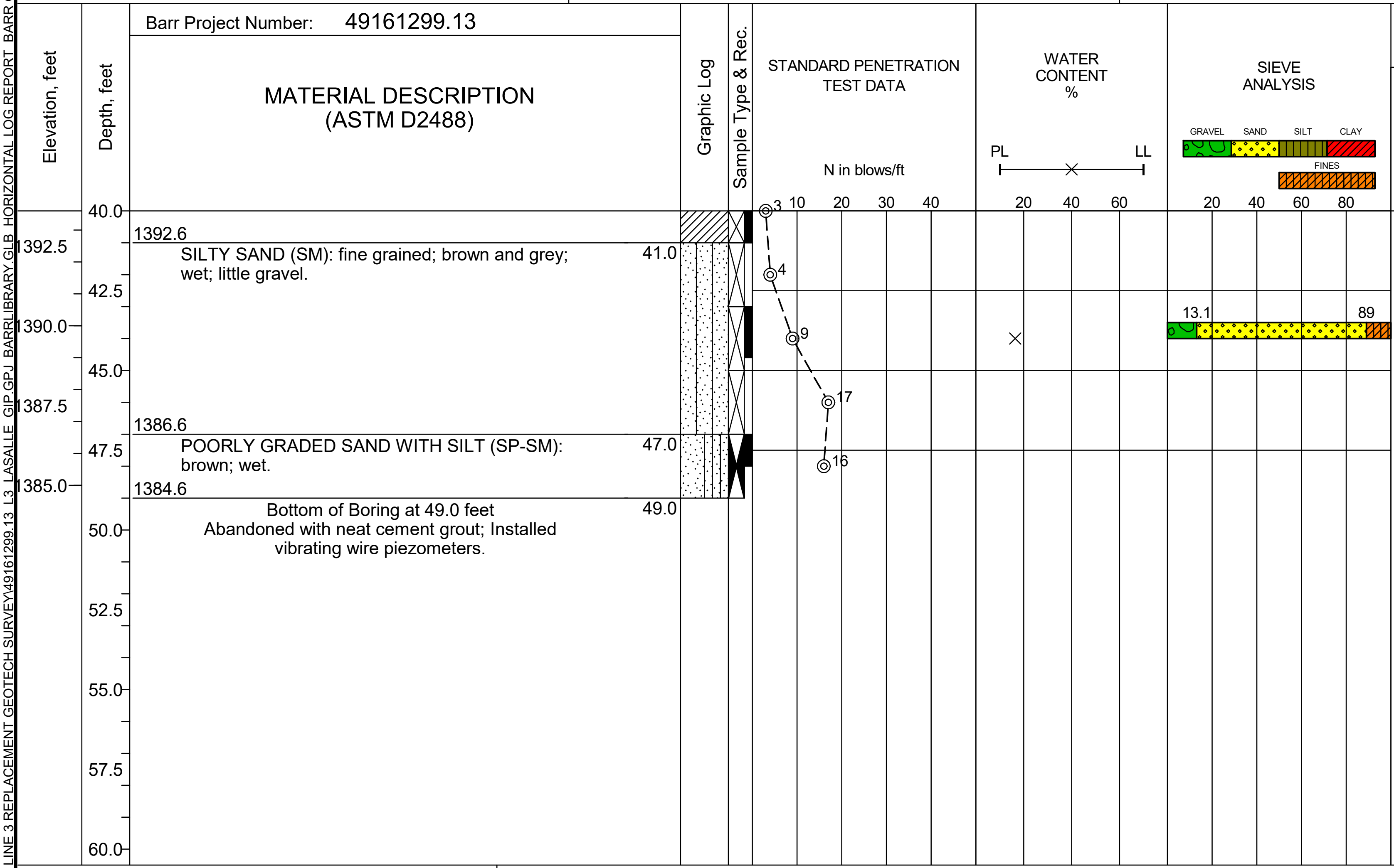
Barr Engineering Company
325 South Lake Avenue, Suite 700
Duluth, MN 55802
Telephone: 218-529-8200

DRAFT
LOG OF BORING LS-21-GIP-1

Sheet 3 of 3

Project: L3 Replacement - LaSalle Creek GIP
Location: LaSalle Creek - MN
Client: Enbridge

Barr Project Number: 49161299.13



MATERIAL DESCRIPTION (ASTM D2488)

Elevation, feet	Material Description	Depth, feet	WC %
1392.6	SILTY SAND (SM): fine grained; brown and grey; wet; little gravel.	41.0	16.4
1386.6	POORLY GRADED SAND WITH SILT (SP-SM): brown; wet.	47.0	
1384.6	Bottom of Boring at 49.0 feet Abandoned with neat cement grout; Installed vibrating wire piezometers.	49.0	

Physical Properties

WC %	γ_d pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
16.4						

Completion Depth:	49.0
Date Boring Started:	8/17/21
Date Boring Completed:	8/19/21
Logged By:	RWO
Drilling Contractor:	Traut/Coleman
Drilling Method:	Rotosonic/Mud rotary
Ground Surface Elevation:	1433.6
Coordinates:	N 617,851.8 ft E 2,112,052.1 ft
Datum:	NAD83, NAVD88

Remarks: Rotosonic drilling method used from 0'- 20'. 21' casing set and grouted with neat cement grout. Boring completed from 20' to 49' using mud rotary.

SAMPLE TYPES

- ▯ ROCK CORE
- ✋ GRAB SAMPLE
- ☒ SPLIT SPOON
- ■ 3-inch Shelby Tube
- ⧗ MODIFIED CALIFORNIA SAMPLER

WATER LEVELS (ft)

▼ At Time of Drilling 10.0

LEGEND

MC	Moisture Content	Q_u	Unconfined Compression
γ	Dry Unit Weight	Q_p	Hand Penetrometer UC
ϕ	Friction Angle	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\49161299.13 L3_LASALLE_GIP.GPJ BARR\LIBRARY.GLB HORIZONTAL LOG REPORT_BARR GEOTECH TEMPLATE.GDT

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

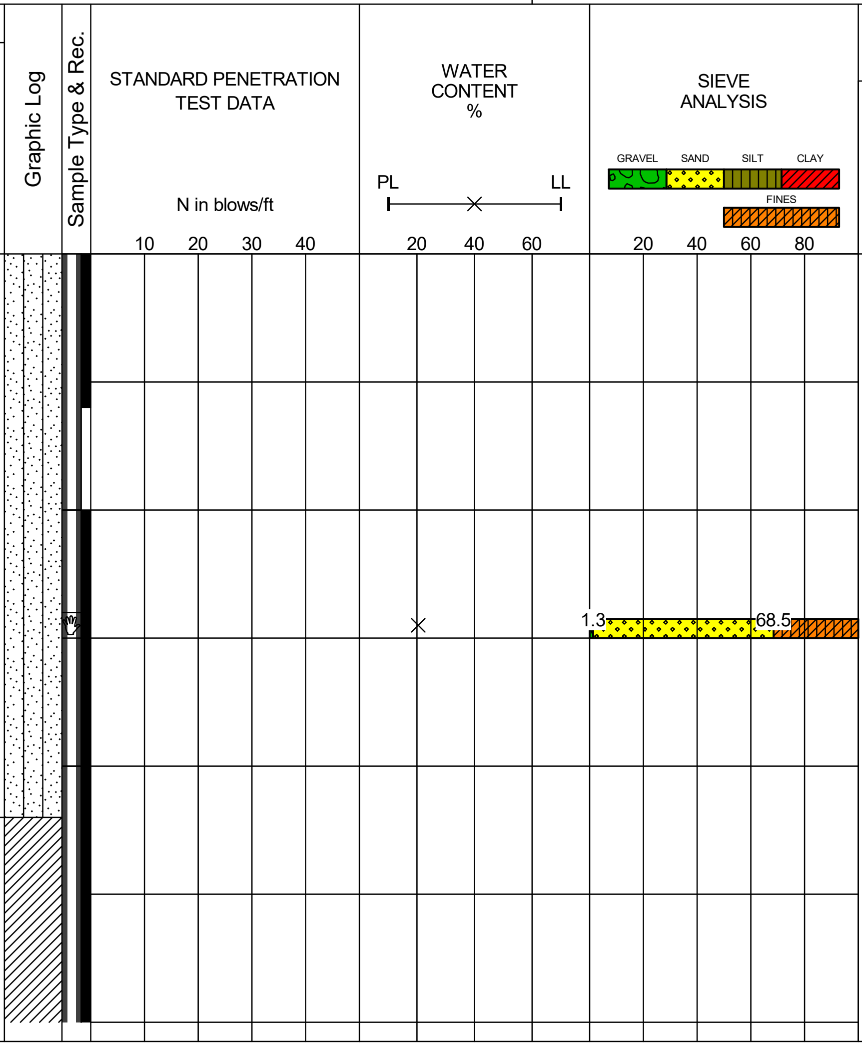
DRAFT
LOG OF BORING LS-21-GIP-2

Sheet 1 of 3

Project: L3 Replacement - LaSalle Creek GIP | Location: LaSalle Creek - MN | Client: Enbridge

Barr Project Number: 49161299.13

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)
		Surface Elev.: 1435.6 ft
	0.0	SILTY SAND (SM): red and brown; wet; occasional pieces of clay.
1435.0		
	2.5	
1432.5		
	5.0	5'; color changed to light brown; with gravel.
1430.0		
	7.5	
1427.5		
	10.0	
1425.0		
1424.6	11.0	LEAN CLAY (CL): grey; wet; fine sand or silt seams.
	12.5	
1422.5		
	15.0	



Physical Properties

WC %	γ_d pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
20.4						

Continued Next Page

Completion Depth:	40.0
Date Boring Started:	8/17/21
Date Boring Completed:	8/19/21
Logged By:	RWO
Drilling Contractor:	Traut
Drilling Method:	Rotosonic
Ground Surface Elevation:	1435.6
Coordinates:	N 617,669.7 ft E 2,112,059.3 ft
Datum:	NAD83, NAVD88

Remarks: Rotosonic drilling method used from 0'- 20'. 21' casing set and grouted with neat cement grout. Boring completed from 20' to 40' using rotosonic.

SAMPLE TYPES

▯ ROCK CORE
✋ GRAB SAMPLE
▮ LARGE SOIL BAGS

WATER LEVELS (ft)

▼	At Time of Drilling	0.0
▼	0.3 hrs At Time of Drilling	-9.5
▽	0.75 hrs After Drilling	-12.5

LEGEND

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

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

DRAFT
LOG OF BORING LS-21-GIP-2

Sheet 2 of 3

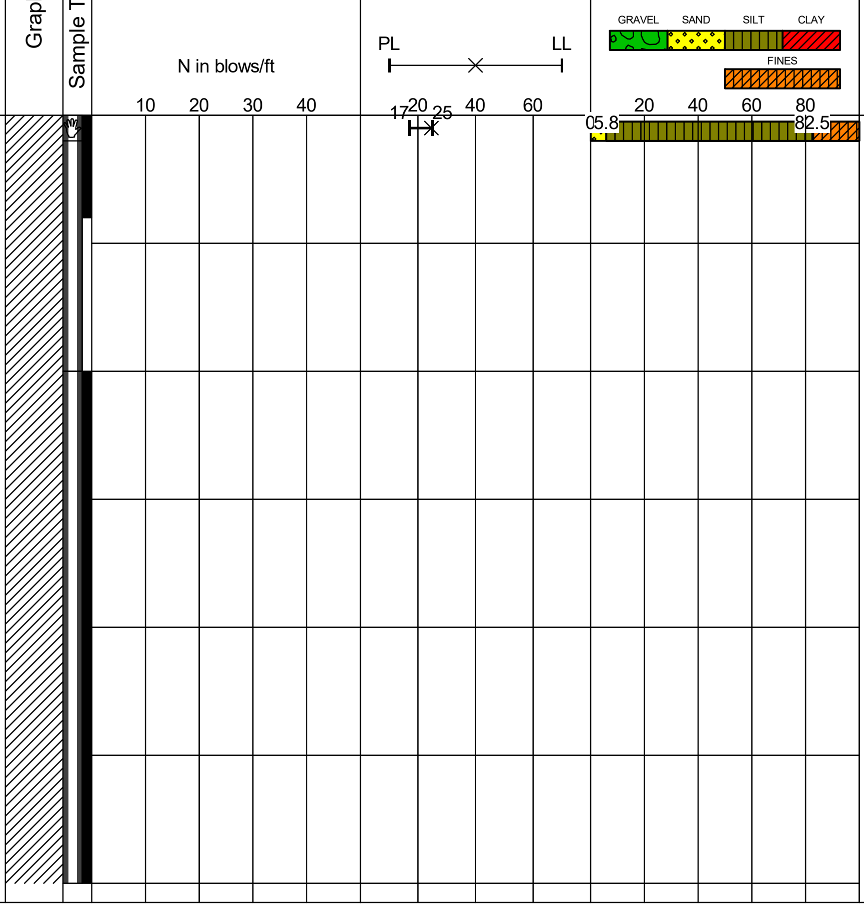
Project: L3 Replacement - LaSalle Creek GIP	Location: LaSalle Creek - MN	Client: Enbridge

Barr Project Number: 49161299.13

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)
1420.0	15.0	LEAN CLAY (CL): grey; wet; fine sand or silt seams. *(Continued)*
1417.5	17.5	
1415.0	20.0	
		21'; 3" silty sand seam.
1412.5	22.5	22'; 2" silty sand seam.
1410.0	25.0	
1407.5	27.5	
	30.0	

Continued Next Page

Graphic Log | Sample Type & Rec. | STANDARD PENETRATION TEST DATA | WATER CONTENT % | SIEVE ANALYSIS



Physical Properties

WC %	γd pcf	ϕ °	Qu tsf	Qp tsf	Gs	RQD %
24.7						

Completion Depth:	40.0
Date Boring Started:	8/17/21
Date Boring Completed:	8/19/21
Logged By:	RWO
Drilling Contractor:	Traut
Drilling Method:	Rotosonic
Ground Surface Elevation:	1435.6
Coordinates:	N 617,669.7 ft E 2,112,059.3 ft
Datum:	NAD83, NAVD88

Remarks: Rotosonic drilling method used from 0'- 20'. 21' casing set and grouted with neat cement grout. Boring completed from 20' to 40' using rotosonic.

SAMPLE TYPES

▯ ROCK CORE
✋ GRAB SAMPLE
■ LARGE SOIL BAGS

WATER LEVELS (ft)

▼ At Time of Drilling	0.0
▼ 0.3 hrs At Time of Drilling	-9.5
▽ 0.75 hrs After Drilling	-12.5

LEGEND

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

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

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DRAFT
LOG OF BORING LS-21-GIP-2

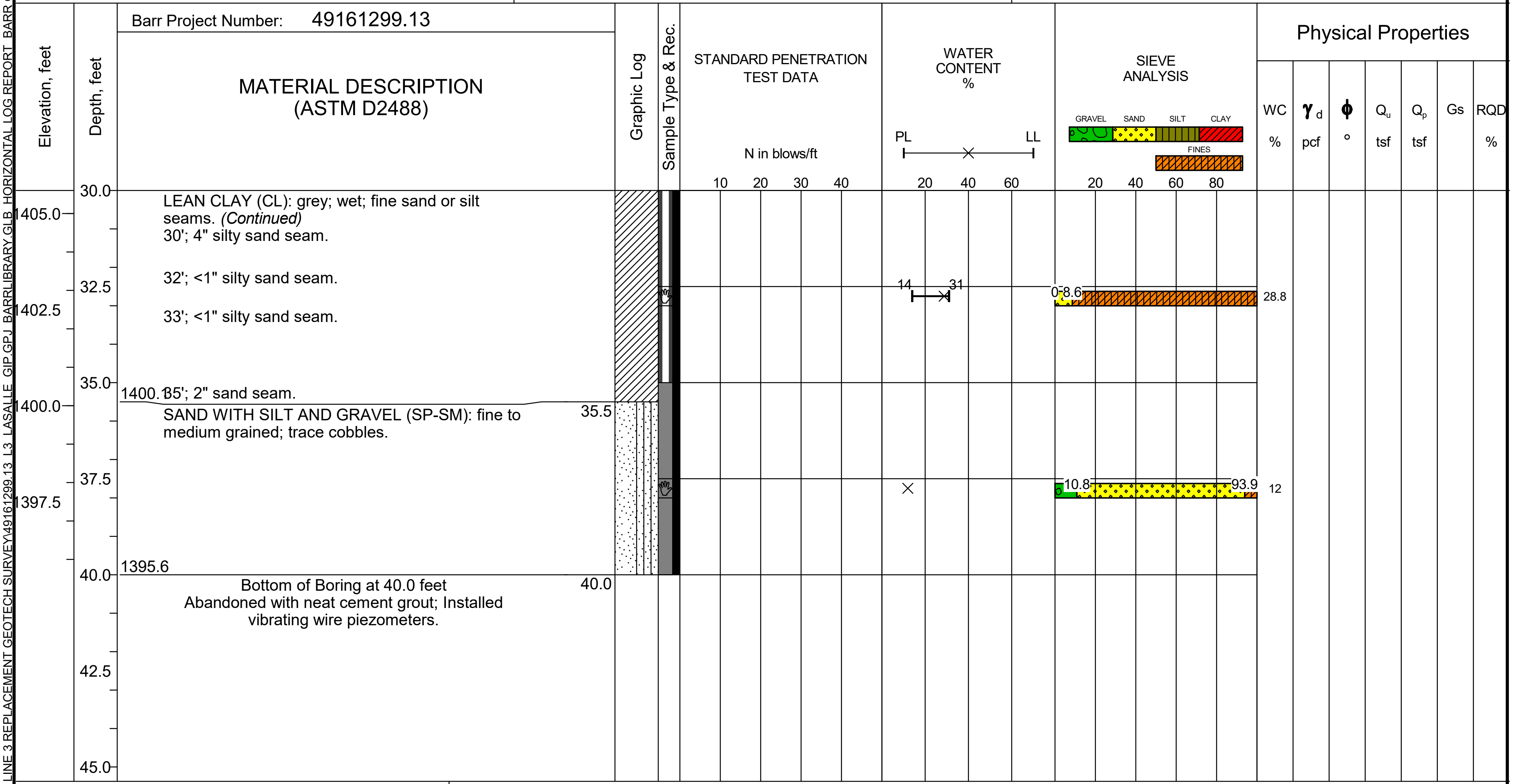
Sheet 3 of 3

Project: L3 Replacement - LaSalle Creek GIP
Location: LaSalle Creek - MN
Client: Enbridge

Barr Project Number: 49161299.13

MATERIAL DESCRIPTION (ASTM D2488)

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)
	30.0	LEAN CLAY (CL): grey; wet; fine sand or silt seams. *(Continued)* 30'; 4" silty sand seam. 32'; <1" silty sand seam. 33'; <1" silty sand seam. 35'; 2" sand seam.
1400.1	35.5	SAND WITH SILT AND GRAVEL (SP-SM): fine to medium grained; trace cobbles.
1395.6	40.0	Bottom of Boring at 40.0 feet Abandoned with neat cement grout; Installed vibrating wire piezometers.



Completion Depth:	40.0
Date Boring Started:	8/17/21
Date Boring Completed:	8/19/21
Logged By:	RWO
Drilling Contractor:	Traut
Drilling Method:	Rotosonic
Ground Surface Elevation:	1435.6
Coordinates:	N 617,669.7 ft E 2,112,059.3 ft
Datum:	NAD83, NAVD88

Remarks: Rotosonic drilling method used from 0'- 20'. 21' casing set and grouted with neat cement grout. Boring completed from 20' to 40' using rotosonic.

SAMPLE TYPES

▯ ROCK CORE
✋ GRAB SAMPLE
▮ LARGE SOIL BAGS

WATER LEVELS (ft)

▼	At Time of Drilling	0.0
▼	0.3 hrs At Time of Drilling	-9.5
▽	0.75 hrs After Drilling	-12.5

LEGEND

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

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

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DRAFT
LOG OF BORING LS-21-GIP-3

Sheet 1 of 2

Project: L3 Replacement - LaSalle Creek GIP
Location: LaSalle Creek - MN
Client: Enbridge

Barr Project Number: 49161299.13

Surface Elev.: 1440.4 ft

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	WC %
1439.4	1.0	TOPSOIL: brown.	
		SAND WITH SILT AND GRAVEL (SP-SM): fine to medium grained; brown; moist.	
		5'; color changed to light brown; moisture changed to wet.	15.4
1432.9	7.5	7.5'; sandy lean clay; grey.	
		SAND WITH GRAVEL (SM): fine to coarse grained; brown; wet; seams of brown sandy clay.	
1427.4	13.0	LEAN CLAY (CL): grey; wet; soft.	24.8
1420.4	20.0		

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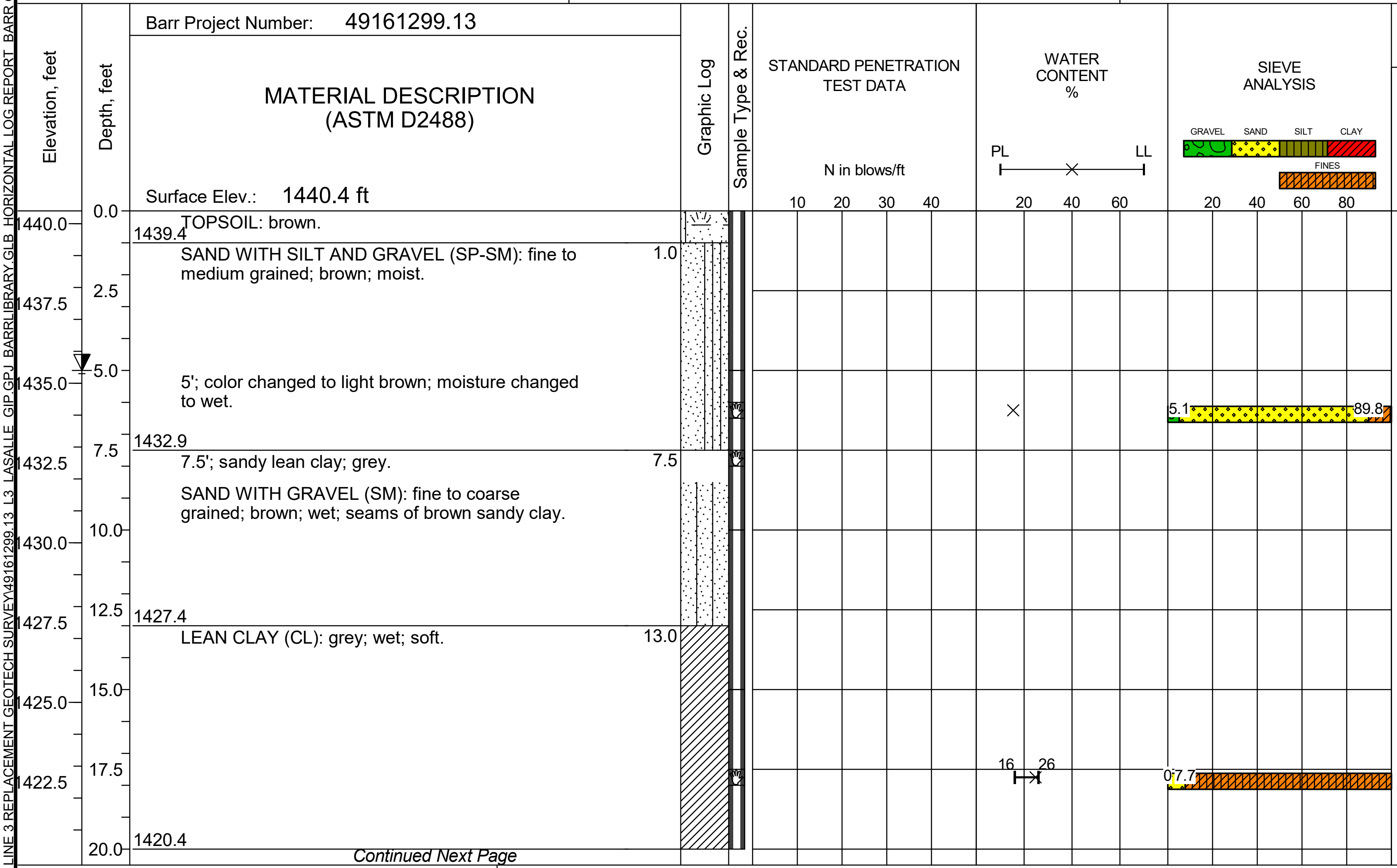

Physical Properties

WC %	γd pcf	ϕ °	Qu tsf	Qp tsf	Gs	RQD %
15.4						
24.8						

Completion Depth:	37.0
Date Boring Started:	8/18/21
Date Boring Completed:	8/18/21
Logged By:	RWO
Drilling Contractor:	Traut/Coleman
Drilling Method:	Rotosonic/Mud rotary
Ground Surface Elevation:	1440.4
Coordinates:	N 617,512.9 ft E 2,112,063.6 ft
Datum:	NAD83, NAVD88

Remarks: Rotosonic drilling method used from 0'- 20'. 21' casing set and grouted with neat cement grout. Boring completed from 20' to 37' using mud rotary.

SAMPLE TYPES

- ROCK CORE
- GRAB SAMPLE
- SPLIT SPOON
- 3-inch Shelby Tube
- MODIFIED CALIFORNIA SAMPLER

WATER LEVELS (ft)

▽ At Time of Drilling 5.0

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.

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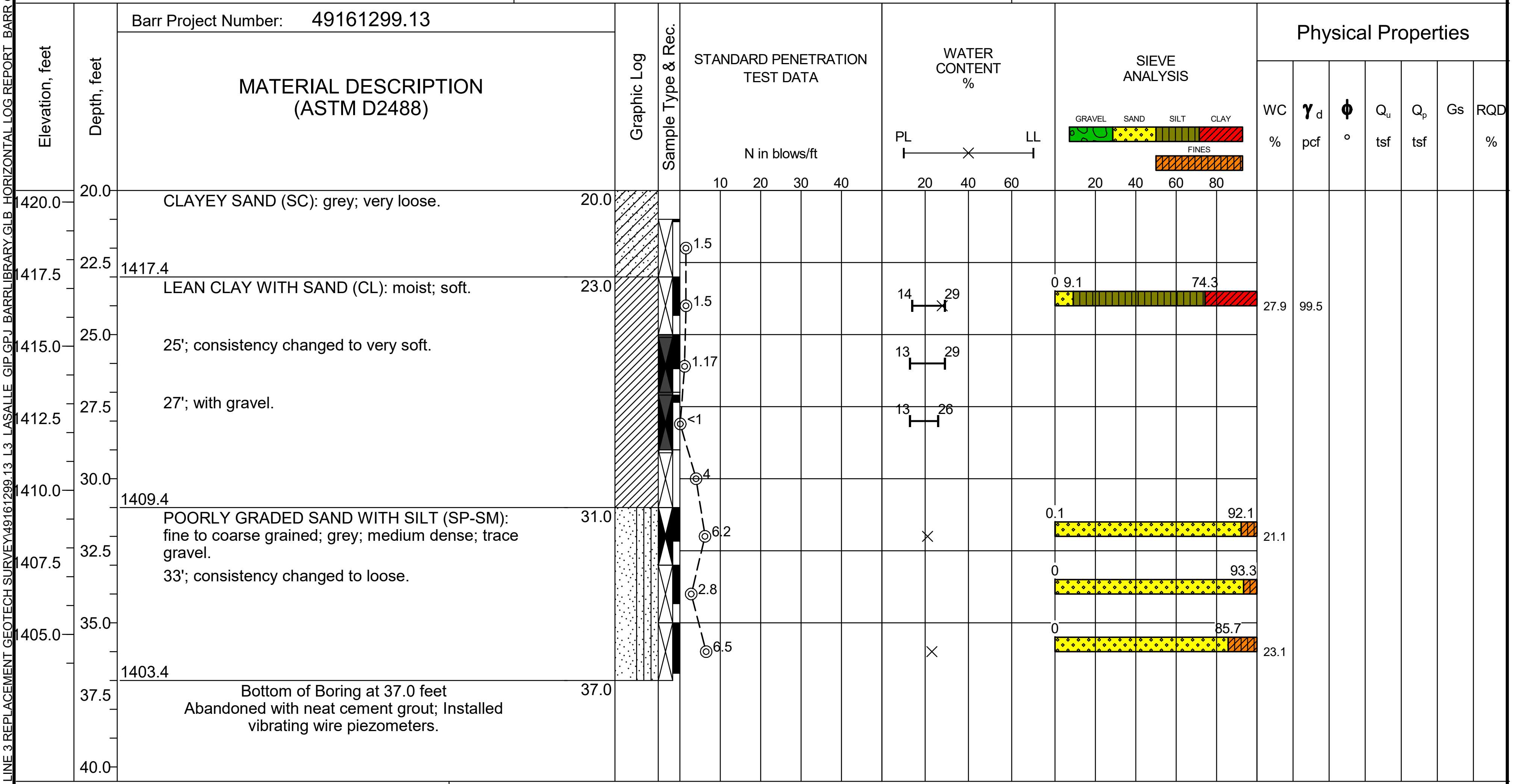
DRAFT
LOG OF BORING LS-21-GIP-3

Sheet 2 of 2

Project:	L3 Replacement - LaSalle Creek GIP	Location:	LaSalle Creek - MN	Client:	Enbridge

Barr Project Number: 49161299.13



CLAYEY SAND (SC): grey; very loose.

LEAN CLAY WITH SAND (CL): moist; soft.

25'; consistency changed to very soft.

27'; with gravel.

POORLY GRADED SAND WITH SILT (SP-SM): fine to coarse grained; grey; medium dense; trace gravel.

33'; consistency changed to loose.

Bottom of Boring at 37.0 feet
Abandoned with neat cement grout; Installed vibrating wire piezometers.

Completion Depth:	37.0
Date Boring Started:	8/18/21
Date Boring Completed:	8/18/21
Logged By:	RWO
Drilling Contractor:	Traut/Coleman
Drilling Method:	Rotosonic/Mud rotary
Ground Surface Elevation:	1440.4
Coordinates:	N 617,512.9 ft E 2,112,063.6 ft
Datum:	NAD83, NAVD88

Remarks: Rotosonic drilling method used from 0'- 20'. 21' casing set and grouted with neat cement grout. Boring completed from 20' to 37' using mud rotary.

SAMPLE TYPES

- ROCK CORE
- GRAB SAMPLE
- SPLIT SPOON
- 3-inch Shelby Tube
- MODIFIED CALIFORNIA SAMPLER

WATER LEVELS (ft)

▼ At Time of Drilling 5.0

LEGEND

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

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

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DRAFT
LOG OF BORING LS-21-GIP-4

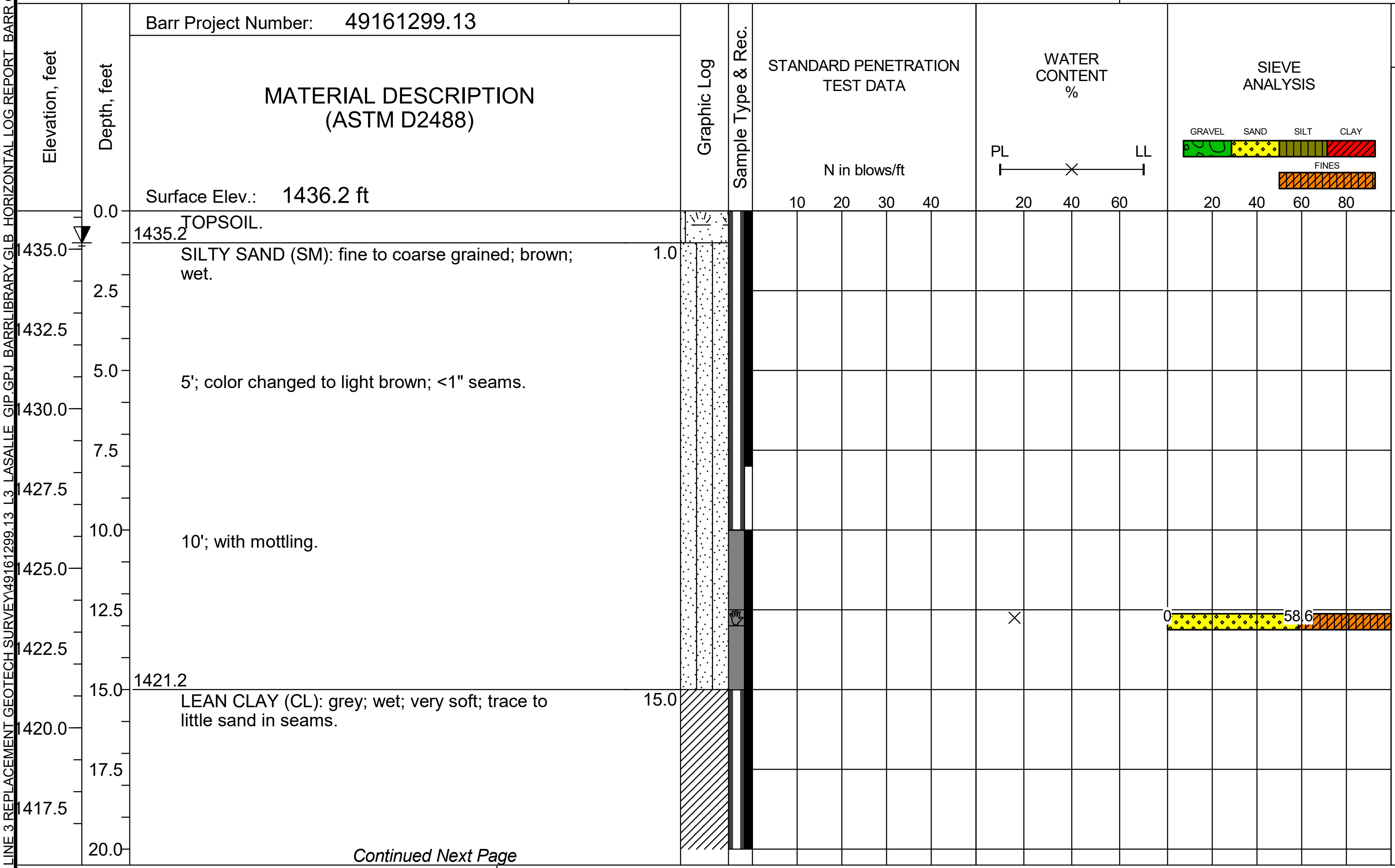
Sheet 1 of 3

Project: L3 Replacement - LaSalle Creek GIP	Location: LaSalle Creek - MN	Client: Enbridge

Barr Project Number: 49161299.13

Surface Elev.: 1436.2 ft

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	WC %	γ d pcf	ϕ °	Q_u tsf	Q_p tsf	Gs	RQD %
	0.0	TOPSOIL.							
1435.2	1.0	SILTY SAND (SM): fine to coarse grained; brown; wet.							
		5'; color changed to light brown; <1" seams.							
		10'; with mottling.							
			16.1						
1421.2	15.0	LEAN CLAY (CL): grey; wet; very soft; trace to little sand in seams.							



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Completion Depth:	50.0
Date Boring Started:	8/18/21
Date Boring Completed:	8/19/21
Logged By:	RWO
Drilling Contractor:	Traut
Drilling Method:	Rotosonic
Ground Surface Elevation:	1436.2
Coordinates:	N 617,129.9 ft E 2,112,080.1 ft
Datum:	NAD83, NAVD88

Remarks: Rotosonic drilling method used from 0'- 20'. 21' casing set and grouted with neat cement grout. Boring completed from 20' to 50' using rotosonic.

SAMPLE TYPES

▯ ROCK CORE ▮ LARGE SOIL BAGS ☐ GRAB SAMPLE

WATER LEVELS (ft)

▼	At Time of Drilling	1.0
▽	0.5 hrs After Drilling	-8.0

LEGEND

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

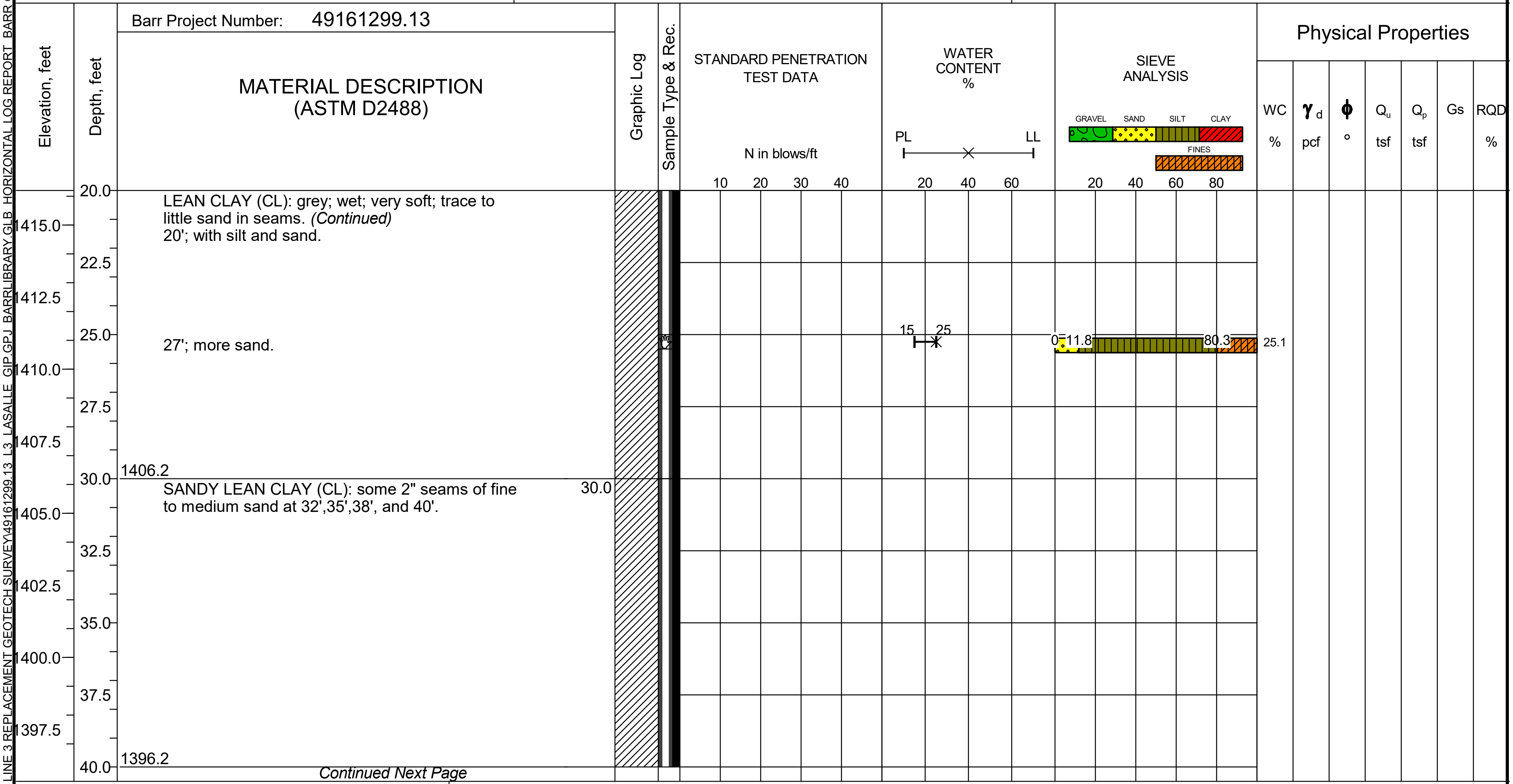
The stratification lines represent approximate boundaries. The transition may be gradual.

DRAFT
LOG OF BORING LS-21-GIP-4

Sheet 2 of 3

Project: L3 Replacement - LaSalle Creek GIP | Location: LaSalle Creek - MN | Client: Enbridge

Barr Project Number: 49161299.13



LEAN CLAY (CL): grey; wet; very soft; trace to little sand in seams. *(Continued)*
20'; with silt and sand.

27'; more sand.

1406.2 | 30.0

SANDY LEAN CLAY (CL): some 2" seams of fine to medium sand at 32',35',38', and 40'.

1396.2

Continued Next Page

Completion Depth:	50.0
Date Boring Started:	8/18/21
Date Boring Completed:	8/19/21
Logged By:	RWO
Drilling Contractor:	Traut
Drilling Method:	Rotosonic
Ground Surface Elevation:	1436.2
Coordinates:	N 617,129.9 ft E 2,112,080.1 ft
Datum:	NAD83, NAVD88

Remarks: Rotosonic drilling method used from 0'- 20'. 21' casing set and grouted with neat cement grout. Boring completed from 20' to 50' using rotosonic.

SAMPLE TYPES

▯ ROCK CORE
▮ LARGE SOIL BAGS
✋ GRAB SAMPLE

WATER LEVELS (ft)

▼ At Time of Drilling	1.0
▽ 0.5 hrs After Drilling	-8.0

LEGEND

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

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

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DRAFT
LOG OF BORING LS-21-GIP-4

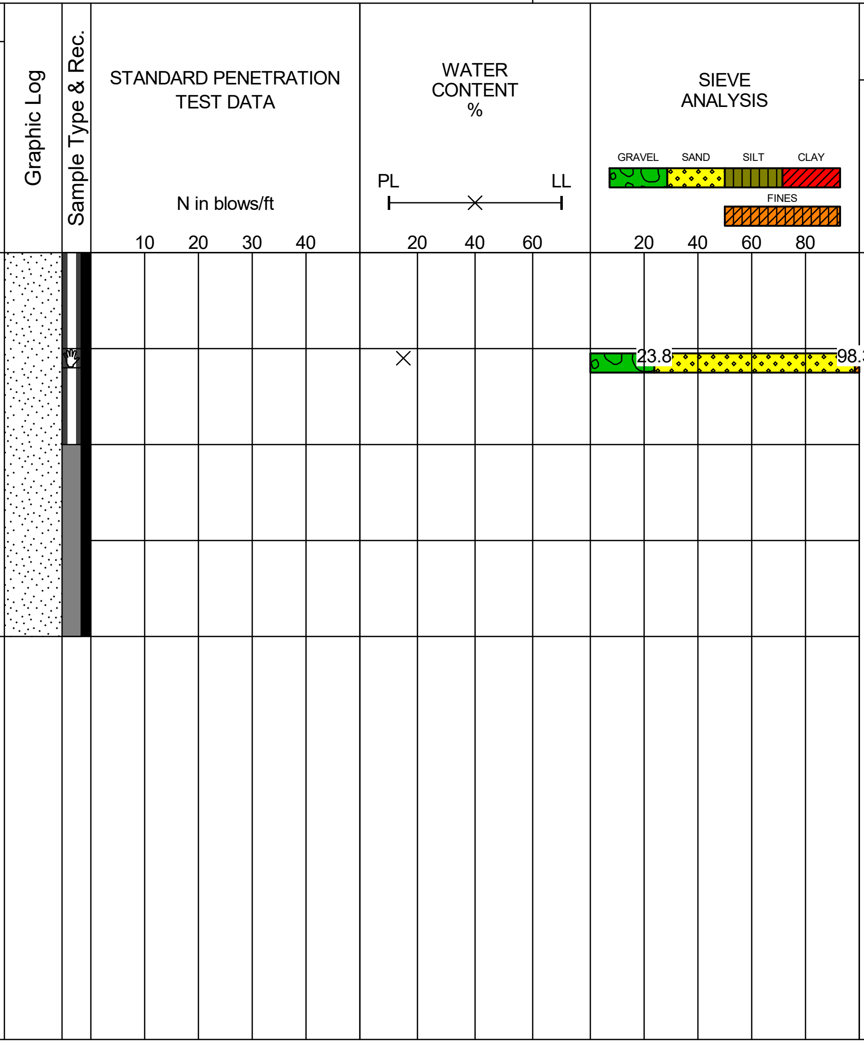
Sheet 3 of 3

Project: L3 Replacement - LaSalle Creek GIP	Location: LaSalle Creek - MN	Client: Enbridge

Barr Project Number: 49161299.13

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)		WC %	γ d pcf	ϕ °	Qu tsf	Qp tsf	Gs	RQD %
	40.0	SAND WITH GRAVEL (SP): fine to coarse grained; grey; wet; trace silt; few cobbles.	40.0							
	42.5			5.1						
1386.2	50.0	Bottom of Boring at 50.0 feet Abandoned with neat cement grout; Installed vibrating wire piezometers.	50.0							

Elevation scale: 1395.0, 1392.5, 1390.0, 1387.5
Depth scale: 40.0, 42.5, 45.0, 47.5, 50.0, 52.5, 55.0, 57.5, 60.0



Completion Depth: 50.0
Date Boring Started: 8/18/21
Date Boring Completed: 8/19/21
Logged By: RWO
Drilling Contractor: Traut
Drilling Method: Rotosonic
Ground Surface Elevation: 1436.2
Coordinates: N 617,129.9 ft E 2,112,080.1 ft
Datum: NAD83, NAVD88

Remarks: Rotosonic drilling method used from 0'- 20'. 21' casing set and grouted with neat cement grout. Boring completed from 20' to 50' using rotosonic.

SAMPLE TYPES

▯ ROCK CORE
▮ LARGE SOIL BAGS
✋ GRAB SAMPLE

WATER LEVELS (ft)

▼	At Time of Drilling	1.0
▽	0.5 hrs After Drilling	-8.0

LEGEND

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

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

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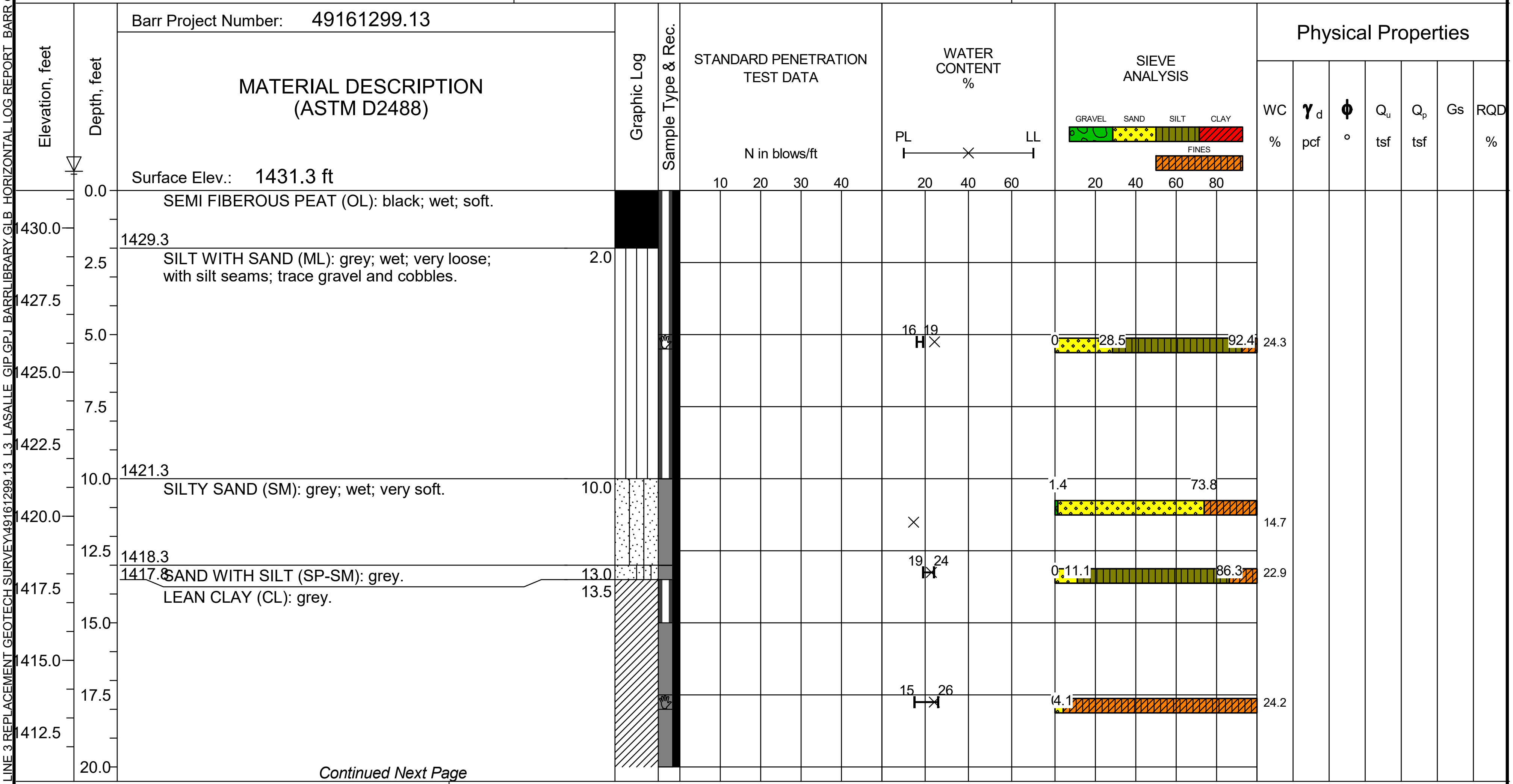
DRAFT
LOG OF BORING LS-21-GIP-5

Sheet 1 of 2

Project: L3 Replacement - LaSalle Creek GIP	Location: LaSalle Creek - MN	Client: Enbridge

Barr Project Number: 49161299.13

Surface Elev.: 1431.3 ft



Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)
	0.0	SEMI FIBEROUS PEAT (OL): black; wet; soft.
1429.3	2.0	SILT WITH SAND (ML): grey; wet; very loose; with silt seams; trace gravel and cobbles.
1421.3	10.0	SILTY SAND (SM): grey; wet; very soft.
1418.3	13.0	SAND WITH SILT (SP-SM): grey.
1417.8	13.5	LEAN CLAY (CL): grey.

Continued Next Page

Completion Depth:	35.0
Date Boring Started:	8/18/21
Date Boring Completed:	8/21/21
Logged By:	RWO
Drilling Contractor:	Traut/Coleman
Drilling Method:	Rotosonic/Mud rotary
Ground Surface Elevation:	1431.3
Coordinates:	N 617,331.9 ft E 2,112,071.8 ft
Datum:	NAD83, NAVD88

Remarks: Rotosonic drilling method used from 0'- 20'. 21' casing set and grouted with neat cement grout. Boring completed from 20' to 35' using mud rotary.

SAMPLE TYPES

- ROCK CORE
- GRAB SAMPLE
- LARGE SOIL BAGS
- SPLIT SPOON
- 3-inch Shelby Tube
- MODIFIED CALIFORNIA SAMPLER

WATER LEVELS (ft)

▽ After Drilling	-0.7

LEGEND

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

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

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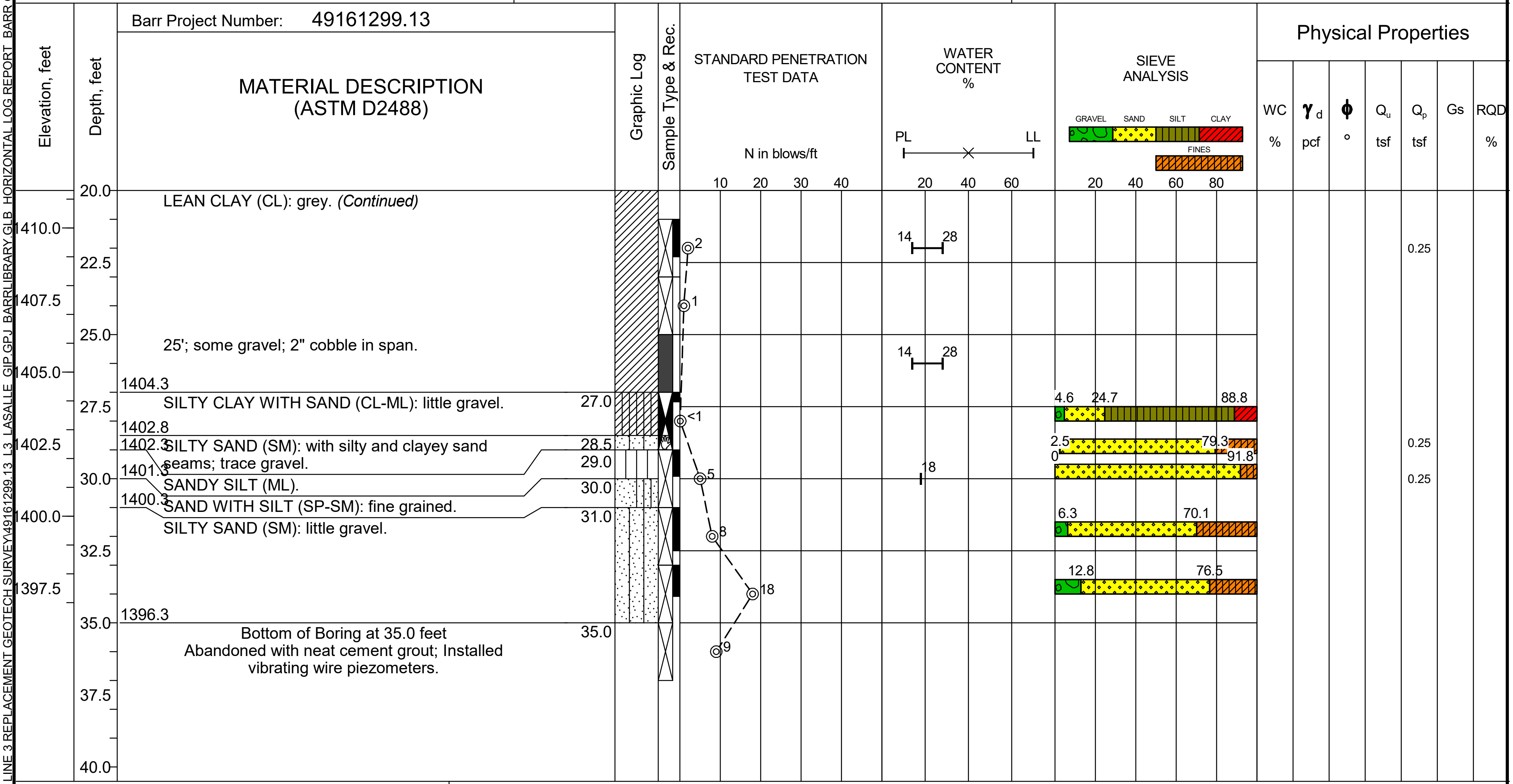
DRAFT
LOG OF BORING LS-21-GIP-5

Sheet 2 of 2

Project: L3 Replacement - LaSalle Creek GIP | Location: LaSalle Creek - MN | Client: Enbridge

Barr Project Number: 49161299.13

Elevation, feet	Depth, feet	MATERIAL DESCRIPTION (ASTM D2488)	
	20.0	LEAN CLAY (CL): grey. *(Continued)*	
		25'; some gravel; 2" cobble in span.	
1404.3		SILTY CLAY WITH SAND (CL-ML): little gravel.	27.0
1402.8		SILTY SAND (SM): with silty and clayey sand seams; trace gravel.	28.5
1402.3		SANDY SILT (ML).	29.0
1401.3		SAND WITH SILT (SP-SM): fine grained.	30.0
1400.3		SILTY SAND (SM): little gravel.	31.0
1396.3	35.0	Bottom of Boring at 35.0 feet Abandoned with neat cement grout; Installed vibrating wire piezometers.	35.0



Completion Depth:	35.0
Date Boring Started:	8/18/21
Date Boring Completed:	8/21/21
Logged By:	RWO
Drilling Contractor:	Traut/Coleman
Drilling Method:	Rotosonic/Mud rotary
Ground Surface Elevation:	1431.3
Coordinates:	N 617,331.9 ft E 2,112,071.8 ft
Datum:	NAD83, NAVD88

Remarks: Rotosonic drilling method used from 0'- 20'. 21' casing set and grouted with neat cement grout. Boring completed from 20' to 35' using mud rotary.

SAMPLE TYPES

- ▯ ROCK CORE
- GRAB SAMPLE
- ▨ LARGE SOIL BAGS
- ☒ SPLIT SPOON
- ■ 3-inch Shelby Tube
- ⧗ MODIFIED CALIFORNIA SAMPLER

WATER LEVELS (ft)

∇ After Drilling	-0.7

LEGEND

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

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

Attachment 2

Laboratory Data

Hydraulic Conductivity Test Data ASTM D5084

Project: La Salle GIP Date: 8/25/2021

Client: Barr Engineering Company Job No.: 13324

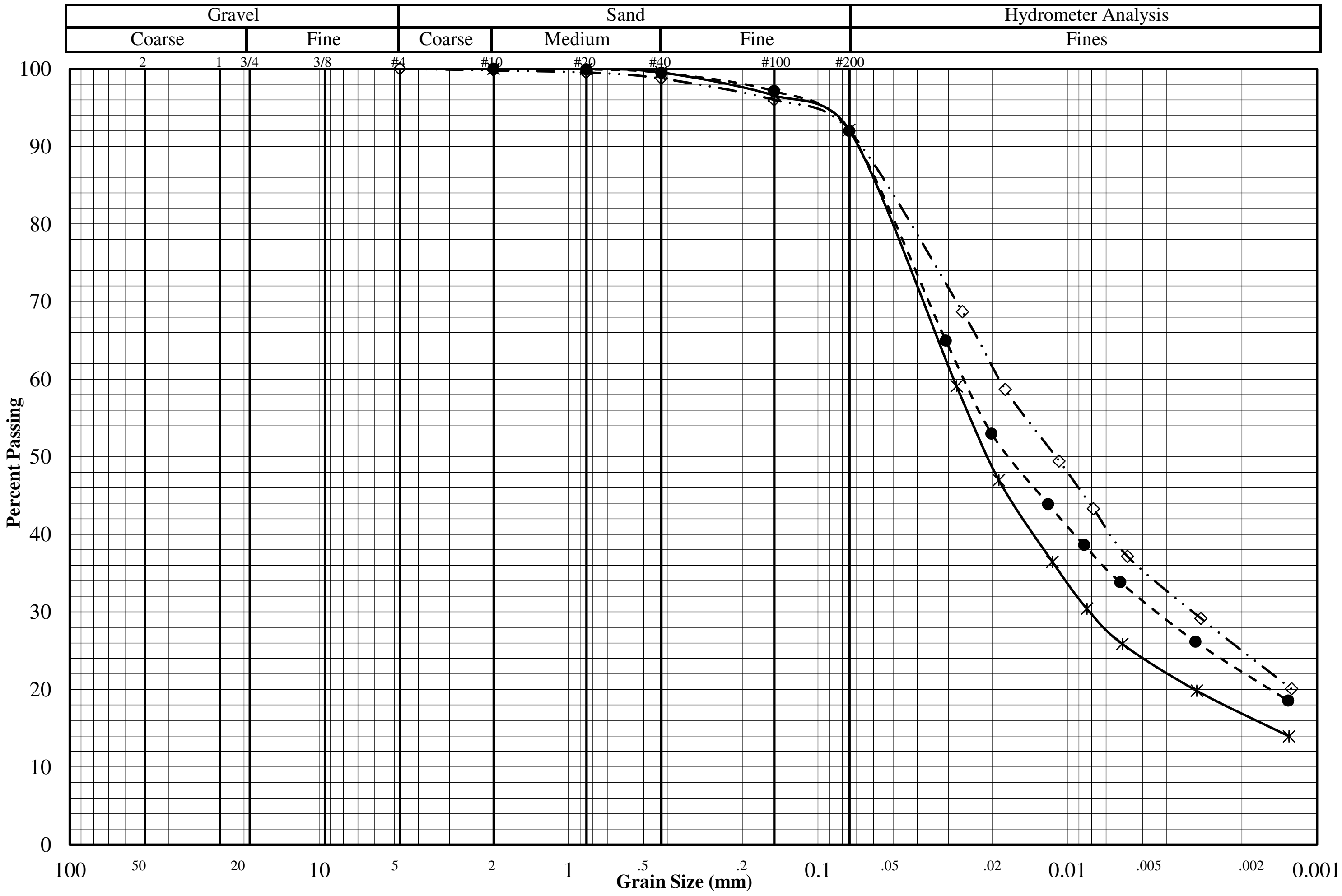
	Boring No.:	GIP-1						
	Sample No.:							
	Depth (ft):	29-31						
	Location:							
	Sample Type:	TWT						
	Soil Classification:	Lean Clay w/laminations of silt and sand (CL)						
Atterberg Limits	Liquid Limit:							
	Plastic Limit:							
	Plasticity Index:							
	Permeability Test	Intact Flex Wall						
Before Test Conditions	Saturation %:							
	Porosity:							
	Height (in):	2.39						
	Diameter (in):	2.89						
	Dry Density (pcf):	102.1						
	Water Content:	24.0%						
Test Conditions	Test Type:	Falling						
	Max Head (ft):	5.0						
	Confining press. (Effective-psi):	2.0						
	Trial Numbers:	12-16						
	Water Temp °C:	22.0						
	Compaction:							
	Saturation %:	101.6%						
	Coefficient of Permeability							
	K @ 20 °C (cm/sec)	**2.6×10^{-6}**						
	K @ 20 °C (ft/min)	**5.1×10^{-6}**						
	Notes:							

Grain Size Distribution ASTM D422-16

Job No. : **13324**

Project:	La Salle GIP	Test Date:	8/21/21
Reported To:	Barr Engineering Company	Report Date:	8/24/21

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
∗	GIP-1		10-15	Bag	Lean Clay (CL)
●	GIP-1		23-25	Jar	Lean Clay (CL)
◇	GIP-1		29-31	TWT	Lean Clay (CL)**



Additional Results	∗	●	◇
Liquid Limit	26	28	25
Plastic Limit	17	15	15
Plasticity Index ASTM:D4316	9	13	10
Water Content ASTM:D2216	24.7	24.0	
Dry Density (pcf) ASTM:D7263		100.7	
Specific Gravity ASTM:D854	2.68*	2.68*	2.68*
Porosity			
Organic Content ASTM:D2974			
pH ASTM:D4972 Method B			

(* = assumed)

Percent Passing

	∗	●	◇
Mass (g)	237.0	133.4	344.2
2"			
1.5"			
1"			
3/4"			
3/8"			
#4			100.0
#10	100.0	100.0	99.8
#20	100.0	100.0	99.5
#40	99.6	99.5	98.8
#100	96.6	97.1	96.0
#200	92.1	92.0	92.0

	∗	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

**Sample contained sand and silt laminations

Grain Size Distribution ASTM D422-16

Job No. : **13324**

Project: La Salle GIP

Test Date: 8/21/21

Reported To: Barr Engineering Company

Report Date: 8/24/21

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
Spec 1	GIP-1		10-15	Bag	Lean Clay (CL)
Spec 2	GIP-1		23-25	Jar	Lean Clay (CL)
Spec 3	GIP-1		29-31	TWT	Lean Clay (CL)**

Sieve Data

Specimen 1		Specimen 2		Specimen 3	
Sieve	% Passing	Sieve	% Passing	Sieve	% Passing
2"		2"		2"	
1.5"		1.5"		1.5"	
1"		1"		1"	
3/4"		3/4"		3/4"	
3/8"		3/8"		3/8"	
#4		#4		#4	100.0
#10	100.0	#10	100.0	#10	99.8
#20	100.0	#20	100.0	#20	99.5
#40	99.6	#40	99.5	#40	98.8
#100	96.6	#100	97.1	#100	96.0
#200	92.1	#200	92.0	#200	92.0

Hydrometer Data

Specimen 1		Specimen 2		Specimen 3	
Diameter (mm)	% Passing	Diameter	% Passing	Diameter	% Passing
0.028	59.1	0.031	65.0	0.026	68.7
0.019	47.0	0.020	53.0	0.018	58.7
0.011	36.4	0.012	43.9	0.011	49.5
0.008	30.4	0.009	38.6	0.008	43.3
0.006	25.9	0.006	33.8	0.006	37.1
0.003	19.8	0.003	26.2	0.003	29.1
0.001	14.0	0.001	18.6	0.001	20.1

Remarks

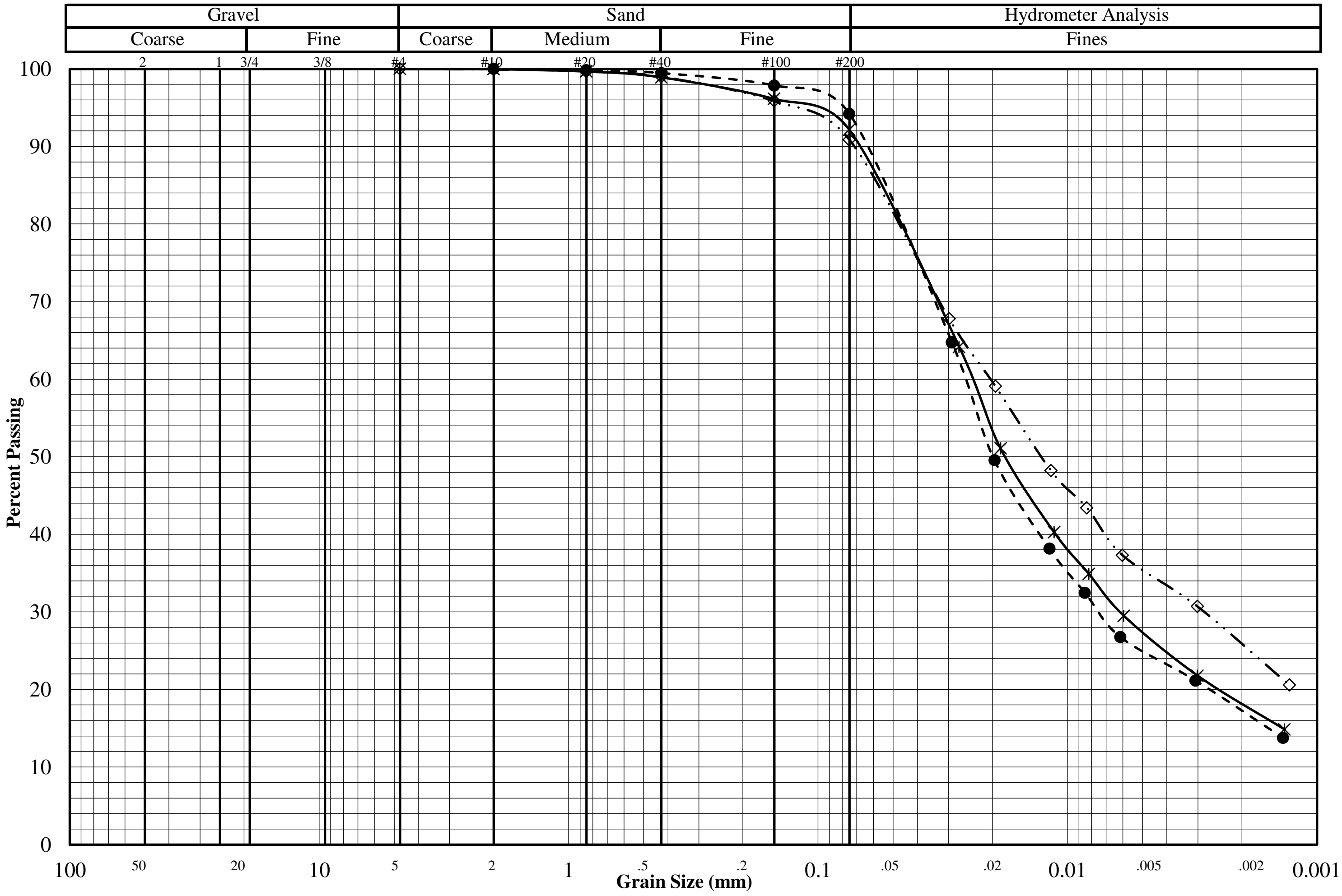
Specimen 1	Specimen 2	Specimen 3

Grain Size Distribution ASTM D422-16

Job No. : **13324**

Project:	La Salle GIP	Test Date:	8/21/21
Reported To:	Barr Engineering Company	Report Date:	8/24/21

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
*	GIP-1		37-39	TWT	Lean Clay (CL)**
●	GIP-2		15-20	Bag	Lean Clay (CL)
◇	GIP-3		23-25	Jar	Lean Clay (CL)**



Additional Results	*	●	◇
Liquid Limit	28	25	29
Plastic Limit	14	17	14
Plasticity Index ASTM:D4316	14	8	15
Water Content ASTM:D2216		24.7	27.9
Dry Density (pcf) ASTM:D7263			99.5
Specific Gravity ASTM:D854	2.68*	2.68*	2.68*
Porosity			
Organic Content ASTM:D2974			
pH ASTM:D4972 Method B			

(* = assumed)

Percent Passing

	*	●	◇
Mass (g)	344.2	268.2	136.4
2"			
1.5"			
1"			
3/4"			
3/8"			
#4	100.0		100.0
#10	100.0	100.0	99.9
#20	99.7	99.8	99.7
#40	98.9	99.5	99.0
#100	96.1	97.9	95.9
#200	92.2	94.2	90.9

	*	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

**Sample contained sand and silt laminations and/or lenses

Grain Size Distribution ASTM D422-16

Job No. : **13324**

Project:	La Salle GIP	Test Date:	8/21/21
Reported To:	Barr Engineering Company	Report Date:	8/24/21

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
Spec 1	GIP-1		37-39	TWT	Lean Clay (CL)**
Spec 2	GIP-2		15-20	Bag	Lean Clay (CL)
Spec 3	GIP-3		23-25	Jar	Lean Clay (CL)**

Sieve Data

Specimen 1		Specimen 2		Specimen 3	
Sieve	% Passing	Sieve	% Passing	Sieve	% Passing
2"		2"		2"	
1.5"		1.5"		1.5"	
1"		1"		1"	
3/4"		3/4"		3/4"	
3/8"		3/8"		3/8"	
#4	100.0	#4		#4	100.0
#10	100.0	#10	100.0	#10	99.9
#20	99.7	#20	99.8	#20	99.7
#40	98.9	#40	99.5	#40	99.0
#100	96.1	#100	97.9	#100	95.9
#200	92.2	#200	94.2	#200	90.9

Hydrometer Data

Specimen 1		Specimen 2		Specimen 3	
Diameter (mm)	% Passing	Diameter	% Passing	Diameter	% Passing
0.027	64.2	0.029	64.7	0.030	67.8
0.019	51.1	0.020	49.6	0.019	59.1
0.011	40.3	0.012	38.2	0.012	48.2
0.008	34.9	0.009	32.5	0.008	43.4
0.006	29.5	0.006	26.8	0.006	37.3
0.003	21.8	0.003	21.1	0.003	30.7
0.001	14.9	0.001	13.8	0.001	20.6

Remarks

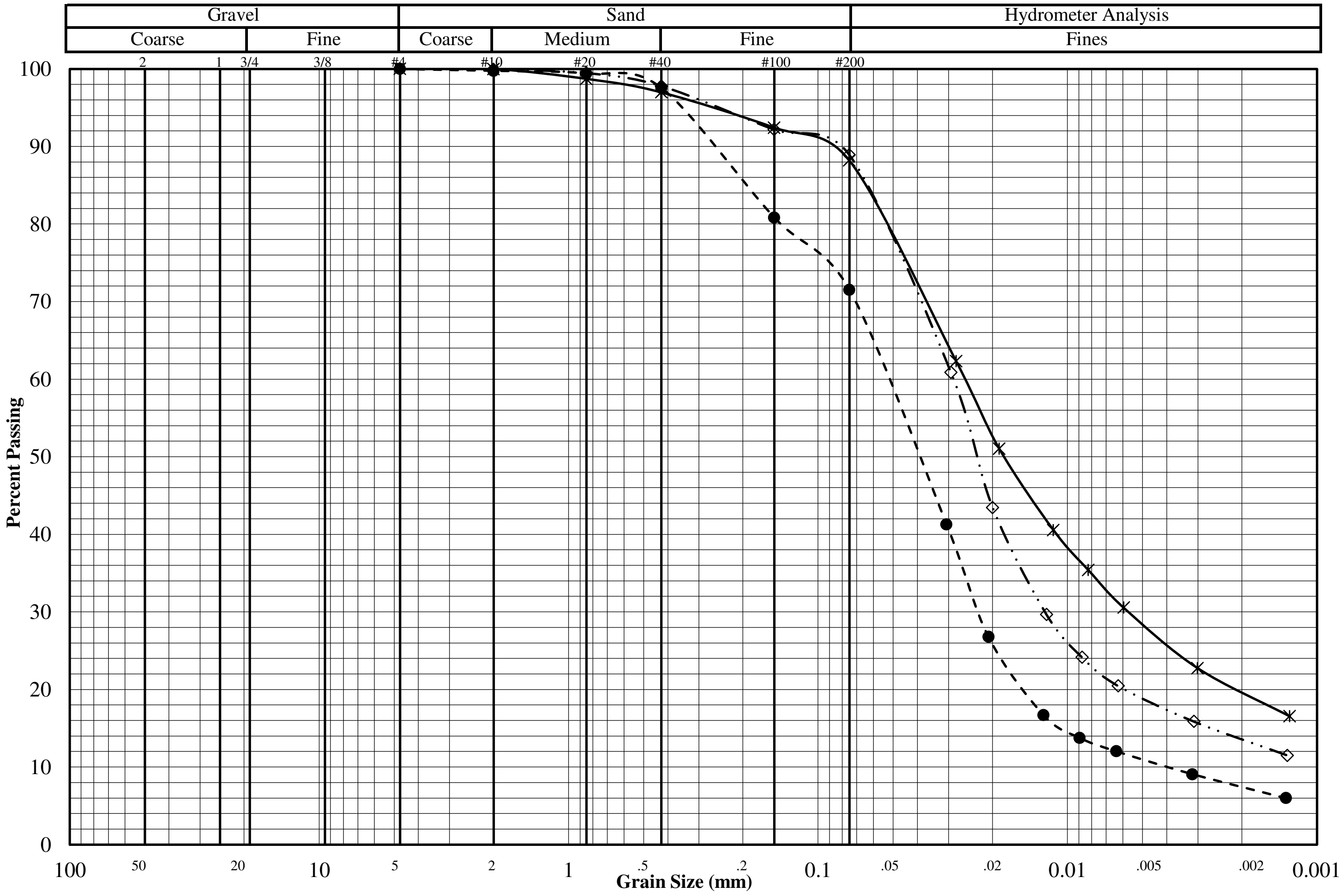
Specimen 1	Specimen 2	Specimen 3

Grain Size Distribution ASTM D422-16

Job No. : **13324**

Project:	La Salle GIP	Test Date:	8/21/21
Reported To:	Barr Engineering Company	Report Date:	8/24/21

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
∗	GIP-4		25-30	Bag	Lean Clay (CL)
●	GIP-5		5-10	Bag	Silt w/sand (ML)
◇	GIP-5		13-13.5	Bag	Silty Clay (CL-ML)**



Additional Results	∗	●	◇
Liquid Limit	25	19	24
Plastic Limit	15	16	19
Plasticity Index ASTM:D4316	10	3	5
Water Content ASTM:D2216	25.1	24.3	22.9
Dry Density (pcf) ASTM:D7263			
Specific Gravity ASTM:D854	2.68*	2.68*	2.68*
Porosity			
Organic Content ASTM:D2974			
pH ASTM:D4972 Method B			

(* = assumed)

Percent Passing

	∗	●	◇
Mass (g)	270.8	411.1	303.8
2"			
1.5"			
1"			
3/4"			
3/8"			
#4	100.0	100.0	100.0
#10	100.0	99.8	99.9
#20	98.7	99.4	99.5
#40	97.0	97.6	97.8
#100	92.4	80.8	92.2
#200	88.2	71.5	88.9

	∗	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

**Sample contained sand laminations

Grain Size Distribution ASTM D422-16

Job No. : **13324**

Project: La Salle GIP

Test Date: 8/21/21

Reported To: Barr Engineering Company

Report Date: 8/24/21

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
Spec 1	GIP-4		25-30	Bag	Lean Clay (CL)
Spec 2	GIP-5		5-10	Bag	Silt w/sand (ML)
Spec 3	GIP-5		13-13.5	Bag	Silty Clay (CL-ML)**

Sieve Data

Specimen 1		Specimen 2		Specimen 3	
Sieve	% Passing	Sieve	% Passing	Sieve	% Passing
2"		2"		2"	
1.5"		1.5"		1.5"	
1"		1"		1"	
3/4"		3/4"		3/4"	
3/8"		3/8"		3/8"	
#4	100.0	#4	100.0	#4	100.0
#10	100.0	#10	99.8	#10	99.9
#20	98.7	#20	99.4	#20	99.5
#40	97.0	#40	97.6	#40	97.8
#100	92.4	#100	80.8	#100	92.2
#200	88.2	#200	71.5	#200	88.9

Hydrometer Data

Specimen 1		Specimen 2		Specimen 3	
Diameter (mm)	% Passing	Diameter	% Passing	Diameter	% Passing
0.028	62.3	0.031	41.3	0.029	60.9
0.019	51.0	0.021	26.8	0.020	43.4
0.011	40.6	0.013	16.7	0.012	29.7
0.008	35.4	0.009	13.8	0.009	24.1
0.006	30.6	0.006	12.0	0.006	20.5
0.003	22.8	0.003	9.1	0.003	15.9
0.001	16.5	0.001	6.0	0.001	11.5

Remarks

Specimen 1	Specimen 2	Specimen 3

Laboratory Test Summary

Project: La Salle GIP Job: 13324

Client: Barr Engineering Company Date: 8/24/2021

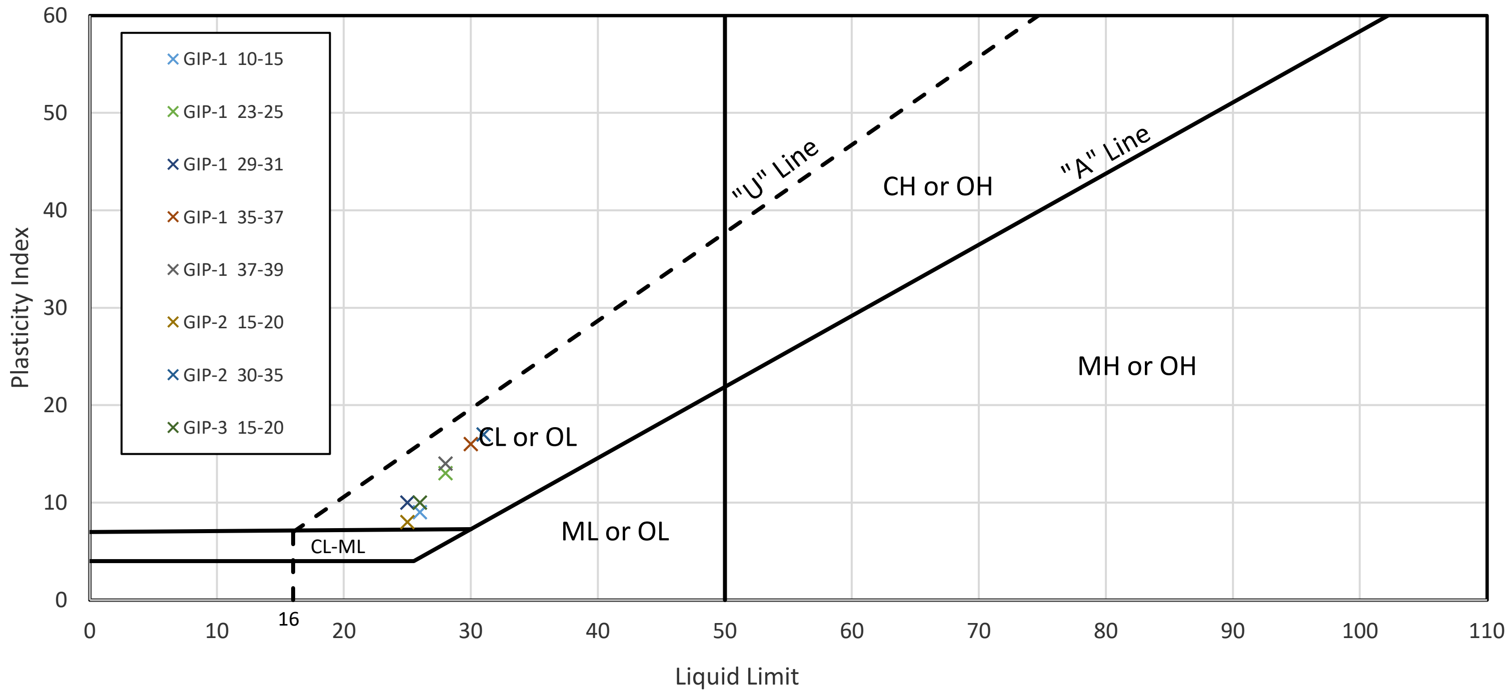
Sample Information & Classification

Boring #	GIP-1	GIP-1	GIP-1	GIP-1	GIP-1	GIP-2	GIP-2	GIP-3
Sample #								
Depth (ft)	10-15	23-25	29-31	35-37	37-39	15-20	30-35	15-20
Sample Type	Bag	Jar	TWT	Jar	TWT	Bag	Bag	Bag
Material Classification	Lean Clay (CL)	Lean Clay (CL)	Lean Clay w/sand and silt laminations (CL)	Lean Clay w/lenses of sand and silt (CL)	Lean Clay w/sand and silt laminations (CL)	Lean Clay (CL)	Lean Clay w/sand lenses (CL)	Lean Clay w/sand lenses (CL)

Atterberg Limits (ASTM:D4318)

Liquid Limit	26	28	25	30	28	25	31	26
Plastic Limit	17	15	15	14	14	17	14	16
Plasticity Index	9	13	10	16	14	8	17	10

Plasticity Chart (ASTM:D2487)



Laboratory Test Summary

Project: La Salle GIP — Job: 13324

Client: Barr Engineering Company — Date: 8/24/2021

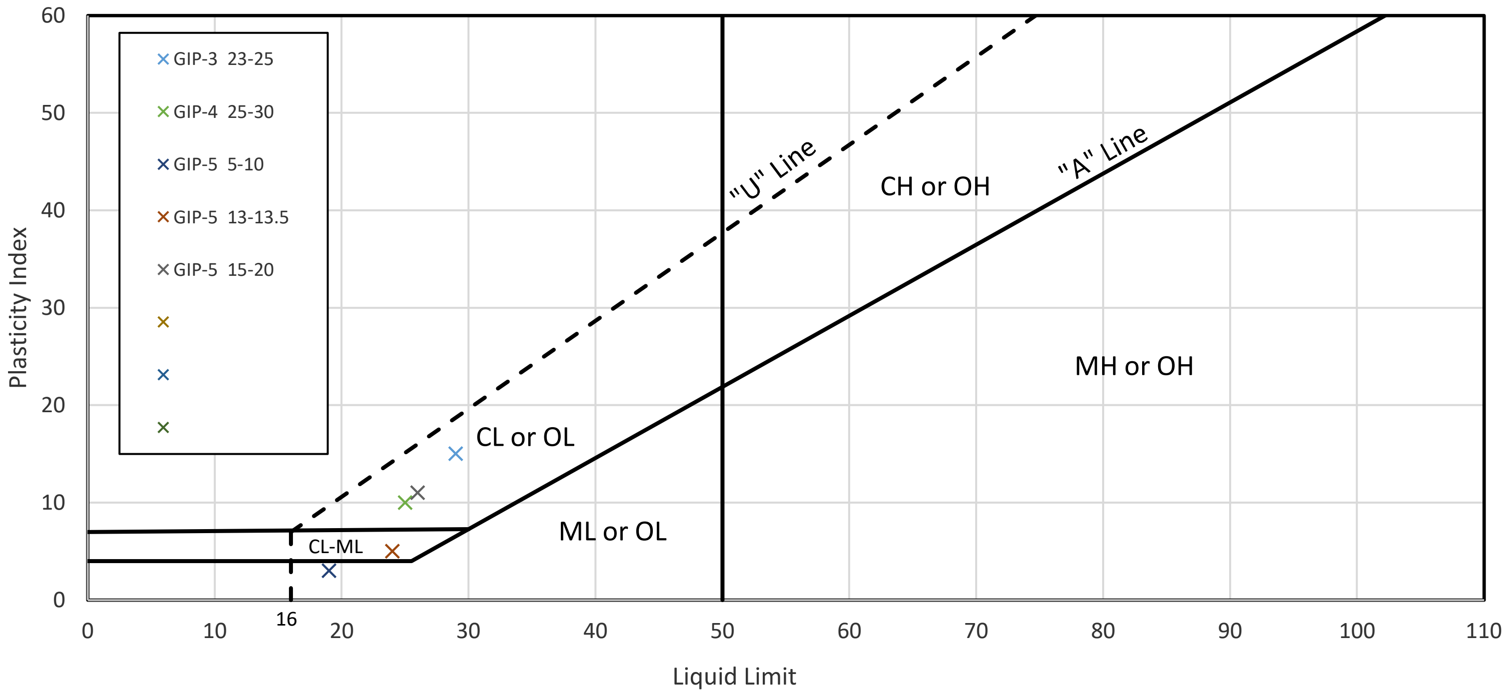
Sample Information & Classification

Boring #	GIP-3	GIP-4	GIP-5	GIP-5	GIP-5			
Sample #								
Depth (ft)	23-25	25-30	5-10	13-13.5	15-20			
Sample Type	Jar	Bag	Bag	Bag	Bag			
Material Classification	Lean Clay w/sand and silt lenses (CL)	Lean Clay (CL)	Silt w/sand (ML)	Silty Clay w/sand laminations (CL-ML)	Lean Clay (CL)			

Atterberg Limits (ASTM:D4318)

Liquid Limit	29	25	19	24	26			
Plastic Limit	14	15	16	19	15			
Plasticity Index	15	10	3	5	11			

Plasticity Chart (ASTM:D2487)



Laboratory Test Summary

Project: La Salle GIP
Job: 13324

Client: Barr Engineering Company
Date: 8/24/21

Sample Information & Classification

Boring #	GIP-1	GIP-1	GIP-3				
Sample #							
Depth (ft)	23-25	35-37	23-25				
Type or BPF	Jar	Jar	Jar				
Classification	Lean Clay (CL)	Lean Clay w/lenses of sand and silt (CL)	Lean Clay w/lenses of sand and silt (CL)				

Water Content, Dry Density (ASTM:D7263)

Water Content (%)	24.0	26.6	27.9				
Dry Density (pcf)	100.7	103.0	99.5				

Sample Information & Classification

Boring #							
Sample #							
Depth (ft)							
Type or BPF							
Classification							

Water Content, Dry Density (ASTM:D7263)

Water Content (%)							
Dry Density (pcf)							

Sample Information & Classification

Boring #							
Sample #							
Depth (ft)							
Type or BPF							
Classification							

Water Content, Dry Density (ASTM:D7263)

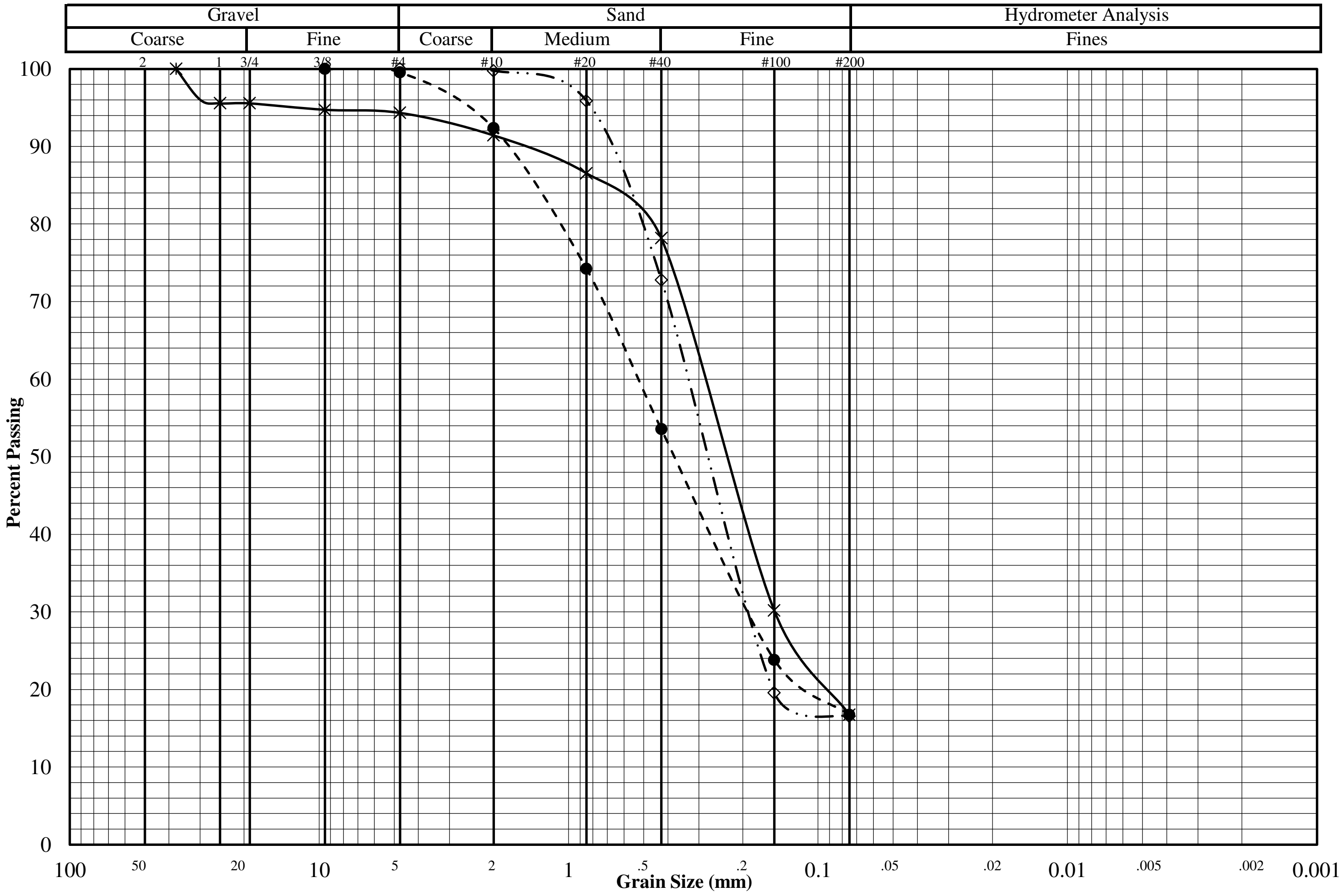
Water Content (%)							
Dry Density (pcf)							

Grain Size Distribution ASTM D422-16

Job No. : **13324**

Project:	La Salle GIP	Test Date:	8/23/21
Reported To:	Barr Engineering Company	Report Date:	8/24/21

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
*	GIP-1		0-5	Bag	Silty Sand w/a little gravel (SM)
●	GIP-1		25-27	TWT	Silty Sand (SM)
◇	GIP-1		33-35	Jar	Silty Sand w/occasional pieces of clay (SM)



Additional Results	*	●	◇
Liquid Limit			
Plastic Limit			
Plasticity Index ASTM:D4316			
Water Content ASTM:D2216	14.2	15.4	20.4
Dry Density (pcf) ASTM:D7263			
Specific Gravity ASTM:D854			
Porosity			
Organic Content ASTM:D2974			
pH ASTM:D4972 Method B			

(* = assumed)

Percent Passing

	*	●	◇
Mass (g)	832.7	257.8	264.7
2"			
1.5"	100.0		
1"	95.6		
3/4"	95.6		
3/8"	94.7	100.0	
#4	94.3	99.6	100.0
#10	91.4	92.4	99.8
#20	86.5	74.3	95.9
#40	78.2	53.6	72.8
#100	30.2	23.8	19.6
#200	16.8	16.7	16.6

	*	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

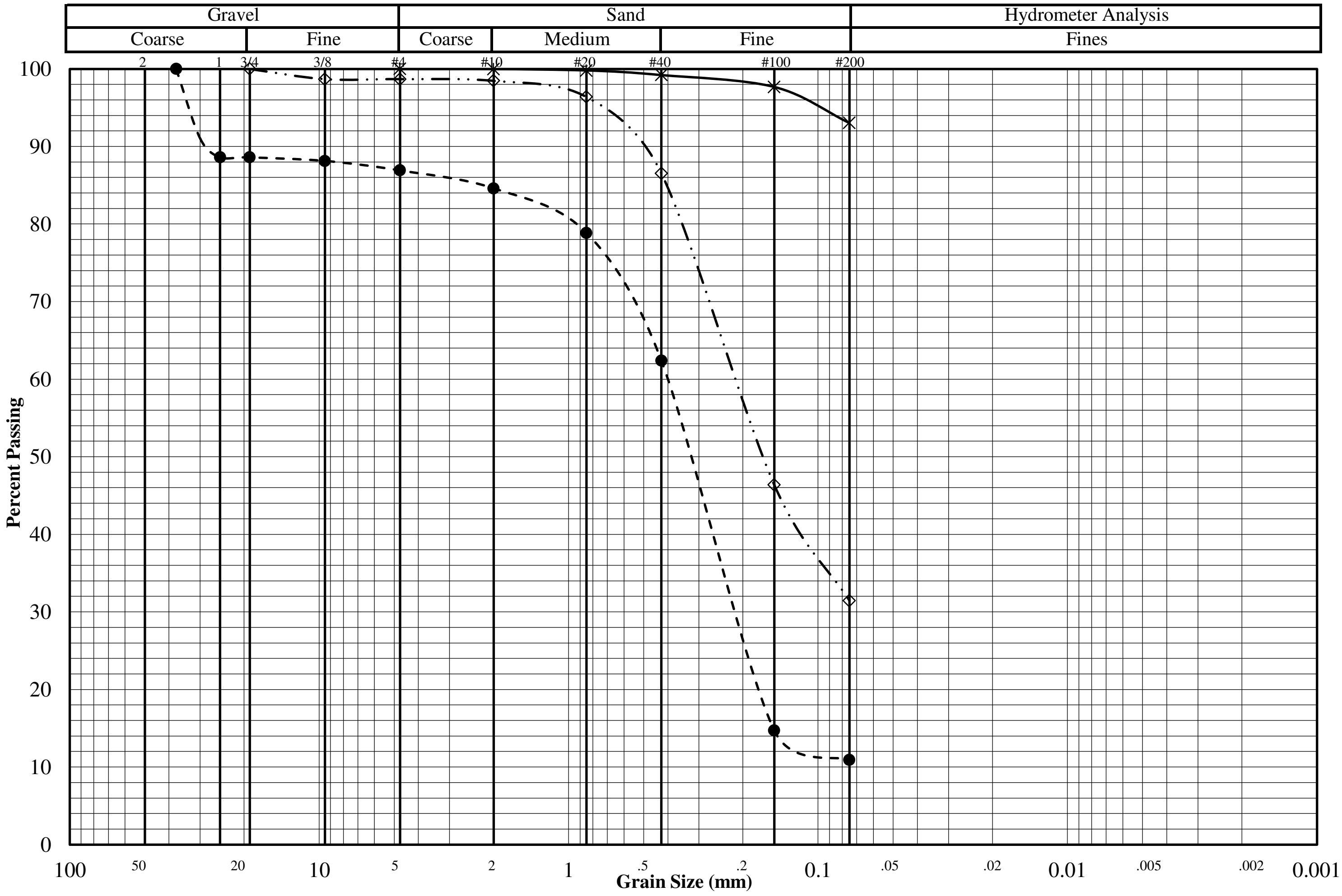
Remarks:

Grain Size Distribution ASTM D422-16

Job No. : **13324**

Project: La Salle GIP
Test Date: 8/23/21
Reported To: Barr Engineering Company
Report Date: 8/24/21

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
*	GIP-1		35-37	Jar	Lean Clay (CL)**
●	GIP-1		43-45	Jar	Sand w/silt and a little gravel, fine grained (SP-SM/SM)
◇	GIP-2		0-5	Bag	Silty Sand w/occasional pieces of clay (SM)



Additional Results	*	●	◇
Liquid Limit	30		
Plastic Limit	14		
Plasticity Index ASTM:D4316	16		
Water Content ASTM:D2216	26.6	16.4	20.4
Dry Density (pcf) ASTM:D7263	103.0		
Specific Gravity ASTM:D854			
Porosity			
Organic Content ASTM:D2974			
pH ASTM:D4972 Method B			

(* = assumed)

Percent Passing

	*	●	◇
Mass (g)	106.0	339.9	345.4
2"			
1.5"		100.0	
1"		88.6	
3/4"		88.6	100.0
3/8"		88.1	98.7
#4	100.0	86.9	98.7
#10	100.0	84.6	98.5
#20	99.8	78.9	96.4
#40	99.2	62.4	86.5
#100	97.7	14.7	46.4
#200	93.0	11.0	31.5

	*	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

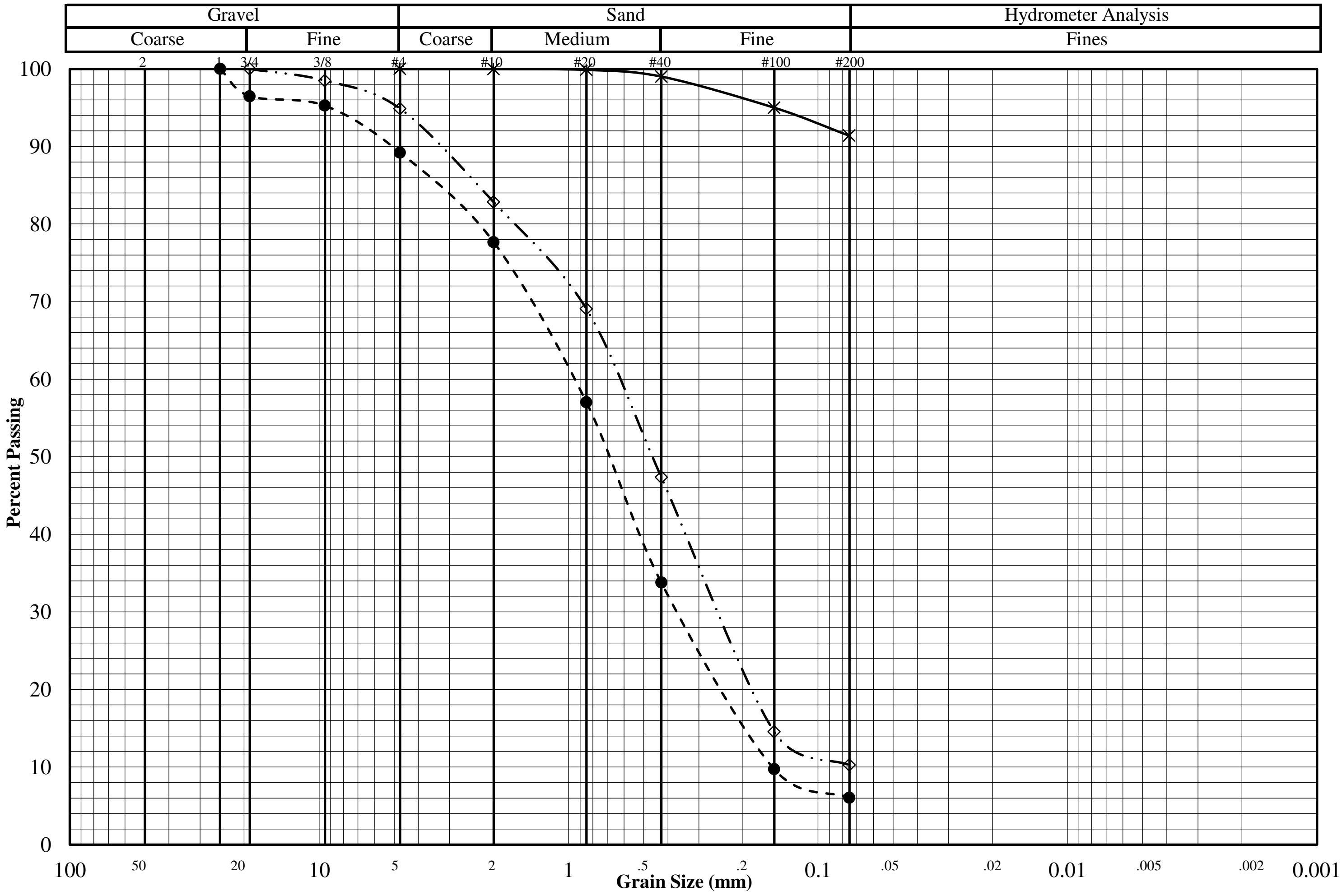
**Sample contained lenses of sand and silt

Grain Size Distribution ASTM D422-16

Job No. : **13324**

Project:	La Salle GIP	Test Date:	8/23/21
Reported To:	Barr Engineering Company	Report Date:	8/24/21

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
✱	GIP-2		30-35	Bag	Lean Clay (CL)**
●	GIP-2		35-40	Bag	Sand w/silt and a little gravel, medium to fine grained (SP-SM)
◇	GIP-3		5-10	Bag	Sand w/silt and a little gravel, fine to medium grained (SP-SM)



Additional Results	✱	●	◇
Liquid Limit	31		
Plastic Limit	14		
Plasticity Index ASTM:D4316	17		
Water Content ASTM:D2216	28.8	12.0	15.4
Dry Density (pcf) ASTM:D7263			
Specific Gravity ASTM:D854			
Porosity			
Organic Content ASTM:D2974			
pH ASTM:D4972 Method B			

(* = assumed)

Percent Passing

	✱	●	◇
Mass (g)	221.3	390.9	395.2
2"			
1.5"			
1"		100.0	
3/4"		96.5	100.0
3/8"		95.3	98.5
#4	100.0	89.2	94.9
#10	100.0	77.7	82.8
#20	99.9	57.0	69.1
#40	99.0	33.8	47.4
#100	95.0	9.7	14.5
#200	91.4	6.1	10.2

	✱	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

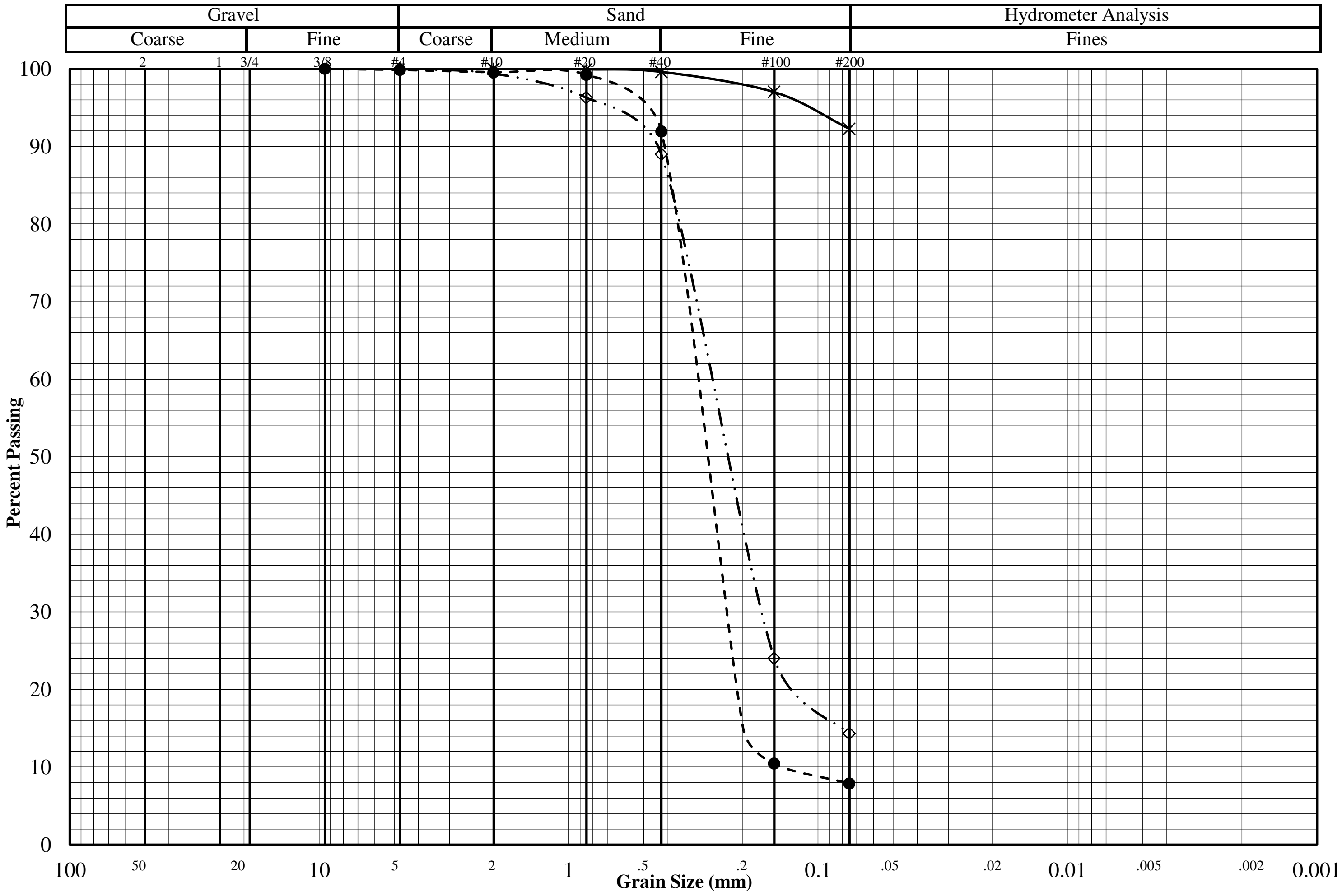
**Sample contained sand lenses

Grain Size Distribution ASTM D422-16

Job No. : **13324**

Project:	La Salle GIP	Test Date:	8/23/21
Reported To:	Barr Engineering Company	Report Date:	8/24/21

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
∗	GIP-3		15-20	Bag	Lean Clay (CL)**
●	GIP-3		31-33	Jar	Sand w/silt, fine grained (SP-SM)
◇	GIP-3		35-37	Jar	Silty Sand (SM/SP-SM)



Additional Results	∗	●	◇
Liquid Limit	26		
Plastic Limit	16		
Plasticity Index ASTM:D4316	10		
Water Content ASTM:D2216	24.8	21.1	23.1
Dry Density (pcf) ASTM:D7263			
Specific Gravity ASTM:D854			
Porosity			
Organic Content ASTM:D2974			
pH ASTM:D4972 Method B			

(* = assumed)

Percent Passing

	∗	●	◇
Mass (g)	188.8	210.3	206.5
2"			
1.5"			
1"			
3/4"			
3/8"		100.0	
#4		99.9	100.0
#10	100.0	99.6	99.4
#20	100.0	99.3	96.3
#40	99.6	91.9	89.0
#100	97.0	10.4	24.0
#200	92.3	7.9	14.3

	∗	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

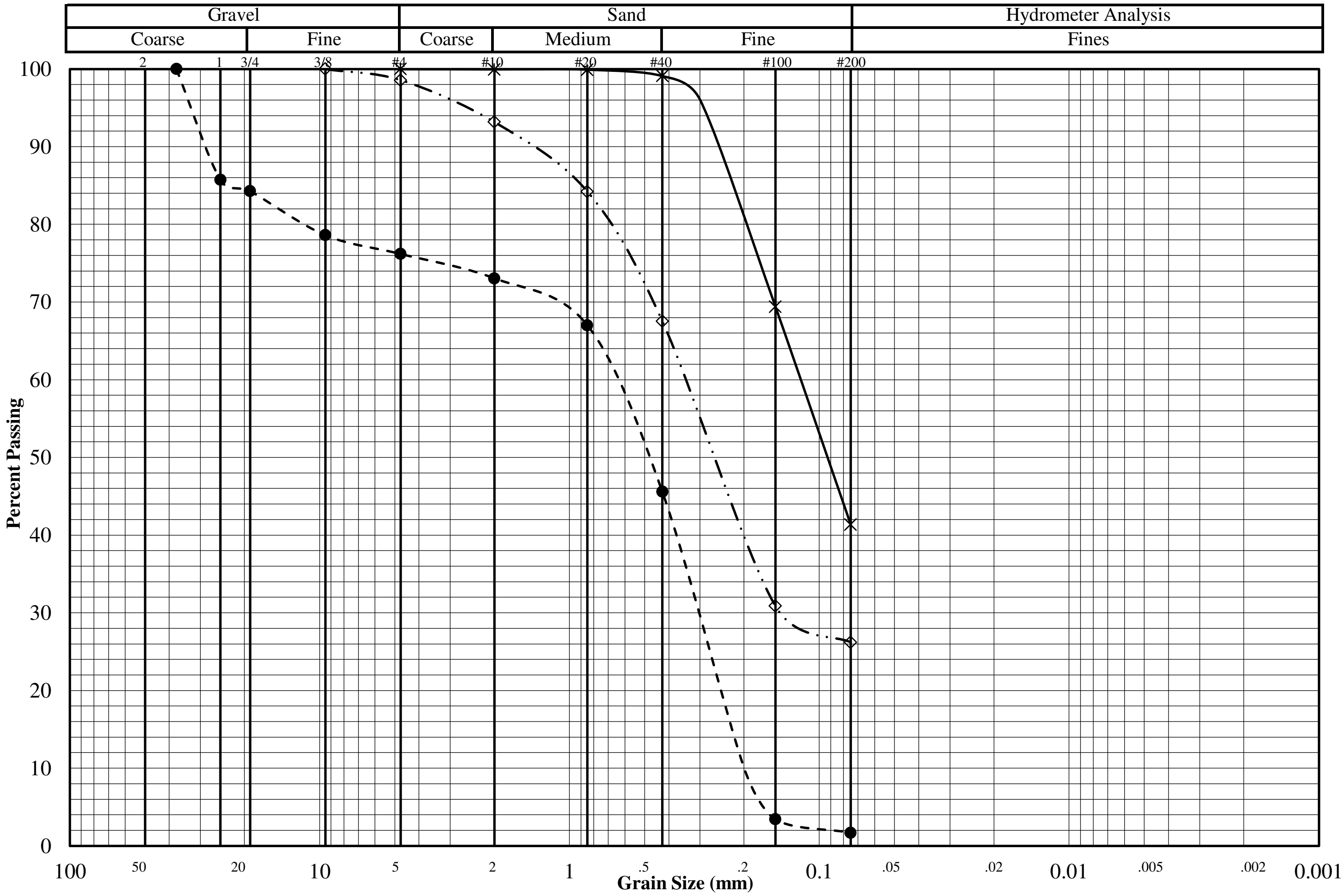
**Sample contained sand lenses

Grain Size Distribution ASTM D422-16

Job No. : **13324**

Project:	La Salle GIP	Test Date:	8/23/21
Reported To:	Barr Engineering Company	Report Date:	8/24/21

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
*	GIP-4		10-15	Bag	Silty Sand (SM)
●	GIP-4		45-50	Bag	Sand w/gravel, fine to medium grained (SP)
◇	GIP-5		10-13	Bag	Silty Sand (SM)



Additional Results	*	●	◇
Liquid Limit			
Plastic Limit			
Plasticity Index ASTM:D4316			
Water Content ASTM:D2216	16.1	15.1	14.7
Dry Density (pcf) ASTM:D7263			
Specific Gravity ASTM:D854			
Porosity			
Organic Content ASTM:D2974			
pH ASTM:D4972 Method B			

(* = assumed)

Percent Passing

	*	●	◇
Mass (g)	326.4	968.5	335.0
2"			
1.5"		100.0	
1"		85.8	
3/4"		84.3	
3/8"		78.6	100.0
#4	100.0	76.2	98.6
#10	100.0	73.1	93.2
#20	99.9	67.0	84.2
#40	99.1	45.6	67.6
#100	69.4	3.4	30.9
#200	41.4	1.7	26.2

	*	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

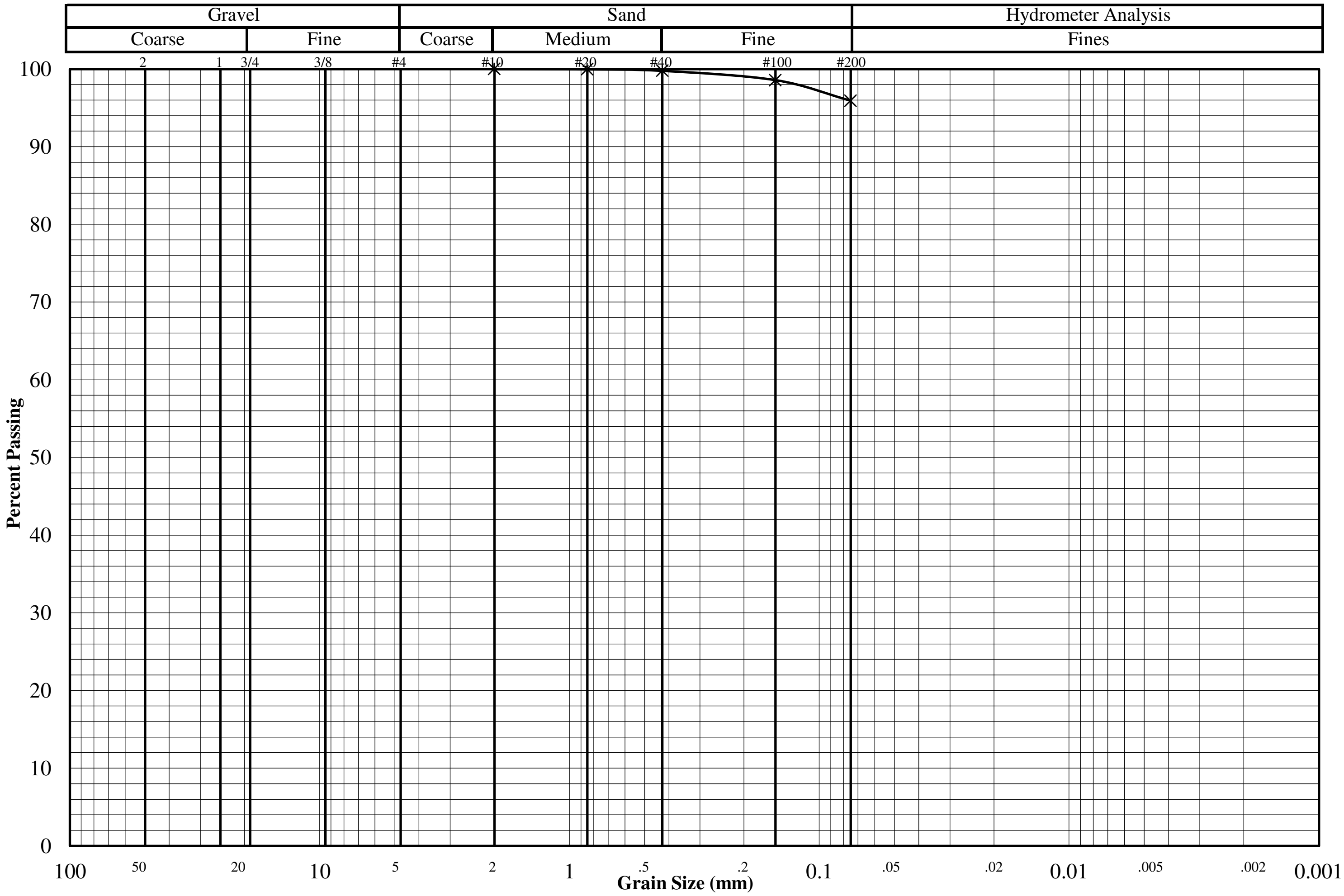
Remarks:

Grain Size Distribution ASTM D422-16

Job No. : **13324**

Project:	La Salle GIP	Test Date:	8/23/21
Reported To:	Barr Engineering Company	Report Date:	8/24/21

	Location / Boring No.	Sample No.	Depth (ft)	Sample Type	Soil Classification
*	GIP-5		15-20	Bag	Lean Clay (CL)
●					
◇					



Additional Results	*	●	◇
Liquid Limit	26		
Plastic Limit	15		
Plasticity Index ASTM:D4316	11		
Water Content ASTM:D2216	24.2		
Dry Density (pcf) ASTM:D7263			
Specific Gravity ASTM:D854			
Porosity			
Organic Content ASTM:D2974			
pH ASTM:D4972 Method B			

(* = assumed)

Percent Passing

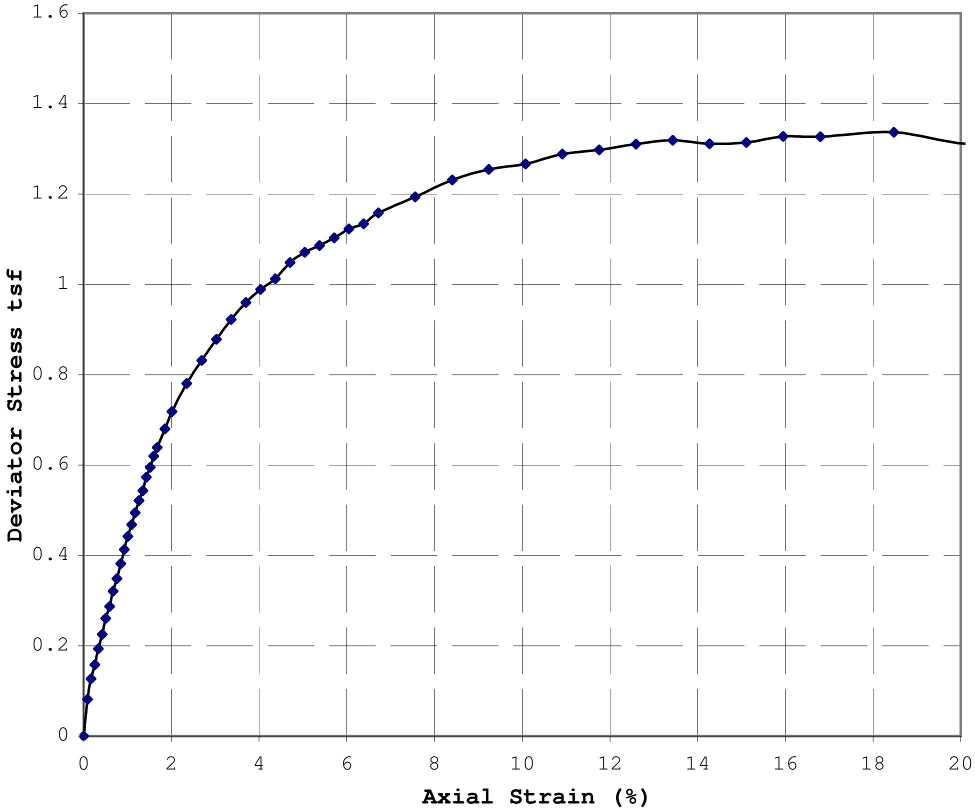
	*	●	◇
Mass (g)	300.0		
2"			
1.5"			
1"			
3/4"			
3/8"			
#4			
#10	100.0		
#20	100.0		
#40	99.8		
#100	98.6		
#200	95.9		

	*	●	◇
D_{60}			
D_{30}			
D_{10}			
C_U			
C_C			

Remarks:

Triaxial U-U Stress/Strain Curves (ASTM:D2850)

Project: La Salle GIP
Job: 13324
Client: Barr Engineering Company
Date: 8/24/21
Remarks: Specimens trimmed to given sizes; Allowed to adjust under applied confining pressures for about 10 minutes.



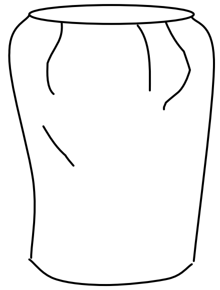
Boring: GIP-1
Depth: 29-31
Sample #:
Soil Type: Lean Clay w/sand and silt laminations (CL)

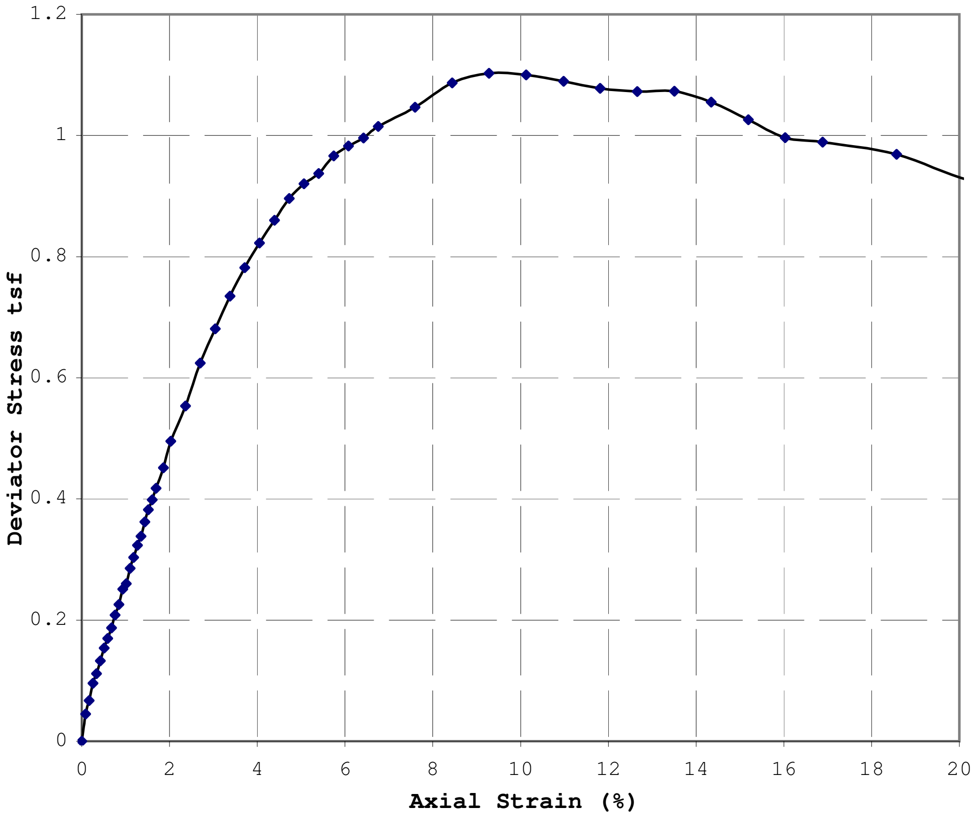
Strain Rate (in/min): 0.060
Sample Type: TWT
Dia. (in) 2.89
Ht. (in) 5.96
Height to Diameter Ratio: 2.06

Max Deviator Stress: 1.34 tsf
Strain at Failure (%): 18.5
Confining Pressure: 1.00 tsf
W.C. (%) 23.2
Yd (pcf): 102.2

LL: 25
PL: 15
PI: 10

Sketch of Specimen After Failure





Boring: GIP-1
Depth: 37-35
Sample #:
Soil Type: Lean Clay w/sand and silt laminations (CL)

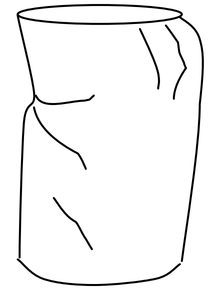
Strain Rate (in/min): 0.060
Sample Type: TWT

Dia. (in): 2.89
Ht. (in): 5.93
Height to Diameter Ratio: 2.05

Max Deviator Stress: 1.10 tsf
Strain at Failure (%): 9.3
Confining Pressure: 1.5 tsf
W.C. (%): 25.9
Yd (pcf): 98.6

LL: 28
PL: 14
PI: 14

Sketch of Specimen After Failure



Water Content Test Summary (ASTM:D2216)

Project: La Salle GIP Job: 13324

Client Barr Engineering Company Date: 8/25/2021

Sample Information & Classification

Boring #	GIP-1	GIP-1	GIP-1	GIP-1	GIP-1	GIP-2	GIP-2	GIP-2
Sample #								
Depth (ft)	0-5	10-15	25-27	33-35	43-45	0-5	15-20	30-35
Type	Bag	Bag	TWT	Jar	Jar	Bag	Bag	Bag
Material Classification	Silty Sand w/a little gravel (SM)	Lean Clay (CL)	Silty Sand (SM)	Silty Sand w/occasional pieces of clay (SM)	Sand w/silt and a little gravel, fine grained (SP-SM/SM)	Silty Sand w/occasional pieces of clay (SM)	Lean Clay (CL)	Lean Clay w/sand lenses (CL)
Water Content (%)	14.2	24.7	15.4	20.4	16.4	20.4	24.7	28.8

Sample Information & Classification

Boring #	GIP-2	GIP-3	GIP-3	GIP-3	GIP-3	GIP-4	GIP-4	GIP-4
Sample #								
Depth (ft)	35-40	5-10	15-20	31-33	35-37	10-15	25-30	45-50
Type	Bag	Bag	Bag	Jar	Jar	Bag	Bag	Bag
Material Classification	Sand w/silt and a little gravel, medium to fine grained (SP-SM)	Sand w/silt and a little gravel, fine to medium grained (SP-SM)	Lean Clay w/sand lenses (CL)	Sand w/silt, fine grained (SP-SM)	Silty Sand (SM/SP-SM)	Silty Sand (SM)	Lean Clay (CL)	Sand w/gravel, fine to medium grained (SP)
Water Content (%)	12.0	15.4	24.8	21.1	23.1	16.1	25.1	15.1

Sample Information & Classification

Boring #	GIP-5	GIP-5	GIP-5	GIP-5				
Sample #								
Depth (ft)	5-10	10-13	13-13.5	15-20				
Type	Bag	Bag	Bag	Bag				
Material Classification	Silt w/sand (ML)	Silty Sand (SM)	Silty Clay w/sand laminations (CL-ML)	Lean Clay (CL)				
Water Content (%)	24.3	14.7	22.9	24.2				

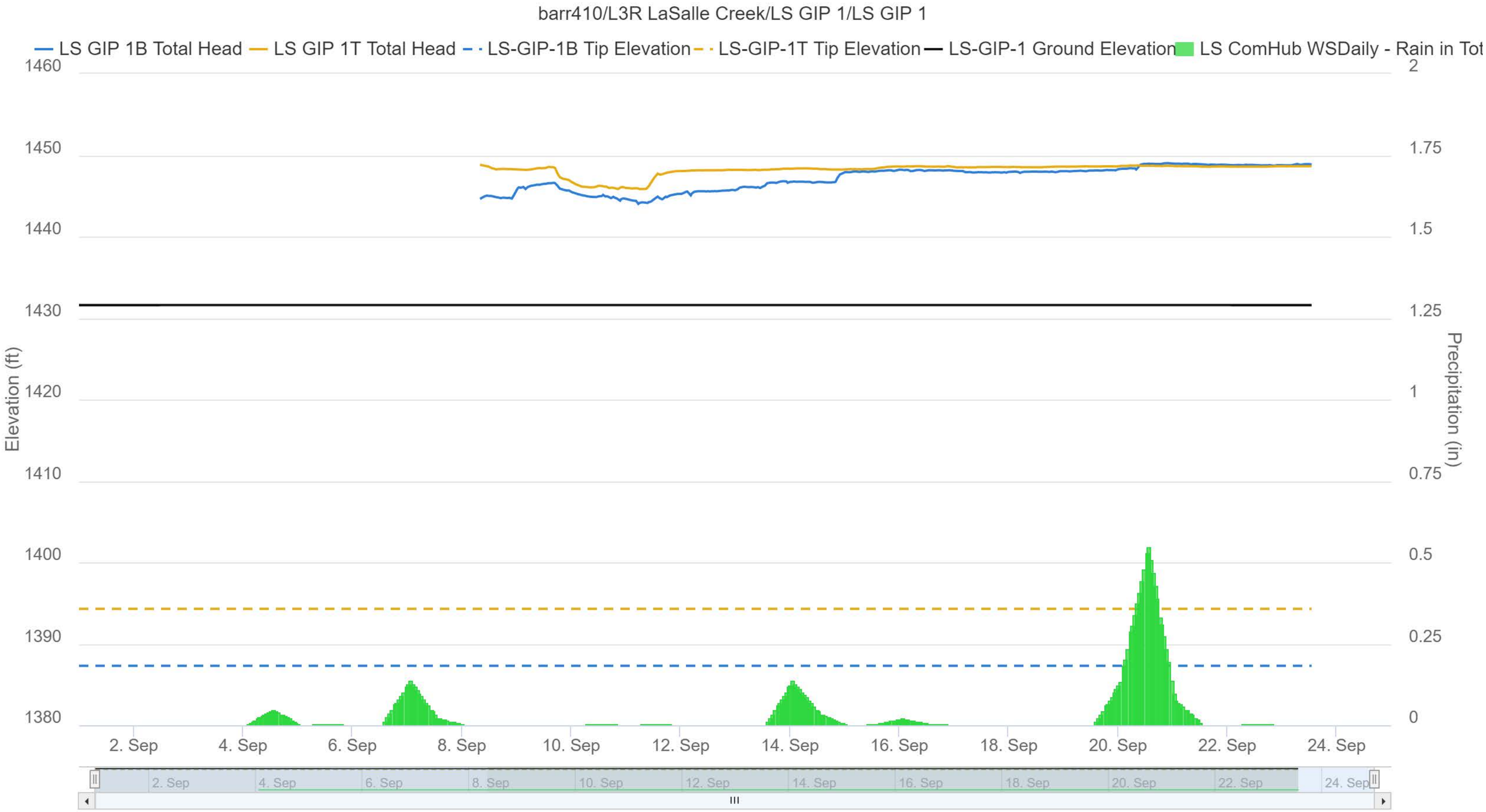
Sample Information & Classification

Boring #								
Sample #								
Depth (ft)								
Type								
Material Classification								
Water Content (%)								

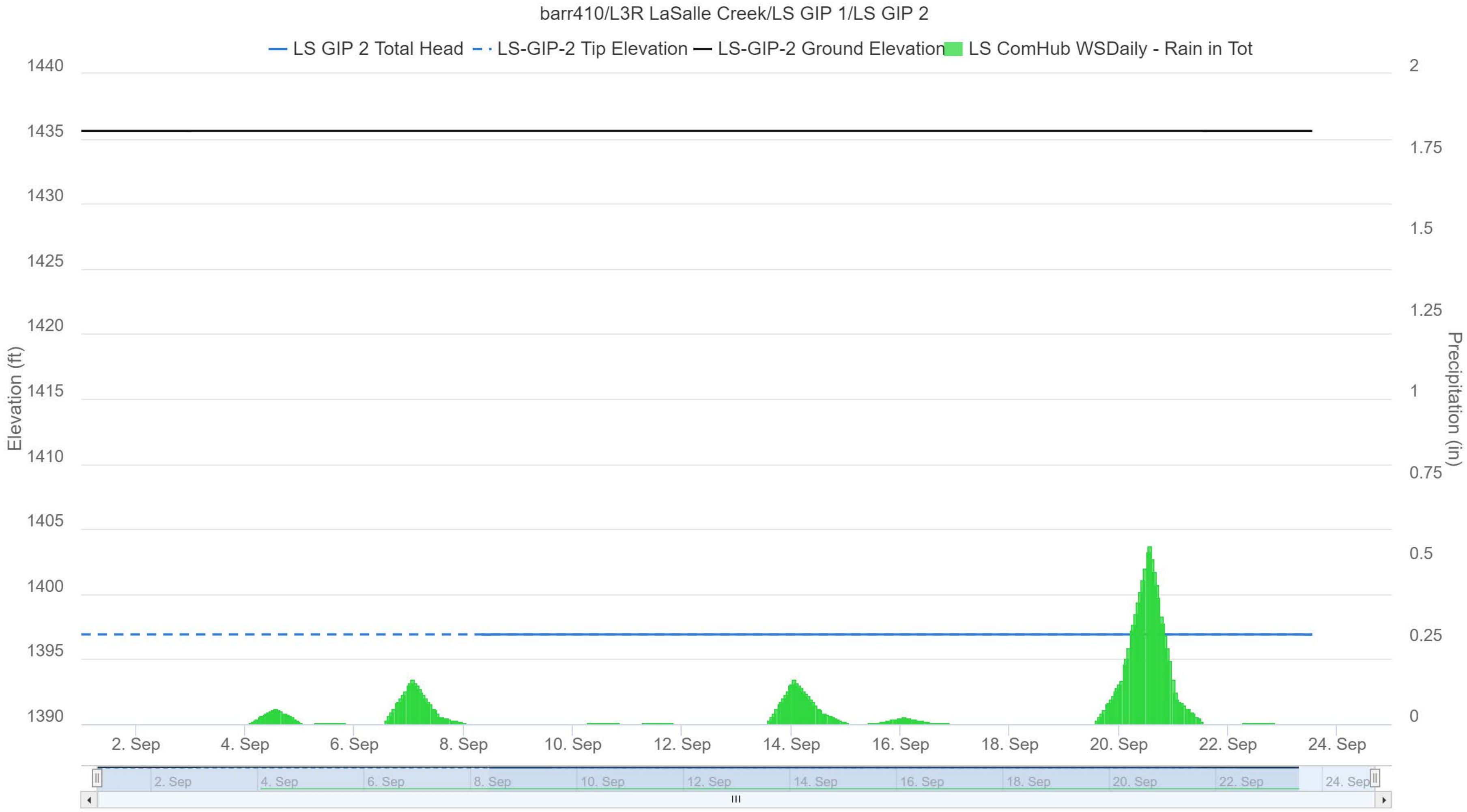
Attachment 3

Vibrating Wire Piezometer Data

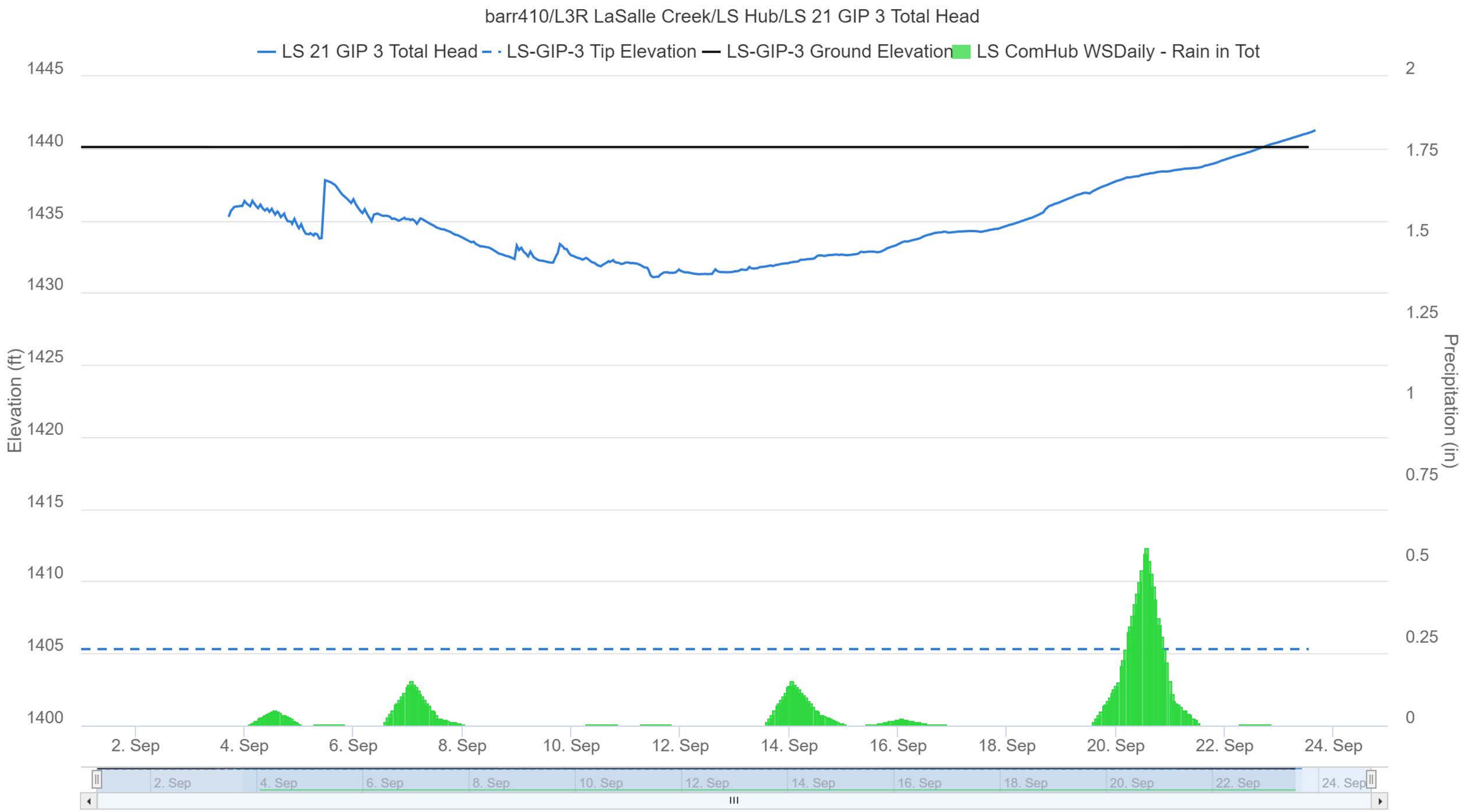
Line 3 Replacement
LaSalle Creek Crossing LS-GIP-1
Attachment - 3A



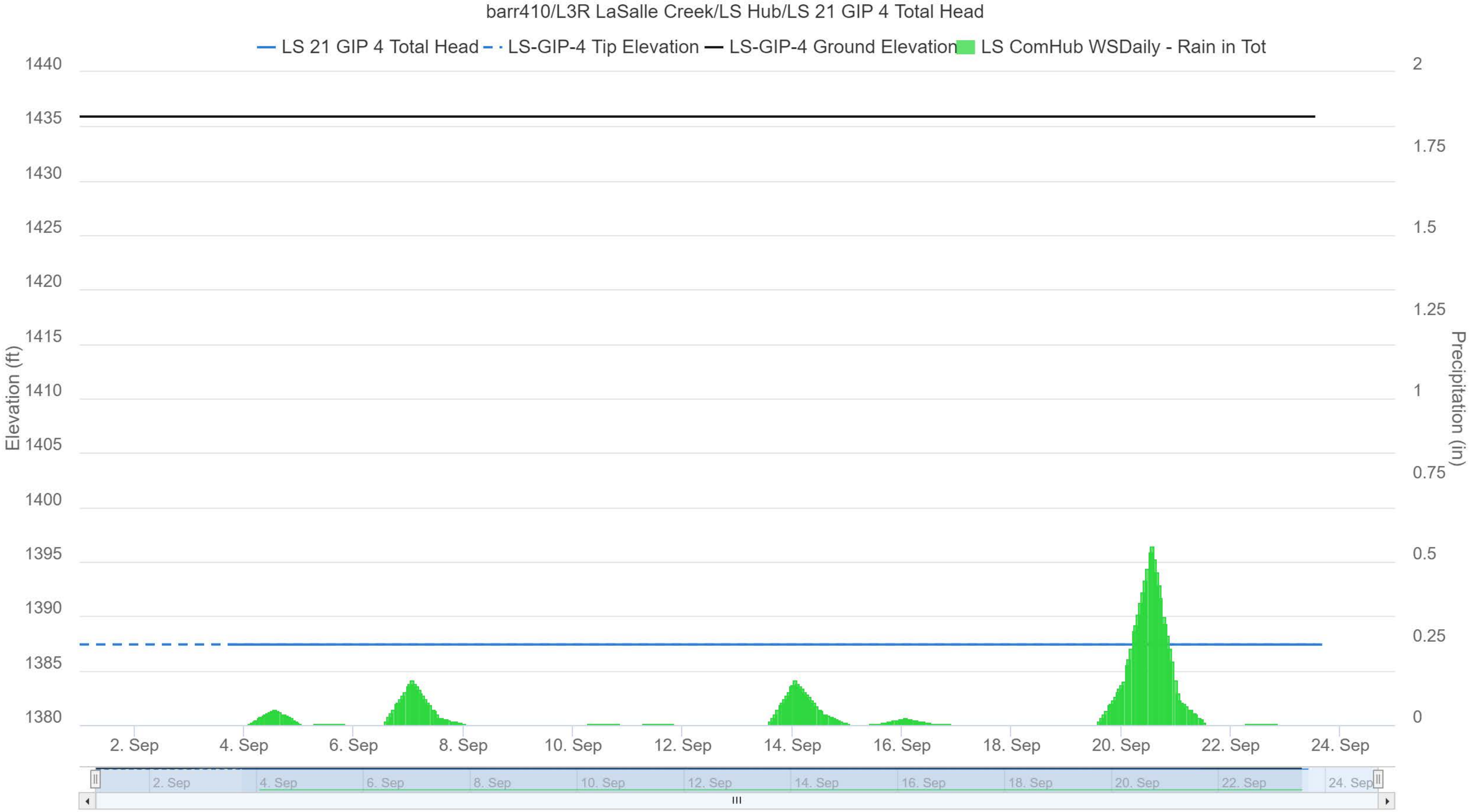
Line 3 Replacement
LaSalle Creek Crossing LS-GIP-2
Attachment - 3B



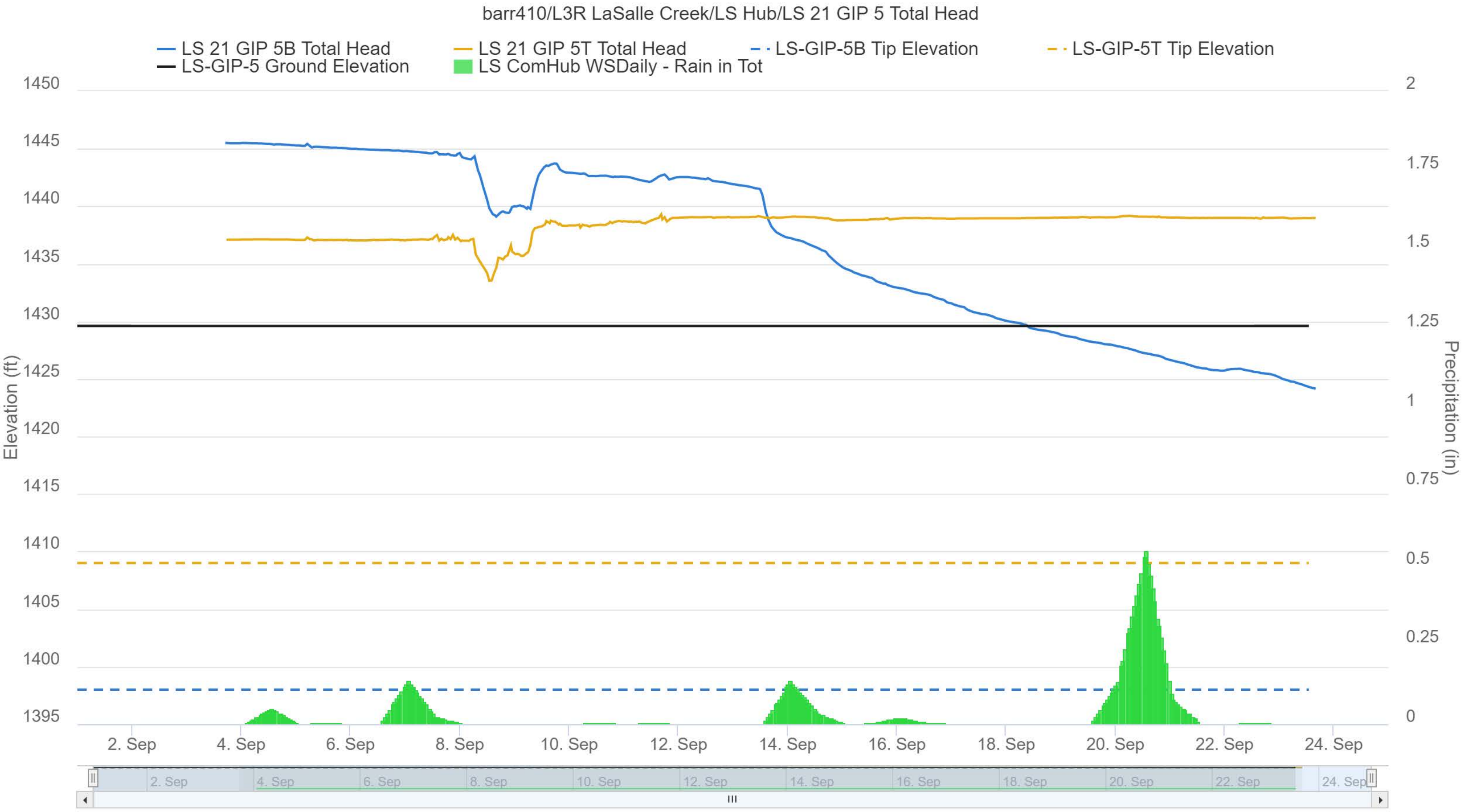
Line 3 Replacement
LaSalle Creek Crossing LS-GIP-3
Attachment - 3C



Line 3 Replacement
LaSalle Creek Crossing LS-GIP-4
Attachment - 3D



Line 3 Replacement
LaSalle Creek Crossing LS-GIP-5
Attachment - 3E

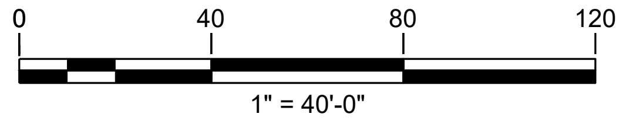


Attachment 2

Preliminary Grouting Plan

1 PLAN VIEW

1"=40'-0"



REFERENCE DRAWINGS

REV NO	REVISION DESCRIPTION	DATE BY	CHK	APPR

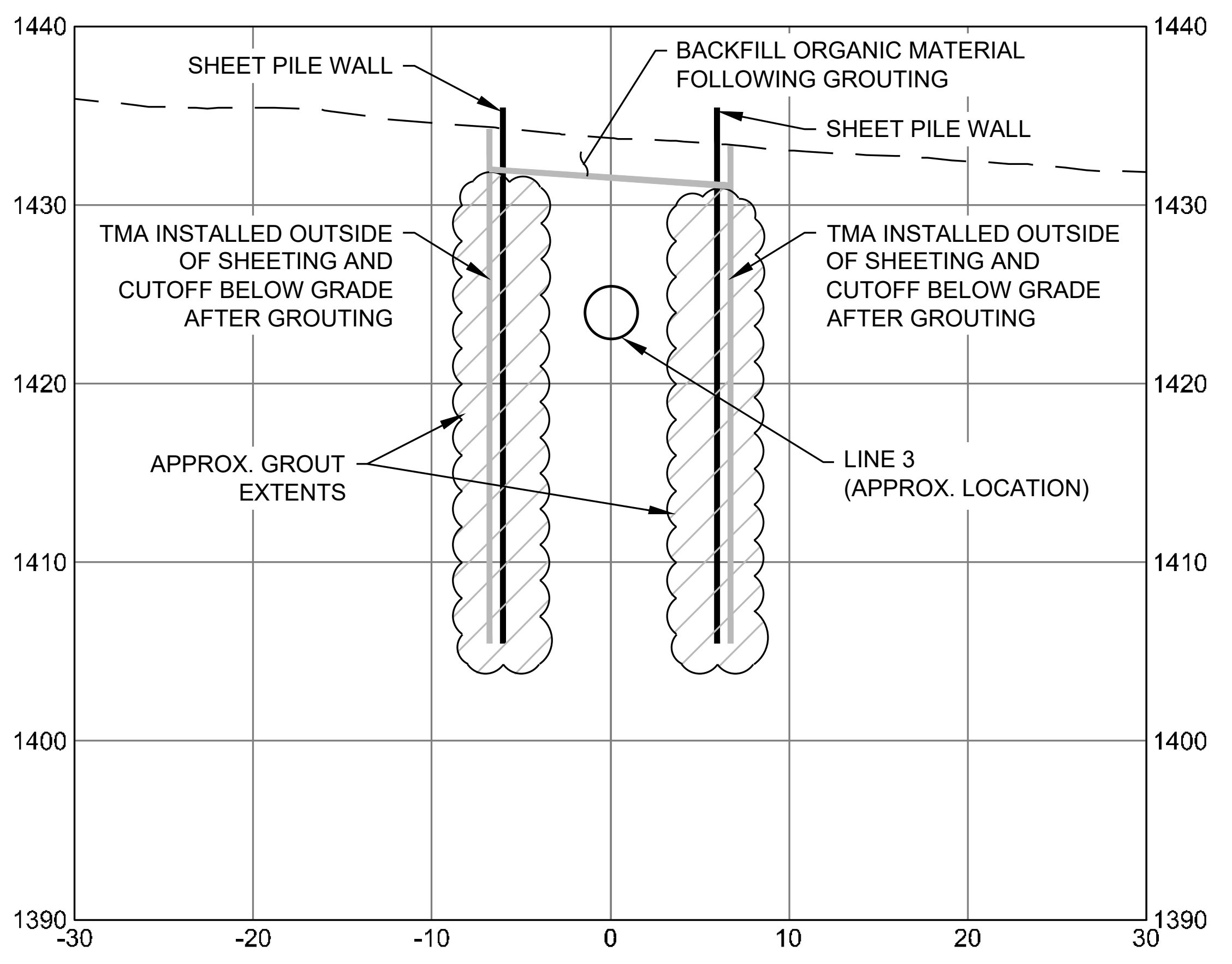
ENBRIDGE®

LINE 3
MP 946.2
LASALLE SHEET PILE WALL
PLAN VIEW

BY: JMD	CHK:	ENG. :	ENB APPR:
DATE:		SCALE:	STATUS:
DWG NO.: C-1			REV NO: 0.A

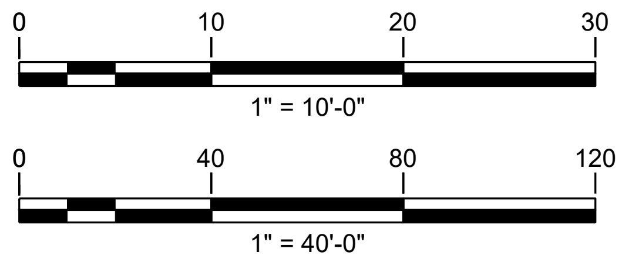
2 PROFILE VIEW

HORIZ. 1"=40'-0" VERT. 1"=10'-0"



3 TYPICAL SECTION

1"=10'-0"



REFERENCE DRAWINGS

REV NO	REVISION DESCRIPTION	DATE BY	CHK	APPR

ENBRIDGE

LINE 3
MP 946.2
LASALLE SHEET PILE WALL
PROFILE AND SECTION

BY: JMD	CHK:	ENG. :	ENB APPR:
DATE:		SCALE:	STATUS:
DWG NO.:		C-2	REV NO: 0.A