HDD Design Summary Report
Crossings HDD 3 to HDD 8
in Segment 3 – Package 1C

Whitehall to Fort Ann
Washington County, New York

CHA Project Number: 066076

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1.0 INTRODUCTION

1.1 PURPOSE

The Champlain Hudson Power Express (CHPE) project consists of installing a pair of HVDC electrical transmission cables with an associated telecommunications line from Canada to New York City. The portion of the work addressed herein is located in the upland portion of the route from the south end of Lake Champlain to New York City along the uplands of the Hudson River Valley. This work includes approximately 170 crossings (two crossings at approximately 85 locations) under roads, railroads, wetlands water bodies, and obstructions to be installed using horizontal directional drilling (HDD) methods to minimize interference with use or impacts to the environment. This Design Summary Report addresses the design for the HDD crossings in Segment 3 – Package 1C from Whitehall to Fort Ann. These crossings are designated HDD 3 through HDD 8, inclusive of A and B designations.

The purposes of this Design Summary Report are to provide the following:

- Review of the existing geological, hydrogeological, and geotechnical conditions for HDD 3 through HDD 8 for a total of 14 crossings (2 per site) in the Segment 3 – Package 1C.
- Provide a descriptive narrative of the HDD Crossings in support of the attached design drawings and technical specifications.
- Present stress and inadvertent release analyses that support the proposed designs.
- Evaluate construction considerations including inadvertent return mitigation.

2.0 PROJECT DESCRIPTION

The proposed CHPE route follows the Hudson River Valley of New York. The new transmission line will be approximately 146 miles in length, extending from the south end of Lake Champlain to Astoria, NY. Segment 3 – Package 1C is located in approximately a 5.9-mile section of the route in Washington County, New York.

A Project Locus Map and a plan showing the locations of the HDD 3 through HDD 8 crossings are presented in Appendix B.

The HDD crossing addressed in this report are located as shown in Table 1 below*:*

Table 1: HDD Locations, Lengths, and Description

HDD #	Start Station	End Station	HDD Length, ft	Obstruction Crossed
3	15074+50	15093+20	1868, 1869	Wetlands
4	15138+60	15144+75	628, 650	Culvert
4A	15163+05	15170+50	735, 760	Railroad Tracks
5	15175+15	15182+40	712, 723	Culvert & Wetlands
6	15218+15	15231+50	1339, 1453	Railroad Tracks & Culvert
7	15256+05	15269+00	1305	Wetlands
8	15296+20	15304+95	655, 838	Railroad Tracks & Culvert

3.0 BACKGROUND

The underground construction of two HVDC electrical transmission cables is proposed to be housed in individual 10-inch-diameter DR 9 HDPE conduits spaced a distance dependent on depth and soil Thermal Resistivity (TR) values provided by NKT and as shown on drawing plans. A third, 2-inch-diameter DR 9 conduit will be bundled with one of the 10-inch diameter conduits for a telecommunications line. Longer and deeper bores may require a larger diameter (i.e. 12-inch and 3-inch) and larger DR, thicker walls, values (i.e. DR 7) to resist tension stresses during installation and collapsing long-term. This is checked and determined on a case-by-case basis and design sizes are shown on the design drawings shown in Appendix E. The conduits are to be installed in 16 to 22-inch final ream diameter bore holes. The proposal is to install the cables at least 25 feet below congested areas, roads, railroads, under/around other obstructions, 15 to 25 feet below wetland and small streams, and 35 to 45 feet below open bodies of water using HDD methods. HDD is a widely used trenchless construction method to install conduits with limited disturbance to the ground around the bore alignment, minimal ground surface impacts above the alignment, and to minimize the potential of inadvertent releases of drilling fluids while boring. The goal for using HDD methods is to install the conduits while controlling and minimizing the amount of impact to congested areas, existing underground obstructions, and to the adjacent wetlands to the extent possible.

4.0 SITE CONDITIONS

4.1.1 Project Datum and Topography

<u>*HDD #3*</u>

HDD #3 consists of two, bores, approximately 1868 and 1869 feet long crossing wetlands and open water to the west of Canadian Pacific (CP) Rail railroad tracks at the CP Rail railroad yard in Whitehall, NY. The ground surface elevations along the HDD path gently slope down from North to South starting at El. 127 and reaching El. 121. About 100' north of the entry, the drill passes underneath open water in a wetland with standing water at about El. 116 (reference datum NAVD 1988).

<u>*HDD #4*</u>

HDD #4 consists of two straight HDD bores, approximately 628 and 650 feet long, crossing under an 84" reinforced concrete culvert pipe (RCP) on the west side of tracks approximately 630 feet east of the Champlain Canal. The ground surface elevations along the HDD path gently undulates between El. 124 and El. 121 for the majority of the run before taking a dip to El. 114 at the southern end, approximately 70% through the alignment (reference datum NAVD 1988).

<u>*HDD #4A*</u>

HDD #4A consists of two straight HDD bores, approximately 735 and 760 feet long, that cross from the west side of the CP Rail railroad tracks, under the tracks, and to the east side approximately 500 feet east of the Champlain Canal. The ground surface elevations along the HDD path gently builds from around El. 116 to El. 124 under the tracks and then gently back down to around El. 113 on the south end of the alignment (reference datum NAVD 1988).

<u>*HDD #5*</u>

HDD #5 consists of two straight HDD bores, approximately 712 and 723 feet long, located on the east side of the CP Rail railroad tracks that pass underneath an arm of the Champlain Canal. There are four (4) 84" corrugated metal pipe (CMP) running underneath the tracks for the canal at this location. It is approximately 200 feet from the Champlain Canal to the east. The ground surface elevations along the HDD path gently undulates around El. 117 to El. 124 aside from an El. drop to approximately El. 111 at the canal edges (reference datum NAVD 1988). The culverts have inverts at a range of El. 107.7 to El. 109.2 (reference datum NAVD 1988). The depth of water at this crossing is not known. A water depth of 5 feet was assumed for design purposes and analysis.

HDD #6

HDD #6 consists of two horizontally curved HDD bores, approximately 1339 and 1453 feet long, crossing the CP Rail railroad tracks from the east side to the west. Both bores cross the tracks at, and under open water immediately west of a 84" RCP crossing at an arm of the Champlain Canal. It is approximately 400 feet west from the Champlain Canal. The ground surface elevations along the HDD path hovers between El. 120 and El. 117 with the tracks at the center of the path reaching a peak at El. 125 (reference datum NAVD 1988). The culvert invert ranges El. 112.3 (on the west side of the tracks) to El. 109.4 (on the east) (reference datum NAVD 1988).

HDD #7

HDD #7 consists of two, straight, HDD bores, approximately 1305 feet long, crossing underneath wetlands and standing water. It is approximately 580' from the Champlain Canal to the east. The ground surface elevations along the HDD path gently undulates between El. 118 and El. 1249 (reference datum NAVD 1988). The depth of water at this crossing is not known. A water depth of 5 feet was assumed for design purposes and analysis.

HDD #8

HDD #8 consists of two straight HDD bores; the eastern bore is approximately 655 and 838 feet long, while the western bore is approximately 802 feet long. Both bores cross the CP Rail railroad tracks from the west to the east side of the tracks heading out of rail R.O.W. and towards N Old Rte 4. It is approximately 500 feet from the Champlain Canal to the east. The ground surface elevations along the HDD path gently undulates between El. 133 and El. 129, with the largest change in elevation occurring within the first 20% of the bores (reference datum NAVD 1988).

4.1.2 Geotechnical Data

HDD #3

Subsurface investigations were conducted in 2012 by TRC, 2021 by SoilTesting, Inc.2022 by Kiewit. There are four borings to date at HDD #3: KB-113.3, B113.4-1, K-113.5 and KB-113.6, which extended to depths of 57, 30, 52 and 52 feet below grade, respectively. There appears to be an 8-foot layer of loose fill over a 49-foot layer of medium stiff low plasticity clay in boring KB-113.3. There appears to be a 4-foot layer of loose fill over a 9.5-foot layer of medium stiff low plasticity clay over a 16.5-foot layer of medium stiff fat clay in boring B113.4-1. There appears to be a 6-foot layer of medium compact fill over a 24-foot layer of medium stiff fat clay, over a 22-foot layer of soft fat clay in boring K-113.5. There appears to be a 2-foot layer of loose fill over an 8-foot layer of medium stiff low plasticity clay, over a 2-foot layer of stiff fat clay, over a 15-foot layer of soft low plasticity clay, over a 10-foot layer of soft fat clay, over a 5-foot layer of soft low plasticity clay in boring KB-113.6. The BoreAid analysis will be based on non-horizontal layering corresponding to borings KB-113.3, K-113.5 and KB-113.6, which all encountered similar conditions.

The Geotechnical Data Report for this location is provided in Appendix C.

Based on the borings, the soil profile for the HDD #3 BoreAid analyses will be divided into three [3] layers: loose fill, medium stiff low plasticity clay and soft fat clay. The soil profiles used for BoreAid analyses of the HDDs in this segment are presented in Appendix D.

HDD #4

Subsurface investigations were conducted in 2012 by TRC for Transmission Developers, Inc. and in 2021/2022 by Kiewit. There are two bores at HDD #4: B114.4-1 and K-114.6. B114.4-1 bore log, reaching a depth of 30 feet, indicates fill over a thin layer of soft clayey silt all over soft to medium stiff clay. Bore K-114.6 terminated at a depth of 72 feet. This bore indicates a 10 to 12 foot initial layer of fill (silty sand with gravel; moist) over wet, a fat medium stiff to stiff clay to 22 feet, then very soft to soft clay to 72 feet. The Geotechnical Data Report for this location is provided in Appendix C.

Based on the borings, the soil profile for the HDD #4 BoreAid analyses will be divided into five [5] layers: Gravel, loose silt, medium stiff clay, and two layers of lower soft clays. The soil profiles used for BoreAid analyses of the HDDs in this segment are presented in Appendix D.

HDD #4A

No subsurface investigations were conducted at HDD #4A. The soil conditions at this location were estimated based on nearby borings since borings within the 4A HDD alignment were not available. It is recommended that the HDD subcontractor drill a test boring at the start of construction at the HDD 4A site before starting the HDD to confirm the ground conditions.

Based on the adjacent borings, the soil profile for HDD #4A BoreAid analysis was divided into three [3] layers: gravel, medium stiff lean clay, and very soft to soft fat clay. The soil profiles used for BoreAid analyses of the HDDs in this segment are presented in Appendix D.

HDD #5

Subsurface investigations were conducted in 2013 by TRC for Transmission Developers, Inc. and in 2021/2022 by Kiewit. There are two borings at HDD #5: B115.2-1 and K-115.2. that reached a depth of 30 feet. Bore B115.2-1 indicates that there is a thin layer of loose fill (ash and cinders) over medium stiff to soft clayey silt. Bore K-115.2, reaching a deeper depth of 30 feet, shows a 10 foot layer of medium stiff lean clay over moist, plastic soft fat clay. The Geotechnical Data Report for this location is provided in Appendix C.

Based on the borings and the elevation and location of that bore, the soil profile for the HDD #5 BoreAid analyses will be divided into three [3] layers: gravel, medium stiff lean clay, and soft fat clay. The soil profiles used for BoreAid analyses of the HDDs in this segment are presented in Appendix D.

HDD #6

Subsurface investigations were conducted in 2013 by TRC for Transmission Developers, Inc. and in 2021/2022 by Kiewit. There are three borings at HDD #6: B116.1-1, B116.2-2, and K-116.1. Borings B116.1-1 and B116.2-2, both reaching a depth of 30 feet, indicate loose fill over stiff to soft clayey stilt with loose silty sand at the bottom ranging from 23.5 to 18.5 feet deep. Bore K116.1, terminated at a depth of 65 feet, shows an initial 4 to 5 foot layer of fill over 11 to 12 feet of medium stiff lean clay, 2 to 3 feet of soft fat clay, of lean clay, 2 to 3 feet of fat clay, all over a 10 foot layer of well graded sand. Fat clay continues to the end of the bore. The Geotechnical Data Report for this location is provided in Appendix C.

Based on the borings, the soil profile for the HDD #6 BoreAid analyses will be divided into five [5] layers: Loose silt, medium stiff lean clay, second layer of loose silt, poorly graded medium dense sand, and soft clay. The soil profiles used for BoreAid analyses of the HDDs in this segment are presented in Appendix D.

HDD #7

Subsurface investigations were conducted in 2012 by TRC for Transmission Developers, Inc. and in 2021/2022 by Kiewit. There are two borings at HDD #7: B116.8-1 and K-116.9. Bore B116.8-

1, that reached a depth of 65 feet, indicates medium dense sand to about 10 to 15 feet deep. The remainder of the bore is medium stiff clay over soft to very soft clay. Bore K-116.9, terminated at a depth of 67 feet, shows a fat medium stiff to stiff clay to 32 feet, then very soft to soft clay to 67 feet under an initial 15-to-16-foot layer of fill (mainly silty sand with gravel). The Geotechnical Data Report for this location is provided in Appendix C.

Based on the borings and the elevation and location of that bore, the soil profile for the HDD #7 BoreAid analyses will be divided into four [4] layers: poorly graded medium dense sand, stiff lean clay, and two layers of soft to very soft fat clay. The soil profiles used for BoreAid analyses of the HDDs in this segment are presented in Appendix D.

HDD #8

Subsurface investigations were conducted in 2021 by AECOM for Transmission Developers, Inc. There are two borings at HDD #8: WFE-1C and WFE-1. Both bores reach a depth of 40'. Both bores indicate that there is mostly medium stiff to soft silty clay underneath a layer of loose sand (Poorly Graded Sand). The Geotechnical Data Report for this location is provided in Appendix C.

Based on the borings, the soil profile for the HDD #8 BoreAid analyses will be divided into two [2] layers: Poorly graded sand and medium stiff fat clay. The soil profiles used for BoreAid analyses of the HDDs in this segment are presented in Appendix D.

5.0 DESIGN SUMMARY

The HDD construction process generally consists of three steps:

Step 1: Drill a small diameter (approximately 7 to 9 inches diameter) pilot hole along the preplanned bore path. During the pilot hole boring, the location of the drill bit is tracked to confirm that it is following the planned path. If the drilling is observed to start to deviate from the planned path, corrections are made using a "bent" lead drilling section and controlled rotation of drill pipe string. The drill bit is designed to cut through the soil in combination with pressurized drilling fluid assisting the cutting of the soil, and transport of the cuttings to the entry pit for removal. The drilling fluid is generally a combination of bentonite (a clay mineral) and water, combined with NSF certified additives to support sides of the borehole and to better carry the cuttings to the entry pit at lower pressures and velocities. The drilling fluids used under waterbodies and wetland areas are typically required in the project specifications to be “non-toxic and environmentally friendly”. Once the pilot bore reaches the exit point, the next step of the process, hole enlargement begins.

Step 2: Enlarge the pilot hole to the diameter required for insertion of the conduits. This is accomplished by using successively larger reaming bits pulled through the pilot bore to gradually enlarge the bore from about 8 inches diameter to 16 to 22 inches diameter to accommodate in this case a HDPE conduit about 10 inches in diameter in one bore and a bundle of two conduits, one 10 inches diameter and the other 2 inches diameter, that are to be pulled into the enlarged bore hole. We estimate that one, and possibly a second reaming pass, will be used to create the 16-to-22-inch diameter borehole. This pulling in of a bundle of conduits is sometimes referred to as a slick bore. During this step, the borehole is still filled with drilling fluid to support the sides of the bore hole in preparation for Step 3, the insertion of the conduit.

Step 3: Pull the conduits into the enlarged hole. While the pilot hole and reaming operations are ongoing, the contractor will also be fabricating the conduits to be installed. The conduits come in about 40-foot-long sections and need to be fusion butt welded, debeaded internally, and arranged for the pullback into to the borehole. Ideally, the complete conduit (or bundle of conduits) will be welded (and bundled) into one long length for insertion. The goal is usually to pull the bundle into the bore in one, continuous, smooth, around the clock, operation. However, depending on work area and access constraints, sometimes the pipe is assembled in 2 or 3 lengths that then joined (welded), “on the fly” as the conduit (bundle) is slowly pulled into the borehole. As the conduit (bundle) is pulled into the hole it is usually ballasted with clean water, and some of the drilling fluid supporting the sides of the hole is displaced by the conduit and collected for eventual disposal. Upon completion of the conduit installation, the conduit will be allowed to relax and come to equilibrium in the hole, and the conduit will be cleaned and capped as described in the HDD technical specifications.

5.1 GEOMETRY AND LAYOUT

The HDD profiles are generally defined by the following parameters:

- Entry point location;
- Exit point location;

- Entry angle;
- Exit angle;
- Horizontal and vertical radius of Curvature;
- Lengths of tangent sections;
- Length of crossing;
- Depth of crossing and depth of cover;
- Site constraints and obstructions; and
- Available work and layout areas

The proposed bore paths entry angle, exit angle, and a vertical and horizontal design radii of curvature for each HDD crossing in this segment are shown in the design drawings provided in Appendix E. Inadvertent release prevention and mitigation plans for each HDD crossing are provided as separate documents.

The design drawings to summarize the proposed HDD installations are in Appendix E. The HDD technical specifications are found in Section 330507.13 of the Technical Specifications. Inadvertent release prevention and mitigation plans for each HDD crossing are provided as separate documents.

The site conditions posed various challenges in developing a design that is both constructible and minimizes the potential for negative environmental impacts. The proposed design has entry and exit pits areas constrained by available easements and traffic constraints. Available work areas may limit the lengths of the conduit that can be pre-assembled, necessitating having to pre-assemble the bundle several segments that will have to be welded together during the pull back. Work zone requirements are shown in Appendix A. HDD specific work areas at the entry and exit ends of the bores are noted on the drawings in Appendix E. In addition, space and easement constraints will require that during pullback, the above ground sections of the conduit will not be straight and will require rollers to accommodate a horizontal bend. Conduit assembly is expected to be performed at the ends of the alignment shown on the drawings in Appendix E for HDD specific work areas. In some cases, the limited work area at the one end of the HDD alignment, may require that the drilling and reaming prior to pullback be performed by the HDD rig located at the one end of the alignment, but the HDD rig may need to be relocated to the other end of the alignment for the pullback/conduit installation phase of the work. In addition, for some longer bores in soft/weak ground conditions, the intersection bore method may be used to better control the risk of inadvertent drilling fluid releases.

5.2 SUBSURFACE MODEL DEVELOPMENT

A subsurface model was developed based on the boring logs as approximate representation of subsurface conditions along the proposed HDD alignment. BoreAid Version 5.0.14 (2015) modeling software (a product of Vermeer) was used to model the HDD. Geotechnical input parameters of the soil were estimated as described below.

The internal friction angles (AASHTO LRFD, Ed. 7) were estimated using the Standard Penetration Test (SPT) blow counts. The shear modulus (G) of each layer was estimated using soil density or consistency based on SPT blow count (N-value) and representative soil layer descriptions were used to estimate Young's Modulus (E) using Hunt (1986). The shear modulus was estimated using the relationship $G = E/[2(1+\nu)]$, taking Poison's Ratio (ν) equal to 0.3. Dry and saturated unit weights were selected based on soil type using Table 2-8 from the Manual on Estimating Soil Properties for Foundation Design (EPRI, 1990). For cohesive soils, cohesion was estimated based on empirical correlations with SPT blow counts (EPRI 1990). Tables for soil properties that will be used for the HDDs in Segment 3 – Package 1C are presented in Appendix F.

5.2.1 BoreAid Analysis

For the BoreAid analyses, the pipe configuration analyzed was for a pipe with a dimension ratio (DR) of 9 which is assumed to not be ballasted with water during pullback to create a near neutral buoyancy. The following conduit configurations will be used:

1) An individual 10-inch-diameter DR 9 HDPE (or 12-inch diameter DR 7 HDPE) conduit, and

2) A bundle consisting of a 10-inch-diameter DR 9 HDPE conduit and a 2-inch-diameter DR 9 HDPE conduit (or a 12-inch diameter DR 7 HDPE conduit with a 3-inch-diameter DR 7 HDPE conduit)

The stresses and deflections of the pipe are evaluated and compared to allowable values as shown on the BoreAid runs presented in Appendix D.

In addition, a run where 2-inch-diameter DR 9 HDPE conduit is modeled alone was performed to check stresses in that conduit.

5.2.2 Inadvertent Return and Hydro-fracture Analysis

BoreAid modeling software was used to perform inadvertent return analyses for each HDD alignment. The bore path alignment was selected and checked so that the allowable bore pressures are greater than the static and circulating pressures throughout most of the alignment except at the ends. The allowable pressures are related to in-situ ground and water stresses around the bore hole, and the strength of the ground. The Limiting Formation Pressure Figure indicates a generally acceptable factor of safety against the potential for inadvertent return along the proposed bore paths except at the ends.

Based on the bore path selection process, areas with the greatest potential for an inadvertent return were examined and adjusted during the design process to further limit the risks associated with an inadvertent return when possible. The entry and exit points exhibited the greatest potential for inadvertent returns. The depth of the entry/exit pits should be considered by the Contractor to increase the effective soil stress and provide a storage volume for returns to and near the entry and exit points. Note that while the potential for inadvertent return has been reduced through the design process, inadvertent returns are still possible through existing fissures in the soil or rock, shrinkage cracks, weak soils, or porous deposits of coarse gravel.

Fractures within and/or inadvertent releases through the surrounding soils may cause loss of drilling fluid pressures or inadvertent return of drilling fluid into the wetlands. The areas of greatest concern are reduced soil cover over the bore alignment and where there is a risk of release to the wetlands. The contractor will be required to institute pre-emptive measures in this area to mitigate the effects of a release in the event that one should occur. Such measures may include containment booms and a standby vacuum truck to collect any released drilling fluids immediately. Ground heave or settlement from inadvertent releases also pose risks to structures such as roadways. The HDD alignment was designed with geometries to providing enough soil cover to reduce the risk of inadvertent return. The Inadvertent Release Contingency Plan details additional methods for mitigating inadvertent returns.

5.3 LIMITATIONS

The structural analysis and inadvertent return mitigation analysis were performed using the proposed design bore paths and typically anticipated equipment and means and methods. The HDD subcontractor must submit structural and inadvertent return mitigation calculations and analysis for each bore path, including their final bore path geometry reflecting its specific equipment and contractor's specific means, methods, drilling fluids, and proposed final contractor refined final planned alignment. It is important to note that the Kiewit Design Team's analysis has been done without consideration for point loading due to unpredictable subsurface features such as encountering rocks, boulders, or other extremely dense material that may damage the conduit. The risk of such conduit damage is low yet has been reported on some projects in recent years.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 RISK AWARENESS AND ASSESSMENT

The risks to be aware of during HDD include: inadvertent returns or fluid loss; any potential obstructions blocking or causing large deviations from the planned bore path; and electromagnetic effects on the HDD steering equipment from nearby high voltage power lines.

6.2 SITE ANALYSIS

A site analysis must be performed prior to commencing HDD operations. Considerations might need to be taken for items such as for site access, construction of HDD entry and exit pits, and layout area for equipment and supplies.

6.3 EROSION CONTROL

The proposed bore path crosses under roads, parking lots, water, stormwater and gas and electric utility lines, as well as under streams/wetlands, bodies of water, and railroads. The soil erosion control drawing will show where primary soil erosion control measures are required. The technical specifications and Inadvertent Release Contingency Plan both detail the requirements for both primary and secondary sediment and erosion control measures to be followed in case of an inadvertent return, which ultimately could deposit the fine bentonite sediment into the stream or wetland or bodies of water if not controlled. Construction of the exit pit will be close to the stream/wetlands. Silt fence, straw bales, and other soil erosion control measures will be required to be installed as shown in the construction drawings. Secondary control measures are to be readily accessible at or near the work areas in accordance with the project specifications and Inadvertent Release Contingency Plan.

6.4 SURVEILLANCE AND MONITORING

During installation of the pipe by HDD, monitoring the stream, wetlands, waterbodies and bore alignment for indications of potential inadvertent returns or inadvertent releases will be necessary. The contractor will have primary responsibility for this monitoring and associated response and reporting in real-time. This will be accomplished as detailed in the Inadvertent Release Contingency Plan. Continuous visual inspection of the entire path is the most significant method of detection. However, an experienced drill crew can often prevent a return by monitoring drilling fluid pressures. A loss of pressure may indicate inadvertent release has occurred. Regardless of the level of preparation, inspection, monitoring, etc., inadvertent returns are not always possible to predict or prevent. However, a significant effort can minimize the possibility but not eliminate it.

7.0 REFERENCES

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Mayne, P.W., and Kulhawy, F.H. (1990). Manual on Estimating Soil Properties for Foundation Design. Electric Power Research Institute (EPRI).

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Appendix A

Work Zones

HDD WORK ZONE CONFIGURATION CONSIDERATIONS

Introduction:

In general, HDD requires ample space for both entry and exit operations, work area, or Work zones. The HDD contractor or subcontractor ideally wants to consolidate all operations within these footprints. The exit Work zone also includes a narrower extension for the assembly of the full length pull back string of conduit or pipe. The size of these desired Work zones is driven by rig size in Table 1.

TYPICAL HDD ENTRY AND EXIT WORKSPACE		
SYSTEM DESCRIPTION	ENTRY WORKSPACE	EXIT WORKSPACE
MAXI (24"-48")	150' X 350'	150' X 250'
MIDI (12"-<24")	150' X 250'	100' X 200'
MINI (2"-<12")	VARIES PER SITE	VARIES PER SITE

TABLE 1

An example of an entry Work zones is shown in Figure 1a below.

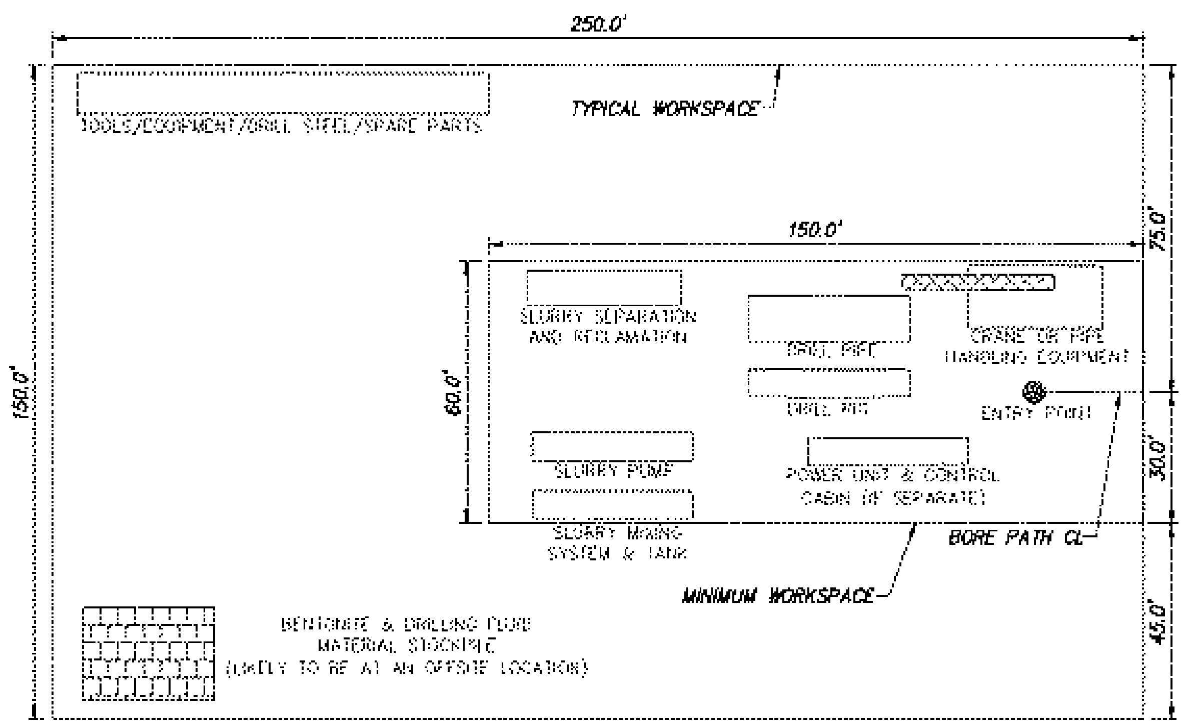


FIGURE 1a: Typical Entry Work Zone Configuration

An example of an exit Work zones is shown in Figure 1b below.

Appendix A

HDD WORK ZONE CONFIGURATION CONSIDERATIONS

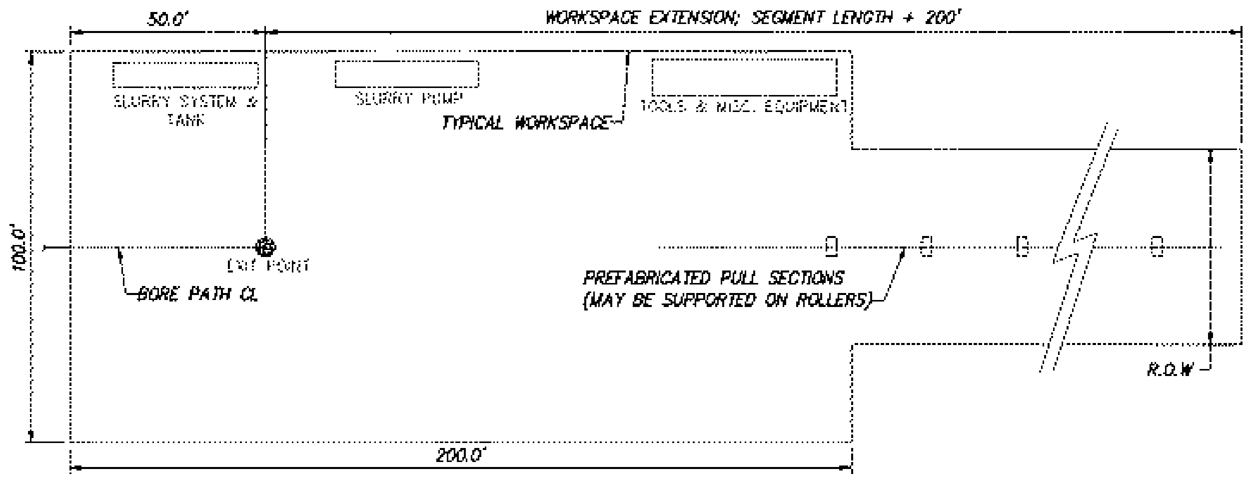


FIGURE 1b: Typical Exit Work Zone Configuration

Work zones should also be able to facilitate contingencies for space to recover a failed bore hole and a new offset bore, the ability swap entry for exit, or in some cases rigs on both ends.

CHPE Project Limitations:

Available Work zone areas for the Champlain Hudson Power Express Project (CHPE) are constrained because the project occupies a narrow existing corridor and is essential in a linear brown field. This is complicated by the rail corridor which precedes most forms of environmental regulations, and it traverses numerous wetlands or other sensitive areas which affects available Work zone areas.

We have assumed the majority of HDDs will be accommodated by a Mini or Midi HDD class machine and support equipment, <12-inch diameter and 1500 feet individual bores.

1. Ideally, an Entry workspace approximately 20 to 25 feet wide x 150 to 200 feet long for a small rig with a mounted pipe rack and self-contained power unit and operator control cabin on the rig; a separate mud mixing and pumping unit, plus a separate mud processing and separation unit support by equipment arranged linearly. Since each crossing is a pair two, 20 x 150 Work zones are equivalent to a 40 x 150 overall work area, and we have assumed the support equipment will be set once for both HDDs. It is also assumed existing roads or access roads will parallel one side of a Work zone.
2. Ideally, an exit workspace approximately 15 to 20 feet wide and between 60% and 110% of the bore length is needed to layout and assemble the conduit for pullback.

A somewhat smaller entry Work zones may be possible depending on drill rig specifics and the availability of nearby areas for support equipment support operations. The project will have remote yards. Small work areas tend to reduce access and efficiency of operations, raise costs, but are necessitated by the specific project and site constraints.

See Figure 1c below covers general considerations and typical workspace configurations drafted for the CHPE Project.

GROUND TYPE	RIG SIZE	BORE LENGTH (ft)	WORK AREA (ft²)	NOMINAL FOOTPRINT [ft x ft)
SOIL	Large/Maxi	>2,500	37,500*	150 x 250*
	Medium/Midi	1000-2500	15,000*	100 x 150*
	Small/Mini	<1000	3,000*	30 x 100*
ROCK	Large/Maxi	>2,500	37,500*	150 x 250*
	Small/Mini & Medium/Midi	1000-2500	15,000*	100 x 150*
PIPE ASSEMBLY	ALL	ALL	**	25 x (conduit length + 50)**

Notes:

* The entry and exit workspaces typically need space for a drill rig and support equipment such as a pipe rack, power unit operator control cabin, a mud mixing and pumping unit, plus a separate mud processing and separation unit support equipment arranged linearly in line may be possible. Somewhat smaller work areas may be possible depending on drill rig specifics and availability of nearby areas for support equipment and support operations. Often need to coordinate final work areas with selected contractor's specific operations. Smaller work areas tend to reduce access and efficiency of operations.

** For HDD conduit bundle assembly and pullback, need a corridor equal to at least 1/3 to ½ of the length of the total bundle length and minimum 20 feet wide, typically at the exit end. Best if corridor equals the full length of the total bundle length plus about 50 ft

FIGURE 1c

Appendix B

Locus Map


HDD3
The Saddles State Forest
12
HDD4
HDD4A
HDD5
4
HDD6
HDD7
Adirondack Park
HDD8
© 2022 Google
22
Comstock
22

Appendix C

Geotechnical Data Report for CHPE Segment 3 – Package 1C HDDs

Kiewit

MEMORANDUM

DATE: February 28, 2023

TO: Antonio Marruso, P.E.; CHA Consulting, Inc.

FROM: Matthew Hawley, P.E.; Kiewit Engineering (NY) Corp. MKH
Jaren Knighton; Kiewit Engineering (NY) Corp.

SUBJECT: Geotechnical Data: Segment 3 – Package 1C - HDD Crossing 3 – Revision 2
Champlain Hudson Power Express Project
Whitehall, New York

Kiewit Engineering is providing the attached geotechnical data for use in the horizontal direction drill (HDD) design for the Champlain Hudson Power Express project in Upstate New York. This HDD crossing is located south of Whitehall, New York. The approximate station for the start of HDD crossing Number 3 is STA 15084+00 (43.5380°N, 73.4067°W).

The geotechnical data at this HDD crossing is attached. The available data is from the previous investigation by TRC and recent investigations by Schnabel and Kiewit, referenced below.

- TRC, Geotechnical Data Report, Champlain Hudson Power Express, Canadian Pacific Railway Borings MP 113.1-177.1, dated March 29, 2013.
- Schnabel Engineering, Geotechnical Data Report, Champlain Hudson Power Express, Canadian Pacific Railway Subsurface Explorations, dated March 3, 2022.
- Kiewit Engineering (NY) Corp., Package 1C Phase 4 Borings, Champlain Hudson Power Express, New York, dated January 20, 2023.

Contact us if you have questions or require additional information.

HDD 3
Borings B113.4-1, K-113.5
KB-113.3, KB-113.6
Segment 3 - Package 1C

CHPE Segments 1, 2, and 3 - Packages 1A, 1B, and 1C
HDD Soil Boring Coordinates and Elevations

Firm	Boring	Northing (feet)	Easting (feet)	Ground Surface Elevation (feet)
S.W. Cole*	B102.4-1	1762367.3	777951.9	139.42
	B109.7-1	1729097.5	774410.6	116.4
	B109.8-1	1728870.4	774869.2	99.8
	B110.1-1	1728142.0	776337.8	105.0
TRC*	B113.4-1	1714875.2	781894.9	122.9
	B114.4-1	1709558.6	780857.2	122.7
	B115.2-1	1705777.9	780186.6	120.9
	B116.1-1	1701426.5	778616.5	124.1
	B116.2-1	1700894.8	778375.8	124.3
	B116.8-1	1697938.4	777308.2	131.6
AECOM**	PD-7	1783019.4	778020.6	266.4
	PD-7A	1782960.9	778149.9	269.5
	WFE-1	1693492.9	776280.6	127.9
	WFE-1C	1693895.8	776092.3	129.3

Notes:
- Northings and Eastings are provided in NAD83 New York State Plane East Zone.
- Elevations are referenced to the NAVD88 datum.

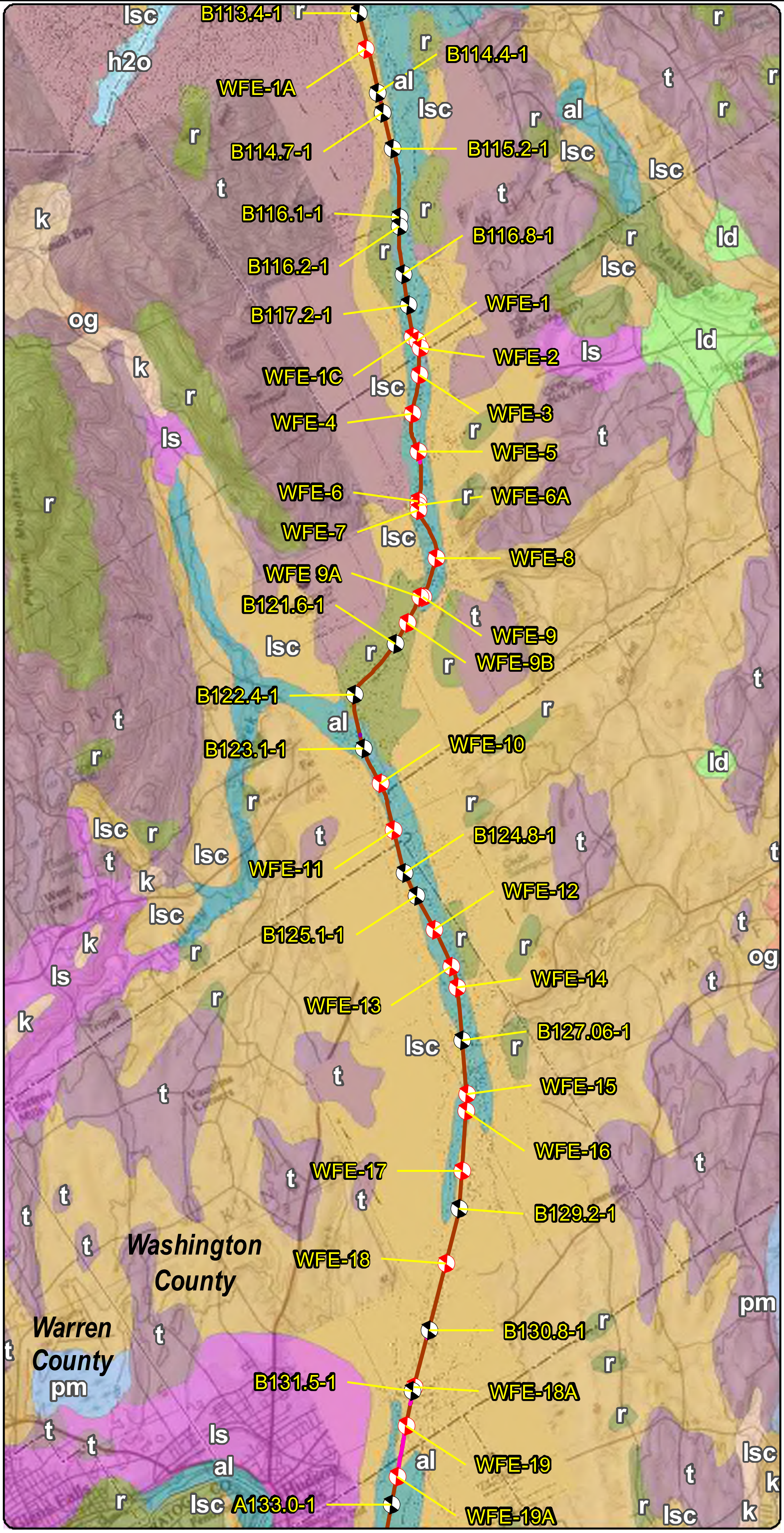
* TRC and S.W. Cole boring coordinates as shown in Table 1-6 in AECOM report (reference below). Boring elevations estimated from November 2021 topographic survey by Williams Aerial.

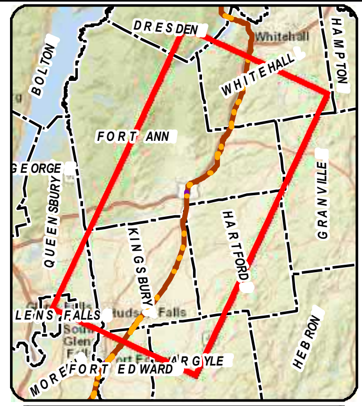
** AECOM boring coordinates and elevations as shown in Table 1-6 in AECOM report.

*** Kiewit boring coordinates and elevations are noted on the boring logs.

Reference:

AECOM, Geotechnical Data Report, Upland Segments: Putnam Station, Washington County, to Cementon, Green County, NY, Champlain Hudson Power Express, dated May 28, 2021.





LEGEND

- 2021 Boring Location
- Previous (2013) Boring Location
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- Town Boundary
- County Boundary

Surficial Geology

- al - Recent alluvium
- h2o - Water
- k - Kame deposits
- ld - Lacustrine delta
- ls - Lacustrine sand
- lsc - Lacustrine silt and clay
- og - Outwash sand and gravel
- pm - Swamp deposits
- r - Bedrock
- t - Till

1 0.5 0 1 Miles

Transmission Developers Inc.

Champlain Hudson Power Express Project

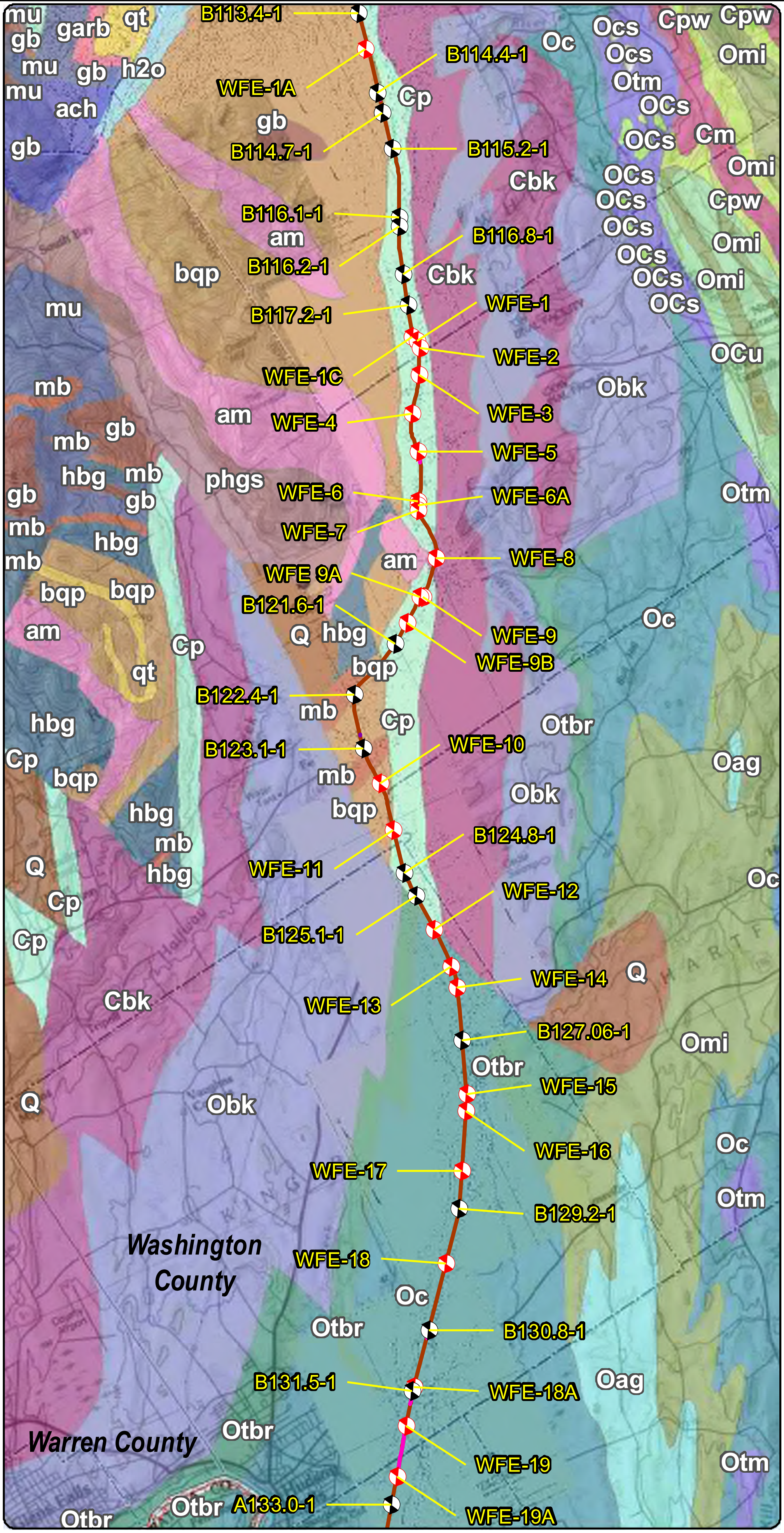
Champlain Hudson Power Express Inc.

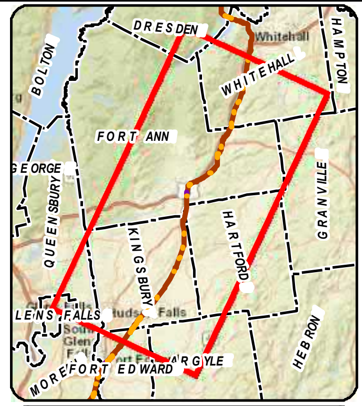
Surficial Geology and Geotechnical Borings Whitehall to Fort Edward
Figure 3-3

Prepared on 5/5/2021
by: AECOM

DATA SOURCES: ESRI, NYSDOT, NOAA, USACE, NYDOS, TDI, TRC

Y:\Projects\CHPE\Route\Consensus_Alternative_Routes\MXD\Alt_5_Routes_DZ_201909\Boring_Locations\Maps_for_May_2021_Report\Whitehall_to_Ft_Ed_Boring_Locations_Surficial_May_2021_Report.mxd





LEGEND

2021 Boring Location

Previous (2013) Boring Location

Terrestrial Route HVDC

Submarine Route HVDC

Terrestrial Route HVAC

Preliminary HDD Locations

Preliminary Pipe Bridge Location

Town Boundary

County Boundary

Bedrock Geology

- Cbk - Beekmantown Group
- Cm - Mettawee Formation
- Cp - Potsdam Sandstone
- Cpw - Poultney Formation ("A" Member)
- No Label
- OCs - Cambrian-Middle Ordovician carbonate
- OCu - Undivided Ordovician and Cambrian
- Oag - Austin Glen Formation
- Obk - Beekmantown Group
- Oc - Canajoharie Shale
- Omi - Mount Merino Formation
- Op - Poultney Formation ("B" and "C")
- Otbr - Dolgeville Formation
- Otm - Taconic Melange
- Q - Glacial and Alluvial Deposits
- ach - metanorthosite and anorthosite
- am - Amphibolite, pyroxenic amphibolite
- bqp - Biotite-quartz-plagioclase
- garb - Quartz-feldspar paragneiss
- gb - Olivine metagabbro
- h2o - Water
- hbg - Biotite and or hornblende granite gneiss
- mb Calcitic and dolomitic marble
- mu - Undivided metased rock and migmatite
- phgs - Charnockite, granitic, quartz syenite
- qt - Quartzite

N

1 0.5 0 1 Miles

Transmission Developers Inc.

Champlain Hudson Power Express Project

Champlain Hudson Power Express Inc.

Bedrock Geology and Geotechnical Borings Whitehall to Fort Edward Figure 4-3

Prepared on 5/5/2021

by: AECOM

DATA SOURCES: ESRI, NYSDOT, NOAA, USACE, NYDOS, TDI, TRC

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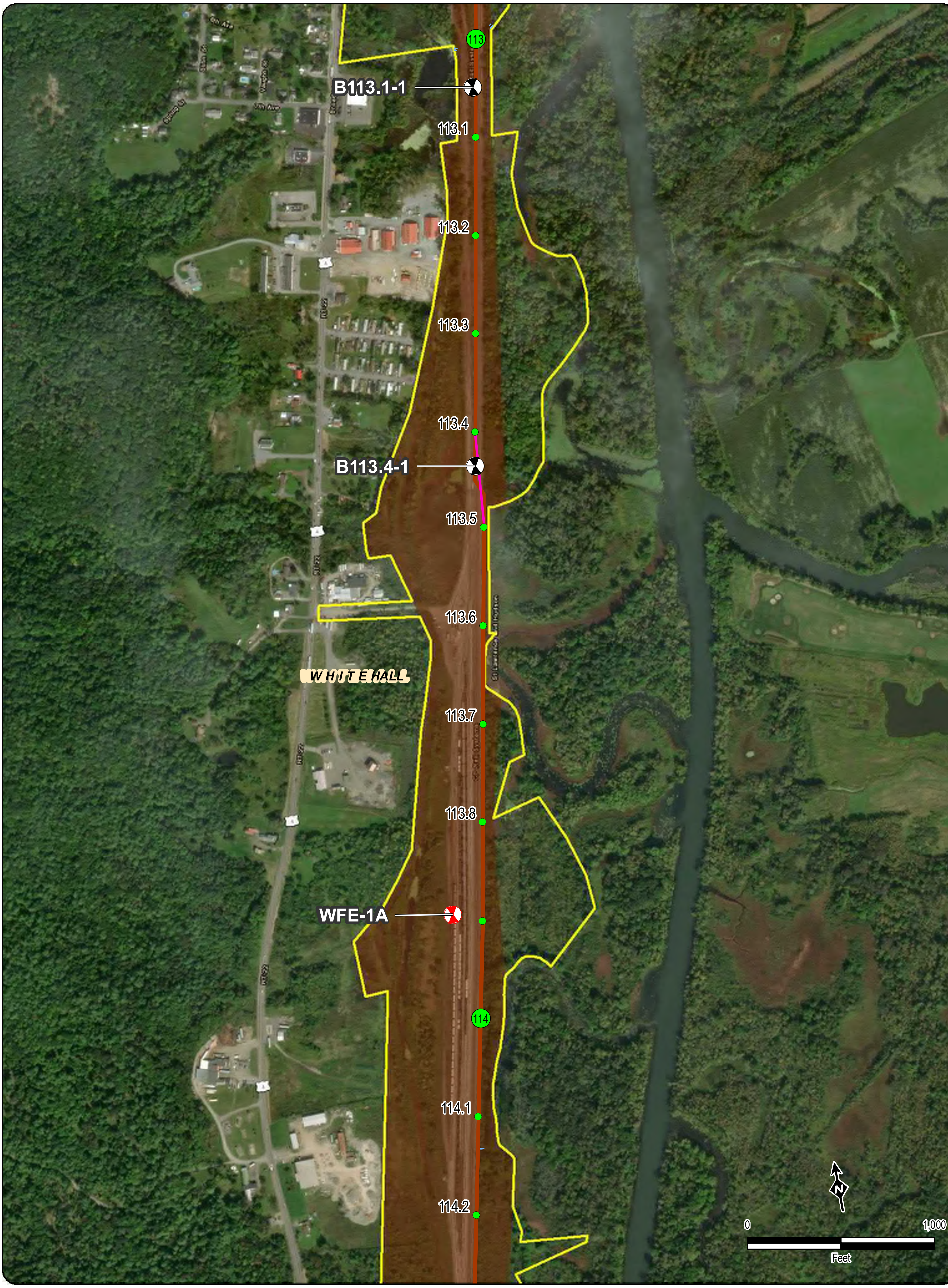
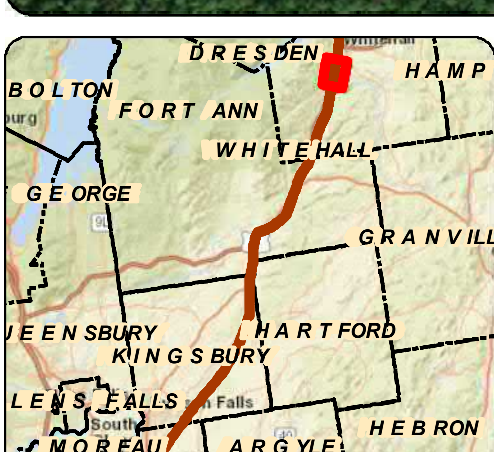




LEGEND

- Certified Milepost - Tenths
- Certified Milepost
- Preferred Alternative Milepost - Tenths
- Preferred Alternative Milepost
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- 2021 Boring Location
- Previous (2013) Boring Location
- Streams/Ditches
- Railroad ROW
- Deviation Zone
- Deviation Zone Outside ROW
- Preferred Alternative Deviation Zone
- Preferred Alternative Deviation Zone Outside ROW
- Town Boundary
- Village Boundary
- State Park (OPRHP)

Parcel Ownership

TOWN NAME

Road Name

Village Name

Transmission Developers Inc.

Champlain Hudson Power Express Project

Champlain Hudson Power Express Inc.

BORING LOCATION PLAN

Whitehall to Fort Edward

Figure A-3

Sheet 1 of 16

Prepared by: AECOM 5/19/2021

DATA SOURCES: ESRI, NETWORK MAPPING 2010, NYSDOT, OPRHP, TDI, TRC

Y:\Projects\CHPE\Route\Consensus_Alternative_Routes\MXD\Alt_5_Routes_DZ_201909\Boring_Locations\Maps_for_May_2021_Report\Whitehall_to_Edward_Boring_Locations_Mapset_May_2021_Report.mxd

TEST BORING LOG

TRC

PROJECT: TDI CHAMPLAIN HUDSON POWER EXPRESS
LOCATION: CP RAILROAD ROW, NY

BORING	**B113.4-1**
G.S. ELEV.	N/A
FILE	195651
SHEET	1 OF 1

GROUNDWATER DATA

FIRST ENCOUNTERED DRY

DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE

a	FROM	0.0 '	TO	10.0 '
d	FROM	10.0 '	TO	30.0 '

DRILLER	P. PLANTIER
HELPER	M. NAGEY
INSPECTOR	C. POPPE
DATE STARTED	12/11/2012
DATE COMPLETED	12/11/2012

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
0–2.0	S-1	7 6 5 7	2.0	***BLACK M/C SAND, SM SILT, SM F/C GRAVEL SIZED ROCK FRAGMENTS, SM ASH AND CINDERS (FILL)***		
2.0–4.0	S-2	10 6 4 3	4.0	***BROWN F/ GRAVEL AND M/C/F SAND, TR SILT (FILL)***	3.4	
5	S-3	5 4 3 5			27.3	
	S-4	1 1 1 1		***GRAY CLAY, SM F/M/C SAND, SM SILT***		
10	S-5	6 5 5 4			24.8	
			13.5			
15	S-6	4 7 7				
20	S-7	2 3 2		***BROWN CLAY, TR SILT***	48.2	
25	S-8	1 3 4			50.3	
30	S-9	2 3 2	30.0			
				END OF BORING AT 30'		
35						

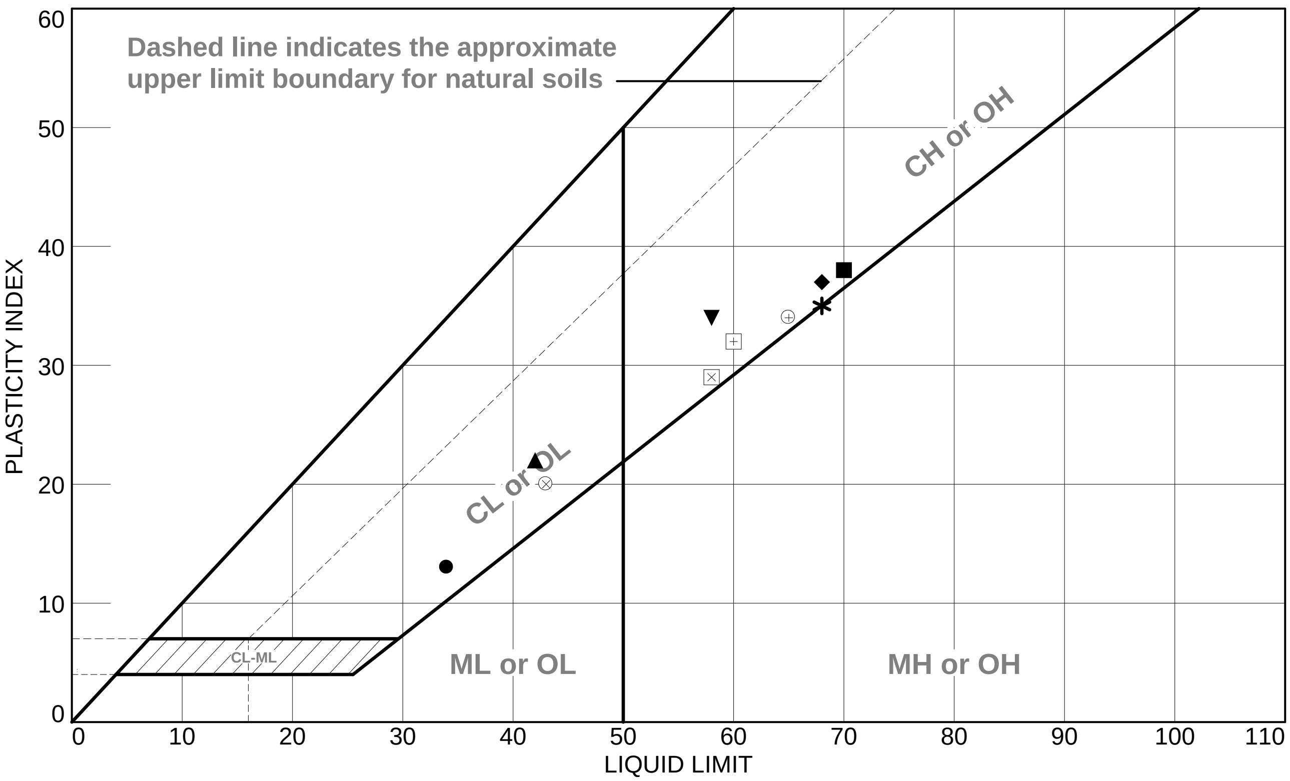
DRN.	CMP
CKD.	PWK

SUMMARY OF LABORATORY TEST DATA

Project Name: TDI Champlain Hudson Power Express – CP
Client Name: Transmission Developers, Inc.
TRC Project #: 195651

SAMPLE IDENTIFICATION			Soil Group (USCS System)	GRAIN SIZE DISTRIBUTION				PLASTICITY				Specific Gravity	Moisture Content (%)	Unit Weight (pcf)	Compressive Strength (tsf)	Organic Content (%)
Boring #	Sample #	Depth (ft)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index)					
B113.1-1	S-3	4.0-6.0	SW-SM	21.2	72.1	6.7		-	-	-	-	-	14.9	-	-	-
	S-4	6.0-8.0														
	S-6	13.5-15.0	-	-	-	-	-	-	-	-	-	-	25.7	-	-	-
	S-7	18.5-20.0	CL	-	-	-	-	34	21	13	0.5	-	27.3	-	-	-
	S-8	23.5-25.0	-	-	-	-	-	-	-	-	-	-	33.9	-	-	5.9
	S-9	28.5-30.0	CH/OH	-	-	-	-	70	32	38	0.2	-	38.8	-	-	-
B113.4-1	S-2	2.0-4.0	SW-SM	44.8	45.0	10.2		-	-	-	-	-	3.4	-	-	-
	S-3	4.0-6.0	CL	18.9		20.5	60.6	42	20	22	0.3	2.81	27.3	-	-	-
	S-4	6.0-8.0														
	S-5	8.0-10.0	-	-	-	-	-	-	-	-	-	-	24.8	97.4	-	-
	S-7	18.5-20.0	-	-	-	-	-	-	-	-	-	-	48.2	73.8	-	-
	S-8	23.5-25.0	CH	-	-	-	-	68	31	37	0.5	-	50.3	-	-	-

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

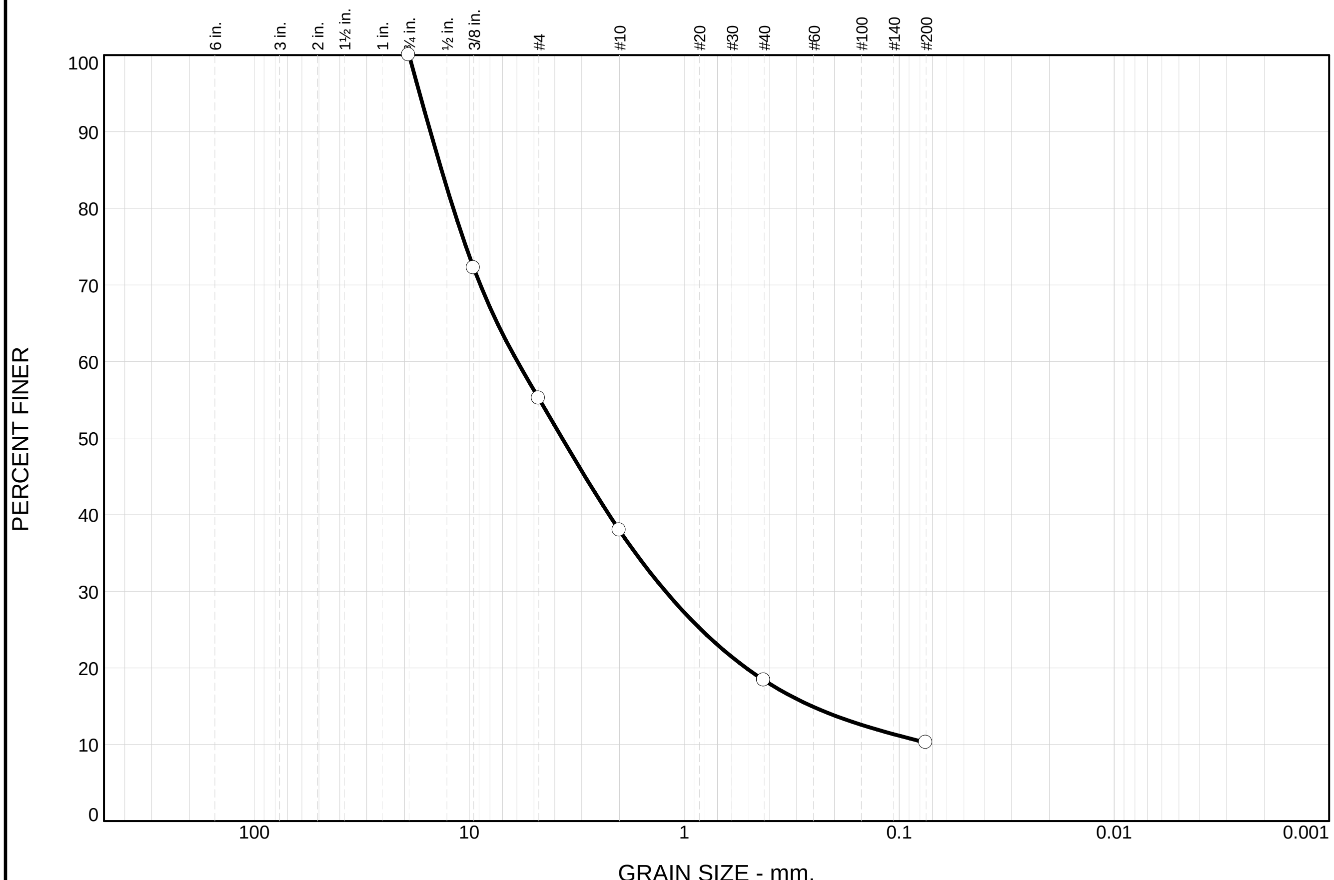
	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B113.1-1	S-7	18.5-20.0 FT	27.3	21	34	13	CL
■	B113.1-1	S-9	28.5-30.0 FT	38.8	32	70	38	CH/OH
▲	B113.4-1	S-3 & S-4	4.0-8.0 FT	27.3	20	42	22	CL
◆	B113.4-1	S-8	23.5-25.0 FT	50.3	31	68	37	CH
▼	B114.4-1	S-9	28.5-30.0 FT	49.2	24	58	34	CH
*	B114.4-1	S-7	18.5-20.0 FT	49.7	33	68	35	CH/MH
⊕	B115.2-1	S-7	18.5-20.0 FT	45.6	31	65	34	CH
⊞	B116.8-1	S-12	43.5-45.0 FT	52.2	28	60	32	CH
⊗	B119.2-1	S-4 & S-5	7.0-11.0 FT	26.7	23	43	20	CL
⊠	B123.1-1	S-4	6.0-8.0 FT	33.0	29	58	29	CH

TRC
Engineers, Inc.
Mt. Laurel, NJ

Client: TDI CHAMPLAIN HUDSON POWER EXPRESS - CP
Project: TRANSMISSION DEVELOPERS, INC.

Project No.: 195651 **Figure** 1

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	44.8	17.2	19.6	8.2	10.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			13.4483	5.9692	3.6971	1.2216	0.2546			

Material Description	USCS	AASHTO
○ GRAY-BROWN F/ GRAVEL AND M/C/F SAND, TR TO SM SILT	SW-SM	

Project No. 195651 **Client:** TDI CHAMPLAIN HUDSON POWER EXPRESS - CP
Project: TRANSMISSION DEVELOPERS, INC.

○ **Source of Sample:** B113.4-1 **Depth:** 2.0-4.0 FT **Sample Number:** S-2

Remarks:
○SAMPLE DESCRIPTION BASED ON VISUAL IDENTIFICATION AND LABORATORY ANALYSIS

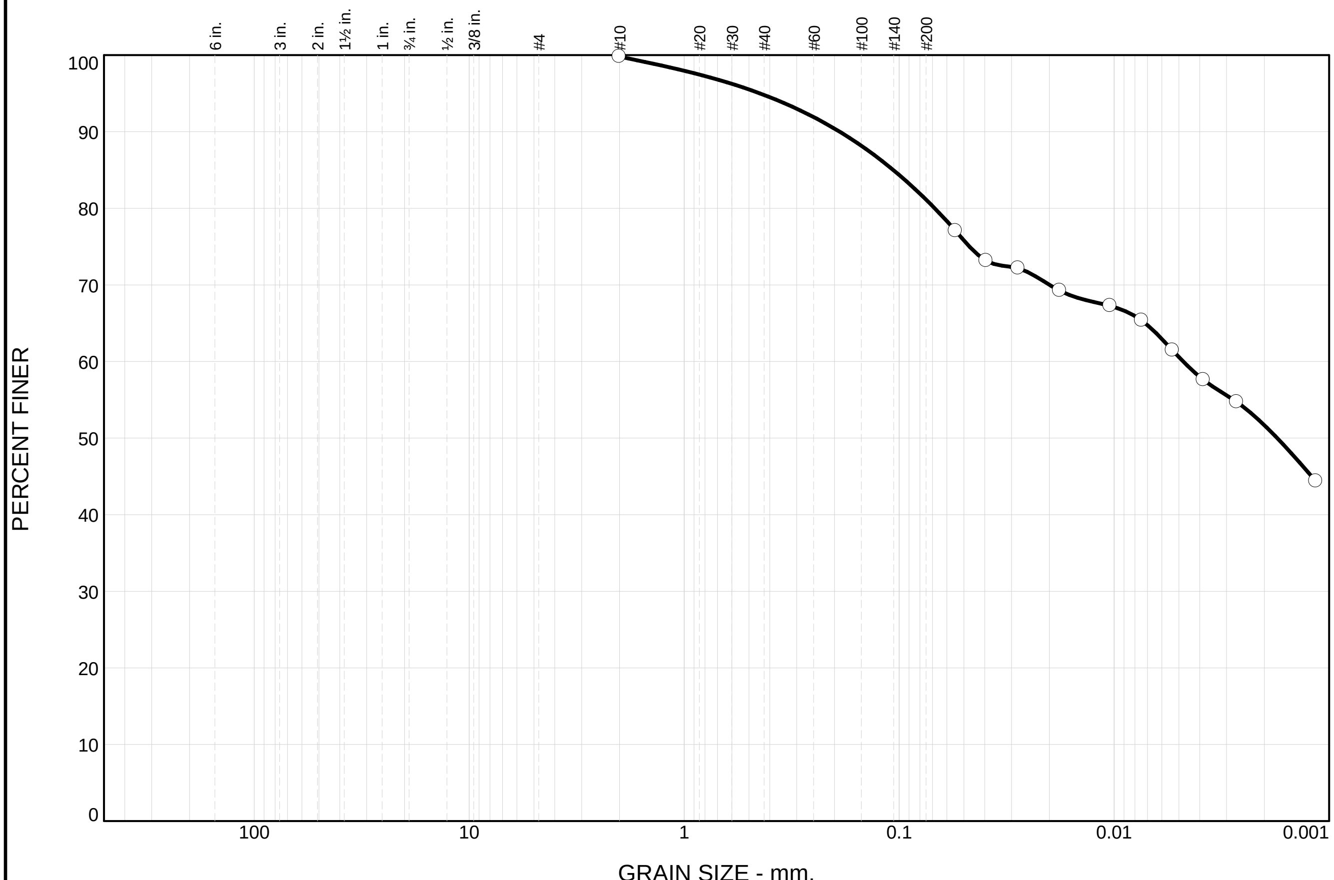
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 5

Tested By: BMH 01/24/13 **Checked By:** ____________

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○					5.0	13.7	20.5	60.6

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	42	20	0.1065	0.0048	0.0017					

	Material Description	USCS	AASHTO
○	BROWN CLAY, SM F/M/C SAND, SM SILT	CL	A-7-6(18)

Project No. 195651 **Client:** TDI CHAMPLAIN HUDSON POWER EXPRESS - CP
Project: TRANSMISSION DEVELOPERS, INC.

○ **Source of Sample:** B113.4-1 **Depth:** 4.0-8.0 FT **Sample Number:** S-3 & S-4

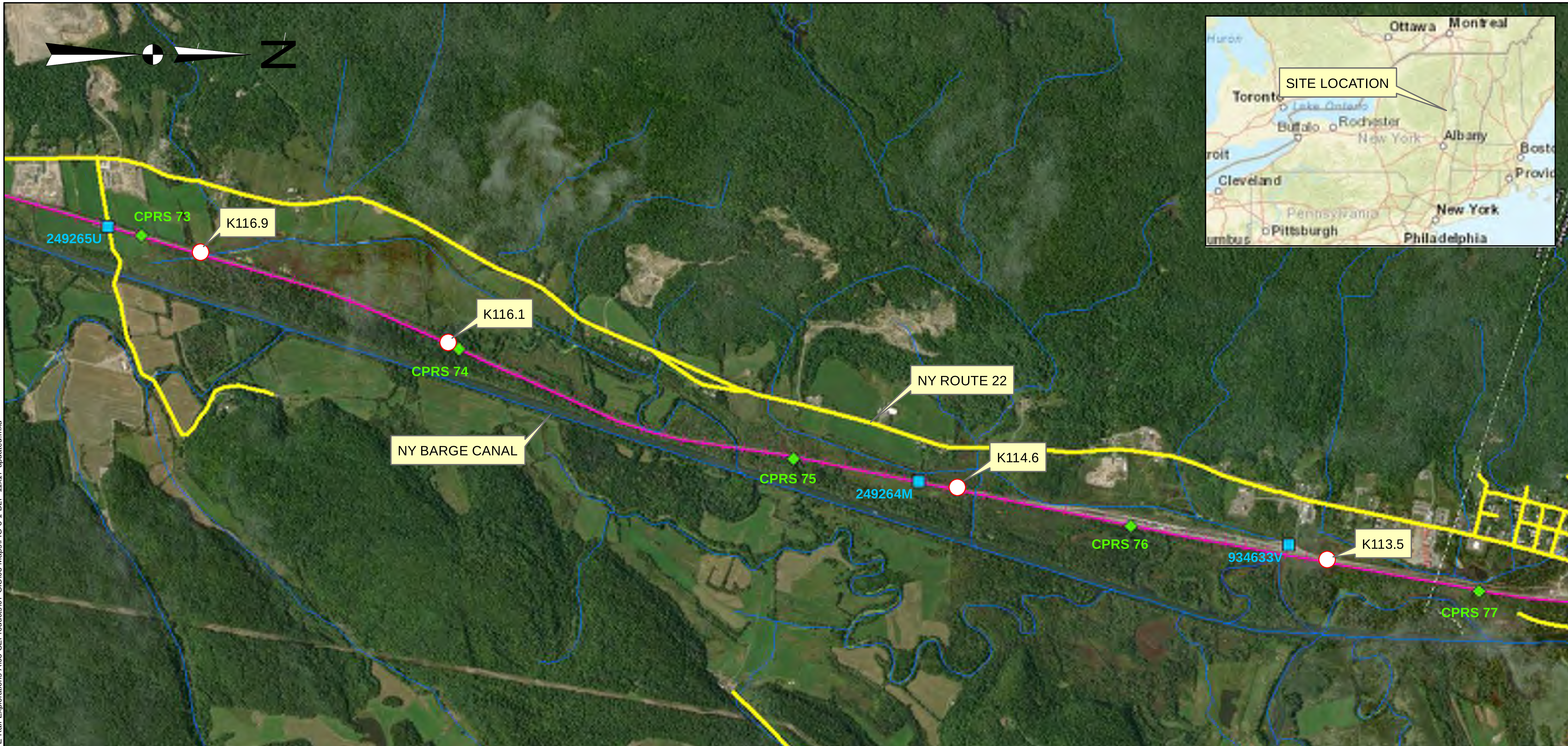
Remarks:
○SAMPLE DESCRIPTION BASED ON VISUAL IDENTIFICATION AND LABORATORY ANALYSIS

TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 6

Tested By: TBT 02/12/13 **Checked By:** ____________



NOTES:
1. RAIL LINE, MILEPOST, AND RAILROAD CROSSING LOCATIONS ARE FROM FRA GIS DATABASE AND REFERENCE NAVD 88 (https://fragis.fra.dot.gov/GISFRASafety/)
2. MILEPOST LOCATIONS ARE APPROXIMATE.

Legend

- Railroad Milepost
- Railroad Crossings
- Roadway
- NYS_Drainage_Streams
- Rail Line
- Boring Location

Source: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

0 1,500 3,000 Feet

Scale: 1:18,000

Schnabel ENGINEERING

CHAMPLAIN HUDSON POWER EXPRESS
WHITEHALL, NEW YORK

PROJECT NO. 21C25020.03

RAIL EXPLORATION BORING LOCATION PLAN

FIGURE 3.1

2/28/2022 12:26:00 PM G:\2021-Jobs\Albany\21C25020_03_Kiewit-CHPE-Rail-Explorations-A\03-SEProducts\07-GIS\03-Maps\FIG-3-1-BLP-11x17-updated.mxd

Schnabel ENGINEERING	TEST BORING LOG	Project: Champlain Hudson Power Express Rail Explorations Whitehall, New York	Boring Number: K113.5 Contract Number: 21C25020.03 Sheet: 1 of 2

Contractor: Soil Testing Inc.
Oxford, Connecticut

Contractor Foreman: S. DeAngelis

Schnabel Representative: S. Henry

Equipment: Diedrich D-50 (ATC)

Method: 4-1/4" I.D. Hollow Stem Auger

Hammer Type: Safety Hammer (140 lb)

Dates Started: 12/23/21 **Finished:** 12/23/21

X: 781852.6 ft **Y:** 1714661 ft **By:** Land Survey

Coordinate System: Lat-Long (Decimal Degrees)

Plunge: -90 **Bearing:**

Ground Surface Elevation: 122.5 (ft) **Total Depth:** 52.0 ft

Water Level Observations

	Date	Time	Depth	Casing	Caved
Encountered ▽	12/23/21	9:55 AM	15.0'	15.0'	---
Completion ▼	12/23/21	11:55 AM	32.0'	50.0'	---

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
0.2	0.0 - 0.2 ft: FILL, sampled as ballast	FILL	122.3			S-1, SPT 12+8+9+14 REC=10", 42%		
	0.2 - 6.0 ft: FILL, sampled as silty sand with gravel; moist, black and brown	FILL		F		S-2, SPT 16+13+6+5 REC=11", 46%		
					5	S-3, SPT 3+4+4+6 REC=0", 0%		
6.0	6.0 - 8.0 ft: SANDY FAT CLAY; moist, gray, probable LACUSTRINE material	CH	116.5			S-4, SPT 8+4+5+5 REC=3", 13%	MC = 21.1% % Passing #200 = 50.1 PP = 0.00 tsf	
8.0	8.0 - 52.0 ft: FAT CLAY; moist, gray, probable LACUSTRINE material	CH	114.5	L		S-5, SPT 1+3+4+5 REC=16", 67%	LL = 65 PL = 21 PP = 0.50 tsf	
					10			
	15.0 ft: Change: wet, gray with mottles of brown ▽				15	S-6, SPT 3+5+9+12 REC=22", 92%	PP = 2.75 tsf	
	20.0 ft: Change: brown				20	S-7, SPT 4+3+5+6 REC=24", 100%	PP = 2.50 tsf	

(continued)

Schnabel ENGINEERING	TEST BORING LOG	Project: Champlain Hudson Power Express Rail Explorations Whitehall, New York	Boring Number: **K113.5** Contract Number: 21C25020.03 Sheet: 2 of 2

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	8.0 - 52.0 ft: FAT CLAY; moist, gray, probable LACUSTRINE material *(continued)* 25.0 ft: Change: gray	CH		L		UD-1, UNDIST REC=24", 100%	LL = 64 PL = 25 MC = 43.7% % Passing #200 = 99.8 PP = 0.00 tsf	
						S-8, SPT 3+5+4+6 REC=24", 100%	PP = 0.75 tsf	
					30	S-9, SPT WOR/12"+4+5 REC=24", 100%	PP = 0.00 tsf	
					35	S-10, SPT WOR+WOH+1+3 REC=24", 100%	PP = 0.00 tsf	
					40	UD-2, UNDIST REC=17", 71%	PP = 0.00 tsf	
						S-11, SPT 3+1+1+3 REC=24", 100%	MC = 71.1% PP = 0.00 tsf	
					45	S-12, SPT WOR/24" REC=24", 100%	PP = 0.00 tsf	
					50	S-13, SPT WOR/24" REC=24", 100%	PP = 0.00 tsf	
52.0			70.5					

Bottom of Boring at 52.0 ft.
Boring terminated at selected depth.
Boring backfilled with cement grout through tremie pipe upon completion.
Unable to obtain a "Casing Pulled" groundwater reading due to grout.
Coordinates and elevations were provided by Kiewit Engineering (NY) Corp. on Jan. 18, 2022.
Stratum Designations:
F: Fill Material
L: Lacustrine Deposits

Summary Of Laboratory Tests

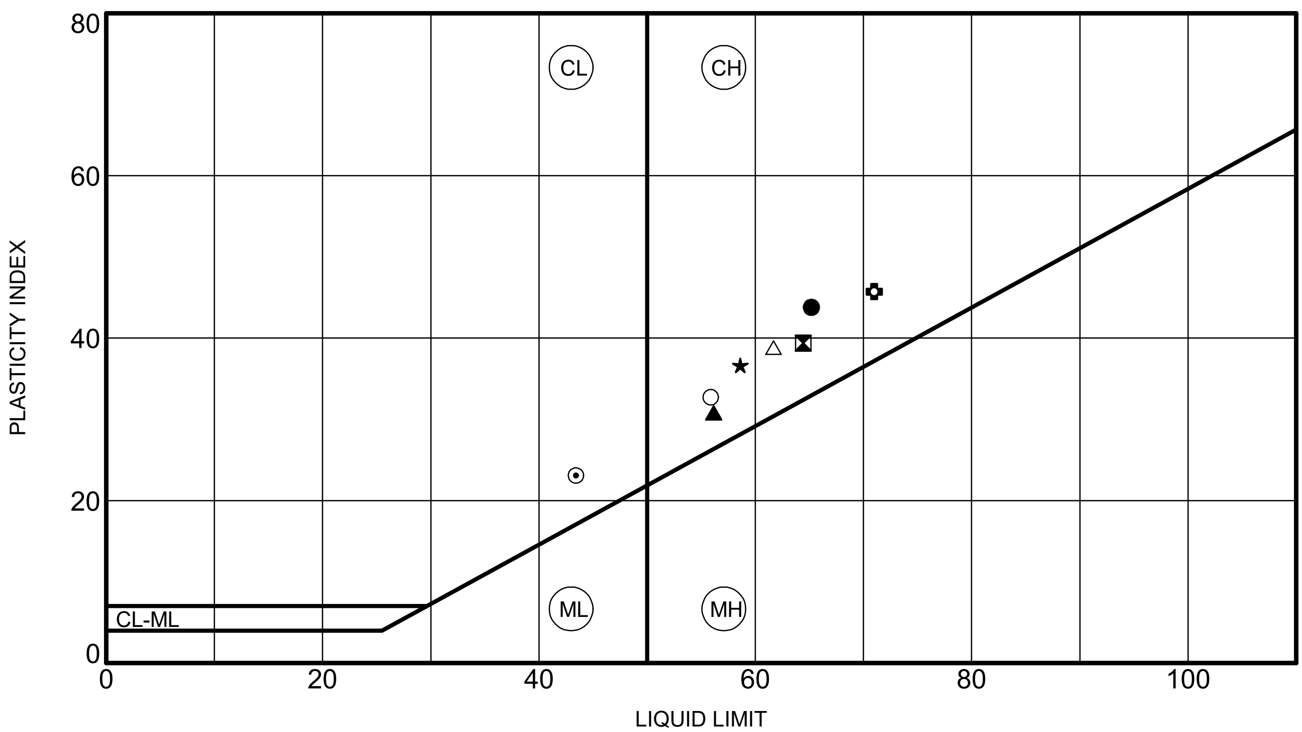
Project Number: 21C25020.03

Boring No.	Sample Depth ft / Elevation ft	Sample Type	Description of Soil Specimen	Stratum	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Passing No. 200 Sieve	Organic Content (%)	pH	Sulfates (mg/Kg)	Chlorides (mg/Kg)	Resistivity (ohm-cm)	Oxidation Reduction Potential (mV)
K113.5	6.0 - 8.0 116.5 - 114.5	Jar	Sandy Fat Clay (visual field description)	L	21.1	--	--	--	50.1	--	--	--	--	--	--
K113.5	8.0 - 10.0 114.5 - 112.5	Jar	Fat Clay (visual field description)	L	--	65	21	44	--	1.84	--	--	--	--	--
K113.5	25.0 - 27.0 97.5 - 95.5	Tube	FAT CLAY (CH), gray	L	43.7	64	25	39	99.8	--	--	--	--	--	--
K113.5	42.0 - 44.0 80.5 - 78.5	Jar	Fat Clay (visual field description)	L	71.1	--	--	--	--	--	--	--	--	--	--
K114.6	5.0 - 7.0 116.8 - 114.8	Jar	Silty Sand with Gravel (visual field description)	F	13.1	--	--	--	--	--	6.48	140	6.2 BRL	3010	590
K114.6	15.0 - 17.0 106.8 - 104.8	Jar	Fat Clay (visual field description)	L	44.7	--	--	--	--	--	--	--	--	--	--
K114.6	35.0 - 37.0 86.8 - 84.8	Tube	FAT CLAY (CH), gray	L	55.7	56	25	31	99.4	--	--	--	--	--	--

Notes:
1. Soil tests in general accordance with ASTM standards.
2. Soil classifications are in general accordance with ASTM D2487(as applicable), based on testing indicated and visual classification.
3. Key to abbreviations: NP=Non-Plastic; -- indicates no test performed; BRL = below reporting limit
4. Strata: F=Fill; L=Lacustrine

Schnabel ENGINEERING

Project: Champlain Hudson Power Express
Rail Explorations
Whitehall, NY



PLOTTED DATA REPRESENTS SOIL PASSING NO. 40 SIEVE

	Specimen		LL	PL	PI	Fines	Description
●	**K113.5**	**8.0 ft**	**65**	**21**	**44**		**Fat Clay (visual field description)**
⧗	**K113.5**	**25.0 ft**	**64**	**25**	**39**	**100**	**FAT CLAY (CH), gray**
▲	**K114.6**	**35.0 ft**	**56**	**25**	**31**	**99**	**FAT CLAY (CH), gray**
★	**K114.6**	**62.0 ft**	**59**	**22**	**37**	**100**	**FAT CLAY (CH), dark brownish gray**
⊙	**K116.1**	**5.0 ft**	**43**	**20**	**23**		**Lean Clay (visual field description)**
✿	**K116.1**	**42.0 ft**	**71**	**25**	**46**	**100**	**FAT CLAY (CH), gray**
○	**K116.9**	**40.0 ft**	**56**	**23**	**33**	**100**	**FAT CLAY (CH), gray**
△	**K116.9**	**50.0 ft**	**62**	**23**	**39**	**95**	**FAT CLAY (CH), gray**

Schnabel ENGINEERING

ATTERBERG LIMITS

Project: Champlain Hudson Power Express
Rail Explorations
Whitehall, NY

Contract: 21C25020.03

Kiewit

Package 1C Phase 4 Borings

Champlain Hudson Power Express

New York

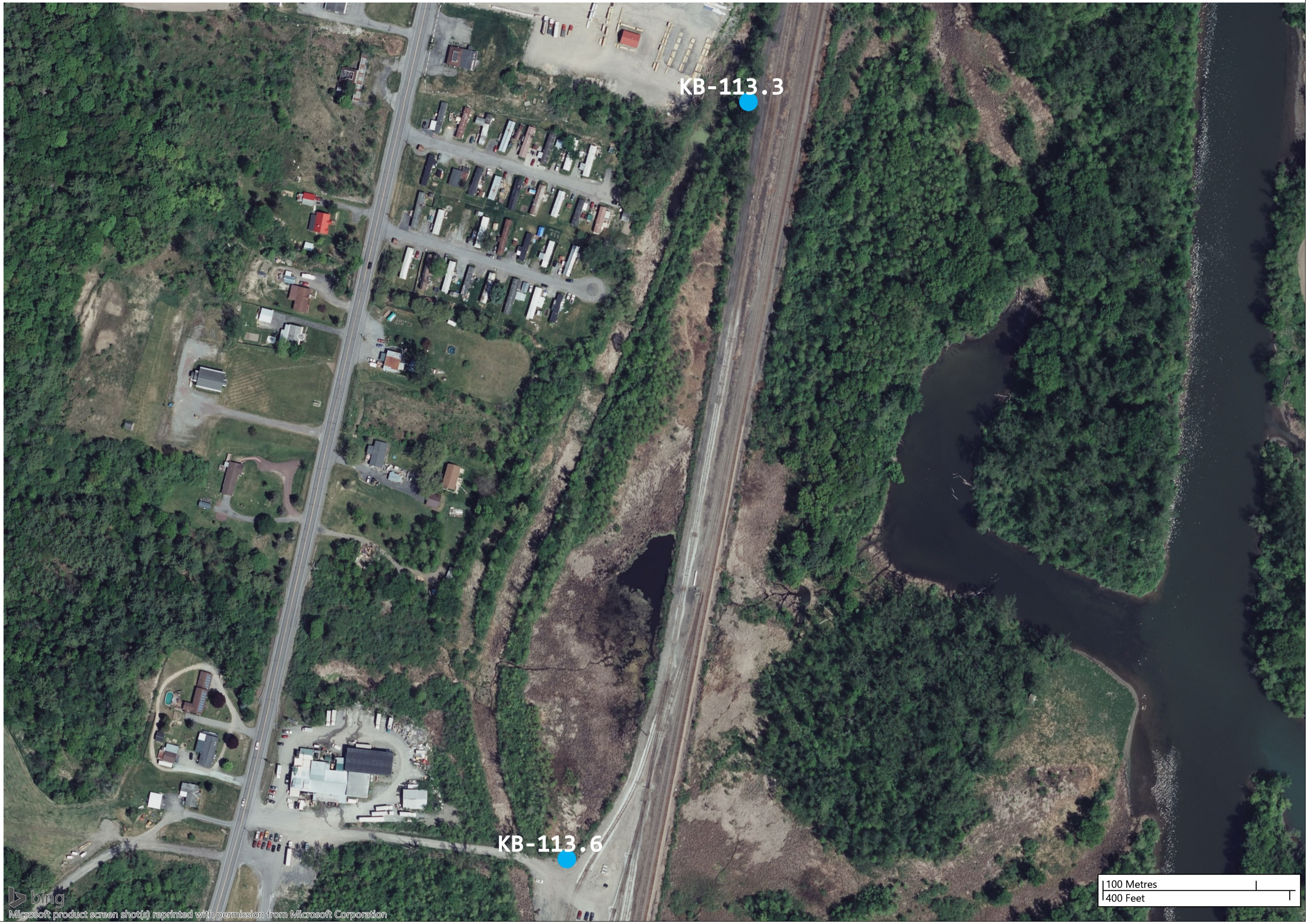
PROJECT NUMBER 20001480

CREATED BY Kiewit

DATE 01/20/2023

Legend Key

- Kiewit Borings



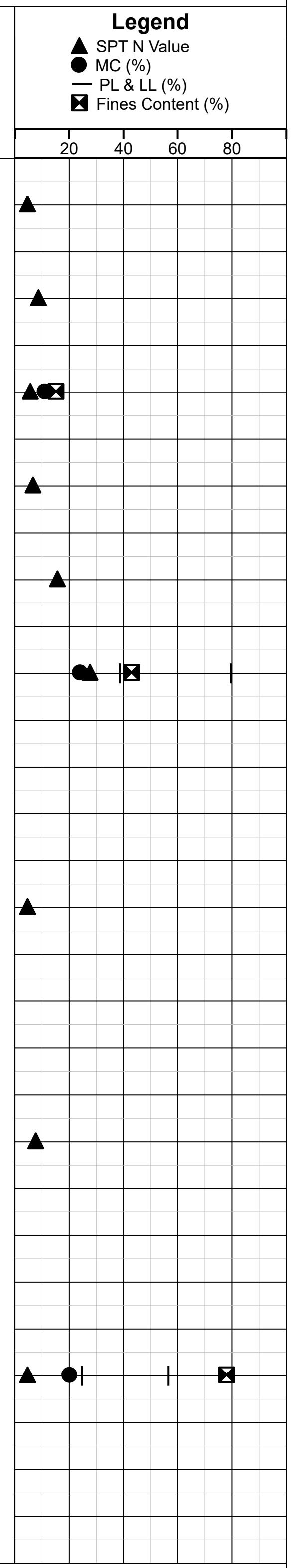
N

EXPLORATORY BORING LOG
Champlain Hudson Power Express
New York

BORING NO: KB-113.3

PROJECT NUMBER	20001480	**LOGGED BY**	S. Crowley	**COORDINATES**	N 1715794.87 E 781974.78
START DATE	11/09/2022	**DRILLER/RIG**	John / Geoprobe 7822DT	**GROUND ELEV.**	123.9 ft
FINISH DATE	11/10/2022	**DRILL CONTRACTOR**	ADT Inc.	**HAMMER TYPE/EFF.**	Automatic

Depth (ft)	Elevation (ft)	Material Description	Recovery % RQD	Blow Counts (N Value)	Notes
0		FILL: Silty SAND with Gravel (SM), brown, loose	58%	3-3-2-2 (5)	
			29%	2-4-5-4 (9)	
5			50%	3-3-3-2 (6)	
			46%	3-3-4-5 (7)	
8	115.9	Silty SAND (SM), brown, medium dense, moist	50%	6-7-9-11 (16)	
10		trace subangular gravel	92%	12-15-13-12 (28)	
15	108.9	CLAY with Sand (CH), brown to gray, firm, moist to wet, high plasticity, fine to medium sand	100%	1-2-3-4 (5)	
20			100%	1-3-5-6 (8)	
25			100%	0-2-3-3 (5)	
30					



EXPLORATORY BORING LOG

Champlain Hudson Power Express

New York

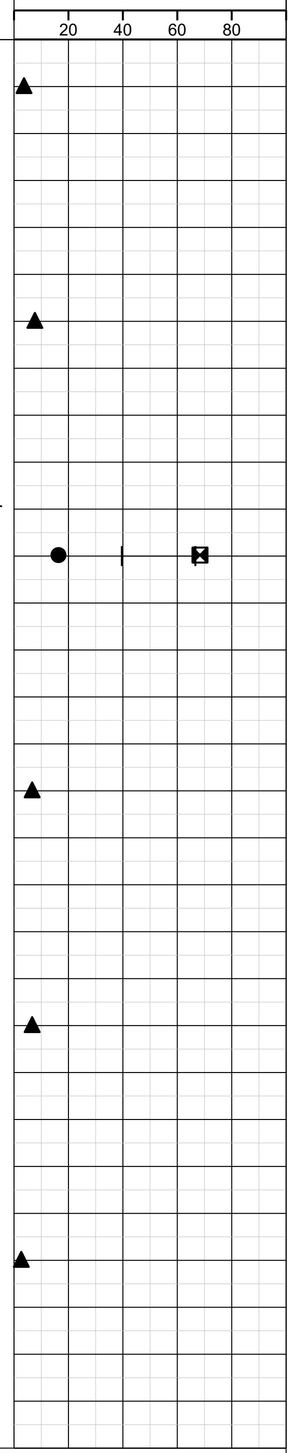
BORING NO: KB-113.3

PROJECT NUMBER	20001480	**LOGGED BY**	S. Crowley	**COORDINATES**	N 1715794.87 E 781974.78
START DATE	11/09/2022	**DRILLER/RIG**	John / Geoprobe 7822DT	**GROUND ELEV.**	123.9 ft
FINISH DATE	11/10/2022	**DRILL CONTRACTOR**	ADT Inc.	**HAMMER TYPE/EFF.**	Automatic

Depth (ft)	Elevation (ft)	Graphic Log	Material Description	Sample Type	Core Run No.	Recovery % RQD	Pocket Pen. (tsf)	Blow Counts (N Value)	Notes
	93.9		Sandy SILT (MH), brown and gray, soft to firm, wet, high plasticity, fine to medium sand			100%		2-2-2-4 (4)	
35						100%		2-3-5-6 (8)	
40								5-7-8-9	3-inch ring sampler
45	78.9		CLAY (CH), brown to gray, firm, moist to wet, high plasticity			100%		4-3-4-5 (7)	
50						100%		0-3-4-5 (7)	
55	68.9					100%		0-0-3-2 (3)	
			Boring Terminated at 57ft						
60									

Legend

▲ SPT N Value
● MC (%)
— PL & LL (%)
☒ Fines Content (%)



Kiewit

EXPLORATORY BORING LOG

Champlain Hudson Power Express

New York

BORING NO: KB-113.6

PROJECT NUMBER	20001480	**LOGGED BY**	S. Crowley	**COORDINATES**	N 1714165.04 E 781604.79
START DATE	11/08/2022	**DRILLER/RIG**	John / Geoprobe 7822DT	**GROUND ELEV.**	120.0 ft
FINISH DATE	11/09/2022	**DRILL CONTRACTOR**	ADT Inc.	**HAMMER TYPE/EFF.**	Automatic

Depth (ft)	Elevation (ft)	Material Description	Sample Type	Core Run No.	Recovery % RQD	Pocket Pen. (tsf)	Blow Counts (N Value)	Notes
0		FILL: Silty SAND with Gravel (SM), brown, loose to dense, moist to wet						
1					36%		2-2-3-6 (5)	
3					34%		3-3-3-2 (6)	
5					34%		4-5-5-6 (10)	
7					54%		7-9-10-11 (19)	
9					75%		14-17-16-15 (33)	
11					70%		22-18-15-16 (33)	
12	108.0	CLAY (CH), brown, soft to firm						
16					100%		0-1-3-4 (4)	
21					100%		2-2-4-5 (6)	
26					100%		0-3-5-6 (8)	

Legend: ▲ SPT N Value; ● MC (%); — PL & LL (%); ☒ Fines Content (%)

20 40 60 80

EXPLORATORY BORING LOG

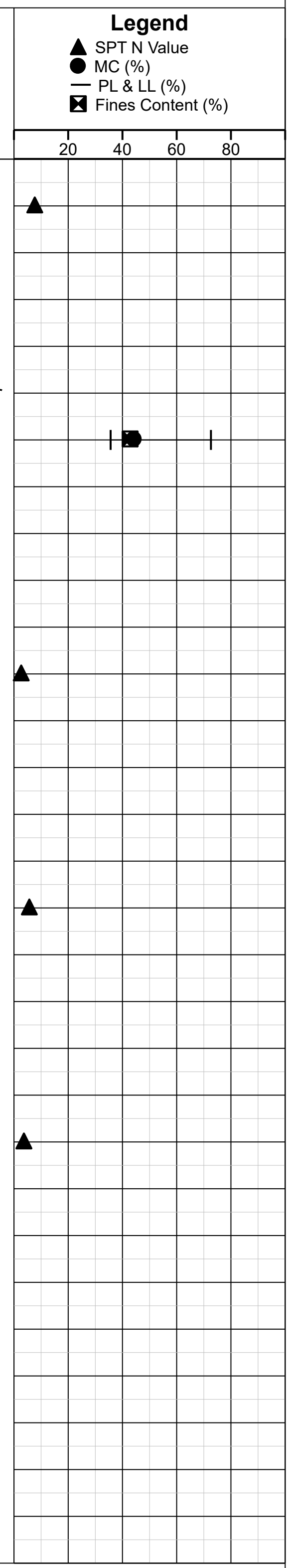
Champlain Hudson Power Express

New York

BORING NO: KB-113.6

PROJECT NUMBER	20001480	**LOGGED BY**	S. Crowley	**COORDINATES**	N 1714165.04 E 781604.79
START DATE	11/08/2022	**DRILLER/RIG**	John / Geoprobe 7822DT	**GROUND ELEV.**	120.0 ft
FINISH DATE	11/09/2022	**DRILL CONTRACTOR**	ADT Inc.	**HAMMER TYPE/EFF.**	Automatic

Depth (ft)	Elevation (ft)	Material Description	Recovery % RQD	Blow Counts (N Value)	Notes
		CLAY (CH), brown, soft to firm	100%	3-3-5-6 (8)	
35	85.0	Silty SAND (SM), brown, wet	100%		3-inch ring sampler
40	80.0	CLAY (CH), brown, soft to firm, wet	100%	0-0-3-3 (3)	
45			100%	0-3-3-4 (6)	
50			66%	0-0-4-4 (4)	
	68.0	Boring Terminated at 52ft			
55					
60					



Kiewit

SOIL LEGEND

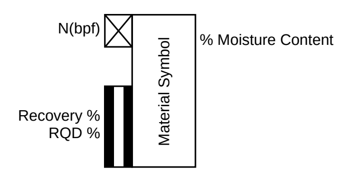
Explanation of Symbols and Terms Used on Boring and Test Pit Logs for Sampling and Description of Soils

SAMPLE AND DRILL METHODS
Standard Penetration Split-Spoon Sample
Undisturbed Sample
Piston Sampler
Grab Sample
Bulk Sample
Auger Cuttings
Rock Core
Modified California Sample

WATER LEVEL SYMBOLS
Observation at time of drilling
Observation after drilling
Delayed observation
Perched water observed at drilling
Observed Seepage
Cave-in Depth

COMMON ABBREVIATIONS AND ACRONYMS			
MR	Mud Rotary	Bulk	Bulk Sample
HSA	Hollow Stem Auger	EOB	End of Boring
SSA	Solid Stem Auger	AR	Auger Refusal
SS	Split Spoon Sampler	N-Value	Sum of blows for last two 6-in. increments of SPT
UD	Undisturbed Sample		
WOR	Weight of Rods	USCS	Unified Soil Classification System
WOH	Weight of Hammer		
SPT	Standard Penetration Test		
REC	Recovery		
RQD	Rock Quality Designation		
MC	Moisture Content		
PI	Plasticity Index		
PL	Plastic Limit		
LL	Liquid Limit		
CPT	Cone Penetration Test		
PP	Pocket Penetrometer		

CROSS SECTION LEGEND



RELATIVE DENSITY / CONSISTENCY				
Coarse-grained Soils		Fine-grained Soils		
N-Value	Density	N-Value	Consistency	Pocket Pen (TSF)
0 - 4	Very Loose	0 - 1	Very Soft	0.0 - 0.25
5 - 10	Loose	2 - 4	Soft	0.25 - 0.50
11 - 30	Medium	5 - 8	Firm	0.51 - 1.00
31 - 50	Dense	9 - 15	Stiff	1.01 - 2.00
> 50	Very Dense	16 - 30	Very Stiff	2.01-4.00
		> 30	Hard	> 4.00

RELATIVE PROPORTIONS OF GRAVEL, SAND, AND FINES	
Trace	> 5 %
Few	5 to 10 %
Little	15 to 25 %
Some	30 - 45 %
Mostly	50 to 100 %

SOIL GRAIN SIZE

U.S. Standard Sieve

	6"	3"	3/4"	4	10	40	200		
Boulders	Cobbles	Gravel		Sand			Silt	Clay	
		Coarse	Fine	Coarse	Medium	Fine			
152	76.2	19.1	4.76	2.00	0.420	0.074	0.002	(mm)	

CRITERIA FOR DESCRIBING MOISTURE CONDITION	
Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible free water
Wet	Visible free water, typically soil is below water table

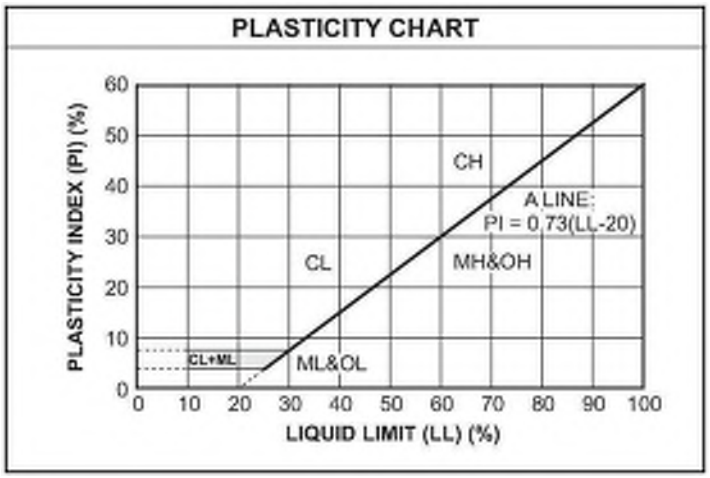
CRITERIA FOR DESCRIBING CEMENTATION	
Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

CRITERIA FOR DESCRIBING STRUCTURE	
Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 1/4 in. thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 1/4 in. thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

SOIL SYMBOLS

USCS SOIL TYPES		
Symbol	Group	Description
	GW	Well-graded gravels, gravel sand mixtures with trace or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures with trace or no fines
	GW-GM	Well-graded gravels, gravel-sand mixtures with silt fines
	GW-GC	Well-graded gravels, gravel-sand mixtures with clay fines
	GP-GM	Poorly-graded gravels, gravel-sand mixtures with silt fines
	GP-GC	Poorly-graded gravels, gravel-sand mixtures with clay fines
	GM	Silty gravels, gravel-silt-sand mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
	GC-GM	Clayey gravels, gravel-sand-clay-silt mixtures
	SW	Well-graded sands, sand-gravel mixtures with trace or no fines
	SP	Poorly-graded sands, sand-gravel mixtures with trace or no fines
	SW-SM	Well-graded sands, sand-gravel mixtures with silt fines
	SW-SC	Well-graded sands, sand-gravel mixtures with clayfines
	SP-SM	Poorly-graded sands, sand-gravel mixtures with silt fines
	SP-SC	Poorly-graded sands, sand-gravel mixtures with clay fines
	SM	Silty sands, sand-gravel-silt mixtures
	SC	Clayey sands, sand-gravel-clay mixtures
	SC-SM	Clayey sands, sand-gravel-clay-silt mixtures
	ML	Inorganic silts with low plasticity
	CL	Inorganic clays of low plasticity, gravelly or sandy clays, silty clays, lean clays
	CL-ML	Inorganic clay-silts of low plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
	MH	Inorganic silts of high plasticity, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays and organic silts of high plasticity
	PT	Peat, humus, swamp soils with high organic contents

OTHER MATERIALS	
Symbol	Description
	Asphalt
	Concrete
	Crushed Stone/Aggregate Base
	Fill



Summary of Laboratory Results

BORING ID	Depth (Ft.)	Water Content (%)
KB-113.3	4-6	11.3
KB-113.3	10-12	24.3
KB-113.3	25-27	20.4
KB-113.3	40-42	16.7
KB-113.6	4-6	57.8
KB-113.6	15-17	45.6
KB-113.6	35-37	44.5
KB-133.6	4-6	17.3
KB-133.6	15-17	20.9
KB-133.6	40-42	62.7
KB-133.6	50-52	62.0
KB-133.7	6-8	22.0
KB-133.7	20-22	21.3
KB-133.7	25-27	48.1
KB-133.7	40-42	51.1
KB-136.2	4-6	11.0
KB-136.2	20-22	28.3
KB-136.2	35-37	39.2
KB-136.2	55-57	21.5
KB-136.3	6-8	28.9
KB-136.3	20-22	39.0
KB-136.3	25-27	19.4
KB-141.1	4-6	9.7
KB-141.1	15-17	24.3
KB-141.1	25-27	24.5
KB-141.1	35-37	36.9
KB-144.5B	4-6	7.5
KB-144.5B	15-17	21.0
KB-144.5B	30-32	20.2
KB-144.5B	45-47	19.9
KB-144.6	4-6	8.9
KB-144.6	15-17	25.2
KB-144.6	35-37	27.6
KB-144.6	50-52	24.4
KB-144.8	4-6	8.7
KB-144.8	15-17	22.8
KB-144.8	35-37	20.2
KB-144.8	50-52	23.0
KB-149.6	6-8	29.7
KB-149.6	25-27	22.4
KB-149.6	35-37	24.7
KB-149.6	45-47	20.0

PROJECT: Lab Testing

SITE: Champlain to Hudsdon Power Express

Terracon
30 Corporate Cir Ste 201
Albany, NY

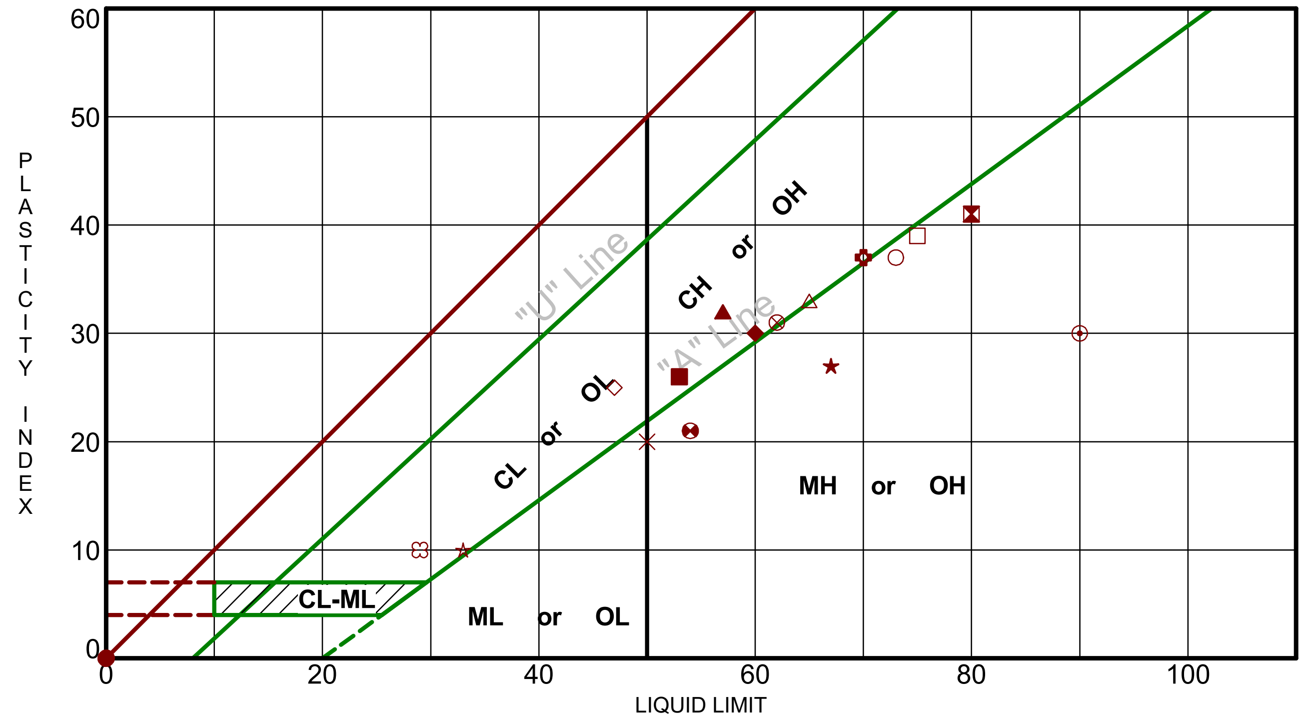
PROJECT NUMBER: JB215256H

CLIENT: Kiewit Engineering (NY) Corp
Lone Tree, CO

EXHIBIT: B-1

ATTERBERG LIMITS RESULTS

ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	KB-113.3	4 - 6	NP	NP	NP	15.5	SM	SILTY SAND with GRAVEL
⊠	KB-113.3	10 - 12	80	39	41	43.3	SM	SILTY SAND
▲	KB-113.3	25 - 27	57	25	32	78.4	CH	FAT CLAY with SAND
★	KB-113.3	40 - 42	67	40	27	68.7	MH	SANDY ELASTIC SILT
⊙	KB-113.6	4 - 6	90	60	30	33.7	SM	SILTY SAND with GRAVEL
✿	KB-113.6	15 - 17	70	33	37	82.9	CH	FAT CLAY with SAND
○	KB-113.6	35 - 37	73	36	37	43.2	SM	SILTY SAND
△	KB-133.6	40 - 42	65	32	33	100.0	CH	FAT CLAY
⊗	KB-133.6	50 - 52	62	31	31	100.0	CH	FAT CLAY
⊕	KB-133.7	6 - 8	NP	NP	NP	50.3	ML	SANDY SILT
□	KB-133.7	25 - 27	75	36	39	68.2	MH	SANDY ELASTIC SILT
◉	KB-133.7	40 - 42	54	33	21	72.6	MH	ELASTIC SILT with SAND
◕	KB-136.2	4 - 6	NP	NP	NP	10.8	SW-SM	WELL-GRADED SAND with SILT and GRAVEL
☆	KB-136.2	20 - 22	33	23	10	52.9	CL	SANDY LEAN CLAY
✾	KB-136.2	35 - 37	29	19	10	75.1	CL	LEAN CLAY with SAND
■	KB-136.2	55 - 57	53	27	26	86.9	CH	FAT CLAY
◆	KB-136.3	6 - 8	60	30	30	23.1	SC	CLAYEY SAND
◇	KB-136.3	20 - 22	47	22	25	81.1	CL	LEAN CLAY with SAND
×	KB-141.1	35 - 37	50	30	20	35.0	SM	SILTY SAND

PROJECT: Lab Testing

SITE: Champlain to Hudsdon Power Express

Terracon
30 Corporate Cir Ste 201
Albany, NY

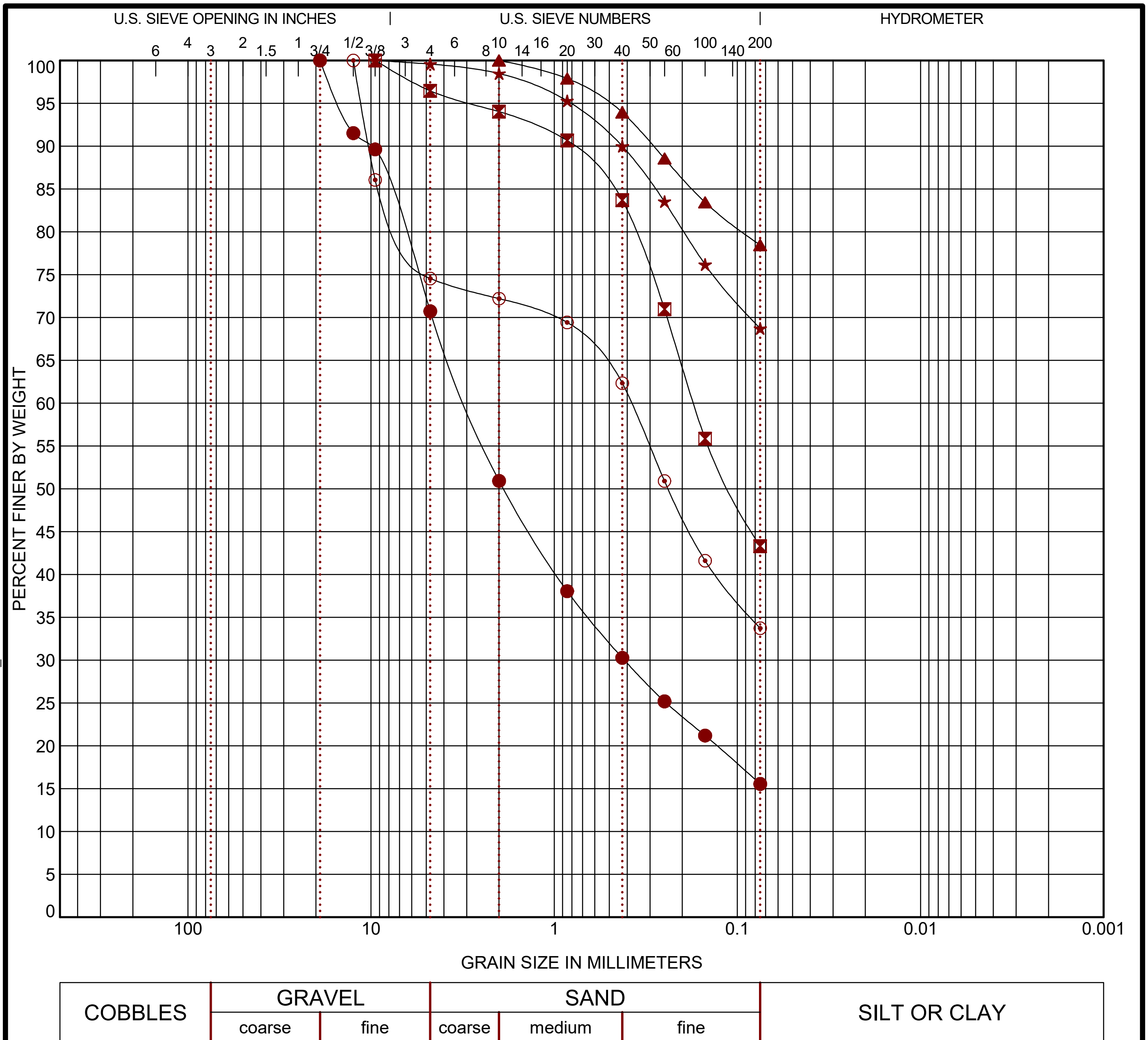
PROJECT NUMBER: JB215256H

CLIENT: Kiewit Engineering (NY) Corp
Lone Tree, CO

EXHIBIT: B-1

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



	Boring ID	Depth (Ft)	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	KB-113.3	4 - 6	SILTY SAND with GRAVEL (SM)	11.3	NP	NP	NP		
⊠	KB-113.3	10 - 12	SILTY SAND (SM)	24.3	80	39	41		
▲	KB-113.3	25 - 27	FAT CLAY with SAND (CH)	20.4	57	25	32		
★	KB-113.3	40 - 42	SANDY ELASTIC SILT (MH)	16.7	67	40	27		
⊙	KB-113.6	4 - 6	SILTY SAND with GRAVEL (SM)	57.8	90	60	30		

	Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Silt	%Fines	%Clay
●	KB-113.3	4 - 6	19	2.974	0.413		0.0	29.3	55.2		15.5	
⊠	KB-113.3	10 - 12	9.5	0.173			0.0	3.5	53.2		43.3	
▲	KB-113.3	25 - 27	2				0.0	0.0	21.6		78.4	
★	KB-113.3	40 - 42	9.5				0.0	0.4	30.9		68.7	
⊙	KB-113.6	4 - 6	12.5	0.381			0.0	25.5	40.8		33.7	

PROJECT: Lab Testing

SITE: Champlain to Hudsdon Power Express

30 Corporate Cir Ste 201
Albany, NY

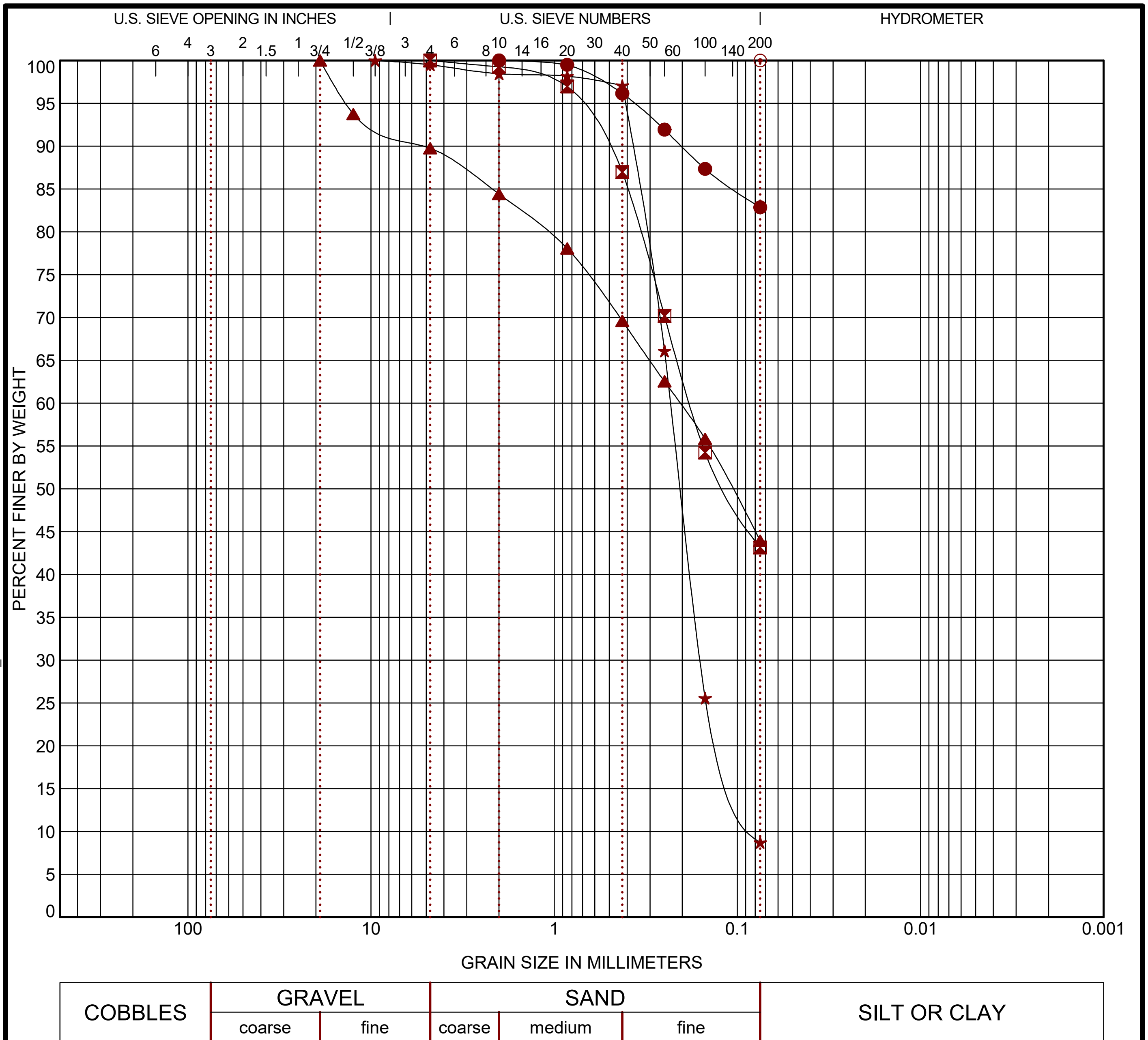
PROJECT NUMBER: JB215256H

CLIENT: Kiewit Engineering (NY) Corp
Lone Tree, CO

EXHIBIT: B-1

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



	Boring ID	Depth (Ft)	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	KB-113.6	15 - 17	FAT CLAY with SAND (CH)	45.6	70	33	37		
⊠	KB-113.6	35 - 37	SILTY SAND (SM)	44.5	73	36	37		
▲	KB-133.6	4 - 6	SILTY SAND (SM)	17.3					
★	KB-133.6	15 - 17	POORLY GRADED SAND with SILT (SP-SM)	20.9				1.37	2.93
⊙	KB-133.6	40 - 42	FAT CLAY (CH)	62.7	65	32	33		

	Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Silt	%Fines	%Clay
●	KB-113.6	15 - 17	2				0.0	0.0	17.1		82.9	
⊠	KB-113.6	35 - 37	4.75	0.18			0.0	0.0	56.8		43.2	
▲	KB-133.6	4 - 6	19	0.206			0.0	10.2	45.8		43.9	
★	KB-133.6	15 - 17	9.5	0.232	0.159	0.079	0.0	0.5	90.8		8.7	
⊙	KB-133.6	40 - 42	0.075				0.0	0.0	0.0		100.0	

PROJECT: Lab Testing

SITE: Champlain to Hudsdon Power Express

Terracon
30 Corporate Cir Ste 201
Albany, NY

PROJECT NUMBER: JB215256H

CLIENT: Kiewit Engineering (NY) Corp
Lone Tree, CO

EXHIBIT: B-2

Kiewit

MEMORANDUM

DATE: September 23, 2022

TO: Antonio Marruso, P.E.; CHA Consulting, Inc.

FROM: Matthew Hawley, P.E.; Kiewit Engineering (NY) Corp. MKH
Jaren Knighton; Kiewit Engineering (NY) Corp.

SUBJECT: Geotechnical Data: Segment 3 – Package 1C - HDD Crossing 4 – Revision 1
Champlain Hudson Power Express Project
Whitehall, New York

Kiewit Engineering is providing the attached geotechnical data for use in the horizontal direction drill (HDD) design for the Champlain Hudson Power Express project in Upstate New York. This HDD crossing is located south of Whitehall, New York. The approximate station for the start of HDD crossing number 4 is STA 15139+00 (43.5206° N, 73.4114° W).

The geotechnical data at this HDD crossing is attached. The available data is from the previous investigation by TRC and the recent investigation by Schnabel, referenced below.

- TRC, Geotechnical Data Report, Champlain Hudson Power Express, Canadian Pacific Railway Borings MP 113.1-177.1, dated March 29, 2013.
- Schnabel Engineering, Geotechnical Data Report, Champlain Hudson Power Express, Canadian Pacific Railway Subsurface Explorations, dated March 3, 2022.

Contact us if you have questions or require additional information.

HDD 4

Borings B114.4-1, K-114.6

Segment 3 - Package 1C

CHPE Segments 1, 2, and 3 - Packages 1A, 1B, and 1C
HDD Soil Boring Coordinates and Elevations

Firm	Boring	Northing (feet)	Easting (feet)	Ground Surface Elevation (feet)
S.W. Cole*	B102.4-1	1762367.3	777951.9	139.42
	B109.7-1	1729097.5	774410.6	116.4
	B109.8-1	1728870.4	774869.2	99.8
	B110.1-1	1728142.0	776337.8	105.0
TRC*	B113.4-1	1714875.2	781894.9	122.9
	B114.4-1	1709558.6	780857.2	122.7
	B115.2-1	1705777.9	780186.6	120.9
	B116.1-1	1701426.5	778616.5	124.1
	B116.2-1	1700894.8	778375.8	124.3
	B116.8-1	1697938.4	777308.2	131.6
AECOM**	PD-7	1783019.4	778020.6	266.4
	PD-7A	1782960.9	778149.9	269.5
	WFE-1	1693492.9	776280.6	127.9
	WFE-1C	1693895.8	776092.3	129.3

Notes:
- Northings and Eastings are provided in NAD83 New York State Plane East Zone.
- Elevations are referenced to the NAVD88 datum.

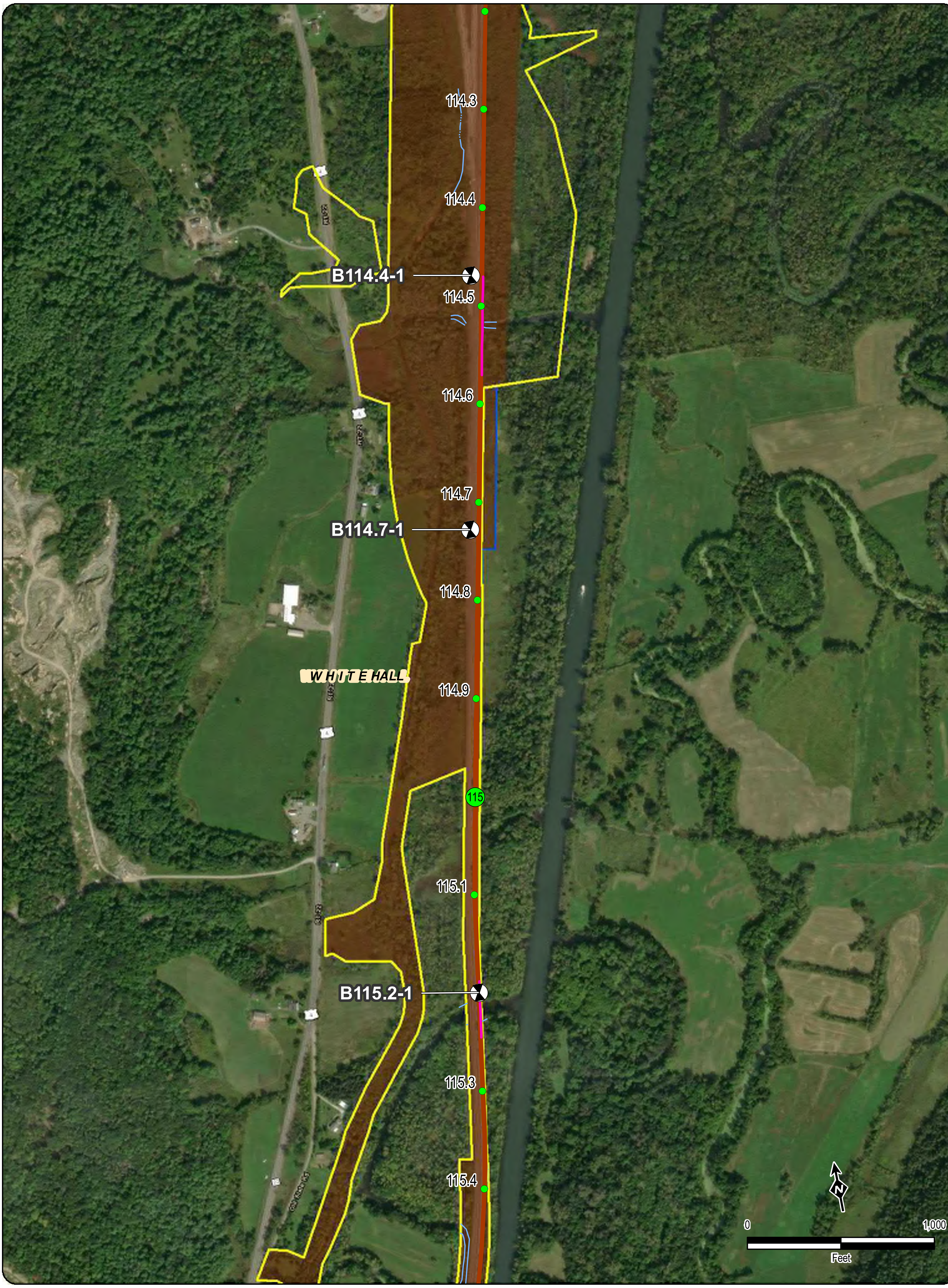
* TRC and S.W. Cole boring coordinates as shown in Table 1-6 in AECOM report (reference below). Boring elevations estimated from November 2021 topographic survey by Williams Aerial.

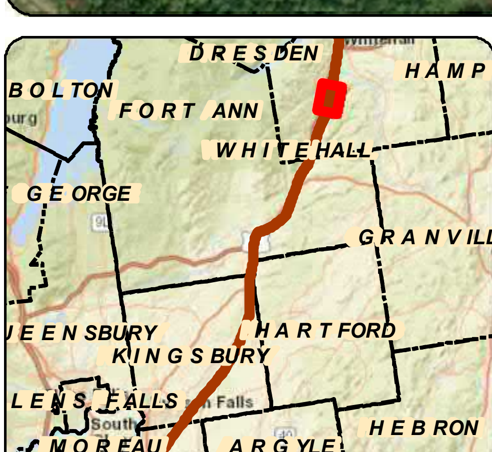
** AECOM boring coordinates and elevations as shown in Table 1-6 in AECOM report.

*** Kiewit boring coordinates and elevations are noted on the boring logs.

Reference:

AECOM, Geotechnical Data Report, Upland Segments: Putnam Station, Washington County, to Cementon, Green County, NY, Champlain Hudson Power Express, dated May 28, 2021.





LEGEND

- 111.8 Certified Milepost - Tenths
- 135 Certified Milepost
- 111.8 Preferred Alternative Milepost - Tenths
- 135 Preferred Alternative Milepost
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- 2021 Boring Location
- Previous (2013) Boring Location
- Streams/Ditches
- Railroad ROW
- Deviation Zone
- Deviation Zone Outside ROW
- Preferred Alternative Deviation Zone
- Preferred Alternative Deviation Zone Outside ROW
- Town Boundary
- Village Boundary
- State Park (OPRHP)

Parcel Ownership

TOWN NAME

Road Name

Village Name

Transmission Developers Inc.

Champlain Hudson Power Express Project

Champlain Hudson Power Express Inc.

BORING LOCATION PLAN

Whitehall to Fort Edward

Figure A-3

Sheet 2 of 16

Prepared by: AECOM 5/19/2021

DATA SOURCES: ESRI, NETWORK MAPPING 2010, NYSDOT, OPRHP, TDI, TRC

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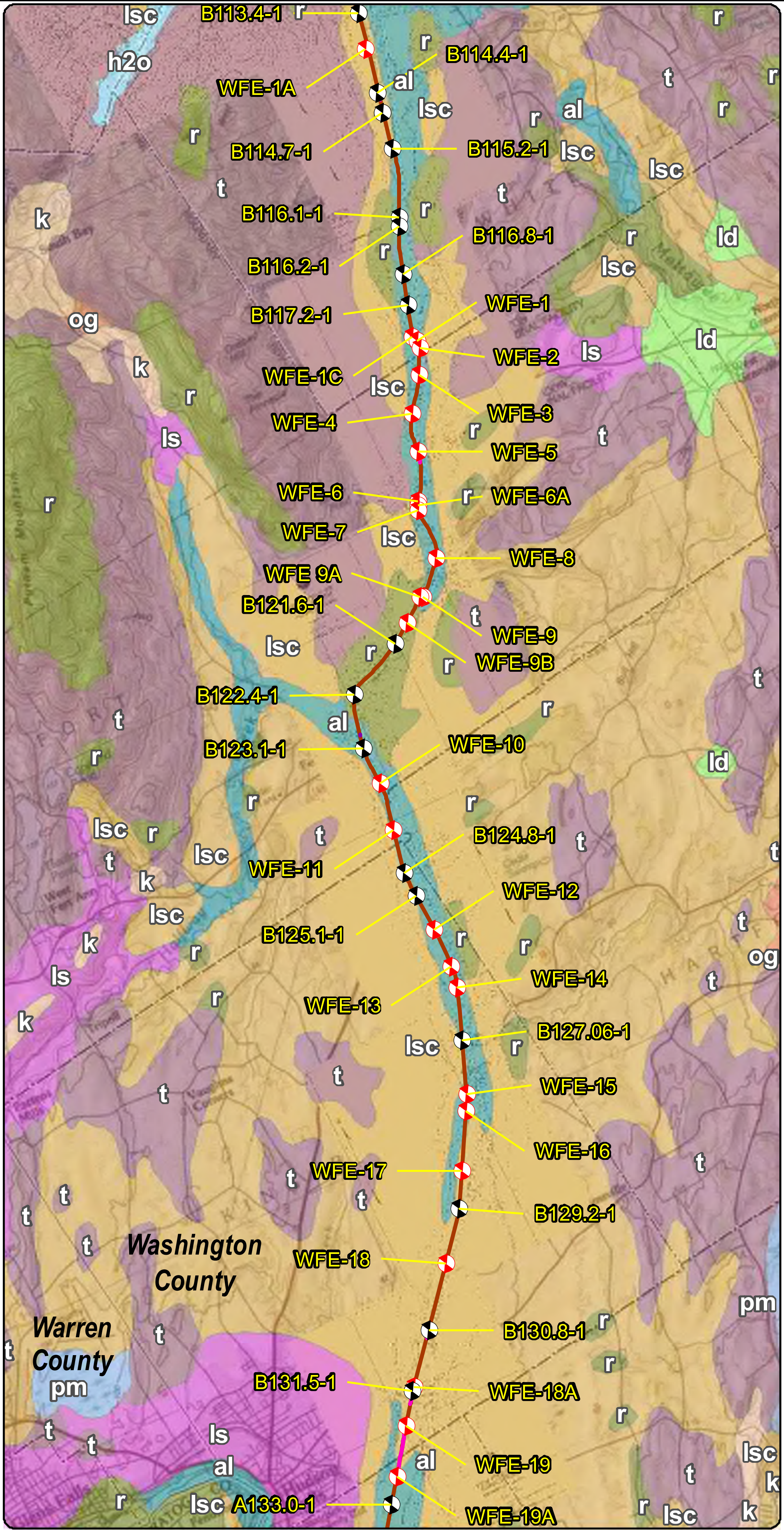

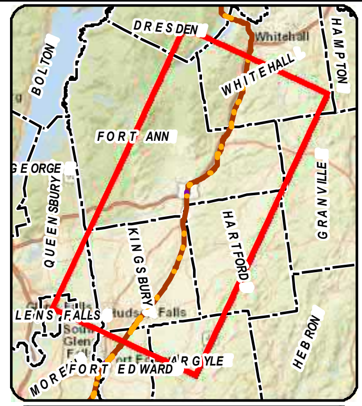

LEGEND

- 2021 Boring Location
- Previous (2013) Boring Location
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- Town Boundary
- County Boundary

Surficial Geology

- al - Recent alluvium
- h2o - Water
- k - Kame deposits
- ld - Lacustrine delta
- ls - Lacustrine sand
- lsc - Lacustrine silt and clay
- og - Outwash sand and gravel
- pm - Swamp deposits
- r - Bedrock
- t - Till

N

1 0.5 0 1 Miles

Transmission Developers Inc.

Champlain Hudson Power Express Project

Champlain Hudson Power Express Inc.

Surficial Geology and Geotechnical Borings Whitehall to Fort Edward Figure 3-3

Prepared on 5/5/2021

by: AECOM

DATA SOURCES: ESRI, NYSDOT, NOAA, USACE, NYDOS, TDI, TRC

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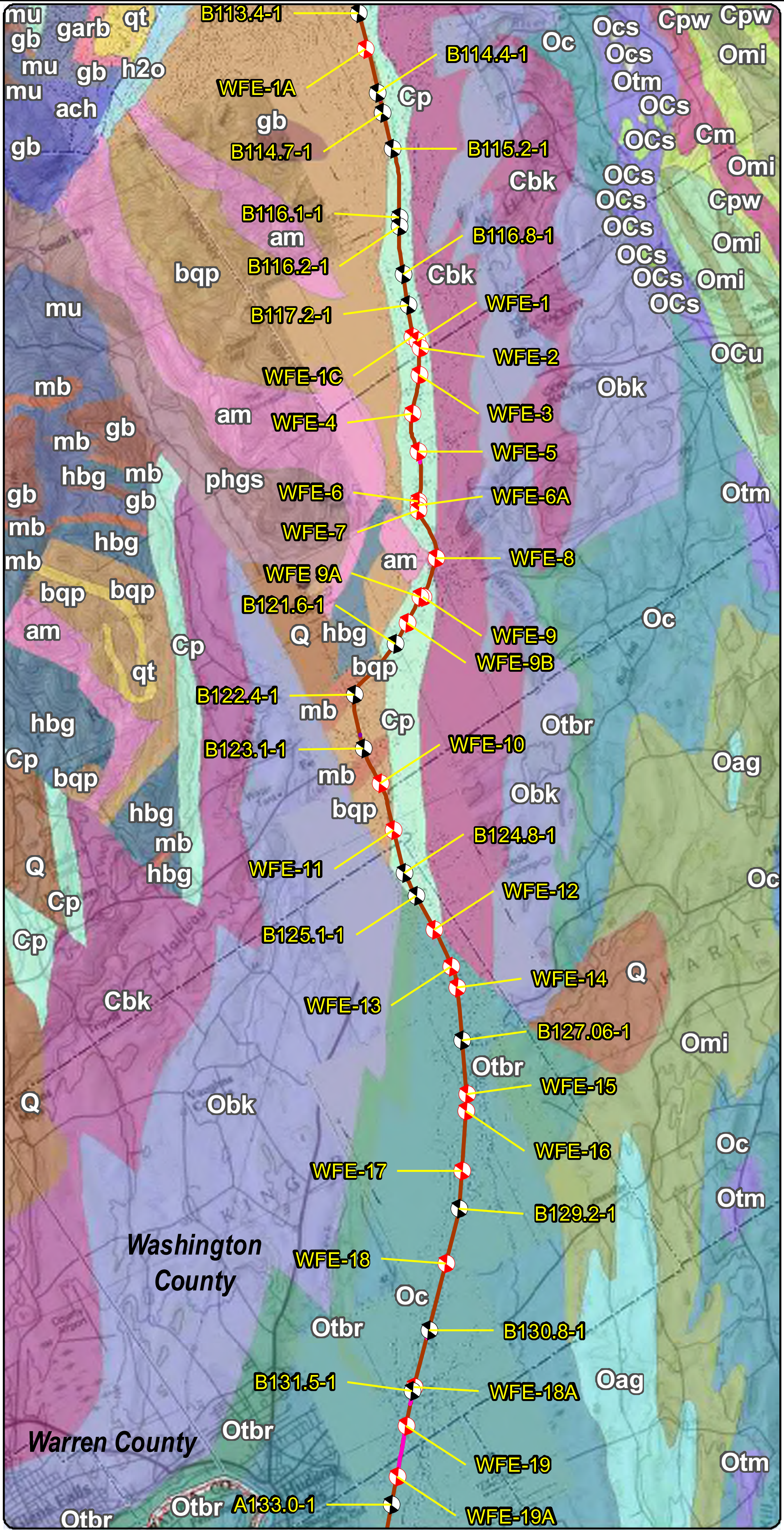

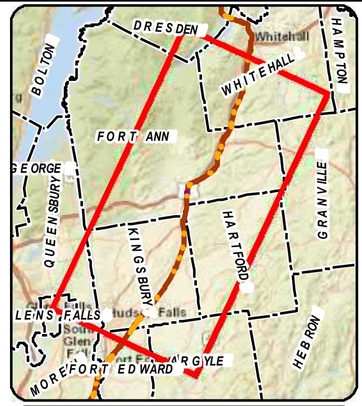

LEGEND

- 2021 Boring Location
- Previous (2013) Boring Location
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- Town Boundary
- County Boundary

Bedrock Geology

- Cbk - Beekmantow n Group
- Cm - Mettawee Formation
- Cp - Potsdam Sandstone
- Cpw - Poultney Formation ("A" Member)
- No Label
- OCs - Cambrian-Middle Ordovician carbonate
- OCu - Undivided Ordovician and Cambrian
- Oag - Austin Glen Formation
- Obk - Beekmantow n Group
- Oc - Canajoharie Shale
- Omi - Mount Merino Formation
- Op - Poultney Formation ("B" and "C")
- Otbr - Dolgeville Formation
- Otm - Taconic Melange
- Q - Glacial and Alluvial Deposits
- ach - metanorthosite and anorthosite
- am - Amphibolite, pyroxenic amphibolite
- bqp - Biotite-quartz-plagioclase
- garb - Quartz-feldspar paragneiss
- gb - Olivine metagabbro
- h2o - Water
- hbg - Biotite and or hornblende granite gneiss
- mb Calcitic and dolomitic marble
- mu - Undivided metased rock and migmatite
- phgs - Charnockite, granitic, quartz syenite
- qt - Quartzite

N

1 0.5 0 1 Miles

Transmission Developers Inc.

Champlain Hudson Power Express Project

Champlain Hudson Power Express Inc.

Bedrock Geology and Geotechnical Borings Whitehall to Fort Edward Figure 4-3

Prepared on 5/5/2021

by: AECOM

DATA SOURCES: ESRI, NYSDOT, NOAA, USACE, NYDOS, TDI, TRC

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TEST BORING LOG

TRC

BORING	B114.4-1
G.S. ELEV.	N/A
FILE	195651
SHEET	1 OF 1

PROJECT: TDI CHAMPLAIN HUDSON POWER EXPRESS
LOCATION: CP RAILROAD ROW, NY

GROUNDWATER DATA

FIRST ENCOUNTERED DRY

DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE

a	FROM	0.0 '	TO	10.0 '
d	FROM	10.0 '	TO	30.0 '

DRILLER	R. CARUSO
HELPER	C. SMART
INSPECTOR	C. POPPE
DATE STARTED	12/12/2012
DATE COMPLETED	12/12/2012

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
	S-1	7 13 9 7		***BLACK C/M/F SAND, SM F/ GRAVEL SIZED ROCK FRAGMENTS, SM ASH AND CINDERS, TR SILT (FILL)***		
	S-2	4 3 3 3			15.2	
5	S-3	2 1 2 2	6.0			
	S-4	2 2 2 2	8.0	***GRAY CLAYEY SILT, SM F/M/C SAND***	41.1	
10	S-5	2 3 5 8			37.8	
15	S-6	4 5 7		***BROWN CLAY, SM SILT***	45.3	
20	S-7	4 5 6			49.7	
			23.5			
25	S-8	2 3 3		***GRAY CLAY, SM SILT***	51.1	
30	S-9	3 4 2	30.0		49.2	
				END OF BORING AT 30'		
35						

DRN.	CMP
CKD.	PWK

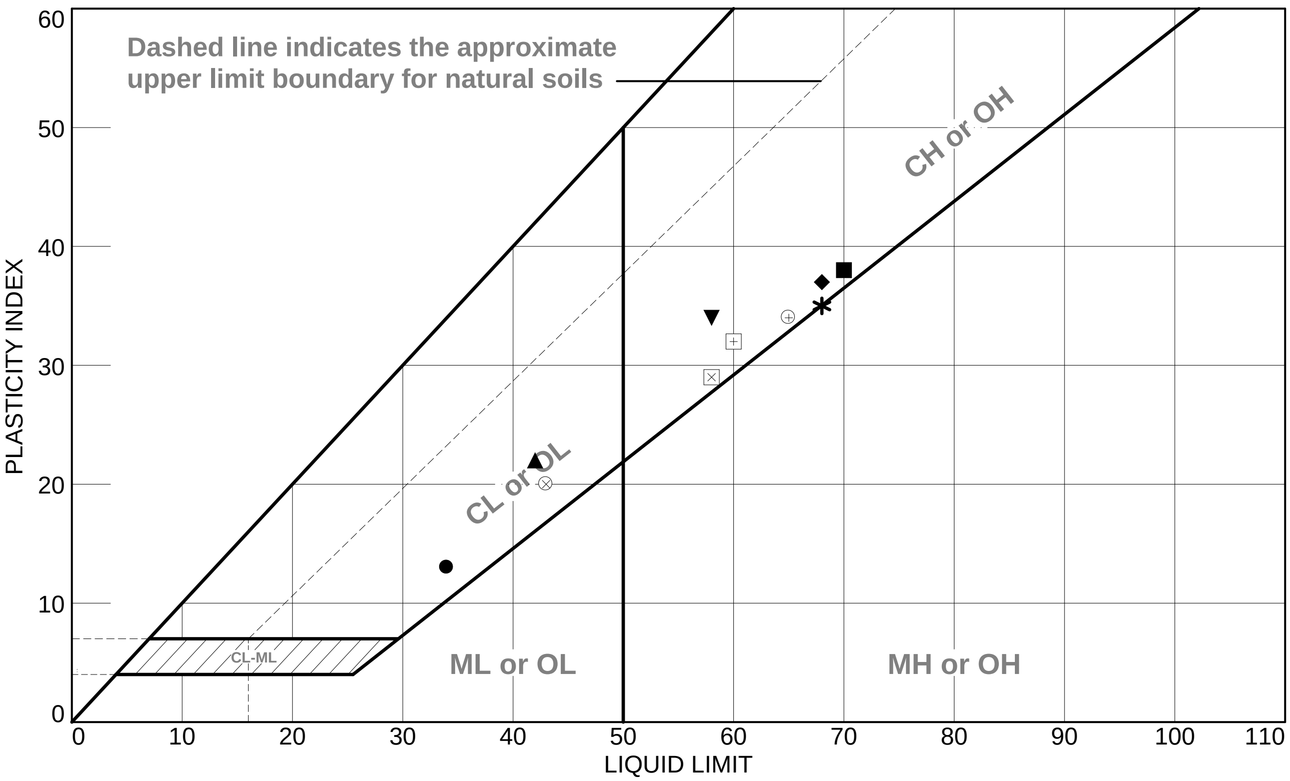
NEW PROJECTS TEST BORING LOG 195651_TDI_CP.GPJ SITE BLAUVELT.GDT 3/27/13

SUMMARY OF LABORATORY TEST DATA

Project Name: TDI Champlain Hudson Power Express – CP
Client Name: Transmission Developers, Inc.
TRC Project #: 195651

SAMPLE IDENTIFICATION			Soil Group (USCS System)	GRAIN SIZE DISTRIBUTION				PLASTICITY				Specific Gravity	Moisture Content (%)	Unit Weight (pcf)	Compressive Strength (tsf)	Organic Content (%)
Boring #	Sample #	Depth (ft)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index)					
B114.4-1	S-2	2.0-4.0	SW-SM	25.4	66.9	7.7		-	-	-	-	-	15.2	-	-	-
	S-3	4.0-6.0														
	S-4	6.0-8.0	-	-	-	-	-	-	-	-	-	-	41.1	-	-	-
	S-5	8.0-10.0	-	-	-	-	-	-	-	-	-	-	37.8	84.5	-	-
	S-6	13.5-15.0	-	-	-	-	-	-	-	-	-	-	45.3	-	-	-
	S-7	18.5-20.0	CH/MH	-	-	-	-	68	33	35	0.5	-	49.7	-	-	-
	S-8	23.5-25.0	-	-	-	-	-	-	-	-	-	-	51.1	72.2	-	-
	S-9	28.5-30.0	CH	-	-	-	-	58	24	34	0.7	-	49.2	-	-	-
B114.7-1	S-4	6.0-8.0	-	-	-	-	-	-	-	-	-	-	55.7	-	-	-
	S-6	13.5-15.0	-	-	-	-	-	-	-	-	-	-	45.7	78.0	-	-
	S-7	18.5-20.0	-	-	-	-	-	-	-	-	-	-	49.0	-	-	-
	S-8	23.5-25.0	-	-	-	-	-	-	-	-	-	-	53.7	-	-	-
B115.2-1	S-2	2.0-4.0	-	-	-	-	-	-	-	-	-	-	26.9	-	-	-

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

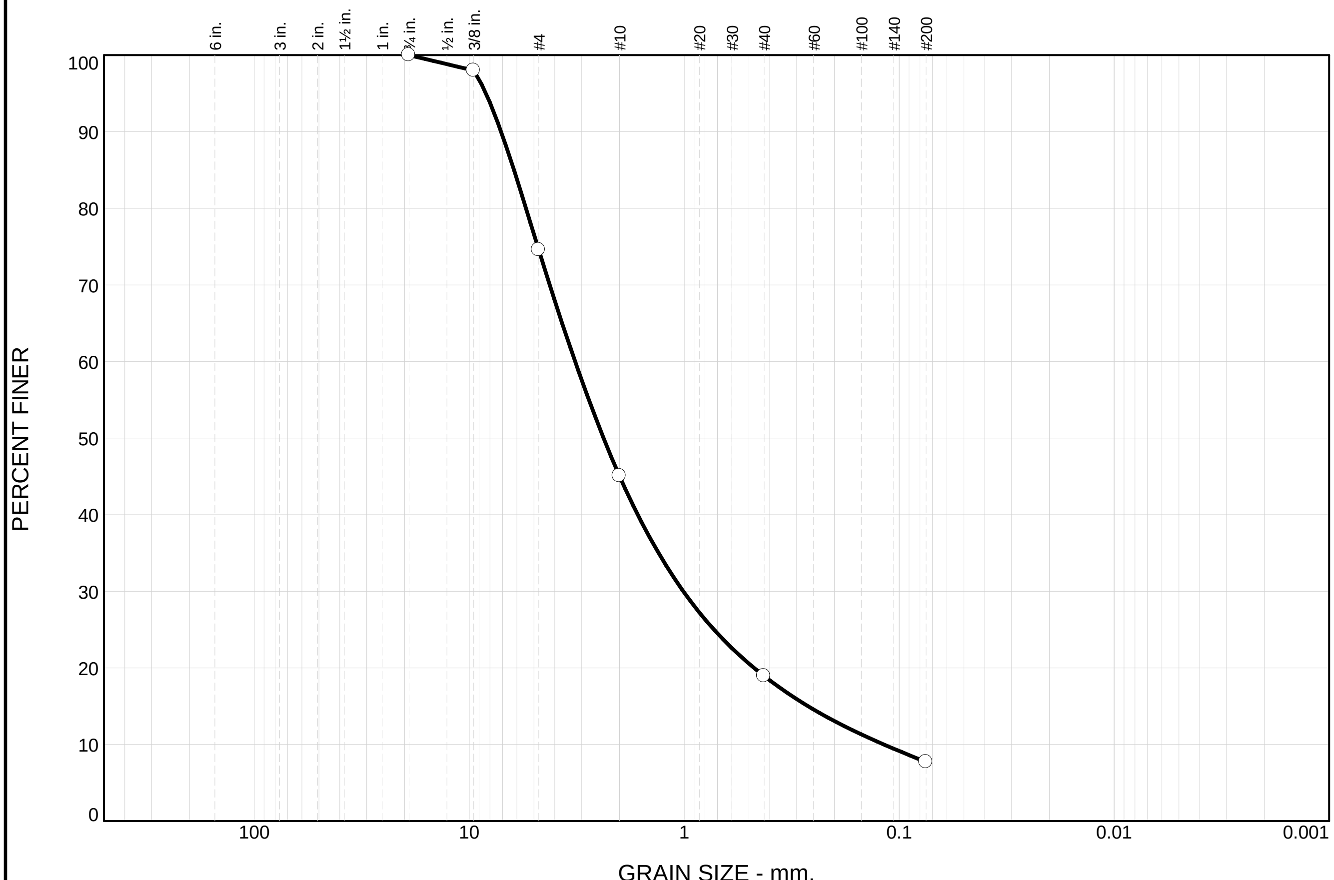
	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B113.1-1	S-7	18.5-20.0 FT	27.3	21	34	13	CL
■	B113.1-1	S-9	28.5-30.0 FT	38.8	32	70	38	CH/OH
▲	B113.4-1	S-3 & S-4	4.0-8.0 FT	27.3	20	42	22	CL
◆	B113.4-1	S-8	23.5-25.0 FT	50.3	31	68	37	CH
▼	B114.4-1	S-9	28.5-30.0 FT	49.2	24	58	34	CH
✱	B114.4-1	S-7	18.5-20.0 FT	49.7	33	68	35	CH/MH
⊕	B115.2-1	S-7	18.5-20.0 FT	45.6	31	65	34	CH
⊞	B116.8-1	S-12	43.5-45.0 FT	52.2	28	60	32	CH
⊗	B119.2-1	S-4 & S-5	7.0-11.0 FT	26.7	23	43	20	CL
⊠	B123.1-1	S-4	6.0-8.0 FT	33.0	29	58	29	CH

TRC
Engineers, Inc.
Mt. Laurel, NJ

Client: TDI CHAMPLAIN HUDSON POWER EXPRESS - CP
Project: TRANSMISSION DEVELOPERS, INC.

Project No.: 195651 **Figure** 1

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	25.4	29.5	26.2	11.2	7.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			6.1888	3.2153	2.3713	1.0094	0.2653	0.1178	2.69	27.29

Material Description	USCS	AASHTO
○ GRAY TO BLACK C/M/F SAND, SM F/ GRAVEL, TR SILT	SW-SM	

Project No. 195651 **Client:** TDI CHAMPLAIN HUDSON POWER EXPRESS - CP
Project: TRANSMISSION DEVELOPERS, INC.

○ **Source of Sample:** B114.4-1 **Depth:** 2.0-6.0 FT **Sample Number:** S-2 & S-3

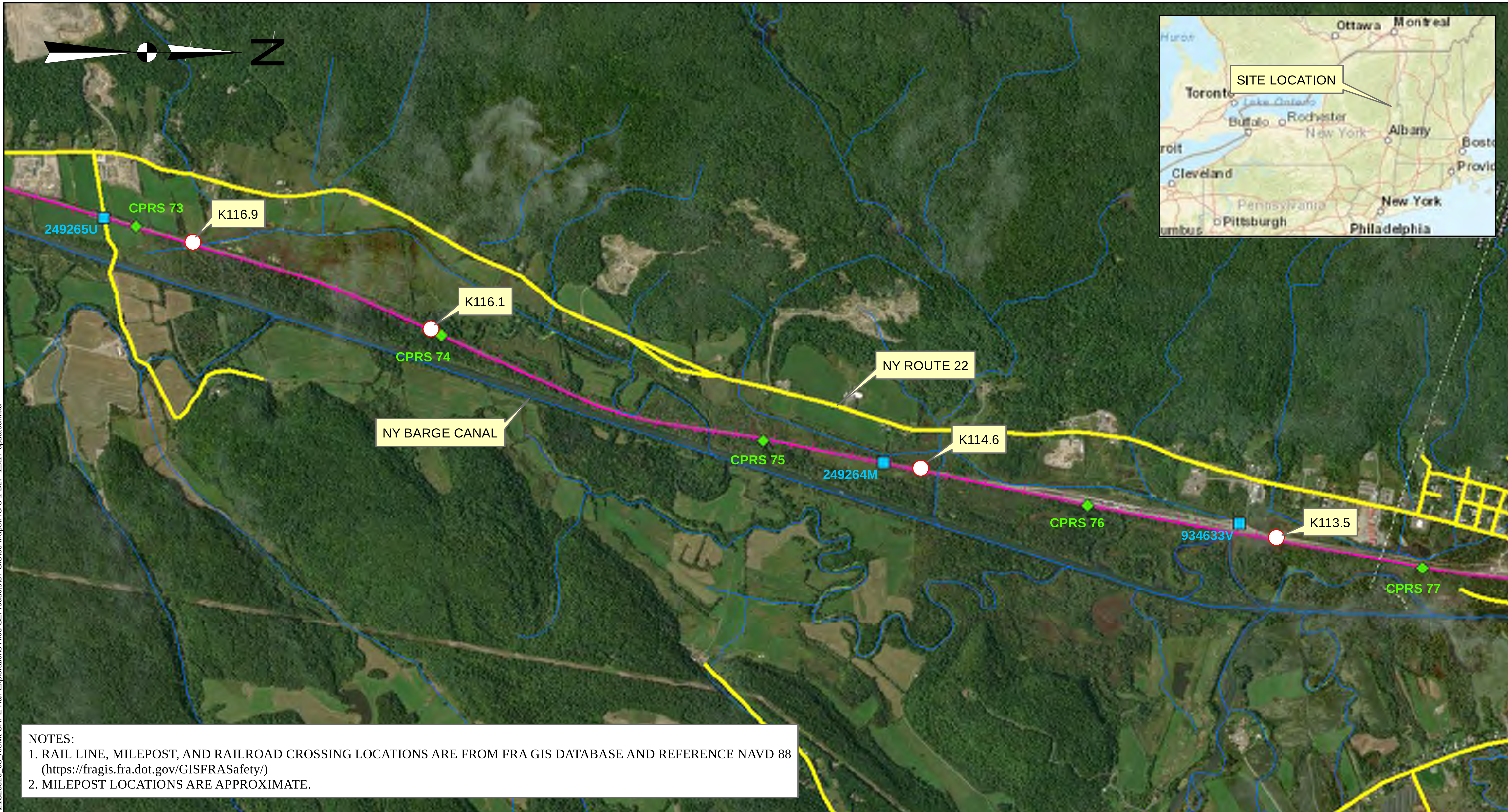
Remarks:
○SAMPLE DESCRIPTION BASED ON VISUAL IDENTIFICATION AND LABORATORY ANALYSIS

TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 7

Tested By: BMH 01/24/13 **Checked By:** ________________



NOTES:
1. RAIL LINE, MILEPOST, AND RAILROAD CROSSING LOCATIONS ARE FROM FRA GIS DATABASE AND REFERENCE NAVD 88 (https://fragis.fra.dot.gov/GISFRASafety/)
2. MILEPOST LOCATIONS ARE APPROXIMATE.

Legend

- Railroad Milepost
- Railroad Crossings
- Roadway
- NYS_Drainage_Streams
- Rail Line
- Boring Location

Source: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

0 1,500 3,000 Feet

Scale: 1:18,000

Schnabel ENGINEERING

CHAMPLAIN HUDSON POWER EXPRESS
WHITEHALL, NEW YORK

PROJECT NO. 21C25020.03

RAIL EXPLORATION
BORING LOCATION
PLAN

FIGURE 3.1

2/28/2022 12:26:00 PM G:\2021-Jobs\Albany\21C25020_03_Kiewit-CHPE-Rail-Explorations-A03-SE\Products\07-GIS\03-Maps\FIG-3-1-BLP-11x17-updated.mxd

Schnabel ENGINEERING	TEST BORING LOG	**Project:** Champlain Hudson Power Express Rail Explorations Whitehall, New York	**Boring Number:** K114.6 **Contract Number:** 21C25020.03 **Sheet:** 1 of 3

Contractor: Soil Testing Inc.
Oxford, Connecticut

Contractor Foreman: S. DeAngelis

Schnabel Representative: S. Henry

Equipment: Diedrich D-50 (ATC)

Method: 4-1/4" I.D. Hollow Stem Auger / 3" Fluid Rotary

Hammer Type: Safety Hammer (140 lb)

Dates Started: 12/20/21 **Finished:** 12/22/21

X: 780759.1 ft **Y:** 1709035 ft **By:** Land Survey

Coordinate System: Lat-Long (Decimal Degrees)

Plunge: -90 **Bearing:**

Ground Surface Elevation: 121.8 (ft) **Total Depth:** 72.0 ft

Water Level Observations

	Date	Time	Depth	Casing	Caved
Encountered ▽	12/20/21	1:30 PM	11.5'	10.0'	---
Completion ▼	12/22/21	1:05 PM	10.0'	45.0'	---

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	0.0 - 11.7 ft: FILL, sampled as silty sand with gravel; moist, black, contains mica	FILL		F		S-1, SPT 3+4+5+4 REC=14", 58%		
					5	S-2, SPT 2+1+1+1 REC=7", 29%	MC = 13.1% Resistivity = 3010 Ohms-cm Redox = 590 mv pH = 6.48	
	10.0 ft: Change: wet, gray				10	S-3, SPT 2+4+1+2 REC=5", 21%		
11.7	11.7 - 72.0 ft: FAT CLAY; wet, gray with mottles of brown, probable LACUSTRINE material	CH	110.1	L		S-4, SPT 2+3+3+6 REC=24", 100%	PP = 2.00 tsf PP = 2.00 tsf	
					15	S-5, SPT 1+2+4+6 REC=20", 83%	MC = 44.7% PP = 2.00 tsf	
	20.0 ft: Change: gray				20	S-6, SPT 2+2+3+4 REC=24", 100%	PP = 0.50 tsf	

(continued)

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	11.7 - 72.0 ft: FAT CLAY; wet, gray with mottles of brown, probable LACUSTRINE material *(continued)*	CH		L		S-7, SPT WOR/24" REC=24", 100%	PP = 0.00 tsf	
					30	S-8, SPT WOR/24" REC=24", 100%	PP = 0.00 tsf	
					35	UD-1, UNDIST REC=24", 100%	LL = 56 PL = 25 MC = 55.7% % Passing #200 = 99.4 PP = 0.00 tsf	
						S-9, SPT WOR/24" REC=2", 8%	PP = 0.00 tsf	
					40	S-10, SPT WOR/24" REC=24", 100%	PP = 0.00 tsf	
					45	S-11, SPT WOR/24" REC=9", 38%	PP = 0.00 tsf	45.0 ft: Drilling method switched to mud rotary with tricone rollerbit.
					50	S-12, SPT WOR/24" REC=24", 100%	PP = 0.00 tsf	
					55	S-13, SPT WOR/24" REC=24", 100%	MC = 60.2% PP = 0.00 tsf	

(continued)

Schnabel ENGINEERING	TEST BORING LOG	Project:	Champlain Hudson Power Express Rail Explorations Whitehall, New York	Boring Number: K114.6 Contract Number: 21C25020.03 Sheet: 3 of 3

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	11.7 - 72.0 ft: FAT CLAY; wet, gray with mottles of brown, probable LACUSTRINE material *(continued)*	CH		L				
					60	UD-2, UNDIST REC=22", 92%	PP = 0.00 tsf	
	62.0 ft: Change: dark brownish gray					S-14, SPT WOR/18"+WOH REC=24", 100%	LL = 59 PL = 22 MC = 52.7% % Passing #200 = 99.9 PP = 0.00 tsf	
					65	S-15, SPT WOR/18"+WOH REC=24", 100%	PP = 0.00 tsf	
					70	S-16, SPT WOR+WOH/18" REC=24", 100%	PP = 0.00 tsf	
72.0			49.8					

Bottom of Boring at 72.0 ft.
Boring terminated at selected depth.
Boring backfilled with cement grout through tremie pipe upon completion.
"Completion" groundwater reading likely impacted by mud rotary drilling fluids.
Unable to obtain a "Casing Pulled" groundwater reading due to grout.
Coordinates and elevations were provided by Kiewit Engineering (NY) Corp. on Jan. 18, 2022.
Stratum Designations:
F: Fill Material
L: Lacustrine Deposits

Summary Of Laboratory Tests

Boring No.	Sample Depth ft / Elevation ft	Sample Type	Description of Soil Specimen	Stratum	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Passing No. 200 Sieve	Organic Content (%)	pH	Sulfates (mg/Kg)	Chlorides (mg/Kg)	Resistivity (ohm-cm)	Oxidation Reduction Potential (mV)
K113.5	6.0 - 8.0 / 116.5 - 114.5	Jar	Sandy Fat Clay (visual field description)	L	21.1	--	--	--	50.1	--	--	--	--	--	--
K113.5	8.0 - 10.0 / 114.5 - 112.5	Jar	Fat Clay (visual field description)	L	--	65	21	44	--	1.84	--	--	--	--	--
K113.5	25.0 - 27.0 / 97.5 - 95.5	Tube	FAT CLAY (CH), gray	L	43.7	64	25	39	99.8	--	--	--	--	--	--
K113.5	42.0 - 44.0 / 80.5 - 78.5	Jar	Fat Clay (visual field description)	L	71.1	--	--	--	--	--	--	--	--	--	--
K114.6	5.0 - 7.0 / 116.8 - 114.8	Jar	Silty Sand with Gravel (visual field description)	F	13.1	--	--	--	--	--	6.48	140	6.2 BRL	3010	590
K114.6	15.0 - 17.0 / 106.8 - 104.8	Jar	Fat Clay (visual field description)	L	44.7	--	--	--	--	--	--	--	--	--	--
K114.6	35.0 - 37.0 / 86.8 - 84.8	Tube	FAT CLAY (CH), gray	L	55.7	56	25	31	99.4	--	--	--	--	--	--

Notes:
1. Soil tests in general accordance with ASTM standards.
2. Soil classifications are in general accordance with ASTM D2487(as applicable), based on testing indicated and visual classification.
3. Key to abbreviations: NP=Non-Plastic; -- indicates no test performed; BRL = below reporting limit
4. Strata: F=Fill; L=Lacustrine

Schnabel ENGINEERING

Project: Champlain Hudson Power Express
Rail Explorations
Whitehall, NY

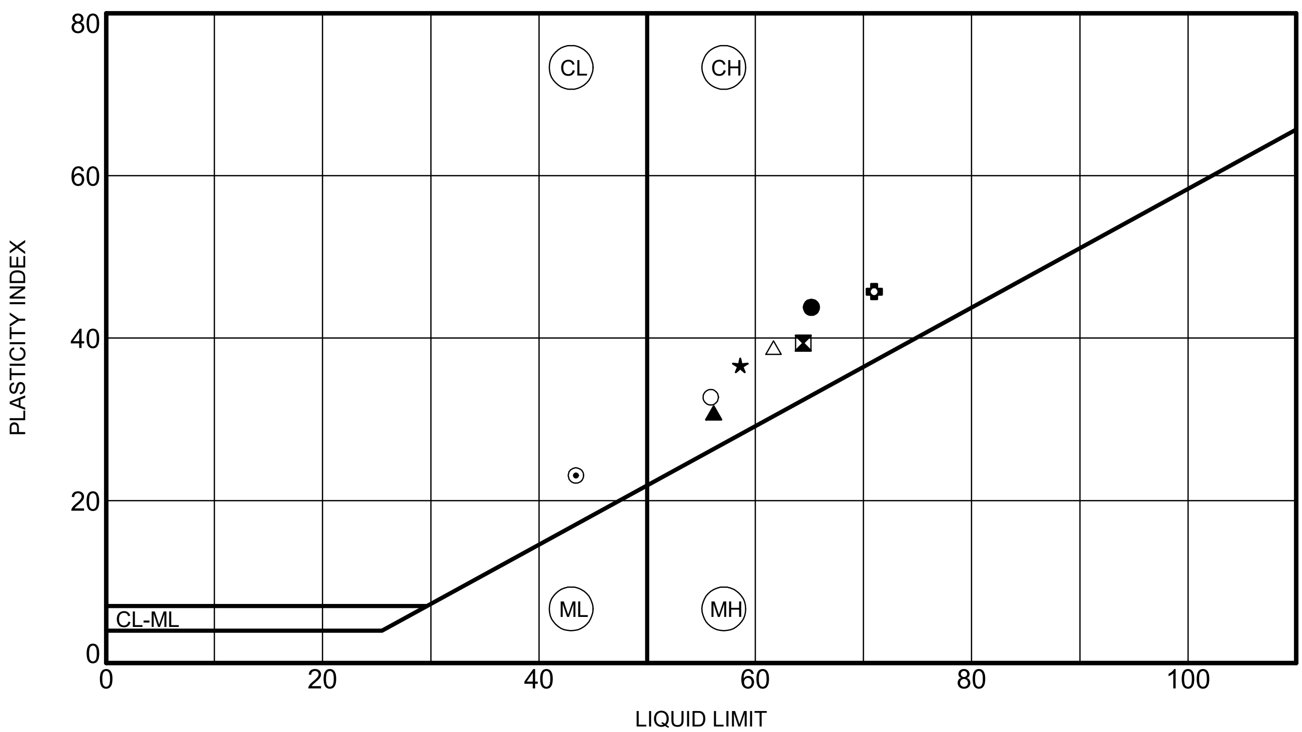
Summary Of Laboratory Tests

Boring No.	Sample Depth ft / Elevation ft	Sample Type	Description of Soil Specimen	Stratum	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Passing No. 200 Sieve	Organic Content (%)	pH	Sulfates (mg/Kg)	Chlorides (mg/Kg)	Resistivity (ohm-cm)	Oxidation Reduction Potential (mV)
K114.6	55.0 - 57.0 / 66.8 - 64.8	Jar	Fat Clay (visual field description)	L	60.2	--	--	--	--	--	--	--	--	--	--
K114.6	62.0 - 64.0 / 59.8 - 57.8	Jar	FAT CLAY (CH), dark brownish gray	L	52.7	59	22	37	99.9	--	--	--	--	--	--
K116.1	5.0 - 7.0 / 119.9 - 117.9	Jar	Lean Clay (visual field description)	L	--	43	20	23	--	--	--	--	--	--	--
K116.1	10.0 - 12.0 / 114.9 - 112.9	Jar	Lean Clay (visual field description)	L	30.5	--	--	--	98.1	--	--	--	--	--	--
K116.1	25.0 - 27.0 / 99.9 - 97.9	Jar	Well-graded Sand (visual field description)	L	19.0	--	--	--	--	--	--	--	--	--	--
K116.1	42.0 - 44.0 / 82.9 - 80.9	Jar	FAT CLAY (CH), gray	L	71.4	71	25	46	99.9	0.88	--	--	--	--	--
K116.1	57.0 - 59.0 / 67.9 - 65.9	Jar	Fat Clay (visual field description)	L	66.6	--	--	--	--	--	--	--	--	--	--

Notes:
1. Soil tests in general accordance with ASTM standards.
2. Soil classifications are in general accordance with ASTM D2487(as applicable), based on testing indicated and visual classification.
3. Key to abbreviations: NP=Non-Plastic; -- indicates no test performed; BRL = below reporting limit
4. Strata: F=Fill; L=Lacustrine

Schnabel ENGINEERING

Project: Champlain Hudson Power Express
Rail Explorations
Whitehall, NY



PLOTTED DATA REPRESENTS SOIL PASSING NO. 40 SIEVE

	Specimen		LL	PL	PI	Fines	Description
●	**K113.5**	**8.0 ft**	**65**	**21**	**44**		**Fat Clay (visual field description)**
⧗	**K113.5**	**25.0 ft**	**64**	**25**	**39**	**100**	**FAT CLAY (CH), gray**
▲	**K114.6**	**35.0 ft**	**56**	**25**	**31**	**99**	**FAT CLAY (CH), gray**
★	**K114.6**	**62.0 ft**	**59**	**22**	**37**	**100**	**FAT CLAY (CH), dark brownish gray**
⊙	**K116.1**	**5.0 ft**	**43**	**20**	**23**		**Lean Clay (visual field description)**
✿	**K116.1**	**42.0 ft**	**71**	**25**	**46**	**100**	**FAT CLAY (CH), gray**
○	**K116.9**	**40.0 ft**	**56**	**23**	**33**	**100**	**FAT CLAY (CH), gray**
△	**K116.9**	**50.0 ft**	**62**	**23**	**39**	**95**	**FAT CLAY (CH), gray**

Schnabel ENGINEERING

ATTERBERG LIMITS

Project: Champlain Hudson Power Express
Rail Explorations
Whitehall, NY

Contract: 21C25020.03

Schnabel ENGINEERING

SOIL MECHANICS LABORATORY
CORROSION POTENTIAL SERIES

Project Name: Champlain Hudson Power Express Rail Explorations
Location: Whitehall, NY
Project No: 21C25020.03

Sample No: K-114.6
Depth (ft): 5.0-7.0
Classification: SILTY SAND WITH GRAVEL (SM), black

Test	Unit	Readings	AWWA Guidelines Points	NACE Guidelines Points
Resistivity	ohm-cm	3,010	0	4
pH	--	6.48	0	0
Redox	mV	590	0	0
Sulfide	ppm	BRL	2	--
Moisture	condition	Moist	1	--
Sulfate	ppm	140	--	--
Chloride	ppm	BRL	--	0
Soil Description	--	Sand	--	0
		Total Points	3	4

Notes:
1. **See attached Tables for point system information and data interpretation**
2. **BRL = Below Reporting Limit**

Set up by:	MDE	Tested by:	Access	Checked by:	SRH
Date:	2/8/22	Date:	2/18/22	Date:	2/24/2022

Table 1: AWWA Guidelines. AWWA C-105, 10-pt soil test evaluation for iron pipe

Soil Characteristics	Points
Resistivity (Ω-cm)[1]	
< 1,500	10
≥1,500-1,800	8
>1,800 – 2,100	5
>2,100-2,500	2
>2,500-3,000	1
> 3,000	0
pH	
0 – 2	5
2.01 – 4.00	3
4.01 – 6.5	0
6.51 – 7.5	0*
7.51 – 8.5	0
> 8.5	3
Redox potential (mV)	
> +100	0
+50 to +100	3.5
0 to +50	4
< 0	5
Sulfides	
Positive	3.5
Trace	2
Negative	0
Moisture	
Wet	2
Moist	1
Dry	0

* If sulfides are present and a low (<100mV) or negative redox result is obtained, three points shall be given for this pH range.
[1] Based on water-saturated soil box. This method is designed to obtain the lowest and most accurate resistivity reading.

NOTE: If total cumulative points ≥ 10, the tested soil has potential for corrosion, according to the AWWA Guidelines.

Table 2: ACI 318 Guidelines-Requirements for concrete exposed to sulfate-containing solutions

Sulfate exposure	Water soluble Sulfate (SO4) in soil, percent by weight	Sulfate (SO4) in water, ppm	Cement type	Maximum water-cementitious material ratio, by weight, normal weight concrete*	Minimum f_c', normal-weight and lightweight concrete, psi*
Negligible	$0.00 \leq SO4 < 0.10$	$0 \leq SO4 < 150$	—	—	—
Moderate[1]	$0.10 \leq SO4 < 0.20$	$150 \leq SO4 < 1500$	II, IP(MS), IS(MS), P(MS), I(PM)(MS), I(SM)(MS)	0.50	4000
Severe	$0.20 \leq SO4 \leq 2.00$	$1500 \leq SO4 \leq 10,000$	V	0.45	4500
Very severe	$SO4 > 2.00$	$SO4 > 10,000$	V plus pozzolan[2]	0.45	4500

* When both Table 4.3.1 and Table 4.2.2 are considered, the lowest applicable maximum water-cementitious material ratio and highest applicable minimum f_c' shall be used.
1 Seawater.
2 Pozzolan that has been determined by test or service record to improve sulfate resistance when used in concrete containing Type V cement.

Table 3: NACE Guidelines. Adapted from Table 20.1 "Assessment of Overall Soil Corrosivity to Steel", C.P. Dillon *Corrosion Control in the Chemical Process Industries.*

ANALYSIS TYPE	ANALYSIS RANGE	POINTS	ANALYSIS TYPE	ANALYSIS RANGE	POINTS
pH	0 – 2	5	Soil Description	Clay (Blue-Gray)	10
	2 – 4	3		Clay/Stone	5
	4 – 8.5	0		Clay	3
	> 8.5	3		Silt	2
Chloride Content	> 1000 ppm	10		Clean Sand	0
	500 – 1000 ppm	6		---	--
	200 – 500 ppm	4	Soil Resistivity	< 1,000 ohm-cm	10
	50 – 200 ppm	2		1,000 – 1,500 ohm-cm	8
	0 – 50 ppm	0		1,500 – 2,500 ohm-cm	6
Redox Potential	Negative	5		2,500 – 5,000 ohm-cm	4
	0 – 100 mV	4		5,000 – 10,000 ohm-cm	2
	> 100 mV	0		> 10,000 ohm-cm	0
	---	--		---	--

SOIL CORROSIVITY	TOTAL POINTS
Severe	15.5
Appreciable	10.0 – 15.5
Moderate	5.0 – 9.5
Mild	0 – 4.5

Kiewit

MEMORANDUM

DATE: September 23, 2022

TO: Antonio Marruso, P.E.; CHA Consulting, Inc.

FROM: Matthew Hawley, P.E.; Kiewit Engineering (NY) Corp. MKH
Jaren Knighton; Kiewit Engineering (NY) Corp.

SUBJECT: Geotechnical Data: Segment 3 - Package 1C - HDD Crossing 5 – Revision 1
Champlain Hudson Power Express Project
Whitehall, New York

Kiewit Engineering is providing the enclosed geotechnical data for use in the horizontal direction drill (HDD) design for the Champlain Hudson Power Express project in Upstate New York. This HDD crossing is located south of Whitehall, New York. The approximate station for the start of HDD crossing Number 5 is STA 15175+00 (43.520129° N, 73.411283° W).

The geotechnical data at this HDD crossing is enclosed. The available data is from the previous investigation by TRC and the recent investigation by Schnabel, referenced below.

- TRC, Geotechnical Data Report, Champlain Hudson Power Express, Canadian Pacific Railway Borings MP 113.1-177.1, dated March 29, 2013.
- Atlantic Testing Laboratories, Boring K-115.2 Subsurface Investigation Log and Laboratory Testing, dated March and April 2022.

Contact us if you have questions or require additional information.

HDD 5
Borings B115.2-1 and
K-115.2
Segment 3

CHPE Segments 1, 2, and 3 - Packages 1A, 1B, and 1C
HDD Soil Boring Coordinates and Elevations

Firm	Boring	Northing (feet)	Easting (feet)	Ground Surface Elevation (feet)
S.W. Cole*	B102.4-1	1762367.3	777951.9	139.42
	B109.7-1	1729097.5	774410.6	116.4
	B109.8-1	1728870.4	774869.2	99.8
	B110.1-1	1728142.0	776337.8	105.0
TRC*	B113.4-1	1714875.2	781894.9	122.9
	B114.4-1	1709558.6	780857.2	122.7
	B115.2-1	1705777.9	780186.6	120.9
	B116.1-1	1701426.5	778616.5	124.1
	B116.2-1	1700894.8	778375.8	124.3
	B116.8-1	1697938.4	777308.2	131.6
AECOM**	PD-7	1783019.4	778020.6	266.4
	PD-7A	1782960.9	778149.9	269.5
	WFE-1	1693492.9	776280.6	127.9
	WFE-1C	1693895.8	776092.3	129.3

Notes:
- Northings and Eastings are provided in NAD83 New York State Plane East Zone.
- Elevations are referenced to the NAVD88 datum.

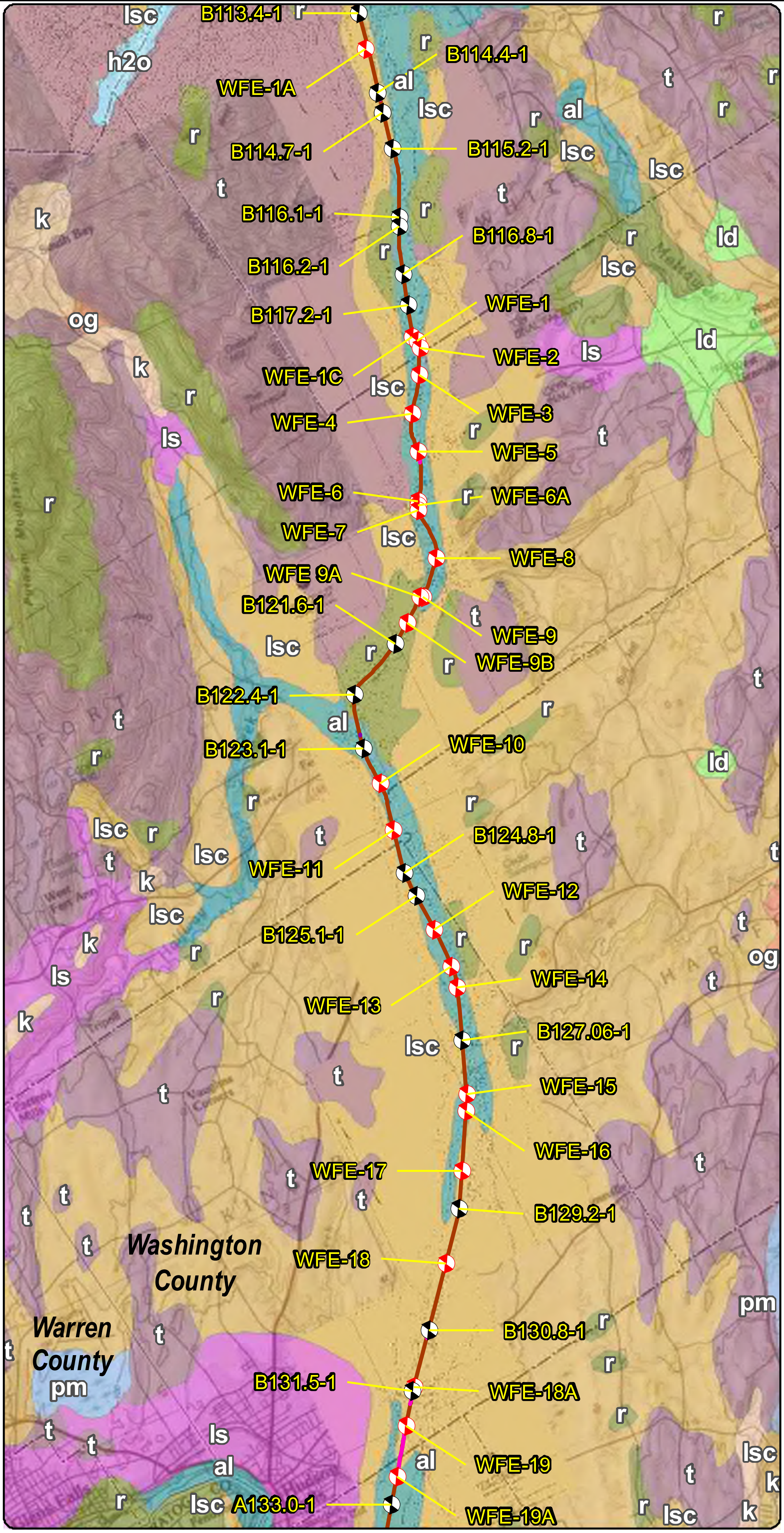
* TRC and S.W. Cole boring coordinates as shown in Table 1-6 in AECOM report (reference below). Boring elevations estimated from November 2021 topographic survey by Williams Aerial.

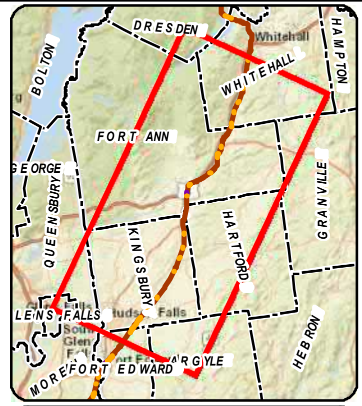
** AECOM boring coordinates and elevations as shown in Table 1-6 in AECOM report.

*** Kiewit boring coordinates and elevations are noted on the boring logs.

Reference:

AECOM, Geotechnical Data Report, Upland Segments: Putnam Station, Washington County, to Cementon, Green County, NY, Champlain Hudson Power Express, dated May 28, 2021.





LEGEND

2021 Boring Location

Previous (2013) Boring Location

Terrestrial Route HVDC

Submarine Route HVDC

Terrestrial Route HVAC

Preliminary HDD Locations

Preliminary Pipe Bridge Location

Town Boundary

County Boundary

Surficial Geology

- al - Recent alluvium
- h2o - Water
- k - Kame deposits
- ld - Lacustrine delta
- ls - Lacustrine sand
- lsc - Lacustrine silt and clay
- og - Outwash sand and gravel
- pm - Swamp deposits
- r - Bedrock
- t - Till

1 0.5 0 1 Miles

Transmission Developers Inc.

Champlain Hudson Power Express Project

Champlain Hudson Power Express Inc.

Surficial Geology and Geotechnical Borings Whitehall to Fort Edward
Figure 3-3

Prepared on 5/5/2021
by: AECOM

DATA SOURCES: ESRI, NYSDOT, NOAA, USACE, NYDOS, TDI, TRC

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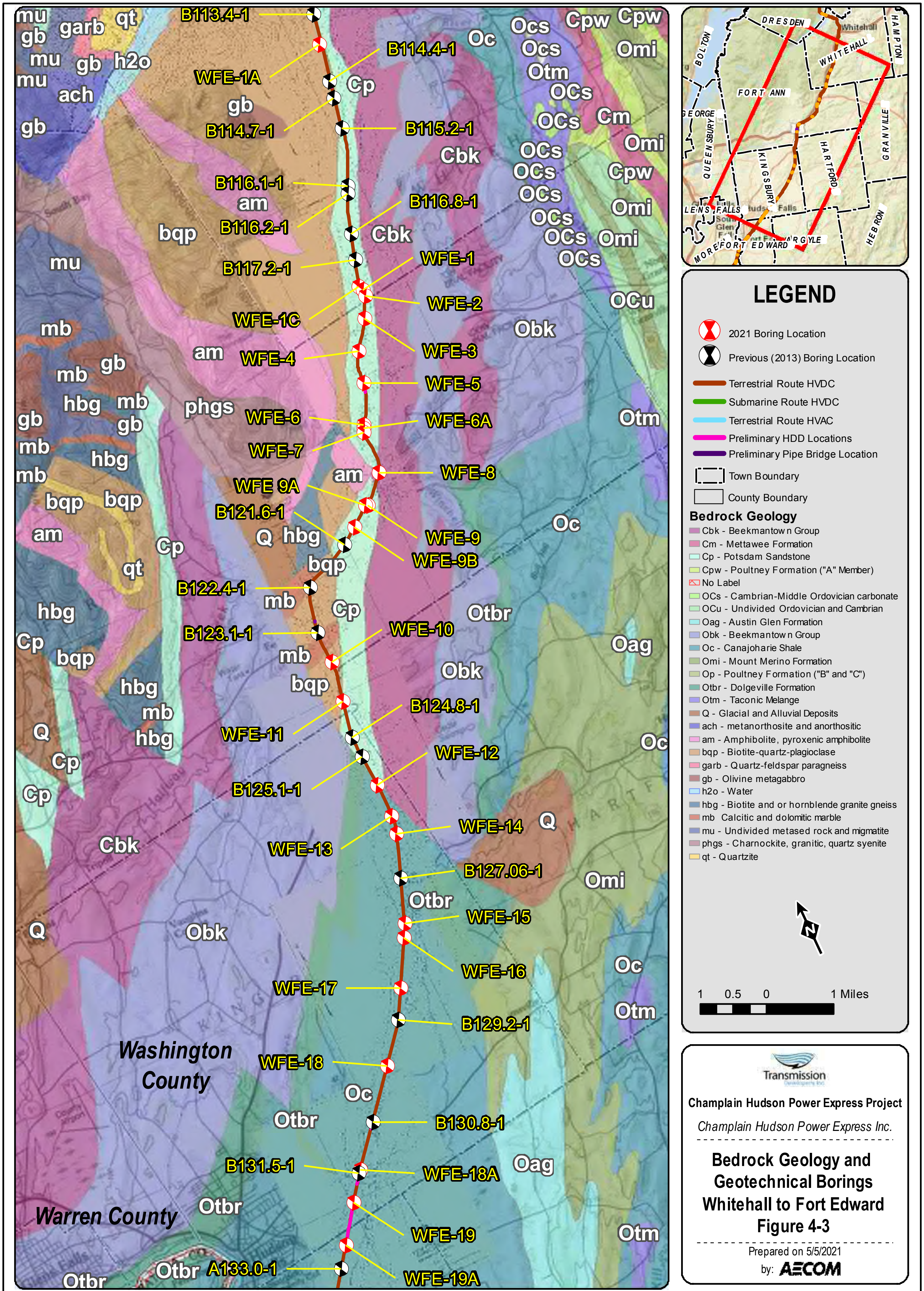

DATA SOURCES: ESRI, NYSDOT, NOAA, USACE, NYDOS, TDI, TRC

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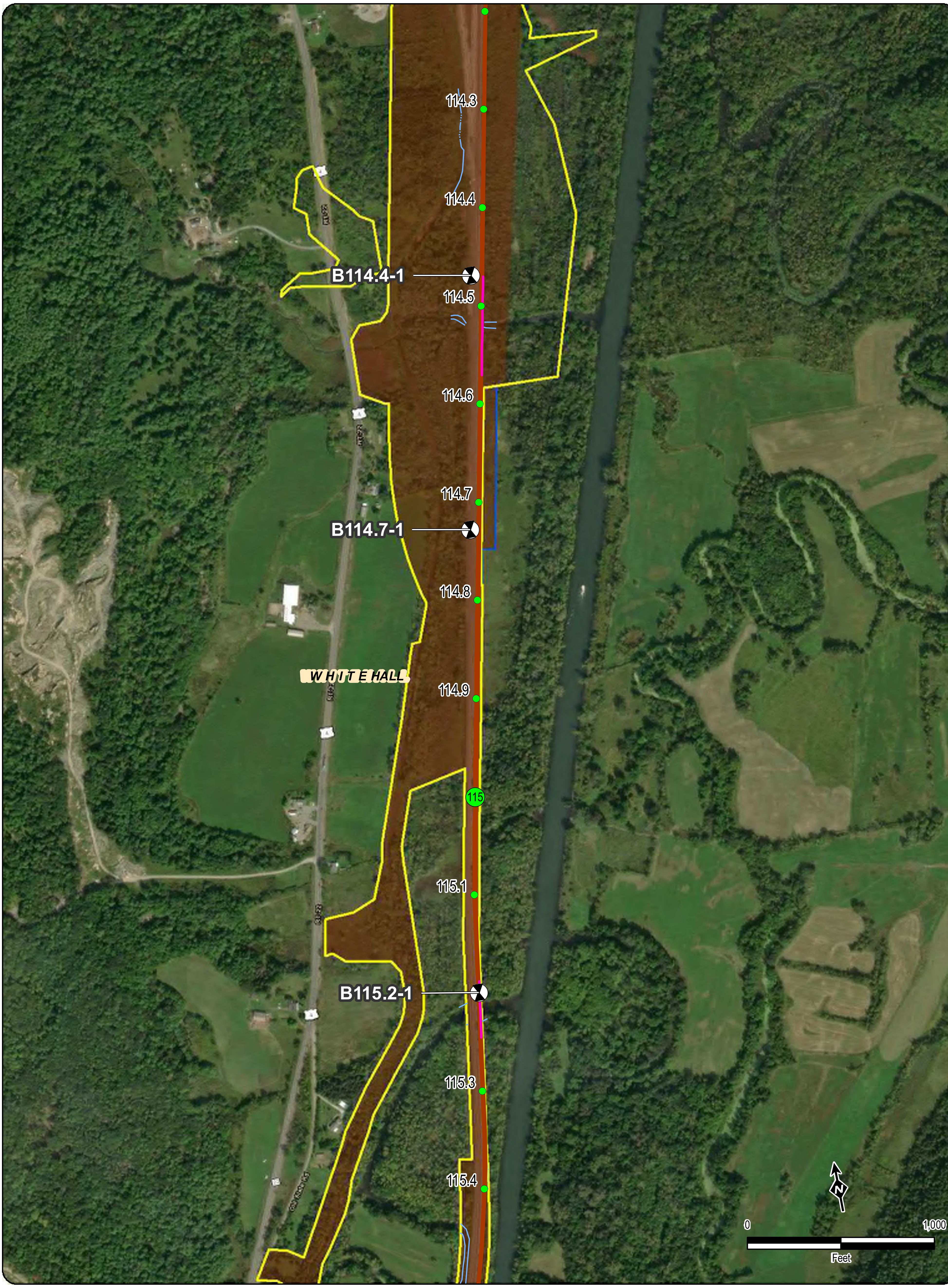

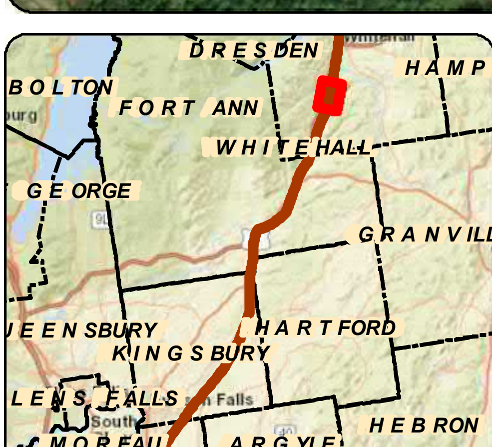

LEGEND

- 111.8 Certified Milepost - Tenths
- Certified Milepost
- 111.8 Preferred Alternative Milepost - Tenths
- 135 Preferred Alternative Milepost
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- 2021 Boring Location
- Previous (2013) Boring Location
- Streams/Ditches
- Railroad ROW
- Deviation Zone
- Deviation Zone Outside ROW
- Preferred Alternative Deviation Zone
- Preferred Alternative Deviation Zone Outside ROW
- Town Boundary
- Village Boundary
- State Park (OPRHP)

Parcel Ownership

TOWN NAME

Road Name

Village Name

Transmission Developers Inc.

Champlain Hudson Power Express Project

Champlain Hudson Power Express Inc.

BORING LOCATION PLAN

Whitehall to Fort Edward

Figure A-3

Sheet 2 of 16

Prepared by: AECOM

5/19/2021

DATA SOURCES: ESRI, NETWORK MAPPING 2010, NYSDOT, OPRHP, TDI, TRC

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TEST BORING LOG

BORING	**B115.2-1**
G.S. ELEV.	N/A
FILE	195651
SHEET	1 OF 1

PROJECT: TDI CHAMPLAIN HUDSON POWER EXPRESS

LOCATION: CP RAILROAD ROW, NY

GROUNDWATER DATA			
FIRST ENCOUNTERED 10.0 '			
DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE				
a	FROM 0.0 '	TO 10.0 '		
d	FROM 10.0 '	TO 30.0 '		

DRILLER	T. FARRELL
HELPER	J. LANGDON
INSPECTOR	J. STAPLETON
DATE STARTED	02/05/2013
DATE COMPLETED	02/05/2013

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
	S-1	10 4 3 3		***ASH AND CINDERS (FILL)***		
3.0					26.9	
	S-2	2 3 4 3				
5	S-3	3 5 4 5				
					26.4	
	S-4	6 7 7 8				
					37.5	
10	S-5	7 8 7 8				
					35.4	
15	S-6	4 5 6				
				OLIVE-BROWN CLAY, SM SILT		
					45.6	
20	S-7	3 5 5				
25	S-8	3 3 4				
30	S-9	2 3 3		30.0		
				END OF BORING AT 30'		
35						

DRN.	JPB
CKD.	PWK

SUMMARY OF LABORATORY TEST DATA

Project Name: TDI Champlain Hudson Power Express – CP
Client Name: Transmission Developers, Inc.
TRC Project #: 195651

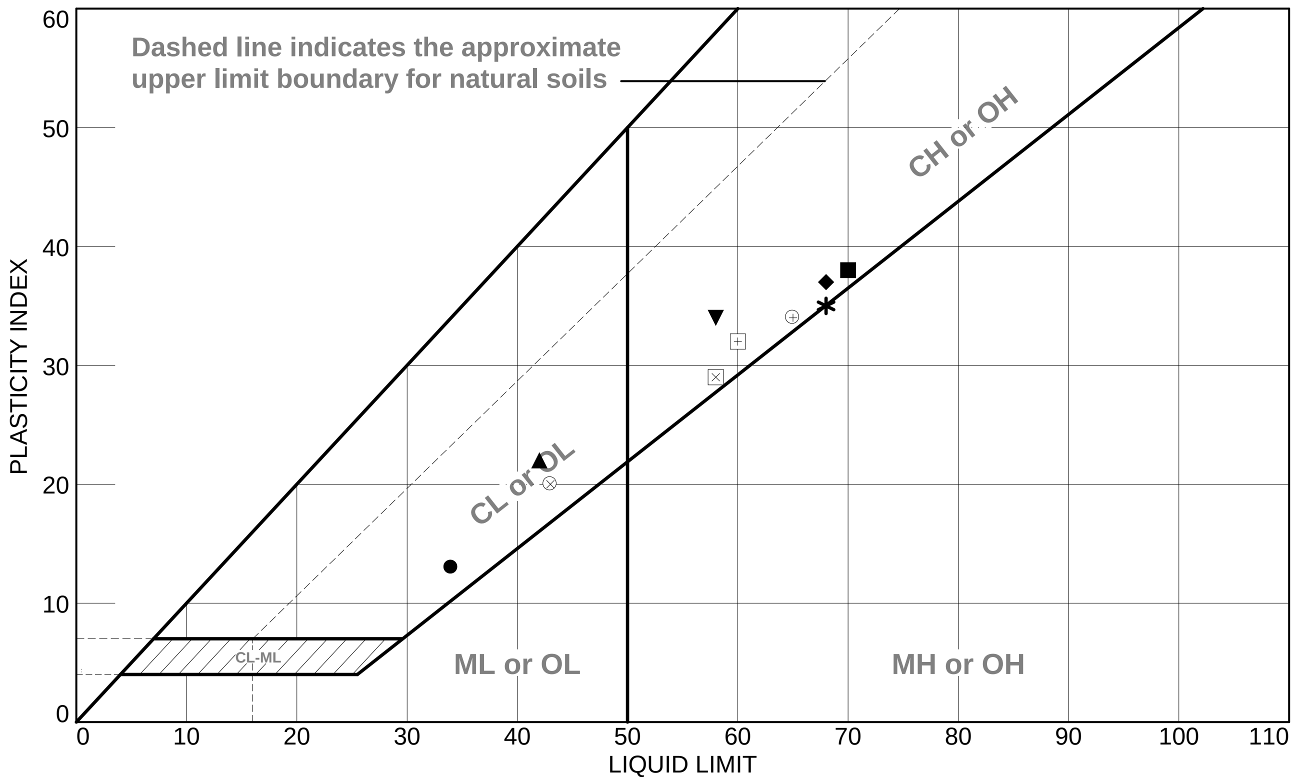
SAMPLE IDENTIFICATION			Soil Group (USCS System)	GRAIN SIZE DISTRIBUTION				PLASTICITY				Specific Gravity	Moisture Content (%)	Unit Weight (pcf)	Compressive Strength (tsf)	Organic Content (%)
Boring #	Sample #	Depth (ft)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index)					
B114.4-1	S-2	2.0-4.0	SW-SM	25.4	66.9	7.7		-	-	-	-	-	15.2	-	-	-
	S-3	4.0-6.0														
	S-4	6.0-8.0	-	-	-	-	-	-	-	-	-	-	41.1	-	-	-
	S-5	8.0-10.0	-	-	-	-	-	-	-	-	-	-	37.8	84.5	-	-
	S-6	13.5-15.0	-	-	-	-	-	-	-	-	-	-	45.3	-	-	-
	S-7	18.5-20.0	CH/MH	-	-	-	-	68	33	35	0.5	-	49.7	-	-	-
	S-8	23.5-25.0	-	-	-	-	-	-	-	-	-	-	51.1	72.2	-	-
	S-9	28.5-30.0	CH	-	-	-	-	58	24	34	0.7	-	49.2	-	-	-
B114.7-1	S-4	6.0-8.0	-	-	-	-	-	-	-	-	-	-	55.7	-	-	-
	S-6	13.5-15.0	-	-	-	-	-	-	-	-	-	-	45.7	78.0	-	-
	S-7	18.5-20.0	-	-	-	-	-	-	-	-	-	-	49.0	-	-	-
	S-8	23.5-25.0	-	-	-	-	-	-	-	-	-	-	53.7	-	-	-
B115.2-1	S-2	2.0-4.0	-	-	-	-	-	-	-	-	-	-	26.9	-	-	-

SUMMARY OF LABORATORY TEST DATA

Project Name: TDI Champlain Hudson Power Express – CP
Client Name: Transmission Developers, Inc.
TRC Project #: 195651

SAMPLE IDENTIFICATION			Soil Group (USCS System)	GRAIN SIZE DISTRIBUTION				PLASTICITY				Specific Gravity	Moisture Content (%)	Unit Weight (pcf)	Compressive Strength (tsf)	Organic Content (%)
Boring #	Sample #	Depth (ft)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index)					
	S-4	6.0-8.0	-	-	-	-	-	-	-	-	-	-	26.4	-	-	-
	S-5	8.0-10.0	-	-	-	-	-	-	-	-	-	-	37.5	-	-	-
	S-6	13.5-15.0	-	-	-	-	-	-	-	-	-	-	35.4	-	-	-
	S-7	18.5-20.0	CH	-	-	-	-	65	31	34	0.4	-	45.6	76.0	-	-
B116.1-1	S-4	6.0-8.0	-	-	-	-	-	-	-	-	-	-	24.8	-	-	-
	S-5	8.0-10.0	-	-	-	-	-	-	-	-	-	-	23.7	100.7	-	-
B116.2-1	S-2	2.0-4.0	SM	37.4	49.7	12.9		-	-	-	-	-	6.9	-	-	-
	S-3	4.0-6.0	-	-	-	-	-	-	-	-	-	-	8.2	-	-	-
	S-4	6.0-8.0	-	-	-	-	-	-	-	-	-	-	27.4	-	-	-
	S-5	8.0-10.0	-	0.0	8.4	24.7	66.9	-	-	-	-	2.78	30.4	87.5	-	-
	S-6	13.5-15.0	-	0.0	22.7	46.6	30.7	-	-	-	-	2.84	26.8	-	-	-
	S-7	18.5-20.0	SP-SM	3.4	85.8	10.8		-	-	-	-	-	20.2	-	-	-
	S-8	23.5-25.0														

LIQUID AND PLASTIC LIMITS TEST REPORT



	SOIL DATA							
	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B113.1-1	S-7	18.5-20.0 FT	27.3	21	34	13	CL
■	B113.1-1	S-9	28.5-30.0 FT	38.8	32	70	38	CH/OH
▲	B113.4-1	S-3 & S-4	4.0-8.0 FT	27.3	20	42	22	CL
◆	B113.4-1	S-8	23.5-25.0 FT	50.3	31	68	37	CH
▼	B114.4-1	S-9	28.5-30.0 FT	49.2	24	58	34	CH
*	B114.4-1	S-7	18.5-20.0 FT	49.7	33	68	35	CH/MH
⊕	B115.2-1	S-7	18.5-20.0 FT	45.6	31	65	34	CH
⊞	B116.8-1	S-12	43.5-45.0 FT	52.2	28	60	32	CH
⊗	B119.2-1	S-4 & S-5	7.0-11.0 FT	26.7	23	43	20	CL
⊠	B123.1-1	S-4	6.0-8.0 FT	33.0	29	58	29	CH

TRC
Engineers, Inc.
Mt. Laurel, NJ

Client: TDI CHAMPLAIN HUDSON POWER EXPRESS - CP
Project: TRANSMISSION DEVELOPERS, INC.

Project No.: 195651 **Figure** 1

Boring Location Plan Champlain Hudson Power Express	Drawn by: JTK	Scale: Not to scale	Project No.: 20001480	Date: April 2022

ATLANTIC TESTING LABORATORIES, Limited

Subsurface Investigation

Report No.: CD10279D-01-04-22

Client: Kiewit Engineering (NY) Corp.

Boring Location: See Boring Location Plan

Project: Subsurface Investigation
Champlain Hudson Power Express, Design Package 1
Various Locations, New York

Start Date: 3/10/2022 Finish Date: 3/10/2022

Boring No.: K-115.2 Sheet 1 of 3

Groundwater Observations

Date	Time	Depth	Casing
3/10/2022	PM	4.3'	10.0'

Coordinates
Northing 1705642.57
Easting 779676.57

Sampler Hammer
Weight: 140 lbs.
Fall: 30 in.
Hammer Type: Automatic

Ground Elev.: 126.4

Boring Advance By: HW (4") Casing/3 7/8" Wet Rotary

DEPTH	METHOD OF ADVANCE	SAMPLE NO.	DEPTH OF SAMPLE From	DEPTH OF SAMPLE To	SAMPLE TYPE	BLOWS ON SAMPLER PER 6" 2" O.D. SAMPLER	DEPTH OF CHANGE	CLASSIFICATION OF MATERIAL	Recovery (Inches)
0-2	CASING	1	0.0	2.0	SS	4 5 2 1	2.0	Brown CLAY; little f SAND; trace f GRAVEL (frozen, plastic) CL	24
2-4		2	2.0	4.0	SS	2 3 4 5		Grey CLAY; trace f SAND; trace SILT (moist, plastic) CL	14
4-6		3	4.0	6.0	SS	3 4 4 5		Similar Soil (moist, plastic) CL	21
6-8		4	6.0	8.0	SS	3 4 3 3		Similar Soil (moist, plastic) CL	22
8-10		5	8.0	10.0	SS	3 4 4 5		Greyish-Brown Similar Soil (moist, plastic) CL	24
10-12	WET ROTARY						12.0	Advanced casing to 10.0 feet and began advancing 3 7/8" tri-cone roller bit wet rotary open hole within the borehole.	
14-16		6	14.0	16.0	SS	2 2 3 4		Greyish-Brown CLAY; trace SILT (moist, plastic) w = 46.5% CH	24
19-21		7	19.0	21.0	SS	1 2 3 2		Grey Similar Soil (moist, plastic) CH	24
24-26		8	24.0	26.0	SS	WH 1 2 3		Similar Soil (moist, plastic) CH	24

f - fine, m - medium, c - coarse; and - 35-50%, some - 20-35%, little - 10-20%, trace - 0-10%

SS Split Spoon Sample
NX Rock Core
SH Undisturbed Sample (Shelby Tube)
Estimated Groundwater

Drillers: Brad Perry; Nate Green
Inspector: James LaMarco (ATL)

ATLANTIC TESTING LABORATORIES, Limited

Subsurface Investigation

Boring No.: K-115.2 | Report No.: CD10279D-01-04-22 | Sheet 2 of 3

DEPTH	METHOD OF ADVANCE	SAMPLE NO.	DEPTH OF SAMPLE From	DEPTH OF SAMPLE To	SAMPLE TYPE	BLOWS ON SAMPLER PER 6" 2" O.D. SAMPLER	DEPTH OF CHANGE	CLASSIFICATION OF MATERIAL (f - fine, m - medium, c - course; and - 35-50%, some - 20-35%, little - 10-20%, trace - 0-10%)	RECOVERY (inches)
26									
27									
28									
29									
30		ST-1	30.0	32.0	SS	3 4 5 6		(3" Brass Lined Split Spoon) Similar Soil (moist, plastic) w = 35.2%, LL = 51, PL = 25, PI = 26 CH	24
31									
32									
33									
34		9	34.0	36.0	SS	WH/12" 3 4		Similar Soil (moist, plastic) CH	24
35									
36									
37									
38									
39		10	39.0	41.0	SS	WH/12" 2 3		Similar Soil (moist, plastic) CH	4
40									
41									
42									
43									
44									
45		ST-2	45.0	47.0	SS	WH/12" 3 4		(3" Brass Lined Split Spoon) Similar Soil (moist, plastic) w = 47.0%, LL = 70, PL = 23, PI = 47 CH	24
46									
47									
48									
49		11	49.0	51.0	SS	WH/18" 4		Similar Soil (moist, plastic) CH	24
50									
51									
52									
53									
54		12	54.0	56.0	SS	WH/24"		Similar Soil (moist, plastic) w = 37.7% CH	24
55									
56									
57									
58		13	58.0	60.0	SS	WH/18" 2		Similar Soil (moist, plastic) CH	24
59							60.0		
60								Boring terminated at 60.0 feet.	
61									
62								Notes:	

ATLANTIC TESTING LABORATORIES, Limited

Subsurface Investigation

Boring No.: K-115.2 Report No.: CD10279D-01-04-22 Sheet 3 of 3

DEPTH	METHOD OF ADVANCE	SAMPLE NO.	DEPTH OF SAMPLE		SAMPLE TYPE	BLOWS ON SAMPLER PER 6" 2" O.D. SAMPLER	DEPTH OF CHANGE	CLASSIFICATION OF MATERIAL f - fine m - medium c - course and - 35-50% some - 20-35% little - 10-20% trace - 0-10%	RECOVERY (inches)
			From	To					
63								1. Borehole backfilled with cement-bentonite grout. 2. Soil classifications based on ATL Field Engineer's field classification. 3. Borehole was advanced with ATL's Geoprobe 7822DT (Rig Unit No. CDGV706) drill rig.	
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ATLANTIC TESTING LABORATORIES

WBE certified company

LABORATORY DETERMINATION OF MOISTURE CONTENT OF SOILS

ASTM D 2216

PROJECT INFORMATION

Client: Kiewit Intrastructure Co.
Project: Champlain Hudson Power Express
United Cable Installation
Various Locations, New York

ATL Report No.: CD10279E-12-04-22
Report Date: April 14, 2022
Date Received: April 6, 2022

TEST DATA

Boring No.	Sample No.	Depth (ft)	Moisture Content (%)
K-115.2	S-6	14-16	46.5
	ST-1	30-32	35.2
	ST-2	45-47	47.0
	S-12	54-56	37.7
[redacted]			

Remarks

1. Sample mass was less than the minimum mass outlined in the referenced test method.

Reviewed By: _______________ Date: 04/14/22

ATLANTIC TESTING LABORATORIES

WBE certified company

AMOUNT OF MATERIAL IN SOILS FINER THAN THE NO. 200 SIEVE
ASTM D 1140

PROJECT INFORMATION

Client: Kiewit Intrastructure Co.
Project: Champlain Hudson Power Express
United Cable Installation
Various Locations, New York

ATL Report No.: CD10279E-12-04-22
Report Date: April 14, 2022
Test Date: April 6, 2022
Performed By: H. Brownell

TEST DATA

Boring No.	Sample No.	Depth (ft)	Method (A or B)	Soak Time (min)	Initial Dry Weight (g)	% Finer than #200
K-115.2	ST-1	30-32	A	10	81.04	98.6
K-115.2	ST-2	45-47	A	10	75.54	91.9

[redacted]

Reviewed By: ____________

Date: 04/14/22

ATLANTIC TESTING LABORATORIES

WBE certified company

LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOIL
ASTM D 4318

PROJECT INFORMATION

Client: Kiewit Instrastructure Co.
Project: Champlain Hudson Power Express
United Cable Installation
Various Locations, New York

ATL Report No.: CD10279E-12-04-22
Report Date: April 14, 2022
Date Received: April 6, 2022

TEST DATA

Boring No.	Sample No.	LL	PL	PI
K-115.2	ST-1	51	25	26
K-115.2	ST-2	70	23	47

[redacted]

SAMPLE INFORMATION

Boring No.	Sample No.	Maximum Grain Size (mm)	Estimated Amount of Sample Retained on No. 40 Sieve (%)	As Received Moisture Content (%)
K-115.2	ST-1	0.074	0	35.2
K-115.2	ST-2	0.074	0	47.0

[redacted]

PREPARATION INFORMATION

Boring No.	Sample No.	Preparation	Method of Removing Oversized Material
K-115.2	ST-1	Air Dry	Not Necessary
K-115.2	ST-2	Air Dry	Not Necessary

[redacted]

EQUIPMENT INFORMATION

Liquid Limit Procedure:	Multipoint - Method A	X	Single Point - Method B	
Liquid Limit Apparatus:	Manual	X	Motor Driven	
Liquid Limit Grooving Tool Material:	Plastic	X	Metal	
Liquid Limit Grooving Tool Shape:	Flat	X	Curved (AASHTO Only)	
Plastic Limit:	Hand Rolled	X	Mechanical Rolling Device	

Reviewed By: ______________ Date: 04/14/22

Kiewit

MEMORANDUM

DATE: September 23, 2022

TO: Antonio Marruso, P.E.; CHA Consulting, Inc.

FROM: Matthew Hawley, P.E.; Kiewit Engineering (NY) Corp. MKH
Jaren Knighton; Kiewit Engineering (NY) Corp.

SUBJECT: Geotechnical Data: Segment 3 - Package 1C - HDD Crossing 6 – Revision 1
Champlain Hudson Power Express Project
Whitehall, New York

Kiewit Engineering is providing the enclosed geotechnical data for use in the horizontal direction drill (HDD) design for the Champlain Hudson Power Express project in Upstate New York. This HDD crossing is located south of Whitehall, New York. The approximate station for the start of HDD crossing Number 6 is STA 15224+00 (43.498216° N, 73.420237° W).

The geotechnical data at this HDD crossing is enclosed. The available data is from the previous investigation by TRC and the recent investigation by Schnabel, referenced below.

- TRC, Geotechnical Data Report, Champlain Hudson Power Express, Canadian Pacific Railway Borings MP 113.1-177.1, dated March 29, 2013.
- Schnabel Engineering, Geotechnical Data Report, Champlain Hudson Power Express, Canadian Pacific Railway Subsurface Explorations, dated March 3, 2022.

Contact us if you have questions or require additional information.

HDD 6

Borings B116.1-1, B116.2-1, K-116.1

Segment 3

CHPE Segments 1, 2, and 3 - Packages 1A, 1B, and 1C
HDD Soil Boring Coordinates and Elevations

Firm	Boring	Northing (feet)	Easting (feet)	Ground Surface Elevation (feet)
S.W. Cole*	B102.4-1	1762367.3	777951.9	139.42
	B109.7-1	1729097.5	774410.6	116.4
	B109.8-1	1728870.4	774869.2	99.8
	B110.1-1	1728142.0	776337.8	105.0
TRC*	B113.4-1	1714875.2	781894.9	122.9
	B114.4-1	1709558.6	780857.2	122.7
	B115.2-1	1705777.9	780186.6	120.9
	B116.1-1	1701426.5	778616.5	124.1
	B116.2-1	1700894.8	778375.8	124.3
	B116.8-1	1697938.4	777308.2	131.6
AECOM**	PD-7	1783019.4	778020.6	266.4
	PD-7A	1782960.9	778149.9	269.5
	WFE-1	1693492.9	776280.6	127.9
	WFE-1C	1693895.8	776092.3	129.3

Notes:
- Northings and Eastings are provided in NAD83 New York State Plane East Zone.
- Elevations are referenced to the NAVD88 datum.

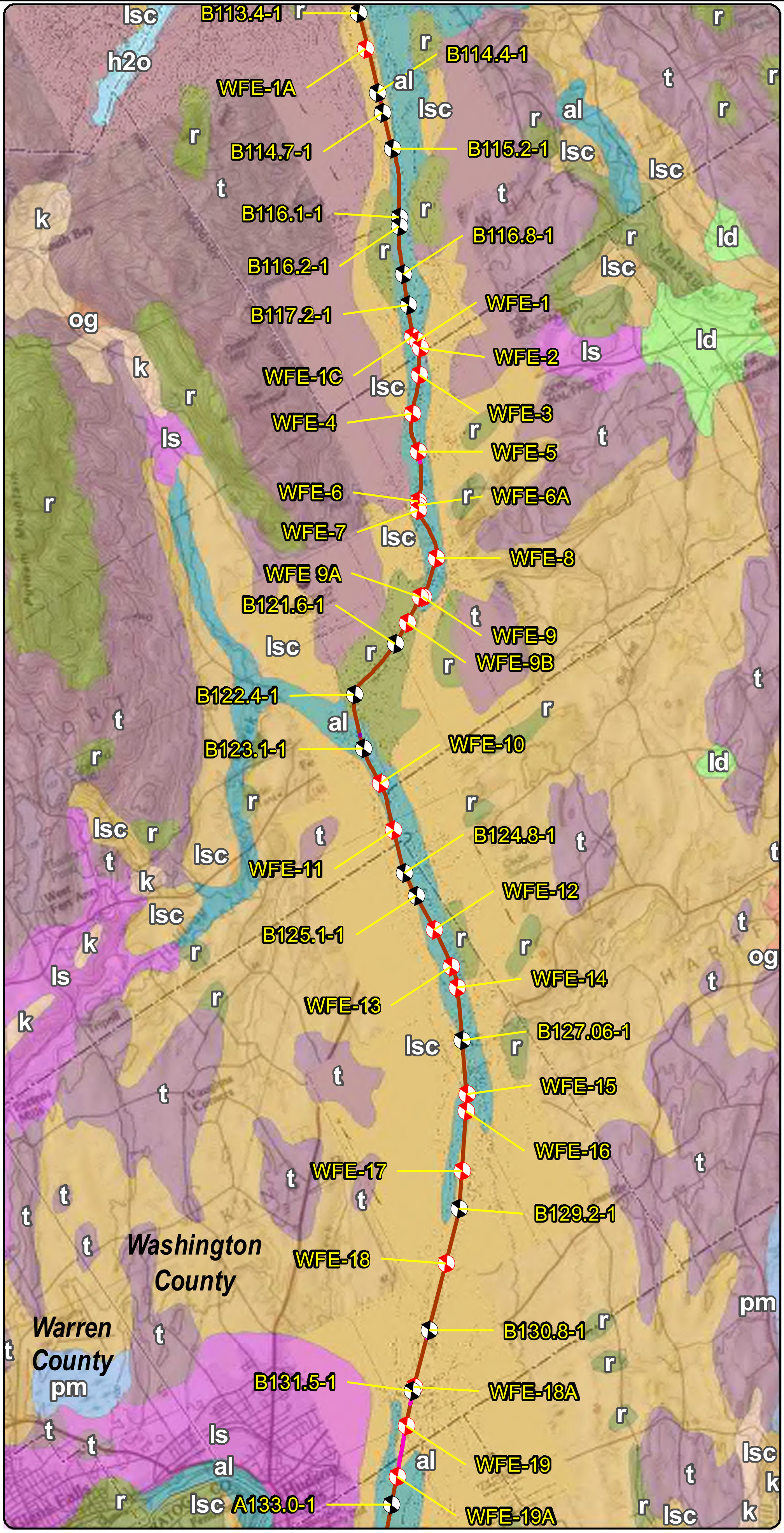
* TRC and S.W. Cole boring coordinates as shown in Table 1-6 in AECOM report (reference below). Boring elevations estimated from November 2021 topographic survey by Williams Aerial.

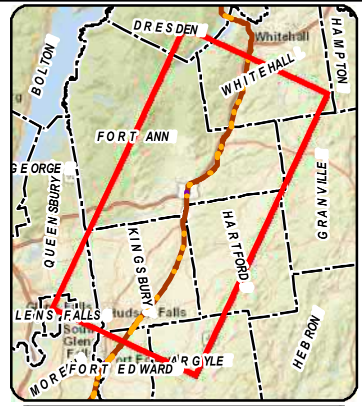
** AECOM boring coordinates and elevations as shown in Table 1-6 in AECOM report.

*** Kiewit boring coordinates and elevations are noted on the boring logs.

Reference:

AECOM, Geotechnical Data Report, Upland Segments: Putnam Station, Washington County, to Cementon, Green County, NY, Champlain Hudson Power Express, dated May 28, 2021.





LEGEND

- 2021 Boring Location
- Previous (2013) Boring Location
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- Town Boundary
- County Boundary

Surficial Geology

- al - Recent alluvium
- h2o - Water
- k - Kame deposits
- ld - Lacustrine delta
- ls - Lacustrine sand
- lsc - Lacustrine silt and clay
- og - Outwash sand and gravel
- pm - Swamp deposits
- r - Bedrock
- t - Till

1 0.5 0 1 Miles

Transmission Developers Inc.

Champlain Hudson Power Express Project

Champlain Hudson Power Express Inc.

Surficial Geology and Geotechnical Borings Whitehall to Fort Edward Figure 3-3

Prepared on 5/5/2021

by: AECOM

DATA SOURCES: ESRI, NYSDOT, NOAA, USACE, NYDOS, TDI, TRC

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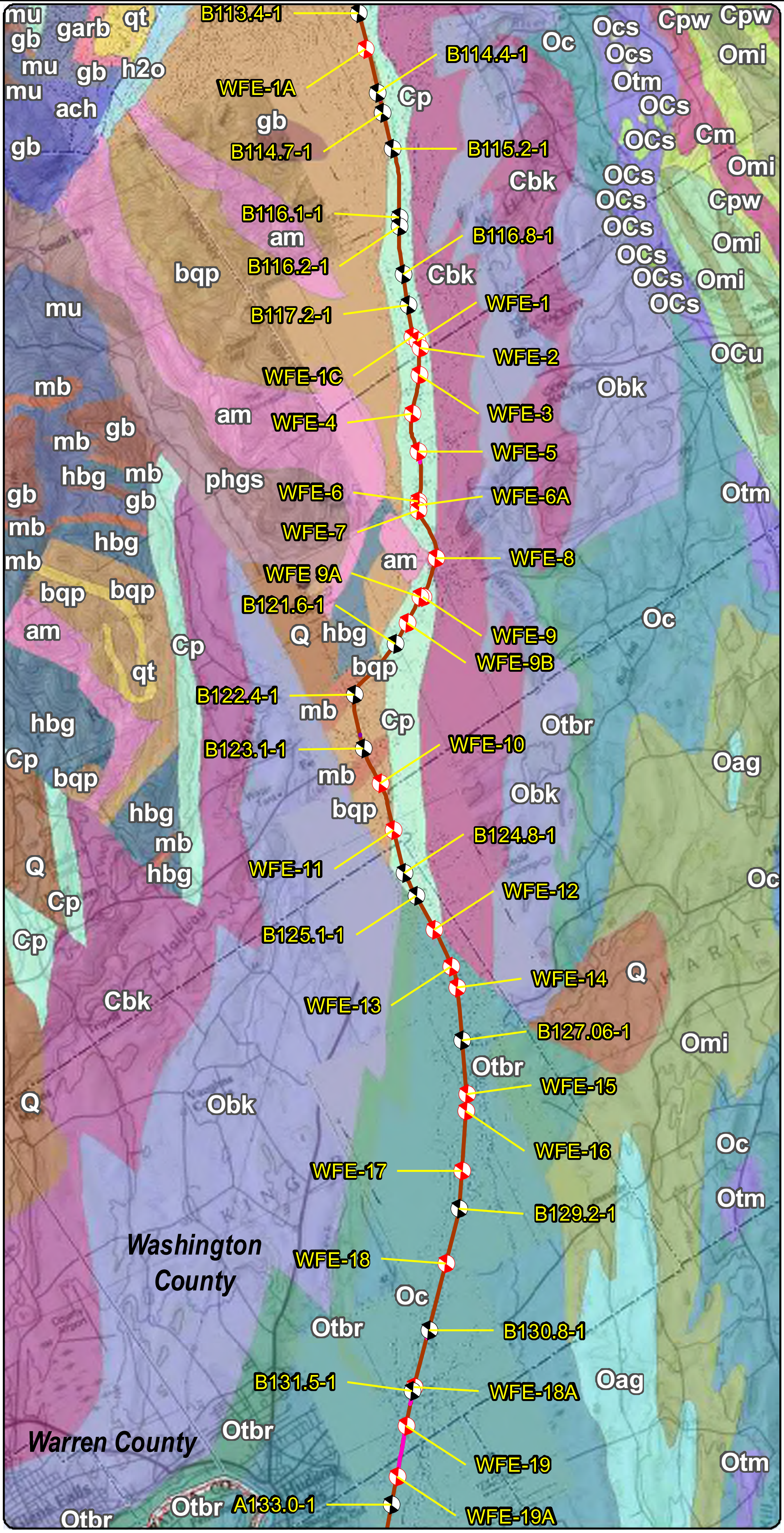

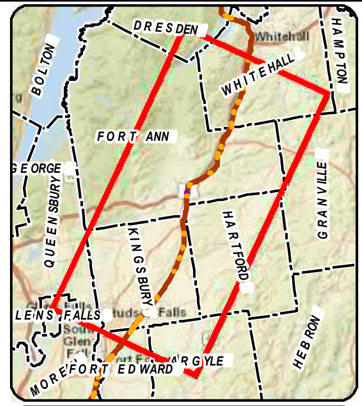

LEGEND

- 2021 Boring Location
- Previous (2013) Boring Location
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- Town Boundary
- County Boundary

Bedrock Geology

- Cbk - Beekmantown Group
- Cm - Mettawee Formation
- Cp - Potsdam Sandstone
- Cpw - Poultney Formation ("A" Member)
- No Label
- OCs - Cambrian-Middle Ordovician carbonate
- OCu - Undivided Ordovician and Cambrian
- Oag - Austin Glen Formation
- Obk - Beekmantown Group
- Oc - Canajoharie Shale
- Omi - Mount Merino Formation
- Op - Poultney Formation ("B" and "C")
- Otbr - Dolgeville Formation
- Otm - Taconic Melange
- Q - Glacial and Alluvial Deposits
- ach - metanorthosite and anorthosite
- am - Amphibolite, pyroxenic amphibolite
- bqp - Biotite-quartz-plagioclase
- garb - Quartz-feldspar paragneiss
- gb - Olivine metagabbro
- h2o - Water
- hbg - Biotite and or hornblende granite gneiss
- mb Calcitic and dolomitic marble
- mu - Undivided metased rock and migmatite
- phgs - Charnockite, granitic, quartz syenite
- qt - Quartzite

1 0.5 0 1 Miles

Transmission Developers Inc.

Champlain Hudson Power Express Project

Champlain Hudson Power Express Inc.

Bedrock Geology and Geotechnical Borings Whitehall to Fort Edward Figure 4-3

Prepared on 5/5/2021

by: AECOM

DATA SOURCES: ESRI, NYSDOT, NOAA, USACE, NYDOS, TDI, TRC

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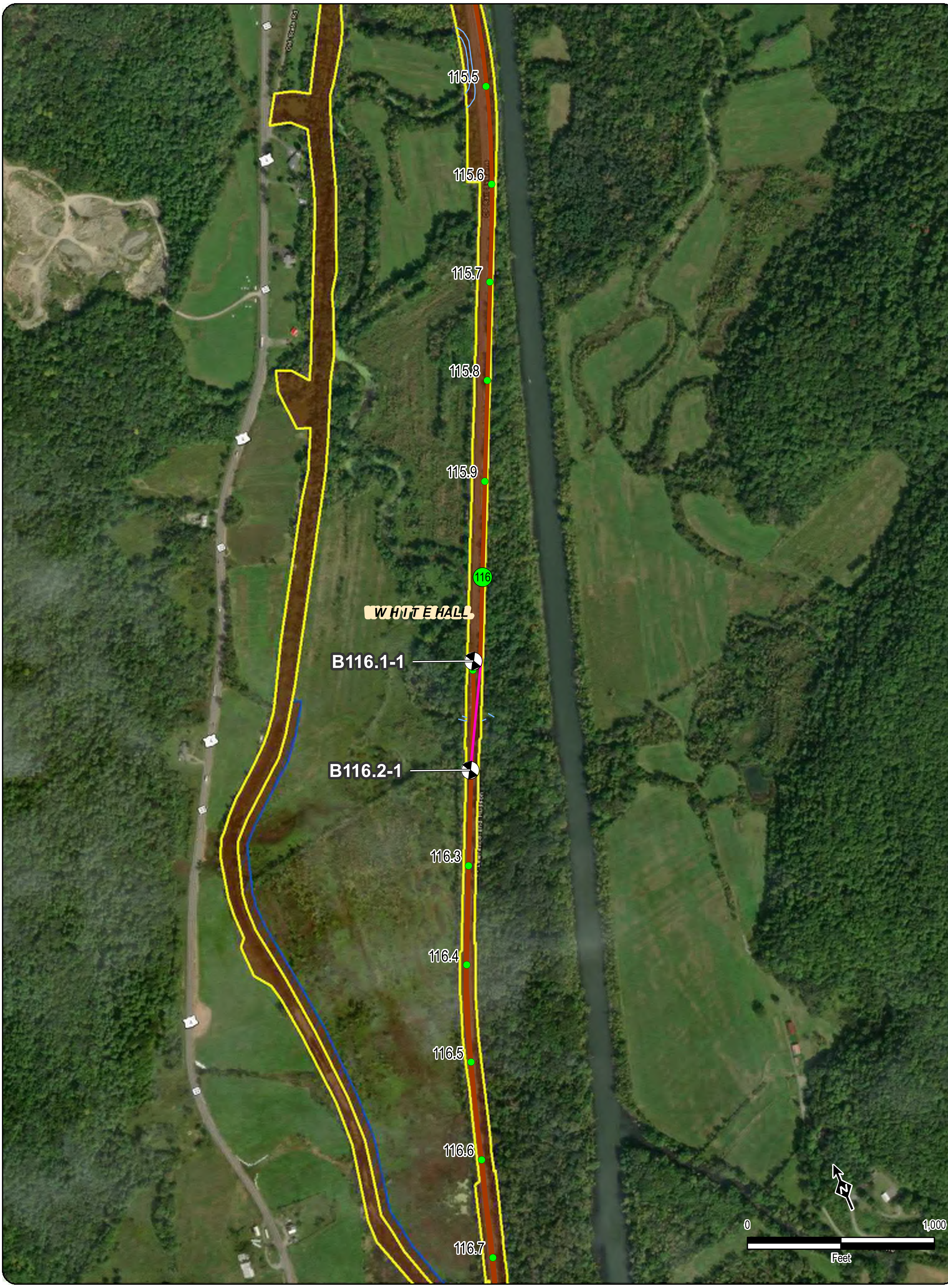

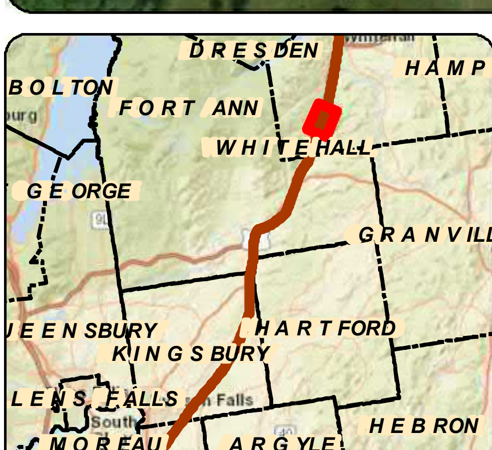

LEGEND

- 111.8 Certified Milepost - Tenths
- 135 Certified Milepost
- 111.8 Preferred Alternative Milepost - Tenths
- 135 Preferred Alternative Milepost
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- 2021 Boring Location
- Previous (2013) Boring Location
- Streams/Ditches
- Railroad ROW
- Deviation Zone
- Deviation Zone Outside ROW
- Preferred Alternative Deviation Zone
- Preferred Alternative Deviation Zone Outside ROW
- Town Boundary
- Village Boundary
- State Park (OPRHP)

Parcel Ownership

TOWN NAME

Road Name

Village Name

Transmission Developers Inc.

Champlain Hudson Power Express Project

Champlain Hudson Power Express Inc.

BORING LOCATION PLAN

Whitehall to Fort Edward

Figure A-3

Sheet 3 of 16

Prepared by: AECOM 5/19/2021

DATA SOURCES: ESRI, NETWORK MAPPING 2010, NYSDOT, OPRHP, TDI, TRC

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TEST BORING LOG

TRC

BORING	B116.1-1
G.S. ELEV.	N/A
FILE	195651
SHEET	1 OF 1

PROJECT: TDI CHAMPLAIN HUDSON POWER EXPRESS
LOCATION: CP RAILROAD ROW, NY

GROUNDWATER DATA

FIRST ENCOUNTERED 10.0 '

DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE

a	FROM 0.0 '	TO 10.0 '		
d	FROM 10.0 '	TO 30.0 '		

DRILLER G. SPIZZIRRI
HELPER E. WARD
INSPECTOR J. STAPLETON
DATE STARTED 01/23/2013
DATE COMPLETED 01/23/2013

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
	S-1	10 4 3 3		***SILT & CLAY WITH COBBLES, GRAVEL, ASH, METAL (FILL)***		
	S-2	3 2 2 3	4.0			
5	S-3	3 3 2 3				
	S-4	6 5 6 4		***LIGHT TO DARK BROWN CLAY, TR TO SM SILT***	24.8	
10	S-5	7 6 4 9			23.7	
			13.5			
15	S-6	1 1 2		***DARK BROWN SILT, SM CLAY***		MILD TO HEAVY PETROLEUM ODOR ENCOUNTERED FROM 13.5-30 FT
20	S-7	1 2 1				
			23.5			
25	S-8	1 1 5		***OLIVE-GREEN F/M/C SAND, SM SILT***		
30	S-9	4 5 5	30.0	***END OF BORING AT 30'***		
35						

DRN. JPB
CKD. PWK

NEW PROJECTS TEST BORING LOG 195651_TDI_CP.GPJ SITE BLAUVELT.GDT 3/27/13

TRC

TEST BORING LOG

BORING	**B116.2-1**
G.S. ELEV.	N/A
FILE	195651
SHEET	1 OF 1

PROJECT: TDI CHAMPLAIN HUDSON POWER EXPRESS

LOCATION: CP RAILROAD ROW, NY

GROUNDWATER DATA			
FIRST ENCOUNTERED 18.5 '			
DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE				
a	FROM	0.0 '	TO	10.0 '
d	FROM	10.0 '	TO	30.0 '

DRILLER	R. CARUSO
HELPER	C. SMART
INSPECTOR	C. POPPE
DATE STARTED	12/11/2012
DATE COMPLETED	12/11/2012

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
	S-1	16 10 9 6		***BLACK F/C GRAVELLY M/F/C SAND, TR TO SM SILT (FILL)***	6.9	
	S-2	10 9 10 17	4.0			
5	S-3	20 14 11 12	6.0	***BROWN SILTY F/M/C SAND, SM F/ GRAVEL (FILL)***	8.2	
	S-4	7 5 5 6		***GRAY CLAY, SM SILT***	27.4	
10	S-5	5 6 10 11	10.0		30.4	
			13.5	***GRAY CLAY, SM SILT, TR M/F SAND***		
15	S-6	4 5 5		***GRAY CLAYEY SILT, SM F/M SAND***	26.8	
			18.5			
20	S-7	3 3 3			20.2	
	S-8	4 6 8				
25				***GRAY F/M/C SAND,TR TO SM SILT, TR F/ GRAVEL***		
30	S-9	2 1 2	30.0		18.4	
				END OF BORING AT 30'		
35						

DRN.	CMP
CKD.	PWK

SUMMARY OF LABORATORY TEST DATA

Project Name: TDI Champlain Hudson Power Express – CP
Client Name: Transmission Developers, Inc.
TRC Project #: 195651

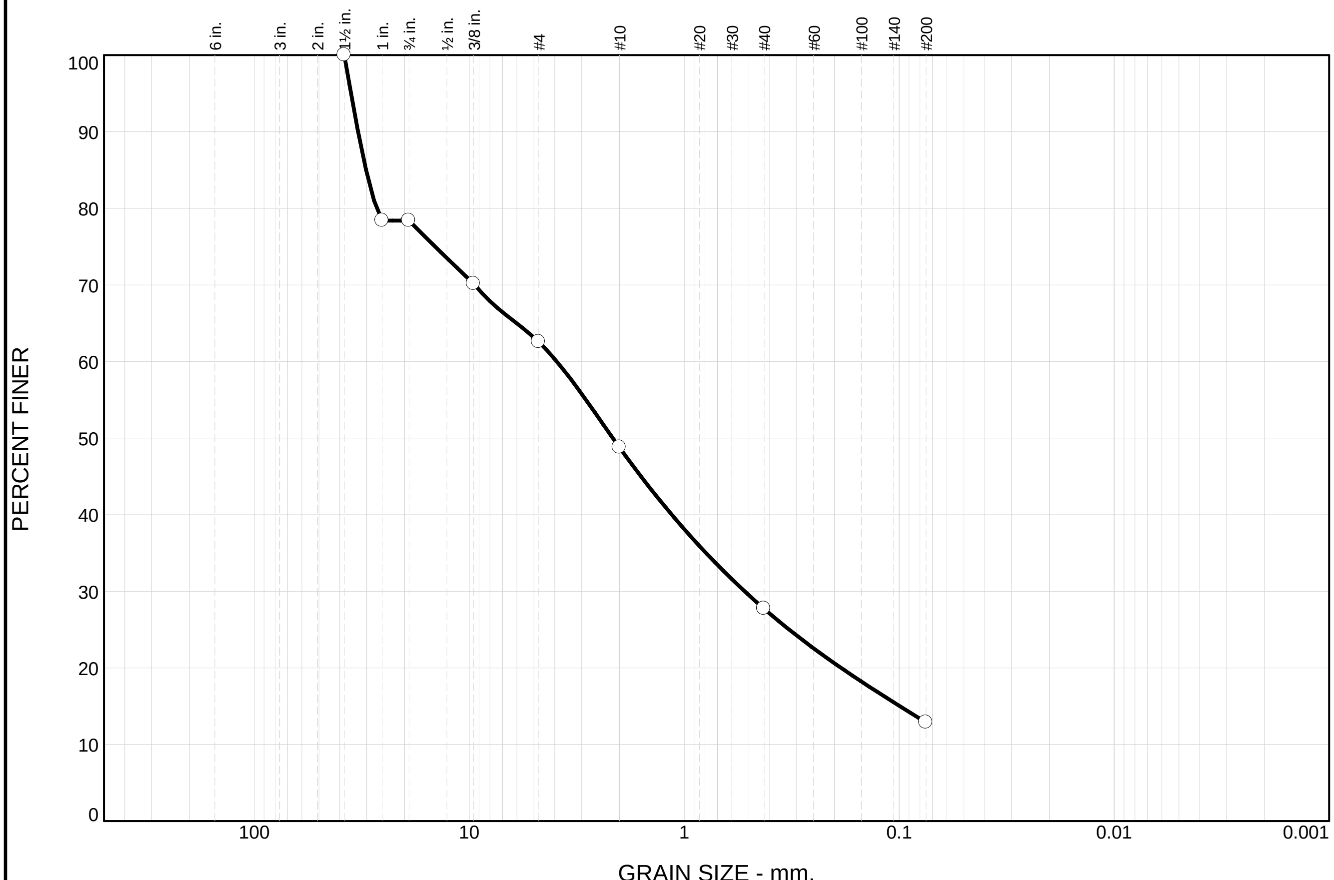
SAMPLE IDENTIFICATION			Soil Group (USCS System)	GRAIN SIZE DISTRIBUTION				PLASTICITY				Specific Gravity	Moisture Content (%)	Unit Weight (pcf)	Compressive Strength (tsf)	Organic Content (%)
Boring #	Sample #	Depth (ft)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index)					
	S-4	6.0-8.0	-	-	-	-	-	-	-	-	-	-	26.4	-	-	-
	S-5	8.0-10.0	-	-	-	-	-	-	-	-	-	-	37.5	-	-	-
	S-6	13.5-15.0	-	-	-	-	-	-	-	-	-	-	35.4	-	-	-
	S-7	18.5-20.0	CH	-	-	-	-	65	31	34	0.4	-	45.6	76.0	-	-
B116.1-1	S-4	6.0-8.0	-	-	-	-	-	-	-	-	-	-	24.8	-	-	-
	S-5	8.0-10.0	-	-	-	-	-	-	-	-	-	-	23.7	100.7	-	-
B116.2-1	S-2	2.0-4.0	SM	37.4	49.7	12.9		-	-	-	-	-	6.9	-	-	-
	S-3	4.0-6.0	-	-	-	-	-	-	-	-	-	-	8.2	-	-	-
	S-4	6.0-8.0	-	-	-	-	-	-	-	-	-	-	27.4	-	-	-
	S-5	8.0-10.0	-	0.0	8.4	24.7	66.9	-	-	-	-	2.78	30.4	87.5	-	-
	S-6	13.5-15.0	-	0.0	22.7	46.6	30.7	-	-	-	-	2.84	26.8	-	-	-
	S-7	18.5-20.0	SP-SM	3.4	85.8	10.8		-	-	-	-	-	20.2	-	-	-
	S-8	23.5-25.0														

SUMMARY OF LABORATORY TEST DATA

Project Name: TDI Champlain Hudson Power Express – CP
Client Name: Transmission Developers, Inc.
TRC Project #: 195651

SAMPLE IDENTIFICATION			Soil Group (USCS System)	GRAIN SIZE DISTRIBUTION				PLASTICITY				Specific Gravity	Moisture Content (%)	Unit Weight (pcf)	Compressive Strength (tsf)	Organic Content (%)
Boring #	Sample #	Depth (ft)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index)					
	S-9	28.5-30.0	-	-	-	-	-	-	-	-	-	-	18.4	-	-	-
B116.8-1	S-2	2.0-4.0	SM	27.1	59.1	13.7		-	-	-	-	-	5.0	-	-	-
	S-3	4.0-6.0														
	S-4	6.0-8.0														
	S-5	8.0-10.0														
	S-6	13.5-15.0	-	-	-	-	-	-	-	-	-	-	48.7	-	-	-
	S-7	18.5-20.0	-	0.0	28.0	12.3	59.7	-	-	-	-	2.76	26.7	93.6	-	-
	S-9	28.5-30.0	-	-	-	-	-	-	-	-	-	-	40.5	-	-	-
	S-10	33.5-35.0	-	-	-	-	-	-	-	-	-	-	66.9	-	-	-
	S-11	38.5-40.0	-	-	-	-	-	-	-	-	-	-	64.3	-	-	-
	S-12	43.5-45.0	CH	-	-	-	-	60	28	32	0.8	-	52.2	-	-	-
	S-13	48.5-50.0	-	-	-	-	-	-	-	-	-	-	43.6	-	-	-
	S-14	53.5-55.0	-	0.0	0.3	1.2	98.5	-	-	-	-	2.83	69.1	-	-	-

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	21.6	15.8	13.8	21.1	14.8	12.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			30.1938	3.9145	2.1477	0.5234	0.0993			

Material Description	USCS	AASHTO
○ GRAY-BLACK C/F GRAVELLY M/F/C SAND, TR TO SM SILT	SM	

Project No. 195651 **Client:** TDI CHAMPLAIN HUDSON POWER EXPRESS - CP

Project: TRANSMISSION DEVELOPERS, INC.

○ **Source of Sample:** B116.2-1 **Depth:** 2.0-4.0 FT **Sample Number:** S-2

Remarks:
○SAMPLE DESCRIPTION BASED ON VISUAL IDENTIFICATION AND LABORATORY ANALYSIS

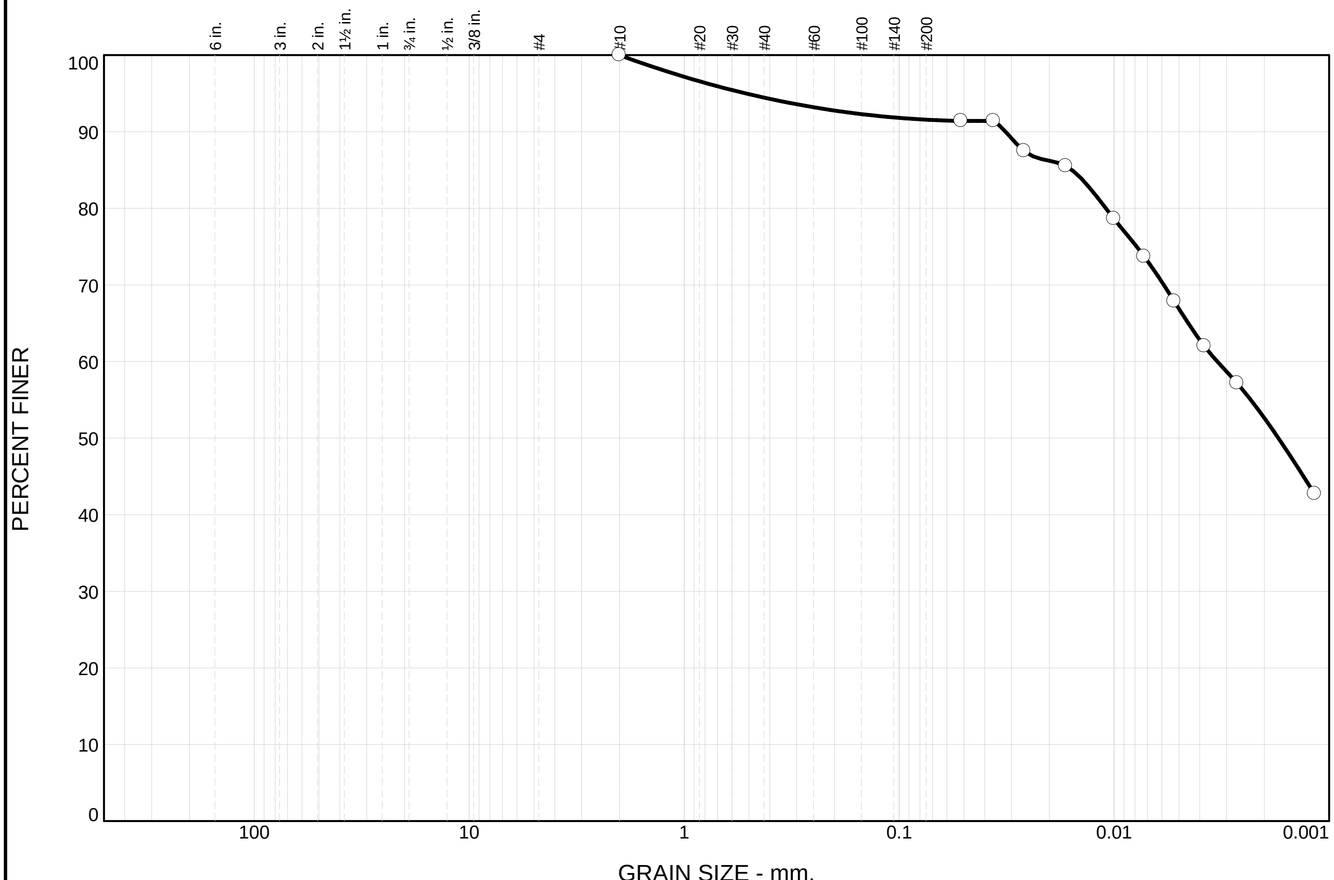
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 8

Tested By: BMH 01/24/13 **Checked By:** ____________

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	5.5	2.9	24.7	66.9

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0157	0.0033	0.0017					

Material Description	USCS	AASHTO
○ BROWN CLAY, SM SILT, TR M/F SAND		

Project No. 195651 **Client:** TDI CHAMPLAIN HUDSON POWER EXPRESS - CP

Project: TRANSMISSION DEVELOPERS, INC.

○ **Source of Sample:** B116.2-1 **Depth:** 8.0-10.0 FT **Sample Number:** S-5

TRC Engineers, Inc.

Mt. Laurel, NJ

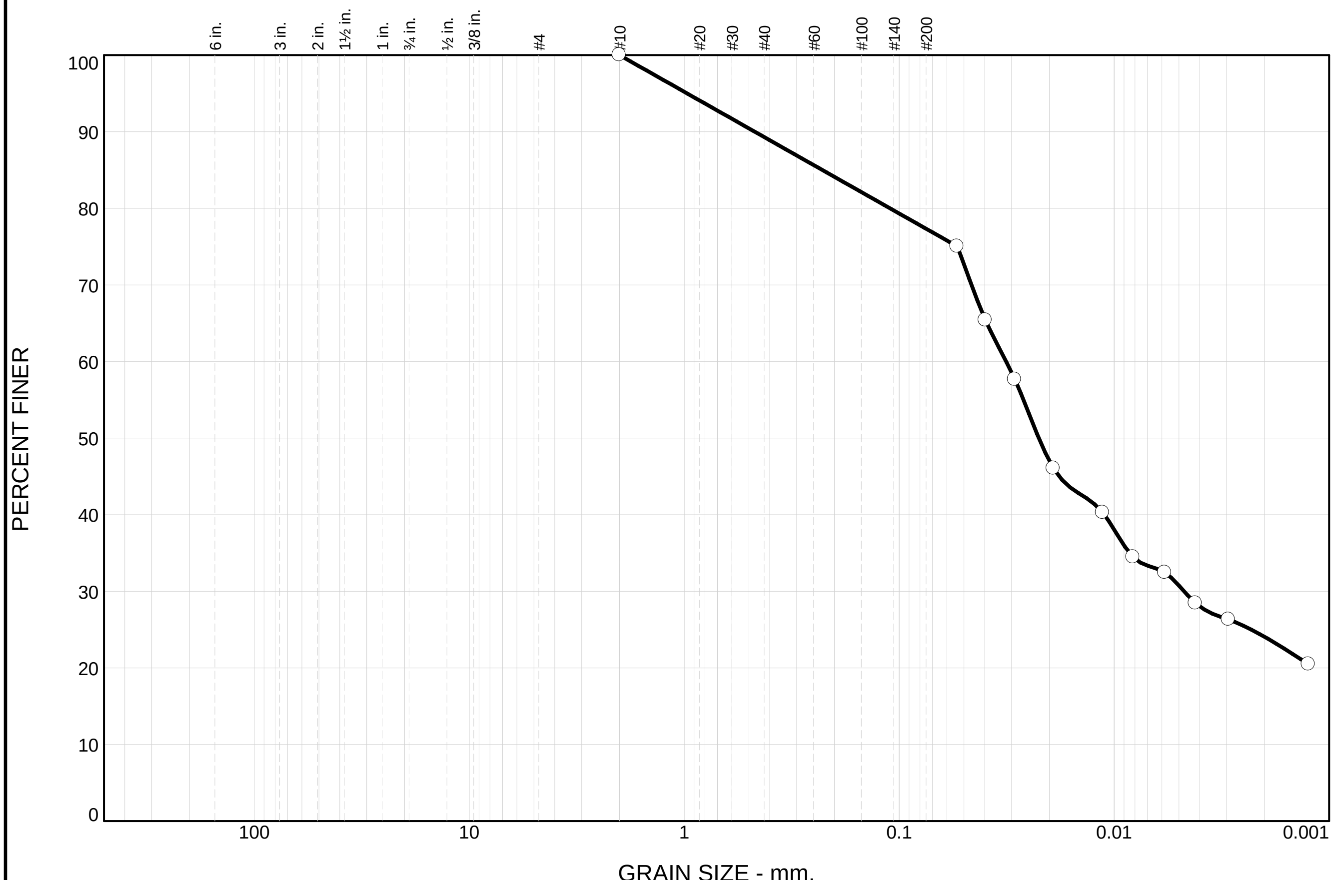
Remarks:

○SAMPLE DESCRIPTION BASED ON VISUAL IDENTIFICATION AND LABORATORY ANALYSIS

Figure 9

Tested By: TBT 02/12/13 **Checked By:** ____________

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	10.7	12.0	46.6	30.7

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2276	0.0318	0.0224	0.0047				

Material Description	USCS	AASHTO
○ BROWN CLAYEY SILT, SM F/M SAND		

Project No. 195651 **Client:** TDI CHAMPLAIN HUDSON POWER EXPRESS - CP

Project: TRANSMISSION DEVELOPERS, INC.

○ **Source of Sample:** B116.2-1 **Depth:** 13.5-15.0 FT **Sample Number:** S-6

TRC Engineers, Inc.

Mt. Laurel, NJ

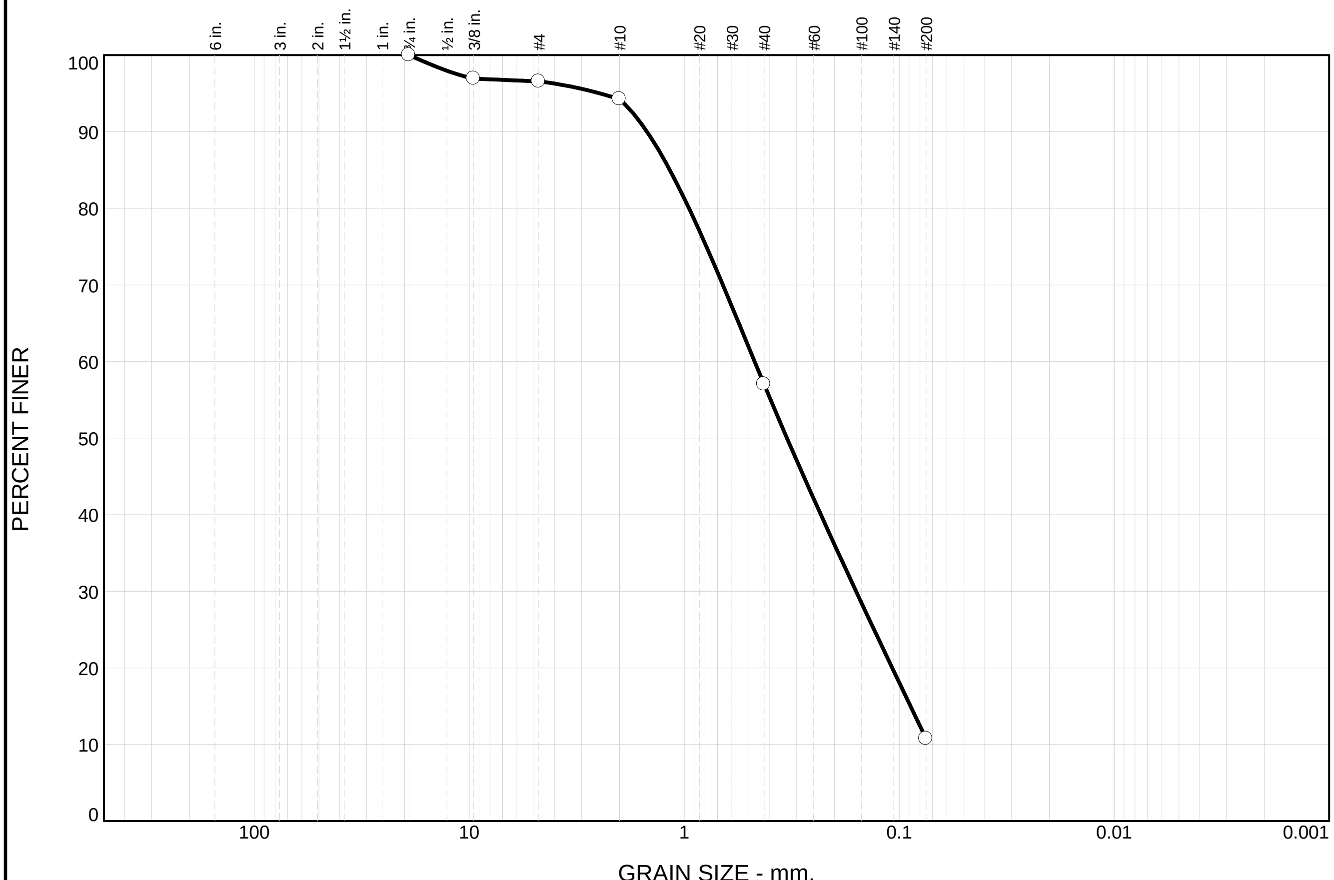
Remarks:

○SAMPLE DESCRIPTION BASED ON VISUAL IDENTIFICATION AND LABORATORY ANALYSIS

Figure 10

Tested By: TBT 02/12/13 **Checked By:**

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	3.4	2.4	37.2	46.2	10.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.1665	0.4705	0.3326	0.1587	0.0886			

Material Description	USCS	AASHTO
○ GRAY F/M/C SAND, TR TO SM SILT, TR F/ GRAVEL	SP-SM	

Project No. 195651 **Client:** TDI CHAMPLAIN HUDSON POWER EXPRESS - CP

Project: TRANSMISSION DEVELOPERS, INC.

○ **Sample Source:** B116.2-1 **Depth:** 18.5-25.0 FT **Sample No.:** S-7 & S-8

Remarks:

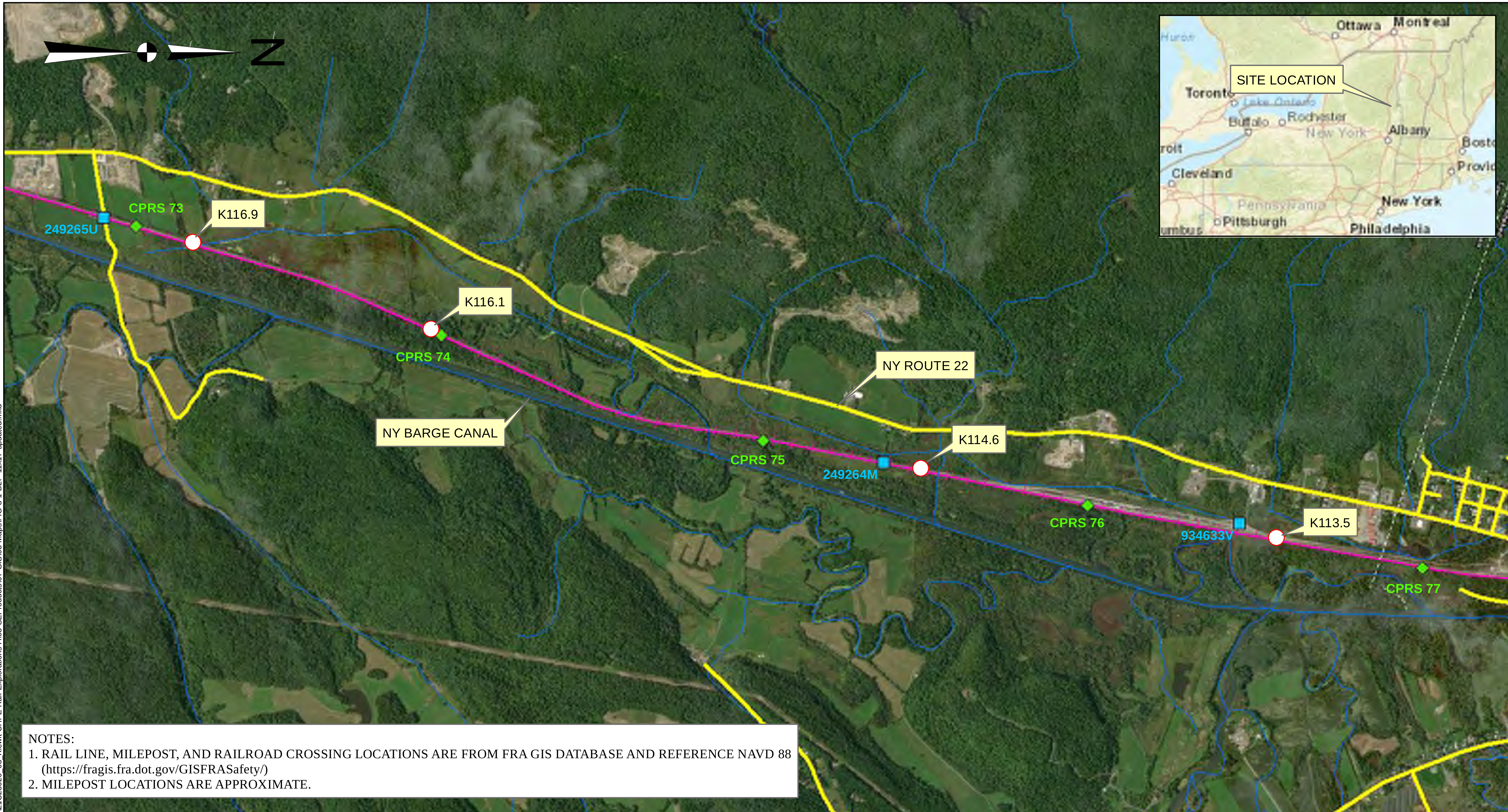
○SAMPLE DESCRIPTION BASED ON VISUAL IDENTIFICATION AND LABORATORY ANALYSIS

TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 11

Tested By: BMH 02/01/13 **Checked By:** ____________



NOTES:
1. RAIL LINE, MILEPOST, AND RAILROAD CROSSING LOCATIONS ARE FROM FRA GIS DATABASE AND REFERENCE NAVD 88 (https://fragis.fra.dot.gov/GISFRASafety/)
2. MILEPOST LOCATIONS ARE APPROXIMATE.

Legend

- Railroad Milepost
- Railroad Crossings
- Roadway
- NYS_Drainage_Streams
- Rail Line
- Boring Location

Source: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

0 1,500 3,000 Feet

Scale: 1:18,000

Schnabel ENGINEERING

CHAMPLAIN HUDSON POWER EXPRESS
WHITEHALL, NEW YORK

PROJECT NO. 21C25020.03

RAIL EXPLORATION
BORING LOCATION
PLAN

FIGURE 3.1

2/28/2022 12:26:00 PM G:\2021-Jobs\Albany\21C25020_03_Kiewit-CHPE-Rail-Explorations-A03-SEProducts\07-GIS\03-Maps\FIG-3-1-BLP-11x17-updated.mxd

Schnabel ENGINEERING	TEST BORING LOG	Project: Champlain Hudson Power Express Rail Explorations Whitehall, New York	Boring Number: K116.1 Contract Number: 21C25020.03 Sheet: 1 of 3

Contractor: Soil Testing Inc.
Oxford, Connecticut

Contractor Foreman: S. DeAngelis

Schnabel Representative: S. Henry

Equipment: Diedrich D-50 (ATC)

Method: 4-1/4" I.D. Hollow Stem Auger / 3" Fluid Rotary

Hammer Type: Safety Hammer (140 lb)

Dates Started: 1/4/22 **Finished:** 1/4/22

X: 778556.8 ft **Y:** 1701289 ft **By:** Land Survey

Coordinate System: Lat-Long (Decimal Degrees)

Plunge: -90 **Bearing:**

Ground Surface Elevation: 124.9 (ft) **Total Depth:** 65.0 ft

Water Level Observations

	Date	Time	Depth	Casing	Caved
Encountered ▽	1/4/22	12:10 PM	20.0'	15.0'	---

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	0.0 - 1.5 ft: FILL, sampled as ballast	FILL						
1.5	1.5 - 4.3 ft: FILL, sampled as silty sand with gravel; moist, black	FILL	123.4	F		S-1, SPT 4+3+3+3 REC=10", 42%		
4.3	4.3 - 16.2 ft: LEAN CLAY; moist, gray and brown, some silt, probable LACUSTRINE material	CL	120.7	L	5	S-2, SPT 3+4+5+7 REC=14", 58%	LL = 43 PL = 20 PP = 2.00 tsf	
					10	S-3, SPT 3+4+7+10 REC=16", 67%	MC = 30.5% % Passing #200 = 98.1 PP = 3.25 tsf	
					15	S-4, SPT 2+4+4+7 REC=19", 79%	PP = 1.50 tsf	15.0 ft: Drilling method switched to mud rotary with tricone rollerbit.
16.2	16.2 - 18.5 ft: FAT CLAY; moist, gray, probable LACUSTRINE material	CH	108.7					
18.5	18.5 - 28.5 ft: WELL GRADED SAND; wet, gray, probable LACUSTRINE material ▽	SW	106.4		20	S-5, SPT WOR+5+4+4 REC=15", 63%		

(continued)

Schnabel ENGINEERING	TEST BORING LOG	Project:	Champlain Hudson Power Express Rail Explorations Whitehall, New York	Boring Number: K116.1 Contract Number: 21C25020.03 Sheet: 2 of 3

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	18.5 - 28.5 ft: WELL GRADED SAND; wet, gray, probable LACUSTRINE material *(continued)*	SW				S-6, SPT 8+8+3+4 REC=10", 42%	MC = 19.0%	
28.5	28.5 - 65.0 ft: FAT CLAY; wet, gray, probable LACUSTRINE material		96.4					
					30	S-7, SPT WOR/18"+WOH REC=24", 100%	PP = 0.00 tsf	
					35	S-8, SPT WOR/24" REC=24", 100%	PP = 0.00 tsf	
					40	UD-1, UNDIST REC=7", 29%	PP = 0.00 tsf	
		CH		L		S-9, SPT WOH+1+2+3 REC=24", 100%	LL = 71 PL = 25 MC = 71.4% % Passing #200 = 99.9 PP = 0.00 tsf	
					45			
						UD-2, UNDIST REC=21", 88%	PP = 0.00 tsf	
					50	S-10, SPT WOR/24" REC=20", 83%	PP = 0.00 tsf	
					55	UD-3, UNDIST REC=23", 96%	PP = 0.00 tsf	
						S-11, SPT WOR/24" REC=24", 100%	MC = 66.6% PP = 0.00 tsf	57.0 ft: Rods sunk to 63 ft; Kiewit agreed to

(continued)

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	28.5 - 65.0 ft: FAT CLAY; wet, gray, probable LACUSTRINE material *(continued)*	CH		L	60			take SPT from 63 - 65 ft instead of drilling the rest of the way.
						S-12, SPT 3+3+3+2 REC=24", 100%	PP = 0.00 tsf	
65.0			59.9		65			

Bottom of Boring at 65.0 ft.
Boring terminated at selected depth.
Boring backfilled with cement grout through tremie pipe upon completion.
Unable to obtain "Completion" and "Casing Pulled" groundwater readings due to drilling fluid and grout.
Coordinates and elevations were provided by Kiewit Engineering (NY) Corp. on Jan. 18, 2022.
Stratum Designations:
F: Fill Material
L: Lacustrine Deposits

Summary Of Laboratory Tests

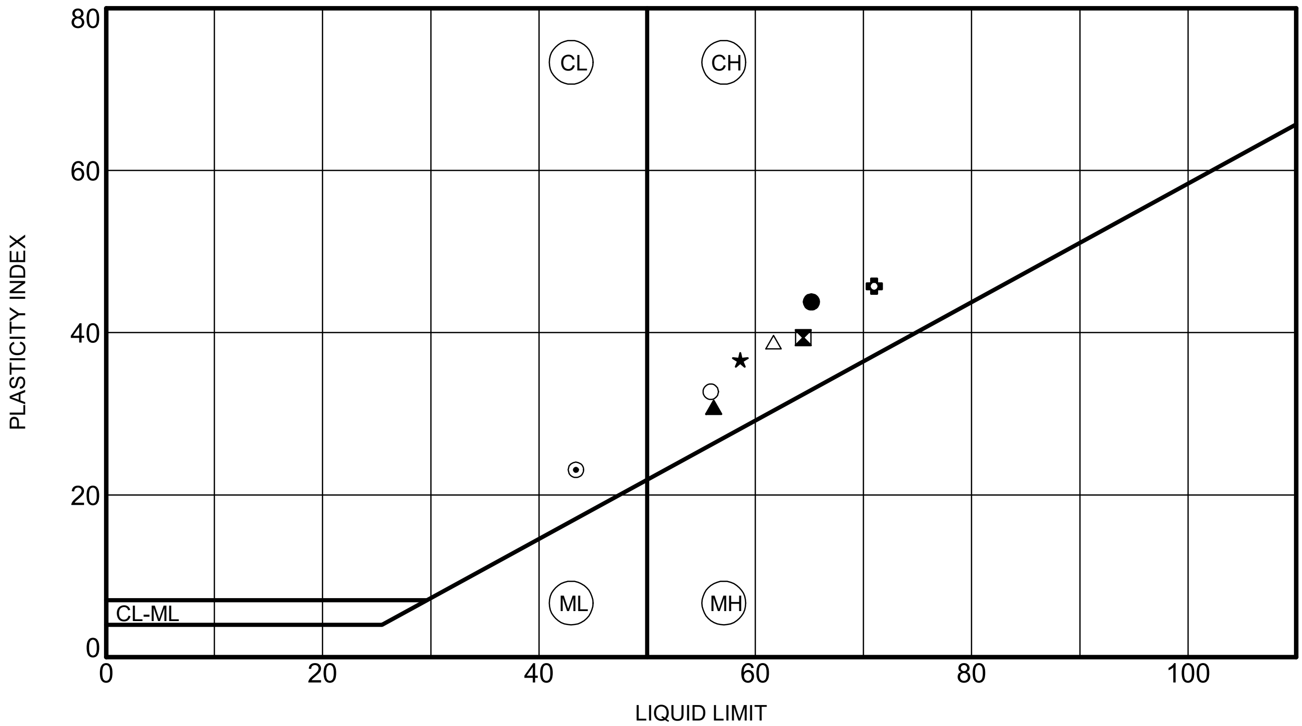
Project Number: 21C25020.03

Boring No.	Sample Depth ft / Elevation ft	Sample Type	Description of Soil Specimen	Stratum	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Passing No. 200 Sieve	Organic Content (%)	pH	Sulfates (mg/Kg)	Chlorides (mg/Kg)	Resistivity (ohm-cm)	Oxidation Reduction Potential (mV)
K114.6	55.0 - 57.0 / 66.8 - 64.8	Jar	Fat Clay (visual field description)	L	60.2	--	--	--	--	--	--	--	--	--	--
K114.6	62.0 - 64.0 / 59.8 - 57.8	Jar	FAT CLAY (CH), dark brownish gray	L	52.7	59	22	37	99.9	--	--	--	--	--	--
K116.1	5.0 - 7.0 / 119.9 - 117.9	Jar	Lean Clay (visual field description)	L	--	43	20	23	--	--	--	--	--	--	--
K116.1	10.0 - 12.0 / 114.9 - 112.9	Jar	Lean Clay (visual field description)	L	30.5	--	--	--	98.1	--	--	--	--	--	--
K116.1	25.0 - 27.0 / 99.9 - 97.9	Jar	Well-graded Sand (visual field description)	L	19.0	--	--	--	--	--	--	--	--	--	--
K116.1	42.0 - 44.0 / 82.9 - 80.9	Jar	FAT CLAY (CH), gray	L	71.4	71	25	46	99.9	0.88	--	--	--	--	--
K116.1	57.0 - 59.0 / 67.9 - 65.9	Jar	Fat Clay (visual field description)	L	66.6	--	--	--	--	--	--	--	--	--	--

Notes:
1. Soil tests in general accordance with ASTM standards.
2. Soil classifications are in general accordance with ASTM D2487(as applicable), based on testing indicated and visual classification.
3. Key to abbreviations: NP=Non-Plastic; -- indicates no test performed; BRL = below reporting limit
4. Strata: F=Fill; L=Lacustrine

Schnabel ENGINEERING

Project: Champlain Hudson Power Express
Rail Explorations
Whitehall, NY



PLOTTED DATA REPRESENTS SOIL PASSING NO. 40 SIEVE

	Specimen		LL	PL	PI	Fines	Description
●	**K113.5**	**8.0 ft**	**65**	**21**	**44**		**Fat Clay (visual field description)**
⧗	**K113.5**	**25.0 ft**	**64**	**25**	**39**	**100**	**FAT CLAY (CH), gray**
▲	**K114.6**	**35.0 ft**	**56**	**25**	**31**	**99**	**FAT CLAY (CH), gray**
★	**K114.6**	**62.0 ft**	**59**	**22**	**37**	**100**	**FAT CLAY (CH), dark brownish gray**
⊙	**K116.1**	**5.0 ft**	**43**	**20**	**23**		**Lean Clay (visual field description)**
✿	**K116.1**	**42.0 ft**	**71**	**25**	**46**	**100**	**FAT CLAY (CH), gray**
○	**K116.9**	**40.0 ft**	**56**	**23**	**33**	**100**	**FAT CLAY (CH), gray**
△	**K116.9**	**50.0 ft**	**62**	**23**	**39**	**95**	**FAT CLAY (CH), gray**

Schnabel ENGINEERING

ATTERBERG LIMITS

Project: Champlain Hudson Power Express
Rail Explorations
Whitehall, NY

Contract: 21C25020.03

Kiewit

MEMORANDUM

DATE: September 23, 2022

TO: Antonio Marruso, P.E.; CHA Consulting, Inc.

FROM: Matthew Hawley, P.E.; Kiewit Engineering (NY) Corp. MKH
Jaren Knighton; Kiewit Engineering (NY) Corp.

SUBJECT: Geotechnical Data: Segment 3 - Package 1C - HDD Crossing 7 – Revision 1
Champlain Hudson Power Express Project
Whitehall, New York

Kiewit Engineering is providing the enclosed geotechnical data for use in the horizontal direction drill (HDD) design for the Champlain Hudson Power Express project in Upstate New York. This HDD crossing is located south of Whitehall, New York. The approximate station for the start of HDD crossing Number 7 is STA 15256+00 (43.488742° N, 73.425331° W).

The geotechnical data at this HDD crossing is enclosed. The available data is from the previous investigation by TRC and the recent investigation by Schnabel, referenced below.

- TRC, Geotechnical Data Report, Champlain Hudson Power Express, Canadian Pacific Railway Borings MP 113.1-177.1, dated March 29, 2013.
- Schnabel Engineering, Geotechnical Data Report, Champlain Hudson Power Express, Canadian Pacific Railway Subsurface Explorations, dated March 3, 2022.

Contact us if you have questions or require additional information.

HDD 7

Borings B116.8-1, K-116.9

Segment 3

CHPE Segments 1, 2, and 3 - Packages 1A, 1B, and 1C
HDD Soil Boring Coordinates and Elevations

Firm	Boring	Northing (feet)	Easting (feet)	Ground Surface Elevation (feet)
S.W. Cole*	B102.4-1	1762367.3	777951.9	139.4
	B109.7-1	1729097.5	774410.6	116.4
	B109.8-1	1728870.4	774869.2	99.8
	B110.1-1	1728142.0	776337.8	105.0
TRC*	B113.4-1	1714875.2	781894.9	122.9
	B114.4-1	1709558.6	780857.2	122.7
	B115.2-1	1705777.9	780186.6	120.9
	B116.1-1	1701426.5	778616.5	124.1
	B116.2-1	1700894.8	778375.8	124.3
	B116.8-1	1697938.4	777308.2	131.6
AECOM**	PD-7	1783019.4	778020.6	266.4
	PD-7A	1782960.9	778149.9	269.5
	WFE-1	1693492.9	776280.6	127.9
	WFE-1C	1693895.8	776092.3	129.3

Notes:
- Northings and Eastings are provided in NAD83 New York State Plane East Zone.
- Elevations are referenced to the NAVD88 datum.

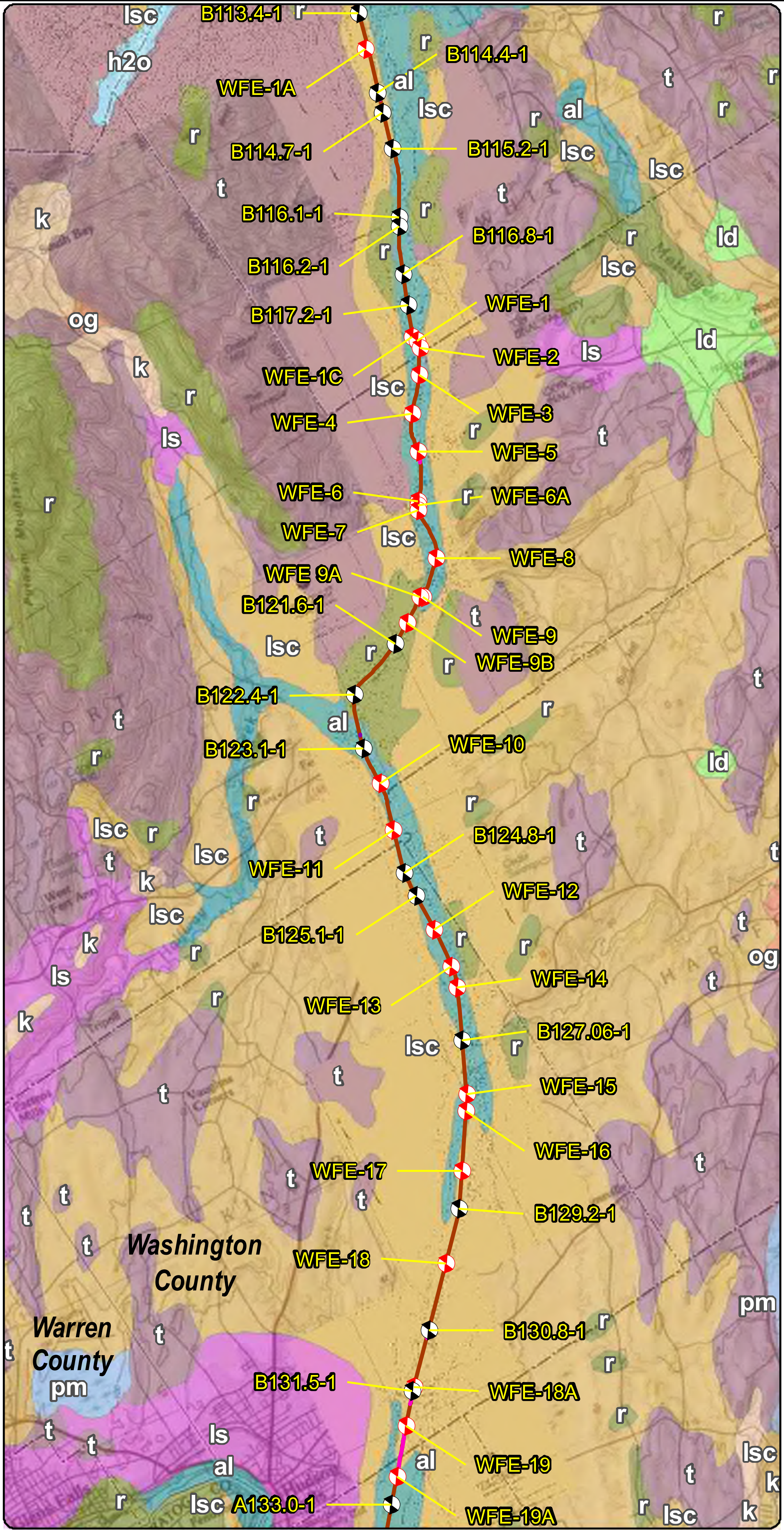
* TRC and S.W. Cole boring coordinates as shown in Table 1-6 in AECOM report (reference below). Boring elevations estimated from November 2021 topographic survey by Williams Aerial.

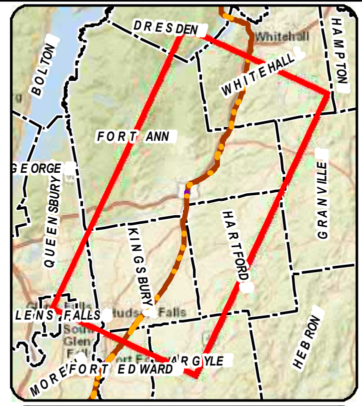
** AECOM boring coordinates and elevations as shown in Table 1-6 in AECOM report.

*** Kiewit boring coordinates and elevations are noted on the boring logs.

Reference:

AECOM, Geotechnical Data Report, Upland Segments: Putnam Station, Washington County, to Cementon, Green County, NY, Champlain Hudson Power Express, dated May 28, 2021.





LEGEND

- 2021 Boring Location
- Previous (2013) Boring Location
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- Town Boundary
- County Boundary

Surficial Geology

- al - Recent alluvium
- h2o - Water
- k - Kame deposits
- ld - Lacustrine delta
- ls - Lacustrine sand
- lsc - Lacustrine silt and clay
- og - Outwash sand and gravel
- pm - Swamp deposits
- r - Bedrock
- t - Till

N

1 0.5 0 1 Miles

Transmission Developers Inc.

Champlain Hudson Power Express Project

Champlain Hudson Power Express Inc.

Surficial Geology and Geotechnical Borings Whitehall to Fort Edward
Figure 3-3

Prepared on 5/5/2021
by: AECOM

DATA SOURCES: ESRI, NYSDOT, NOAA, USACE, NYDOS, TDI, TRC

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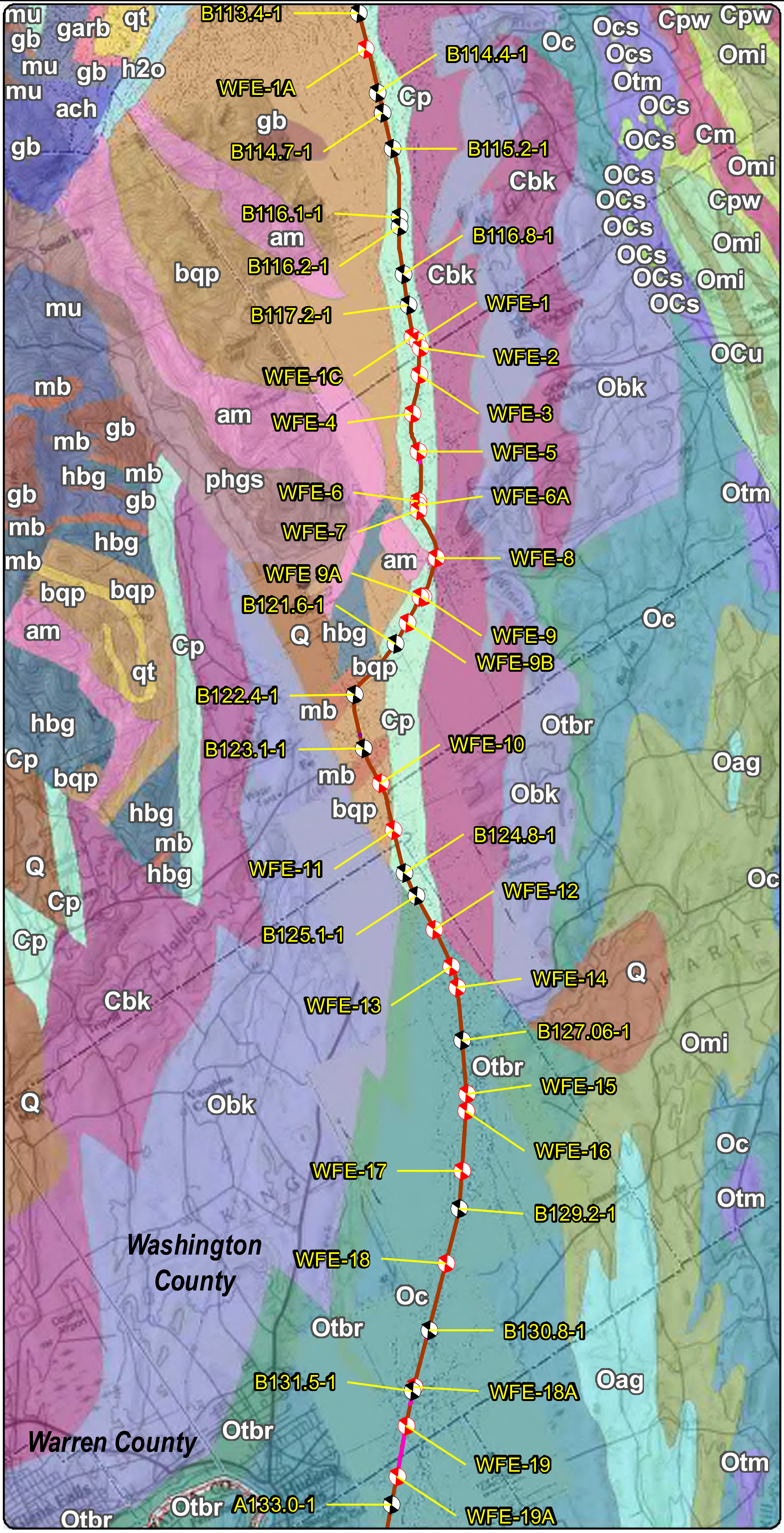

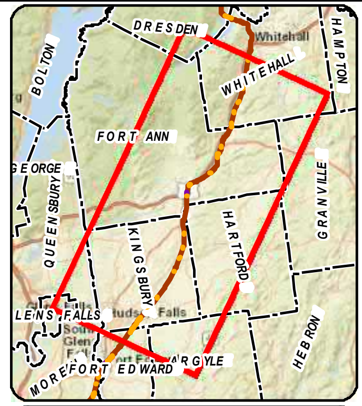

LEGEND

- 2021 Boring Location
- Previous (2013) Boring Location
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- Town Boundary
- County Boundary

Bedrock Geology

- Cbk - Beekmantown Group
- Cm - Mettawee Formation
- Cp - Potsdam Sandstone
- Cpw - Poultney Formation ("A" Member)
- No Label
- OCs - Cambrian-Middle Ordovician carbonate
- OCu - Undivided Ordovician and Cambrian
- Oag - Austin Glen Formation
- Obk - Beekmantown Group
- Oc - Canajoharie Shale
- Omi - Mount Merino Formation
- Op - Poultney Formation ("B" and "C")
- Otbr - Dolgeville Formation
- Otm - Taconic Melange
- Q - Glacial and Alluvial Deposits
- ach - metanorthosite and anorthosite
- am - Amphibolite, pyroxenic amphibolite
- bqp - Biotite-quartz-plagioclase
- garb - Quartz-feldspar paragneiss
- gb - Olivine metagabbro
- h2o - Water
- hbg - Biotite and or hornblende granite gneiss
- mb Calcitic and dolomitic marble
- mu - Undivided metased rock and migmatite
- phgs - Charnockite, granitic, quartz syenite
- qt - Quartzite

1 0.5 0 1 Miles

Transmission Developers Inc.

Champlain Hudson Power Express Project

Champlain Hudson Power Express Inc.

Bedrock Geology and Geotechnical Borings Whitehall to Fort Edward Figure 4-3

Prepared on 5/5/2021 by: AECOM

DATA SOURCES: ESRI, NYSDOT, NOAA, USACE, NYDOS, TDI, TRC

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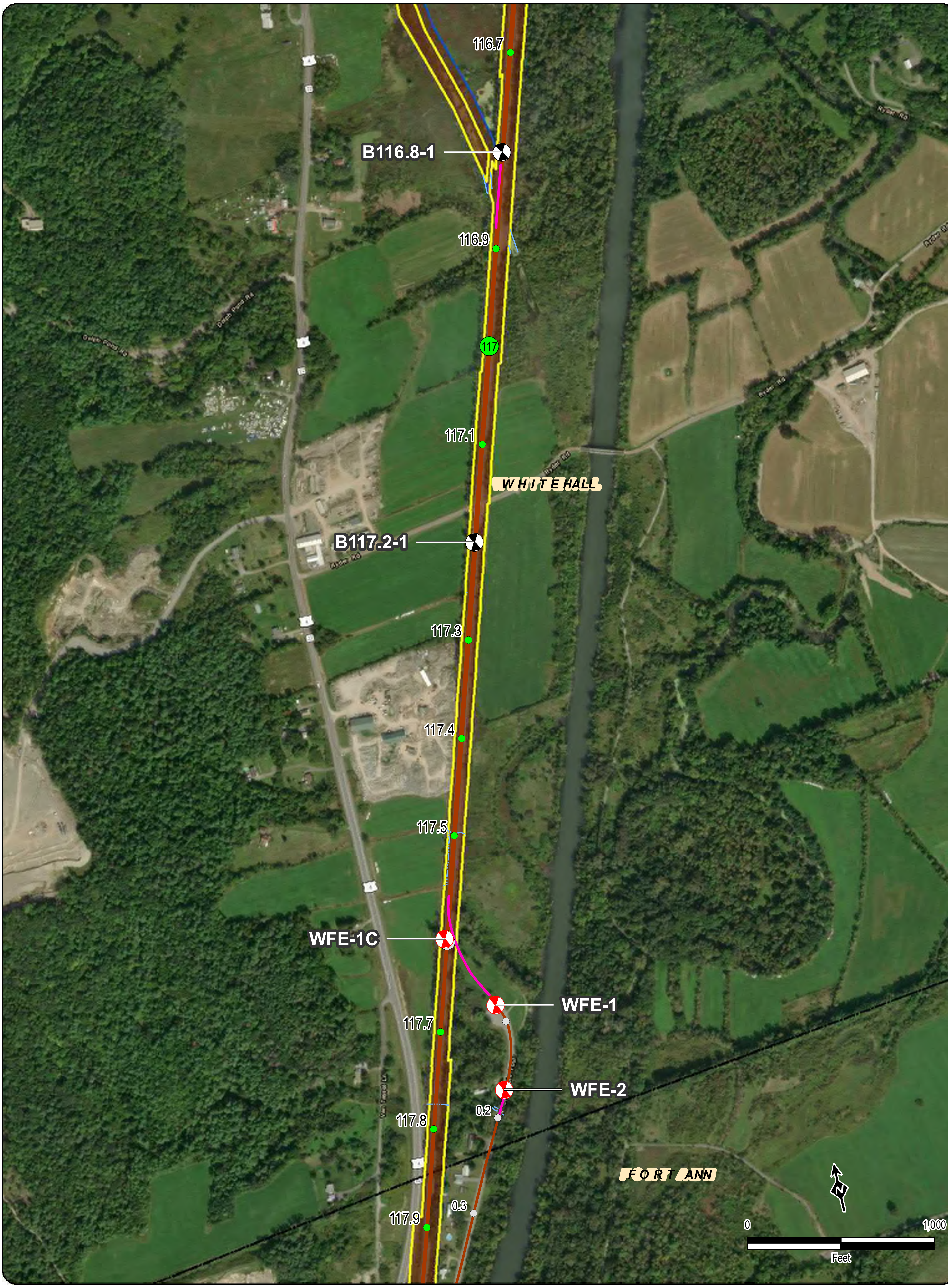

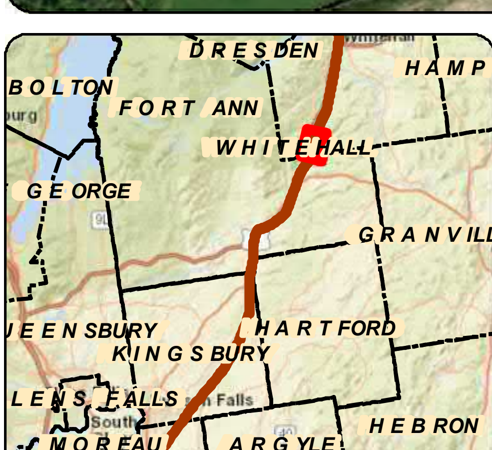

LEGEND

- 111.8 Certified Milepost - Tenths
- 135 Certified Milepost
- 111.8 Preferred Alternative Milepost - Tenths
- 135 Preferred Alternative Milepost
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- 2021 Boring Location
- Previous (2013) Boring Location
- Streams/Ditches
- Railroad ROW
- Deviation Zone
- Deviation Zone Outside ROW
- Preferred Alternative Deviation Zone
- Preferred Alternative Deviation Zone Outside ROW
- Town Boundary
- Village Boundary
- State Park (OPRHP)

Parcel Ownership

TOWN NAME

Road Name

Village Name

Transmission Developers Inc.

Champlain Hudson Power Express Project

Champlain Hudson Power Express Inc.

BORING LOCATION PLAN

Whitehall to Fort Edward

Figure A-3

Sheet 4 of 16

Prepared by: AECOM

5/19/2021

DATA SOURCES: ESRI, NETWORK MAPPING 2010, NYSDOT, OPRHP, TDI, TRC

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TEST BORING LOG

TRC

PROJECT: TDI CHAMPLAIN HUDSON POWER EXPRESS
LOCATION: CP RAILROAD ROW, NY

BORING	**B116.8-1**
G.S. ELEV.	N/A
FILE	195651
SHEET	1 OF 2

GROUNDWATER DATA			
FIRST ENCOUNTERED NR			
DEPTH	HOUR	DATE	ELAPSED TIME
49.2'	NR	12/11	0

METHOD OF ADVANCING BOREHOLE				
a	FROM	0.0 '	TO	10.0 '
d	FROM	10.0 '	TO	65.0 '

DRILLER	R. CARUSO
HELPER	C. SMART
INSPECTOR	C. POPPE
DATE STARTED	12/12/2012
DATE COMPLETED	12/12/2012

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
	S-1	9 7 7 10	2.0	***BLACK M/C SAND, SM CINDERS, TR SILT, TR F/ GRAVEL (FILL)***		
	S-2	14 17 21 18				
5	S-3	14 11 9 9			5.0	
	S-4	10 8 8 8		***BROWN AND BLACK M/C/F SAND, SM F/ GRAVEL, TR TO SM SILT (POSSIBLE FILL)***		
10	S-5	7 4 5 4	13.5			
15	S-6	3 4 5	18.5	***GRAY CLAYEY SILT, TR-SM F/ SAND***	48.7	
20	S-7	5 6 9	23.5	***BROWN CLAY, SM M/F SAND, TR TO SM SILT***	26.7	
25	S-8	4 4 7		***GRAY CLAY, TR SILT***		
30	S-9	2 2 2			40.5	
35	S-10	WOH			66.9	

DRN. CMP
CKD. PWK

NEW PROJECTS TEST BORING LOG 195651_TDI_CP.GPJ SITE BLAUVELT.GDT 3/27/13

TEST BORING LOG

TRC

PROJECT: TDI CHAMPLAIN HUDSON POWER EXPRESS
LOCATION: CP RAILROAD ROW, NY

BORING	**B116.8-1**
G.S. ELEV.	N/A
FILE	195651
SHEET	2 OF 2

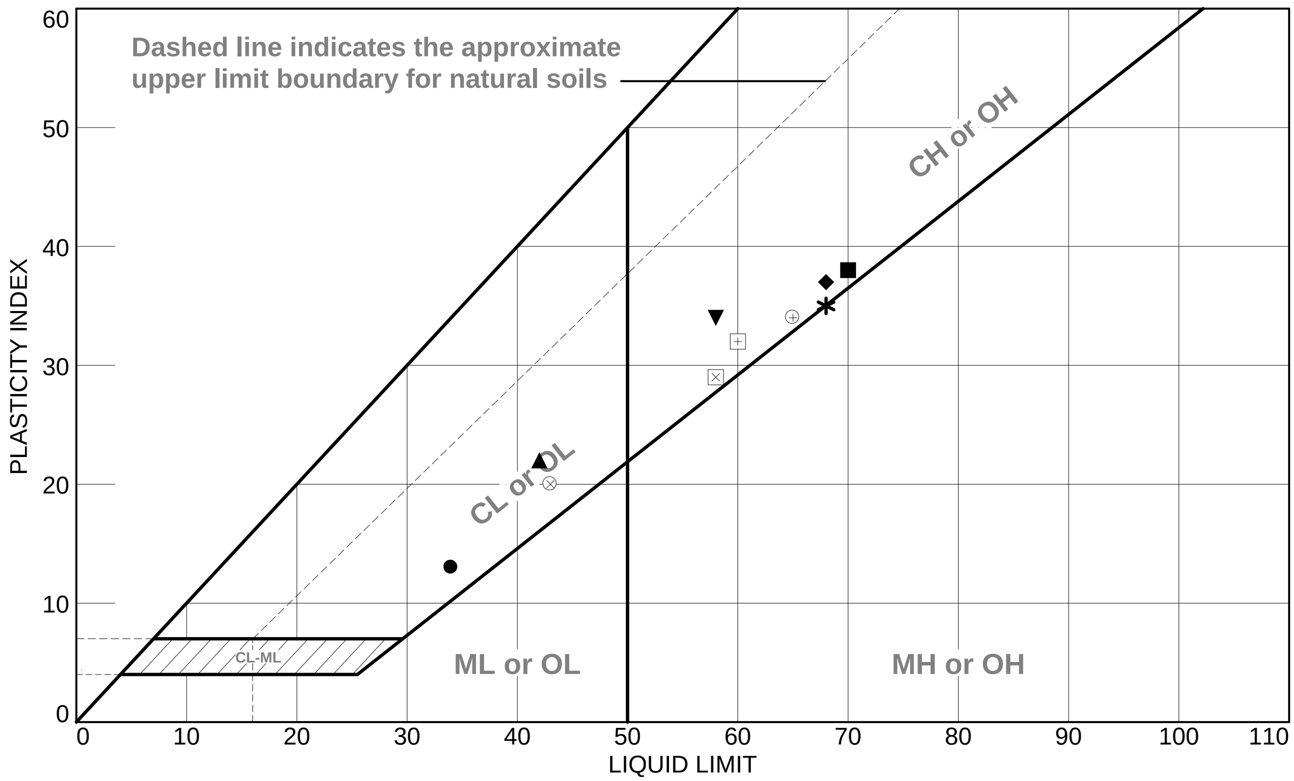
DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
40	S-11	3 2 1			64.3	
45	S-12	WOH			52.2	
50	S-13	2 1 2		***GRAY CLAY, TR SILT***	43.6	
55	S-14	WOH			69.1	
60	S-15	3 2 3				
65	S-16	2 1 1		65.0		
				END OF BORING AT 65'		
70						
75						

SUMMARY OF LABORATORY TEST DATA

Project Name: TDI Champlain Hudson Power Express – CP
Client Name: Transmission Developers, Inc.
TRC Project #: 195651

<table>
<tr><th colspan="3">SAMPLE IDENTIFICATION</th><th rowspan="2">Soil Group (USCS System)</th><th colspan="4">GRAIN SIZE DISTRIBUTION</th><th colspan="4">PLASTICITY</th><th rowspan="2">Specific Gravity</th><th rowspan="2">Moisture Content (%)</th><th rowspan="2">Unit Weight (pcf)</th><th rowspan="2">Compressive Strength (tsf)</th><th rowspan="2">Organic Content (%)</th></tr>
<tr><th>Boring #</th><th>Sample #</th><th>Depth (ft)</th><th>Gravel (%)</th><th>Sand (%)</th><th>Silt (%)</th><th>Clay (%)</th><th>Liquid Limit (%)</th><th>Plastic Limit (%)</th><th>Plasticity Index (%)</th><th>Liquidity Index)</th></tr>
<tr><td></td><td>S-9</td><td>28.5-30.0</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>18.4</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td rowspan="12">B116.8-1</td><td>S-2</td><td>2.0-4.0</td><td rowspan="4">SM</td><td rowspan="4">27.1</td><td rowspan="4">59.1</td><td rowspan="4" colspan="2">13.7</td><td rowspan="4">-</td><td rowspan="4">-</td><td rowspan="4">-</td><td rowspan="4">-</td><td rowspan="4">-</td><td rowspan="4">5.0</td><td rowspan="4">-</td><td rowspan="4">-</td><td rowspan="4">-</td></tr>
<tr><td>S-3</td><td>4.0-6.0</td></tr>
<tr><td>S-4</td><td>6.0-8.0</td></tr>
<tr><td>S-5</td><td>8.0-10.0</td></tr>
<tr><td>S-6</td><td>13.5-15.0</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>48.7</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>S-7</td><td>18.5-20.0</td><td>-</td><td>0.0</td><td>28.0</td><td>12.3</td><td>59.7</td><td>-</td><td>-</td><td>-</td><td>-</td><td>2.76</td><td>26.7</td><td>93.6</td><td>-</td><td>-</td></tr>
<tr><td>S-9</td><td>28.5-30.0</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>40.5</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>S-10</td><td>33.5-35.0</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>66.9</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>S-11</td><td>38.5-40.0</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>64.3</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>S-12</td><td>43.5-45.0</td><td>CH</td><td>-</td><td>-</td><td>-</td><td>-</td><td>60</td><td>28</td><td>32</td><td>0.8</td><td>-</td><td>52.2</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>S-13</td><td>48.5-50.0</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>43.6</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>S-14</td><td>53.5-55.0</td><td>-</td><td>0.0</td><td>0.3</td><td>1.2</td><td>98.5</td><td>-</td><td>-</td><td>-</td><td>-</td><td>2.83</td><td>69.1</td><td>-</td><td>-</td><td>-</td></tr>
</table>

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

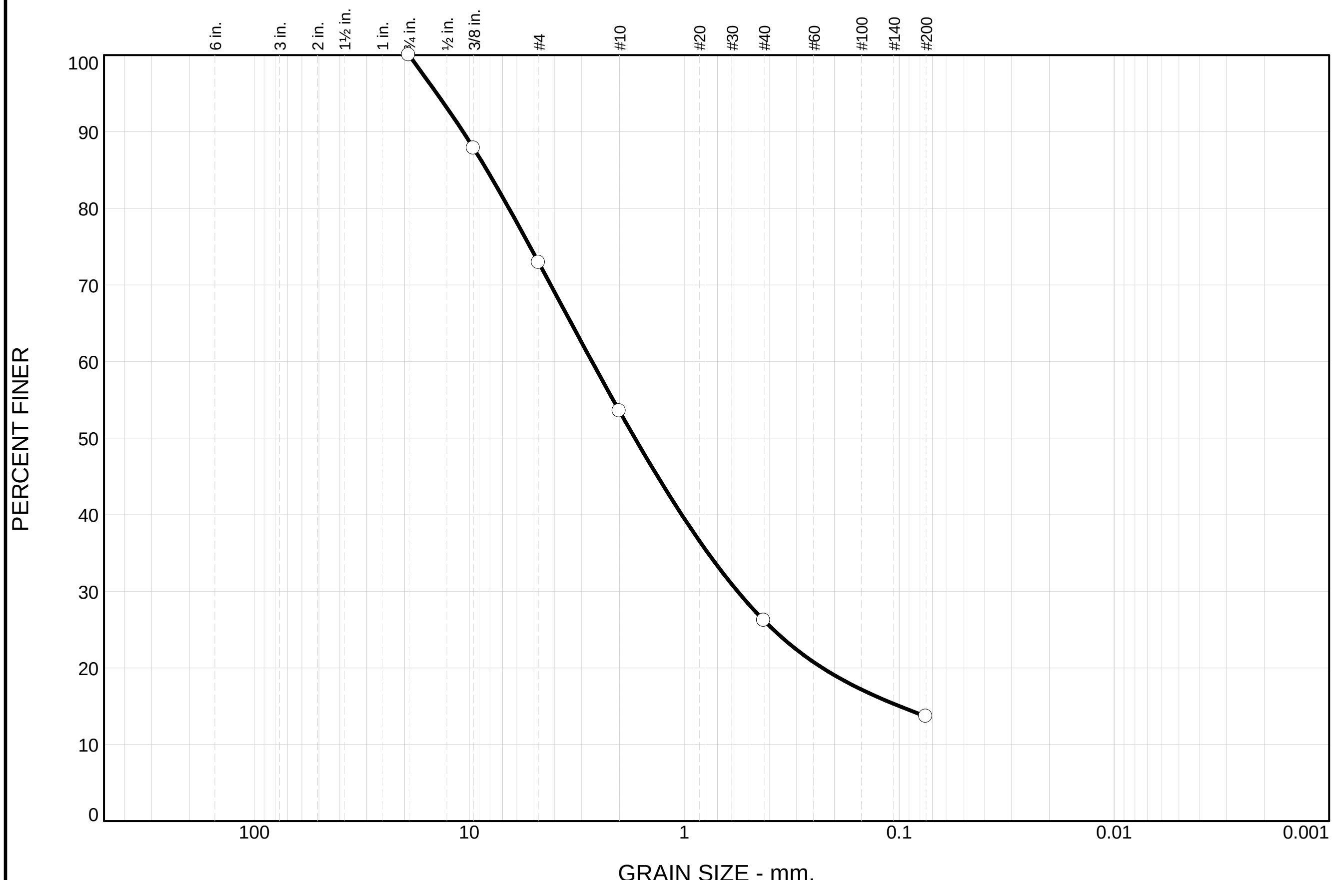
	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B113.1-1	S-7	18.5-20.0 FT	27.3	21	34	13	CL
■	B113.1-1	S-9	28.5-30.0 FT	38.8	32	70	38	CH/OH
▲	B113.4-1	S-3 & S-4	4.0-8.0 FT	27.3	20	42	22	CL
◆	B113.4-1	S-8	23.5-25.0 FT	50.3	31	68	37	CH
▼	B114.4-1	S-9	28.5-30.0 FT	49.2	24	58	34	CH
✱	B114.4-1	S-7	18.5-20.0 FT	49.7	33	68	35	CH/MH
⊕	B115.2-1	S-7	18.5-20.0 FT	45.6	31	65	34	CH
⊞	B116.8-1	S-12	43.5-45.0 FT	52.2	28	60	32	CH
⊗	B119.2-1	S-4 & S-5	7.0-11.0 FT	26.7	23	43	20	CL
⊠	B123.1-1	S-4	6.0-8.0 FT	33.0	29	58	29	CH

TRC
Engineers, Inc.
Mt. Laurel, NJ

Client: TDI CHAMPLAIN HUDSON POWER EXPRESS - CP
Project: TRANSMISSION DEVELOPERS, INC.

Project No.: 195651 **Figure** 1

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	27.1	19.4	27.3	12.5	13.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			8.2728	2.6844	1.6960	0.5646	0.0996			

	Material Description	USCS	AASHTO
○	GRAY-BROWN M/C/F SAND, SM F/ GRAVEL, TR TO SM SILT	SM	

Project No. 195651 **Client:** TDI CHAMPLAIN HUDSON POWER EXPRESS - CP

Project: TRANSMISSION DEVELOPERS, INC.

○ **Sample Source:** B116.8-1 **Depth:** 2.0-10.0 FT **Sample No.:** S-2 TO S-5

Remarks:

○SAMPLE DESCRIPTION BASED ON VISUAL IDENTIFICATION AND LABORATORY ANALYSIS

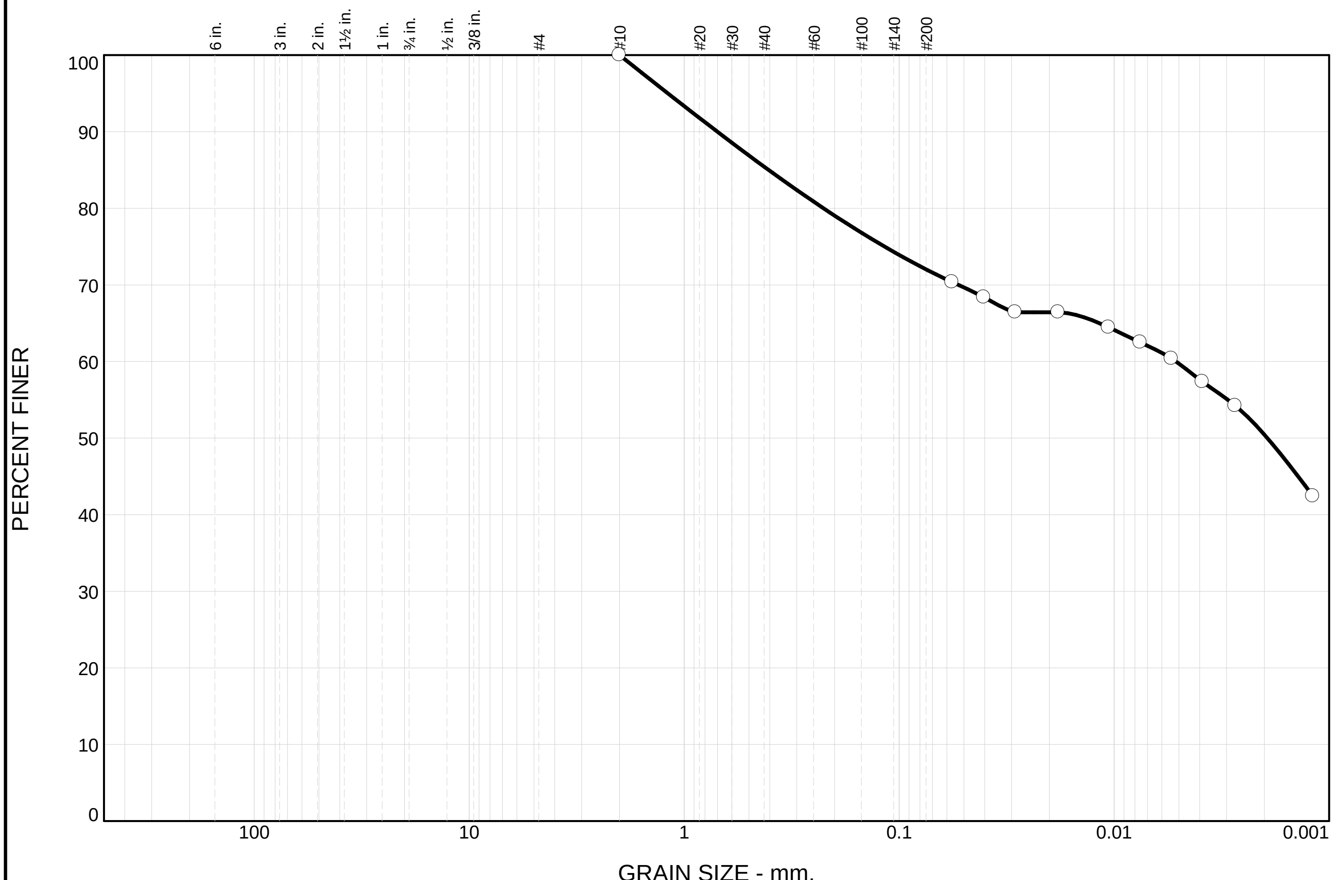
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 12

Tested By: BMH 01/25/13 **Checked By:** ______________

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	14.6	13.4	12.3	59.7

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.4044	0.0052	0.0019					

Material Description	USCS	AASHTO
○ BROWN CLAY, SM M/F SAND, TR TO SM SILT		

Project No. 195651 **Client:** TDI CHAMPLAIN HUDSON POWER EXPRESS - CP

Project: TRANSMISSION DEVELOPERS, INC.

○ **Source of Sample:** B116.8-1 **Depth:** 18.5-20.0 FT **Sample Number:** S-7

Remarks:

○SAMPLE DESCRIPTION BASED ON VISUAL IDENTIFICATION AND LABORATORY ANALYSIS

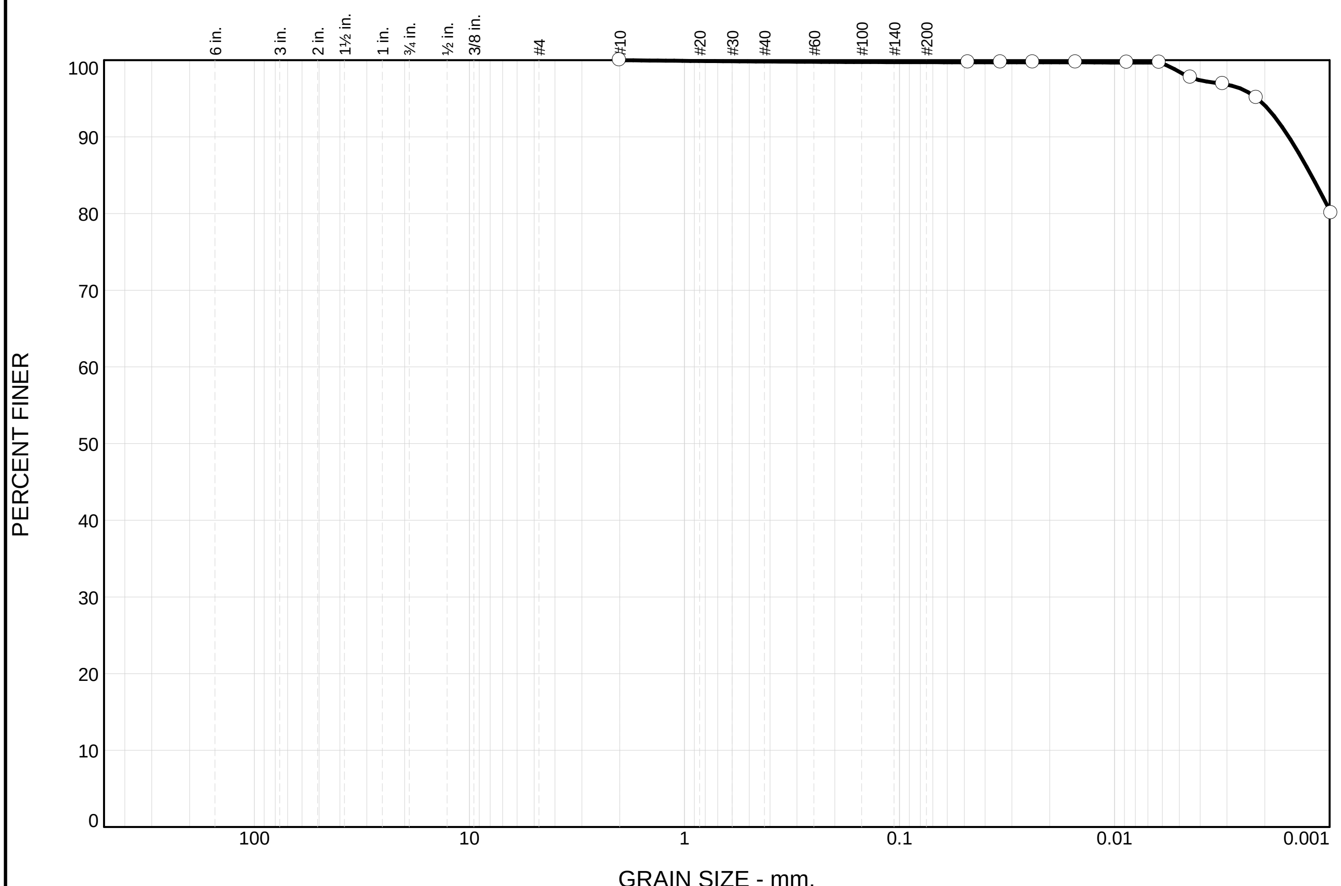
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 13

Tested By: TBT 02/12/13 **Checked By:** ______________________

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.2	0.1	1.2	98.5

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0012							

Material Description	USCS	AASHTO
○ GRAY CLAY, TR SILT		

Project No. 195651 **Client:** TDI CHAMPLAIN HUDSON POWER EXPRESS - CP

Project: TRANSMISSION DEVELOPERS, INC.

○ **Source of Sample:** B116.8-1 **Depth:** 53.5-55.0 FT **Sample Number:** S-14

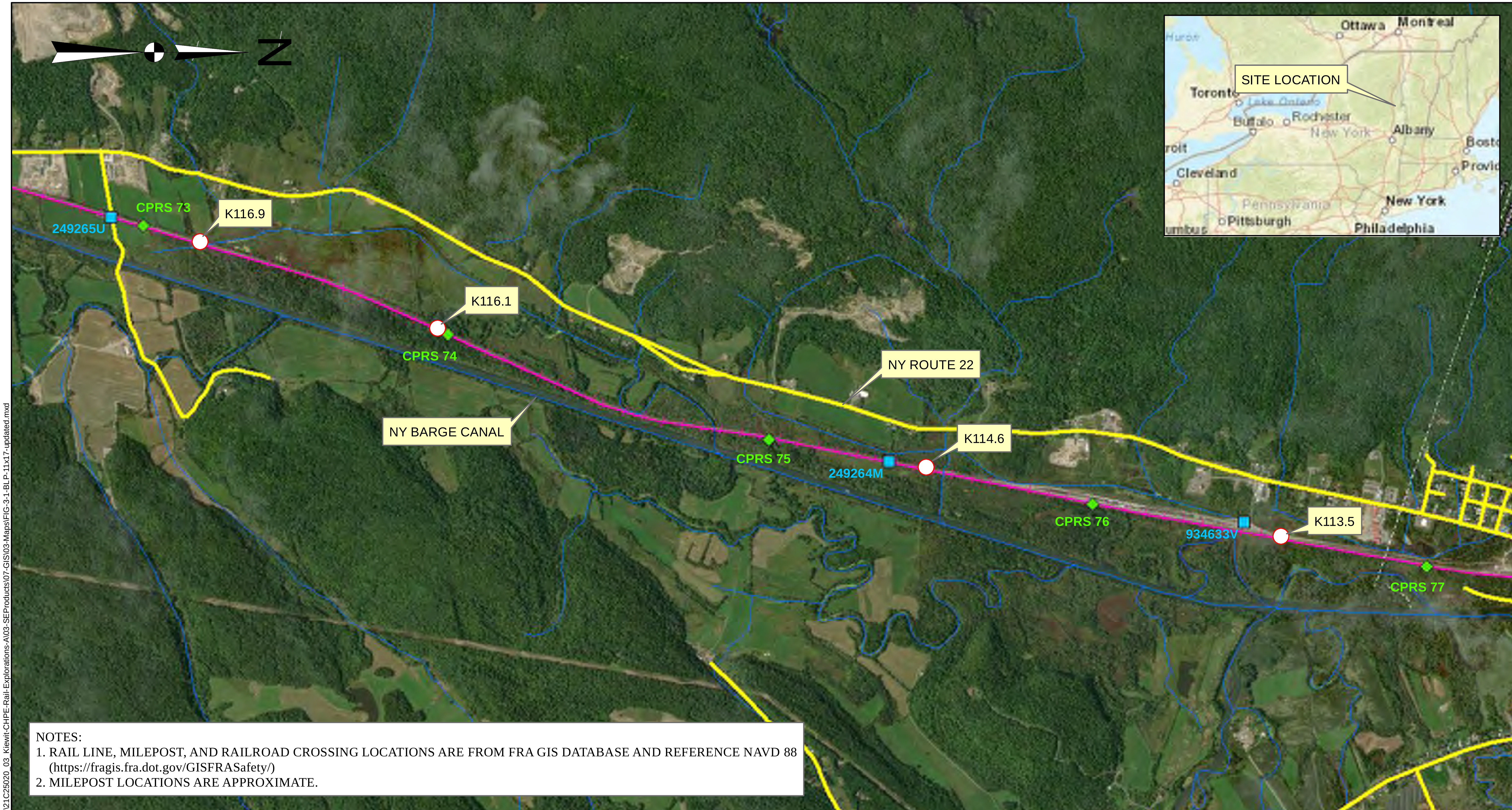
Remarks:
○SAMPLE DESCRIPTION BASED ON VISUAL IDENTIFICATION AND LABORATORY ANALYSIS

TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 14

Tested By: TBT 02/12/13 **Checked By:** ____________



NOTES:
1. RAIL LINE, MILEPOST, AND RAILROAD CROSSING LOCATIONS ARE FROM FRA GIS DATABASE AND REFERENCE NAVD 88 (https://fragis.fra.dot.gov/GISFRASafety/)
2. MILEPOST LOCATIONS ARE APPROXIMATE.

Legend

- Railroad Milepost
- Railroad Crossings
- Roadway
- NYS_Drainage_Streams
- Rail Line
- Boring Location

Source: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

0 1,500 3,000 Feet

Scale: 1:18,000

Schnabel ENGINEERING

CHAMPLAIN HUDSON POWER EXPRESS
WHITEHALL, NEW YORK

PROJECT NO. 21C25020.03

RAIL EXPLORATION
BORING LOCATION
PLAN

FIGURE 3.1

2/28/2022 12:26:00 PM G:\2021-Jobs\Albany\21C25020_03_Kiewit-CHPE-Rail-Explorations-A03-SEProducts\07-GIS\03-Maps\FIG-3-1-BLP-11x17-updated.mxd

Schnabel ENGINEERING	TEST BORING LOG	**Project:** Champlain Hudson Power Express Rail Explorations Whitehall, New York	**Boring Number:** K116.9 **Contract Number:** 21C25020.03 **Sheet:** 1 of 3

Contractor: Soil Testing Inc.
Oxford, Connecticut

Contractor Foreman: S. DeAngelis

Schnabel Representative: S. Henry

Equipment: Diedrich D-50 (ATC)

Method: 4-1/4" I.D. Hollow Stem Auger

Hammer Type: Safety Hammer (140 lb)

Dates Started: 1/5/22 **Finished:** 1/5/22

X: 777188.4 ft **Y:** 1697522 ft **By:** Land Survey

Coordinate System: Lat-Long (Decimal Degrees)

Plunge: -90 **Bearing:**

Ground Surface Elevation: 133.2 (ft) **Total Depth:** 67.0 ft

Water Level Observations

	Date	Time	Depth	Casing	Caved
Encountered ▽	1/5/22	11:00 AM	13.0'	13.0'	---

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	0.0 - 4.0 ft: FILL, sampled as sandy lean clay; moist, black, contains gravel	FILL		F		S-1, AUGER		0.0 - 5.0 ft: Hand excavated to avoid potential utilities.
4.0	4.0 - 5.0 ft: FILL, sampled as silty sand with gravel; moist, brown	FILL	129.2			S-2, AUGER		
5.0	5.0 - 8.5 ft: FILL, sampled as clayey gravel with sand; moist, grayish brown	FILL	128.2		5	S-3, SPT 2+2+2+3 REC=3", 13%		
8.5	8.5 - 12.5 ft: FILL, sampled as silty sand with gravel; moist, grayish brown	FILL	124.7		10	S-4, SPT 6+6+6+6 REC=7", 29%		
12.5	12.5 - 15.3 ft: FILL, sampled as well graded sand; wet, dark gray ▽	FILL	120.7			S-5, SPT 2+4+3+2 REC=6", 25%		12.5 - 13.0 ft: Moderate auger grinding.
15.3	15.3 - 67.0 ft: FAT CLAY; wet, gray with mottles of brown, probable LACUSTRINE material	CH	117.9	L	15	S-6, SPT 5+3+5+9 REC=14", 58%	MC = 41.8% PP = 0.75 tsf	
					20	S-7, SPT 2+3+5+9 REC=18", 75%	PP = 1.75 tsf	

(continued)

Schnabel ENGINEERING

TEST BORING LOG

Project: Champlain Hudson Power Express
Rail Explorations
Whitehall, New York

Boring Number: **K116.9**
Contract Number: 21C25020.03
Sheet: 2 of 3

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	15.3 - 67.0 ft: FAT CLAY; wet, gray with mottles of brown, probable LACUSTRINE material *(continued)*	CH		L		S-8, SPT 1+2+3+7 REC=24", 100%	MC = 49.4% PP = 0.50 tsf	
					30	S-9, SPT 2+2+3+6 REC=24", 100%	PP = 0.00 tsf	
	31.0 ft: Change: gray							
					35	S-10, SPT 1+2+1+5 REC=24", 100%	PP = 0.00 tsf	
					40	UD-1, UNDIST REC=12", 50%	LL = 56 PL = 23 MC = 41.6% % Passing #200 = 99.8 PP = 0.00 tsf	
						S-11, SPT WOH+1+4+4 REC=24", 100%	PP = 0.00 tsf	
					45	S-12, SPT WOH/12"+2+3 REC=24", 100%	PP = 0.00 tsf	
					50	S-13, SPT WOR+WOH/12"+4 REC=24", 100%	LL = 62 PL = 23 MC = 42.6% % Passing #200 = 95.0 PP = 0.00 tsf	
					55	UD-2, UNDIST REC=13", 54%	PP = 0.00 tsf	
						S-14, SPT WOH+3+4+4 REC=24", 100%	PP = 0.00 tsf	

(continued)

Schnabel ENGINEERING	TEST BORING LOG	Project:	Champlain Hudson Power Express Rail Explorations Whitehall, New York	Boring Number: K116.9 Contract Number: 21C25020.03 Sheet: 3 of 3

DEPTH (ft)	MATERIAL DESCRIPTION	SYMBOL	ELEV (ft)	STRATUM	SAMPLING DEPTH	SAMPLING DATA	TESTS	REMARKS
	15.3 - 67.0 ft: FAT CLAY; wet, gray with mottles of brown, probable LACUSTRINE material *(continued)*	CH		L	60	S-15, SPT 1+2+3+3 REC=24", 100%	MC = 44.4% PP = 0.00 tsf	
					65	S-16, SPT WOR/24" REC=24", 100%	PP = 0.00 tsf	
67.0			66.2					

Bottom of Boring at 67.0 ft.
Boring terminated at selected depth.
Boring backfilled with cement grout through tremie pipe upon completion.
Unable to obtain "Completion" and "Casing Pulled" groundwater readings due to grout.
Coordinates and elevations were provided by Kiewit Engineering (NY) Corp. on Jan. 18, 2022.
Stratum Designations:
- F: Fill Material
- L: Lacustrine Deposits

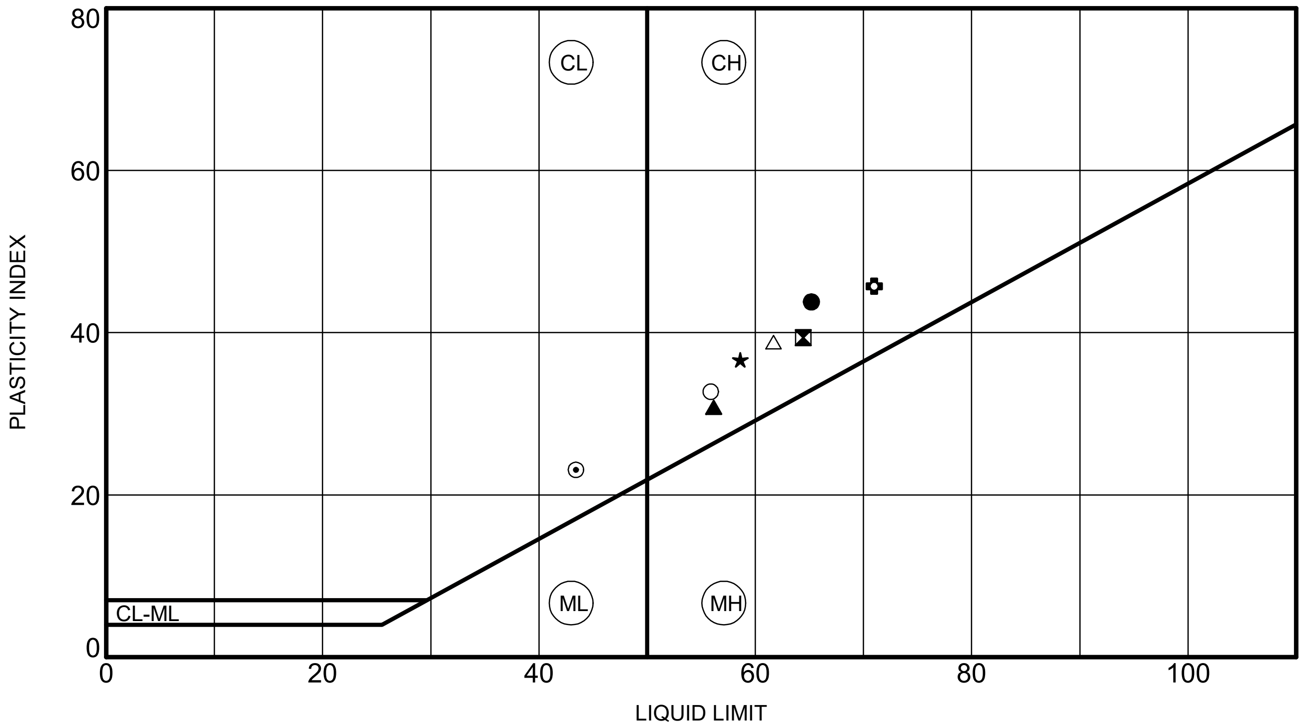
Summary Of Laboratory Tests

Boring No.	Sample Depth ft / Elevation ft	Sample Type	Description of Soil Specimen	Stratum	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	% Passing No. 200 Sieve	Organic Content (%)	pH	Sulfates (mg/Kg)	Chlorides (mg/Kg)	Resistivity (ohm-cm)	Oxidation Reduction Potential (mV)
K116.9	15.0 - 17.0 / 118.2 - 116.2	Jar	Fat Clay (visual field description)	L	41.8	--	--	--	--	--	--	--	--	--	--
K116.9	25.0 - 27.0 / 108.2 - 106.2	Jar	Fat Clay (visual field description)	L	49.4	--	--	--	--	--	--	--	--	--	--
K116.9	40.0 - 42.0 / 93.2 - 91.2	Tube	FAT CLAY (CH), gray	L	41.6	56	23	33	99.8	--	--	--	--	--	--
K116.9	50.0 - 52.0 / 83.2 - 81.2	Jar	FAT CLAY (CH), gray	L	42.6	62	23	39	95.0	--	--	--	--	--	--
K116.9	60.0 - 62.0 / 73.2 - 71.2	Jar	Fat Clay (visual field description)	L	44.4	--	--	--	--	--	--	--	--	--	--

Notes:
1. Soil tests in general accordance with ASTM standards.
2. Soil classifications are in general accordance with ASTM D2487(as applicable), based on testing indicated and visual classification.
3. Key to abbreviations: NP=Non-Plastic; -- indicates no test performed; BRL = below reporting limit
4. Strata: F=Fill; L=Lacustrine

Schnabel ENGINEERING

Project: Champlain Hudson Power Express
Rail Explorations
Whitehall, NY



PLOTTED DATA REPRESENTS SOIL PASSING NO. 40 SIEVE

	Specimen		LL	PL	PI	Fines	Description
●	**K113.5**	**8.0 ft**	**65**	**21**	**44**		**Fat Clay (visual field description)**
⧗	**K113.5**	**25.0 ft**	**64**	**25**	**39**	**100**	**FAT CLAY (CH), gray**
▲	**K114.6**	**35.0 ft**	**56**	**25**	**31**	**99**	**FAT CLAY (CH), gray**
★	**K114.6**	**62.0 ft**	**59**	**22**	**37**	**100**	**FAT CLAY (CH), dark brownish gray**
⊙	**K116.1**	**5.0 ft**	**43**	**20**	**23**		**Lean Clay (visual field description)**
✿	**K116.1**	**42.0 ft**	**71**	**25**	**46**	**100**	**FAT CLAY (CH), gray**
○	**K116.9**	**40.0 ft**	**56**	**23**	**33**	**100**	**FAT CLAY (CH), gray**
△	**K116.9**	**50.0 ft**	**62**	**23**	**39**	**95**	**FAT CLAY (CH), gray**

Schnabel ENGINEERING

ATTERBERG LIMITS

Project: Champlain Hudson Power Express
Rail Explorations
Whitehall, NY

Contract: 21C25020.03

ATTERBERG_LIMITS KIEWIT-CHPE-RAIL-EXPLORATIONS.GPJ SCHNABEL DATA TEMPLATE 2008_04_22.GDT 2/25/22

Kiewit

MEMORANDUM

DATE: September 23, 2022

TO: Antonio Marruso, P.E.; CHA Consulting, Inc.

FROM: Matthew Hawley, P.E.; Kiewit Engineering (NY) Corp. MKH
Jaren Knighton; Kiewit Engineering (NY) Corp.

SUBJECT: Geotechnical Data: Segment 3 - Package 1C - HDD Crossing 8 – Revision 1
Champlain Hudson Power Express Project
Whitehall, New York

Kiewit Engineering is providing the enclosed geotechnical data for use in the horizontal direction drill (HDD) design for the Champlain Hudson Power Express project in Upstate New York. This HDD crossing is located south of Whitehall, New York. The approximate station for the start of HDD crossing Number 8 is STA 15296+00 (43.478169° N, 73.429841° W).

The geotechnical data at this HDD crossing is enclosed. The available data is from the previous investigation by AECOM, referenced below. No additional exploratory borings were performed at this HDD location.

- AECOM, Geotechnical Data Report, Upland Segments, Champlain Hudson Power Express, dated May 28, 2021.

Contact us if you have questions or require additional information.

HDD 8

Borings WFE-1C, WFE-1

Segment 3

CHPE Segments 1, 2, and 3 - Packages 1A, 1B, and 1C
HDD Soil Boring Coordinates and Elevations

Firm	Boring	Northing (feet)	Easting (feet)	Ground Surface Elevation (feet)
S.W. Cole*	B102.4-1	1762367.3	777951.9	139.42
	B109.7-1	1729097.5	774410.6	116.4
	B109.8-1	1728870.4	774869.2	99.8
	B110.1-1	1728142.0	776337.8	105.0
TRC*	B113.4-1	1714875.2	781894.9	122.9
	B114.4-1	1709558.6	780857.2	122.7
	B115.2-1	1705777.9	780186.6	120.9
	B116.1-1	1701426.5	778616.5	124.1
	B116.2-1	1700894.8	778375.8	124.3
	B116.8-1	1697938.4	777308.2	131.6
AECOM**	PD-7	1783019.4	778020.6	266.4
	PD-7A	1782960.9	778149.9	269.5
	WFE-1	1693492.9	776280.6	127.9
	WFE-1C	1693895.8	776092.3	129.3

Notes:
- Northings and Eastings are provided in NAD83 New York State Plane East Zone.
- Elevations are referenced to the NAVD88 datum.

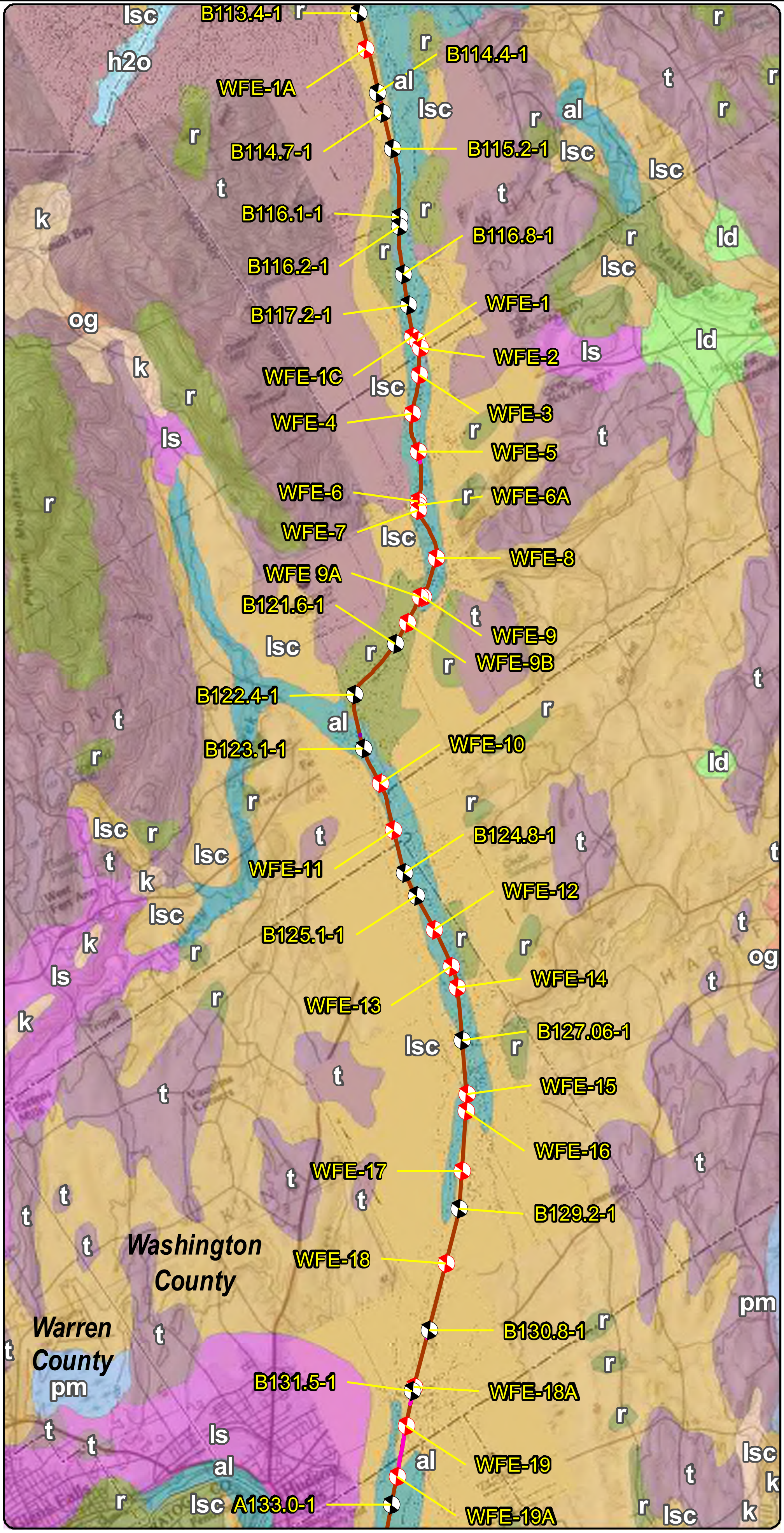
* TRC and S.W. Cole boring coordinates as shown in Table 1-6 in AECOM report (reference below). Boring elevations estimated from November 2021 topographic survey by Williams Aerial.

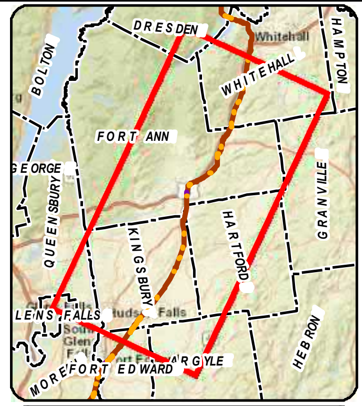
** AECOM boring coordinates and elevations as shown in Table 1-6 in AECOM report.

*** Kiewit boring coordinates and elevations are noted on the boring logs.

Reference:

AECOM, Geotechnical Data Report, Upland Segments: Putnam Station, Washington County, to Cementon, Green County, NY, Champlain Hudson Power Express, dated May 28, 2021.





LEGEND

- 2021 Boring Location
- Previous (2013) Boring Location
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- Town Boundary
- County Boundary

Surficial Geology

- al - Recent alluvium
- h2o - Water
- k - Kame deposits
- ld - Lacustrine delta
- ls - Lacustrine sand
- lsc - Lacustrine silt and clay
- og - Outwash sand and gravel
- pm - Swamp deposits
- r - Bedrock
- t - Till

N

1 0.5 0 1 Miles

Transmission Developers Inc.

Champlain Hudson Power Express Project

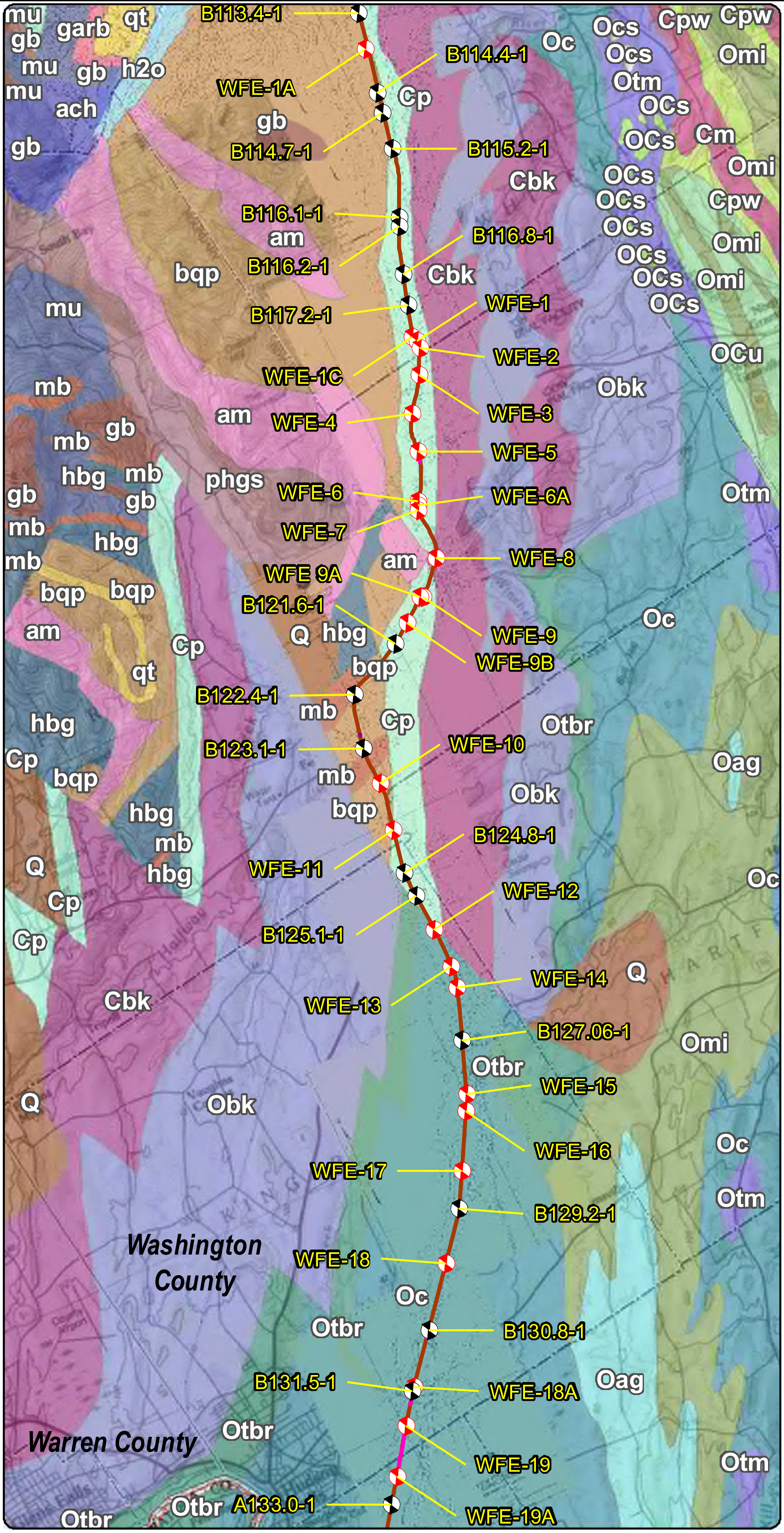
Champlain Hudson Power Express Inc.

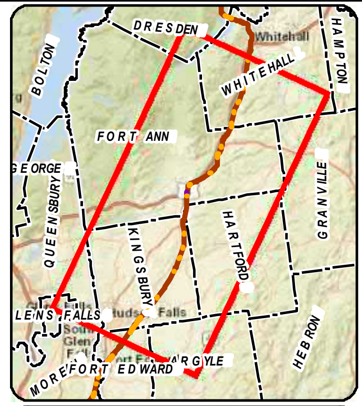
Surficial Geology and Geotechnical Borings Whitehall to Fort Edward Figure 3-3

Prepared on 5/5/2021
by: AECOM

DATA SOURCES: ESRI, NYSDOT, NOAA, USACE, NYDOS, TDI, TRC

Y:\Projects\CHPE\Route\Consensus_Alternative_Routes\MXD\Alt_5_Routes_DZ_201909\Boring_Locations\Maps_for_May_2021_Report\Whitehall_to_Ft_Ed_Boring_Locations_Surficial_May_2021_Report.mxd





LEGEND

- 2021 Boring Location
- Previous (2013) Boring Location
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- Town Boundary
- County Boundary

Bedrock Geology

- Cbk - Beekmantown Group
- Cm - Mettawee Formation
- Cp - Potsdam Sandstone
- Cpw - Poultney Formation ("A" Member)
- No Label
- OCs - Cambrian-Middle Ordovician carbonate
- OCu - Undivided Ordovician and Cambrian
- Oag - Austin Glen Formation
- Obk - Beekmantown Group
- Oc - Canajoharie Shale
- Omi - Mount Merino Formation
- Op - Poultney Formation ("B" and "C")
- Otbr - Dolgeville Formation
- Otm - Taconic Melange
- Q - Glacial and Alluvial Deposits
- ach - metanorthosite and anorthositic
- am - Amphibolite, pyroxenic amphibolite
- bqp - Biotite-quartz-plagioclase
- garb - Quartz-feldspar paragneiss
- gb - Olivine metagabbro
- h2o - Water
- hbg - Biotite and or hornblende granite gneiss
- mb Calcitic and dolomitic marble
- mu - Undivided metased rock and migmatite
- phgs - Charnockite, granitic, quartz syenite
- qt - Quartzite

N

1 0.5 0 1 Miles

Transmission Developers Inc.

Champlain Hudson Power Express Project

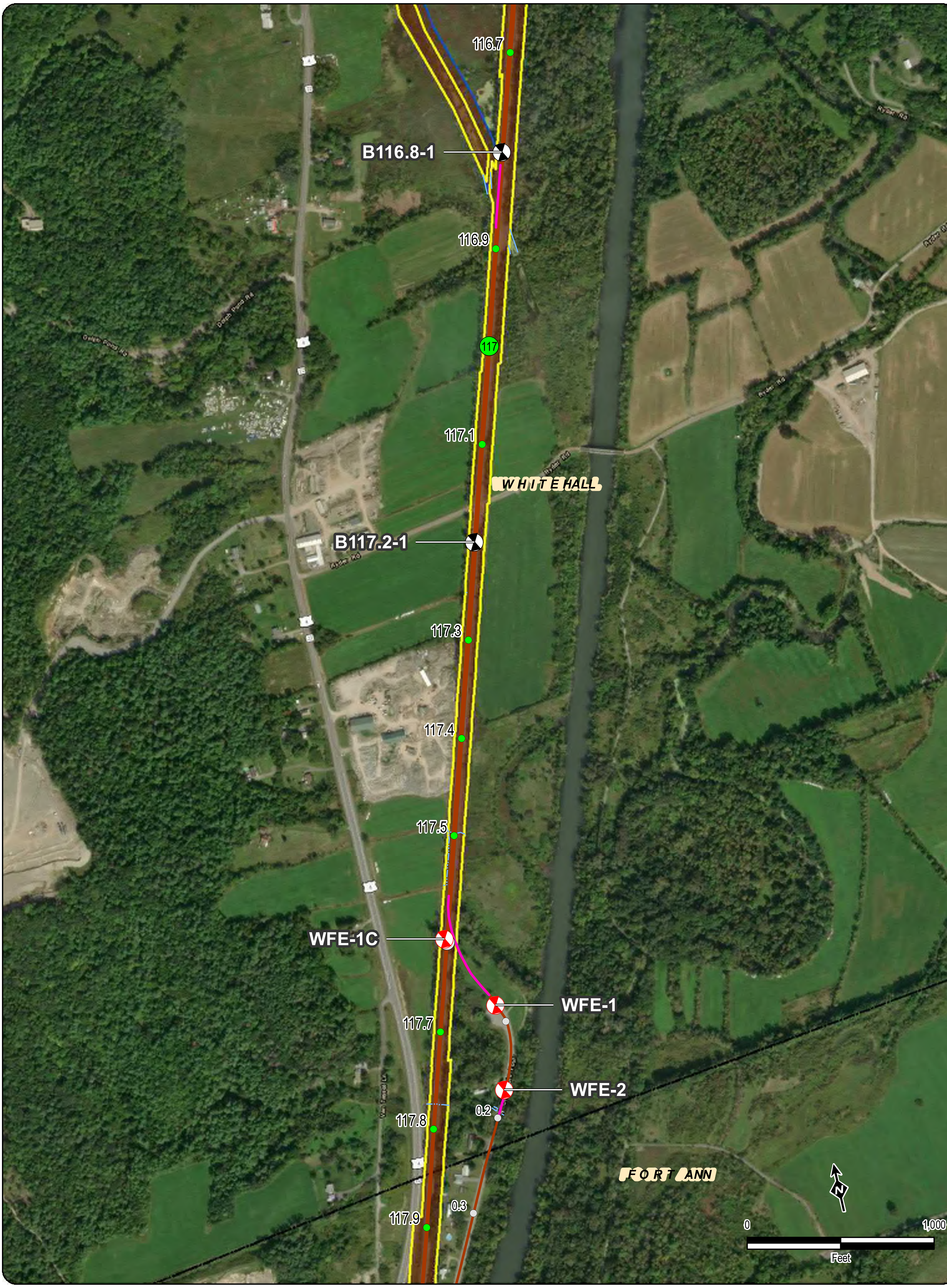
Champlain Hudson Power Express Inc.

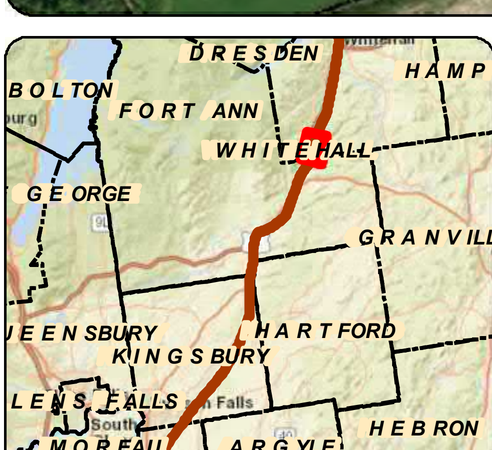
Bedrock Geology and Geotechnical Borings Whitehall to Fort Edward Figure 4-3

Prepared on 5/5/2021 by: AECOM

DATA SOURCES: ESRI, NYSDOT, NOAA, USACE, NYDOS, TDI, TRC

Y:\Projects\CHPE\Route\Consensus_Alternative_Routes\MXD\Alt_5_Routes_DZ_201909\Boring_Locations\Maps_for_May_2021_Report\Whitehall_to_Ft_Ed_Boring_Locations_Bedrock_May_2021_Report.mxd





LEGEND

- 111.8 Certified Milepost - Tenths
- 135 Certified Milepost
- 111.8 Preferred Alternative Milepost - Tenths
- 135 Preferred Alternative Milepost
- Terrestrial Route HVDC
- Submarine Route HVDC
- Terrestrial Route HVAC
- Preliminary HDD Locations
- Preliminary Pipe Bridge Location
- 2021 Boring Location
- Previous (2013) Boring Location
- Streams/Ditches
- Railroad ROW
- Deviation Zone
- Deviation Zone Outside ROW
- Preferred Alternative Deviation Zone
- Preferred Alternative Deviation Zone Outside ROW
- Town Boundary
- Village Boundary
- State Park (OPRHP)

Parcel Ownership

TOWN NAME

Road Name

Village Name

Transmission Developers Inc.

Champlain Hudson Power Express Project

Champlain Hudson Power Express Inc.

BORING LOCATION PLAN

Whitehall to Fort Edward

Figure A-3

Sheet 4 of 16

Prepared by: AECOM 5/19/2021

DATA SOURCES: ESRI, NETWORK MAPPING 2010, NYSDOT, OPRHP, TDI, TRC

Y:\Projects\CHPE\Route\Consensus_Alternative_Routes\MXD\Alt_5_Routes_DZ_201909\Boring_Locations\Maps_for_May_2021_Report\Whitehall_to_Edward_Boring_Locations_Mapset_May_2021_Report.mxd

AECOM

BORING LOG

BORING CONTRACTOR: ADT	PROJECT NAME: CHPE -
DRILLER: Chris Chaillou	PROJECT NO.: 60323056
SOILS ENGINEER/GEOLOGIST: Chris French	HOLE NO.: **WFE-1**
LOCATION: Ft Ann Bypass MP - 0.09	START DATE: 12/21/2021
	FINISH DATE: 12/21/2021
	OFFSET: N/A

GROUND WATER OBSERVATIONS		CASING	SAMPLER	DRILL BIT	CORE BARREL	DRILL RIG: Geoprobe 7822DT
No water observed	TYPE	Flush Joint Steel	California Modified	Tricone Roller Bit		BORING TYPE: SPT
	SIZE I.D.	4"	2.5"	- -		BORING O.D.: 4.5"
	SIZE O.D.	4.5"	3"	3 7/8"		SURFACE ELEV.:
	HAMMER WT.	140 lbs	140 lbs			LONGITUDE:
	HAMMER FALL	30"	30"			LATITUDE:

DEPTH	CORING RATE MIN/FT	SAMPLE DEPTHS FROM - TO (FEET)	TYPE AND NO.	PEN. in	REC. in	BLOWS PER 6 in ON SAMPLER (ROCK QUALITY DESIGNATION)				N Corr.(2)	USCS CLASS.	STRAT. CHNG. DEPTH	FIELD IDENTIFICATION OF SOILS
		0'-5'				Hand Cleared					SM/SP	Silty Sand	0'-3' Br f-c SAND, little silt, little sub angular gravel, loose, moist (fill)
1.0													
2.0													
3.0		3'-5'	S-1									Silty CLAY	3'-4'; Brown SILT and clay, little f-m sand, medium stiff, moist
4.0													4'-5'; Brown f-c SAND, little silt, loose, saturated, TR-1; (3.0'-5.0')
5.0													
		5'-7'	S-2	24"	24"	4	8	9	5	11	CH		Gray CLAY and silt, occasional f-c sand laminates, organic material, stiff, moist
6.0													
7.0													
		7'-9'	S-3	24"	24"	6	6	6	6	8	CH		Gray silty CLAY, occasional fine sand laminates, medium stiff, moist
8.0													TR-2; (8.0'-8.5')
9.0													
		9'-11'	S-4	24"	24"	8	9	9	5	12	CH		Gray silty CLAY, medium stiff, moist
10.0													
11.0													
		11'-13'	S-5	24"	12"	5	6	6	6	8	CH		Gray silty CLAY, medium stiff, moist
12.0													
13.0													
		13'-15'	S-6	24"	20"	8	9	9	9	12	CH		Gray silty CLAY, brown, mottling, medium stiff, moist
14.0													
15.0													
		15'-17'	S-7	24"	24"	5	5	6	8	7	CH		Gray silty CLAY, soft, moist
16.0													TR-3; (16.0'-16.5')
17.0													
18.0													
19.0													
20.0													

NOTES:

(1) Thick-wall ring lined drive sampler (California sampler) used for SPT samples. Rings dimensions = 2-1/2" O.D. by 2-7/16" I.D. by 6" length.

(2) Correction factor: Ncorr=N*(2.0^2-1.375^2)in./(3.0^2-2.4^2)in. = N*0.65.

Soil description represents a field identification after D.M. Burmister unless otherwise noted.

SAMPLE TYPE:	S= SPLIT SPOON	U=SHELBY TUBE	R=ROCK CORE	
PROPORTIONS:	TRACE=1-10%	LITTLE=10-20%	SOME=20-35%	AND=35-50%

BORING CONTRACTOR: ADT	AECOM	SHEET 2 OF 2
DRILLER: Chris Chaillou		PROJECT NAME: CHPE -
SOILS ENGINEER: Chris French		PROJECT NO.: 60323056
		HOLE NO.: **WFE-1**
		START DATE: 12/21/2021
	BORING LOG	FINISH DATE: 12/21/2021
LOCATION: Ft Ann Bypass MP - 0.09		OFFSET: N/A

DEPTH	CORING RATE MIN/FT	DEPTHS FROM - TO (FEET)	TYPE AND NO.	PEN. in	REC. in	BLOWS PER 6 in ON SAMPLER (ROCK QUALITY DESIGNATION)				N Corr.	USCS CLASS.	STRAT. CHNG. DEPTH	FIELD IDENTIFICATION OF SOILS
		20'-22'	S-8	24"	24"	3	8	11	12	12	CH		Gray silty CLAY, brown mottling, very stiff, moist
21.0													
22.0													
23.0													
24.0													
25.0													
		25'-27'	S-9	24"	24"	WOH/15"		1	3	1	CH		Gray silty CLAY, soft, moist
26.0													
27.0													
28.0													
29.0													
30.0												Silty CLAY	
		30'-32'	S-10	24"	24"	WOH/17"			2		CH		Gray silty CLAY, soft, moist
31.0													
32.0													
33.0													
34.0													
35.0													
		35'-37'	S-11	24"	24"	WOH/20"			1		CH		Gray silty CLAY, very soft, moist-wet
36.0													
37.0													
38.0													
		38'-40'	S-12	24"	24"	WOH/18"			1		CH		SAA
39.0													TR-4; (39.0'-39.5')
40.0													
													Boring terminated at 40', grouted to surface
41.0													
42.0													
43.0													
44.0													
45.0													

NOTES:

Soil description represents a field identification after D.M. Burmister unless otherwise noted.

The information contained on this log is not warranted to show the actual subsurface condition. The contractor agrees that he will make no claims against AECOM if he finds that the actual conditions do not conform to those indicated by this log.

SAMPLE TYPE:	S= SPLIT SPOON	U=SHELBY TUBE	R=ROCK CORE	
PROPORTIONS:	TRACE=1-10%	LITTLE=10-20%	SOME=20-35%	AND=35-50%

BORING LOG

BORING CONTRACTOR: ADT	AECOM	SHEET 1 OF 2
DRILLER: Chris Chaillou		PROJECT NAME: CHPE -
SOILS ENGINEER/GEOLOGIST: Chris French		PROJECT NO.: 60323056
		HOLE NO.: **WFE-1C**
		START DATE: 12/10/20
	BORING LOG	FINISH DATE: 12/10/20
LOCATION: MP- 117.6 (CP Rail)		OFFSET: N/A

GROUND WATER OBSERVATIONS		CASING	SAMPLER	DRILL BIT	CORE BARREL	DRILL RIG: Geoprobe 7822DT
Water at 1.5'	TYPE	Flush Joint Steel	California Modified	Tricone Roller Bit		BORING TYPE: SPT
	SIZE I.D.	4"	2.5"	- -		BORING O.D.: 4.5"
	SIZE O.D.	4.5"	3"	3 7/8"		SURFACE ELEV.:
	HAMMER WT.	140 lbs	140 lbs			LONGITUDE:
	HAMMER FALL	30"	30"			LATITUDE:

DEPTH	CORING RATE MIN/FT	SAMPLE DEPTHS FROM - TO (FEET)	TYPE AND NO.	PEN. in	REC. in	BLOWS PER 6 in ON SAMPLER (ROCK QUALITY DESIGNATION)				N Corr.(2)	USCS CLASS.	STRAT. CHNG. DEPTH	FIELD IDENTIFICATION OF SOILS
												Sand and Gravel	0.0'-3.0'; Dark brown coarse SAND, little angular-subrounded gravel, little medium-fine sand, trace cobbles
1.0		0'-3'				Hand Cleared					SP		
2.0													Hand clearing stopped, material sloughing in
3.0													
		3'-5'	S-1	24"	24"	8	2	1	1	2	SP		Gray medium-coarse SAND, little subangular gravel, little fine sand; loose, saturated
4.0													TR-1; (3.0'-5.0')
5.0												Silty CLAY	4.5'; Gray silty CLAY, trace subangular gravel
		5'-7'	S-2	24"	6"	4	4	7	5	7	CH		Gray CLAY and silt, little coarse sand, little subangular gravel; wet, stiff
6.0													
7.0													
		7'-9'	S-3	24"	12"	7	9	8	8	11	CH		Light brown silty CLAY; very stiff, moist
8.0													TR-2; (8.0'-8.5')
9.0													
		9'-11'	S-4	24"	24"	12	7	6	6	8	CH		Light brown slity CLAY; stiff, moist
10.0													
11.0													
		11'-13'	S-5	24"	24"	7	7	7	6	9	CH		Light brown silty CLAY; stiff, moist
12.0													TR-3; (12.0'-12.5')
13.0													
		13'-15'	S-6	24"	24"	8	6	4	6	7	CH		Light brown silty CLAY; stiff, moist
14.0													
15.0													
		15'-17'	S-7	24"	24"	7	8	10	10	12	CH		Light brown silty CLAY; soft to stiff, increasing stiffness with depth, moist
16.0													
17.0													
18.0													
19.0													
20.0													

NOTES:
(1) Thick-wall ring lined drive sampler (California sampler) used for SPT samples. Rings dimensions = 2-1/2" O.D. by 2-7/16" I.D. by 6" length.
(2) Correction factor: Ncorr=N*(2.0^2-1.375^2)in./(3.0^2-2.4^2)in. = N*0.65.

Soil description represents a field identification after D.M. Burmister unless otherwise noted.

The information contained on this log is not warranted to show the actual subsurface condition. The contractor agrees that he will make no claims against AECOM if he finds that the actual conditions do not conform to those indicated by this log.

SAMPLE TYPE:	S= SPLIT SPOON	U=SHELBY TUBE	R=ROCK CORE	
PROPORTIONS:	TRACE=1-10%	LITTLE=10-20%	SOME=20-35%	AND=35-50%

BORING CONTRACTOR: ADT	AECOM	SHEET 2 OF 2
		PROJECT NAME: CHPE -
DRILLER: Chris Chaillou		PROJECT NO.: 60323056
		HOLE NO.: **WFE-1C**
SOILS ENGINEER: Chris French		START DATE: 12/10/20
	BORING LOG	FINISH DATE: 12/10/20
LOCATION: MP- 117.6 (CP Rail)		OFFSET: N/A

DEPTH	CORING RATE MIN/FT	DEPTHS FROM - TO (FEET)	TYPE AND NO.	PEN. in	REC. in	BLOWS PER 6 in ON SAMPLER (ROCK QUALITY DESIGNATION)				N Corr.	USCS CLASS.	STRAT. CHNG. DEPTH	FIELD IDENTIFICATION OF SOILS
		20'-22'	S-8	24"	24"	2	3	5	8	5	CH		Gray silty CLAY; soft to stiff, increasing stiffness with depth, moist
21.0													
22.0													
23.0													
24.0													
25.0													
		25'-27'	S-9	24"	24"	4	6	14	17	13	CH		Gray silty CLAY; soft-medium stiff, stiffness increasing with depth, wet
26.0													
27.0													
28.0													
29.0													
30.0												Silty CLAY	
		30'-32'	S-10	24"	24"	2	5	5	9	7	CH		Gray silty CLAY, soft-medium stiff, increasing stiffness with depth, moist
31.0													
32.0													
33.0													
34.0													
35.0													
		35'-37'	S-11	24"	24"	3	3	6	10	6	CH		SAA
36.0													TR-4; (36.0'-36.5')
37.0													
38.0													
		38'-40'	S-12	24"	24"	2	5	8	10	8	CH		SAA
39.0													
40.0													
													EOB at 40', borehole grouted
41.0													
42.0													
43.0													
44.0													
45.0													

NOTES:

Soil description represents a field identification after D.M. Burmister unless otherwise noted.

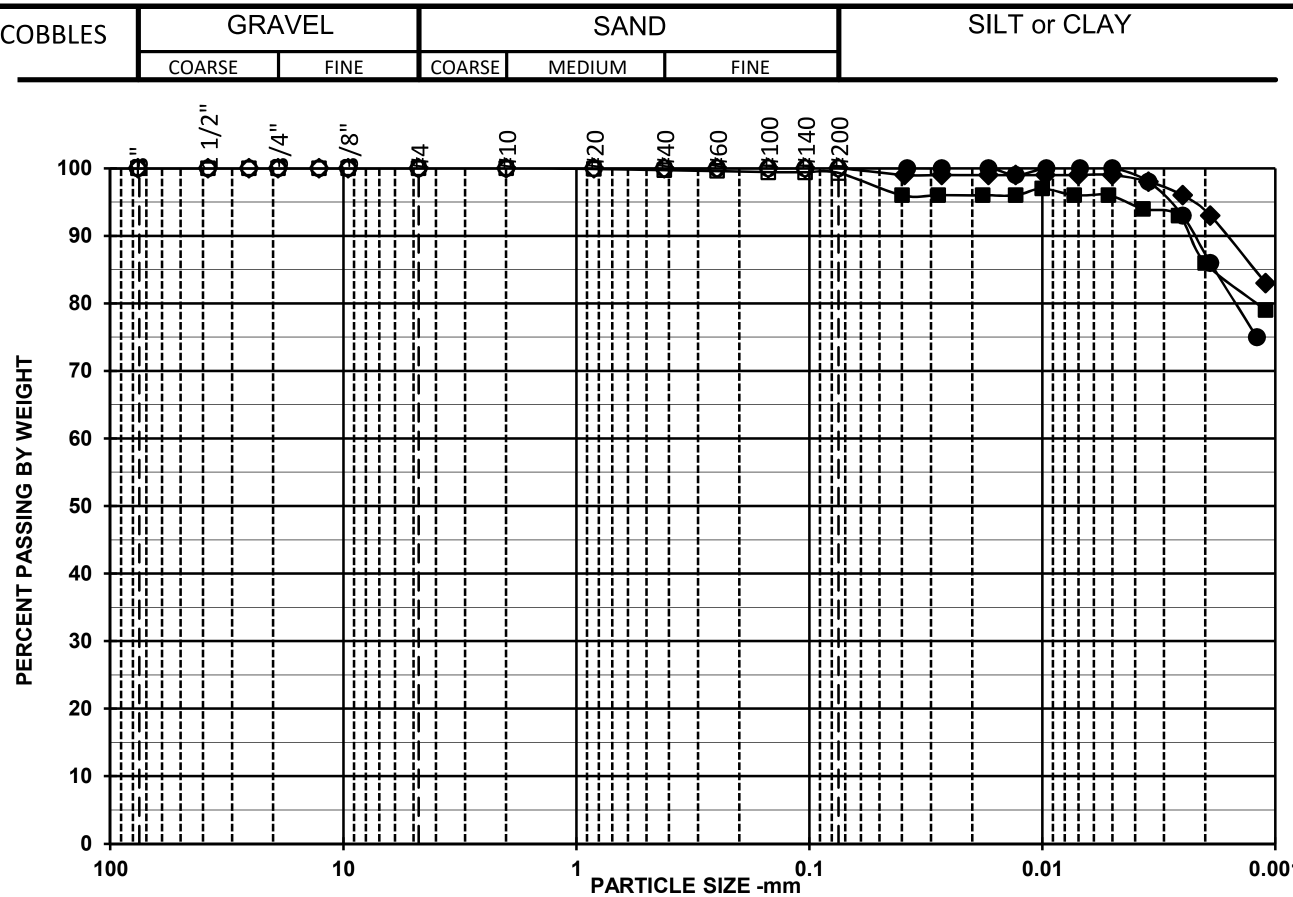
The information contained on this log is not warranted to show the actual subsurface condition. The contractor agrees that he will make no claims against AECOM if he finds that the actual conditions do not conform to those indicated by this log.

SAMPLE TYPE:	S= SPLIT SPOON	U=SHELBY TUBE	R=ROCK CORE	
PROPORTIONS:	TRACE=1-10%	LITTLE=10-20%	SOME=20-35%	AND=35-50%

Aquifer
CHPE- Whitehall-Ft. Edward Borings
LABORATORY SOIL TESTING DATA SUMMARY

BORING NO.	SAMPLE NO.	DEPTH (ft)	IDENTIFICATION TESTS WATER CONTENT (%)	LIQUID LIMIT (-)	PLASTIC LIMIT (-)	PLAS. INDEX (-)	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDROMETER % MINUS 2 μm (%)	ORGANIC CONTENT (burnoff) (%)	REMARKS
WFE-1A	S-2	5-7	24.4	44	17	27	CL	93	39		
WFE-1A	S-5	11-13	43.0	68	23	45	CH	99.8	84		
WFE-1C	S-3	7-9	44.5				CH	99.3	86		
WFE-1C	S-7	15-17	44.5	78	27	51	CH	100	94		
WFE-1C	S-10	30-32	45.7	61	23	38	CH	100	87		
WFE-2	S-2	5-7	7.3				SW-SM	10.7	3		
WFE-2	S-7	15-17	26.0				SC	28.5	13		
WFE-2	S-9	25-27	66.0	71	26	45	CH	100	90		
WFE-4	S-2	5-7	18.0				SC	34	13		
WFE-4	S-4	9-11	18.3				SM	17	5		
WFE-5	S-2	5-7	19.9				SM	19	3		
WFE-5	S-4	9-11	18.6	28	15	13	CL	91	28		
WFE-6A	S-2	5-7	13.6				SP-SC	9	3		
WFE-6A	S-4	9-11	17.4				SP-SM	7	2		
WFE-8	S-3	6-8	24.9				SC	48.5	12		
WFE-8	S-4	8-10	88.5	128	53	75	MH	94	43		
WFE-10	S-2	5-7	38.0	71	24	47	CH	94	76		
WFE-10	S-4	9-11	22.5				CL	83.9	32		
WFE-12	S-2	5-7	23.5	49	20	29	CL	62.5	35		
WFE-12	S-4	9-11	28.3				CL	95.8	37		
WFE-14	S-3	7-9	25.7				CL	75.7	44		
WFE-14	S-5	13-15	22.5				ML	53.9	17		
WFE-16	S-3	7-9	36.7	75	25	50	CH	100	90		
WFE-16	S-9	25-27	37.1	73	24	49	CH	100	80		
WFE-18	S-3	7-9	229.7	293	93	200	OH	58	43	34.1	
WFE-18	S-8	20-22	34.3	30	21	9	CL	95	26		
WFE-18	S-10	30-32	64.3	56	21	35	CH	100	87		
WFE-18A	S-2	5-7	19.9	30	13	17	CL	88.5	29		
WFE-18A	S-7	15-17	18.9				SM	14.3	1		
WFE-18A	S-10	30-32	62.9	62	22	40	CH	99	86		
WFE-19A	S-3	7-9	38.1				SP-SM	8	3		
WFE-19A	S-8	20-22	31.8				SP-SM	8.3	2		
WFE-19A	S-10	30-32	17.6				SW-SM	8	1		

Note: (1) USCS symbol based on visual observation and Sieve and Atterberg limits reported.



Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

Symbol	□	◇	○
Boring	WFE-1C	WFE-1C	WFE-1C
Sample	S-3	S-7	S-10
Depth	7-9	15-17	30-32
% +3"	0	0	0
% Gravel	0	0	0
% SAND	0.7	0	0
%C SAND	0	0	0
%M SAND	0.3	0	0
%F SAND	0.4	0	0
% FINES	99.3	100	100
D_{100} (mm)	2	4.75	2
D_{60} (mm)			
D_{30} (mm)			
D_{10} (mm)			
Cc			
Cu			

Sieve Size/ID #	Percent Finer Data		
6"	100.0	100	100.0
4"	100.0	100	100.0
3"	100.0	100	100.0
1 1/2"	100.0	100	100.0
1"	100.0	100	100.0
3/4"	100.0	100	100.0
1/2"	100.0	100	100.0
3/8"	100.0	100	100.0
#4	100.0	100	100.0
#10	100.0	100	100.0
#20	99.9	100	100.0
#40	99.7	100	100.0
#60	99.6	100	100.0
#100	99.4	100	100.0
#140	99.4	100	100.0
#200	99.3	100	100.0
5μ m	96	99	100
2μ m	86	94	87
1μ m	78	81	71

SYMBOL	w (%)	LL	PL	PI	USCS	AASHTO	USCS DESCRIPTION AND REMARKS	DATE
□	44.5				CH		Brown, Fat clay	03/29/21
◇	44.5	78	27	51	CH		Gray, Fat clay	03/29/21
○	45.7	61	23	38	CH		Gray, Fat clay	03/26/21

Aquifer

CHPE- Whitehall-Ft. Edward Borings

TerraSense, LLC #7853-21003

PARTICLE SIZE DISTRIBUTION
ASTM D6913 & ASTM D7928

TerraSense Analysis File: GrainSizeV6Rev1a14

Siev1b.xlsx 4/30/2021

Appendix D

BoreAid HDD Simulation Output

Generated Output

WARNING: The accuracy of the data obtained by the BoreAid® system is highly dependent upon accurate data gathering, data input and proper use of the software. Vermeer is not responsible for that information. BoreAid® data is not intended to replace the need for future on-site utility locating, measuring and verification procedures, which are essential for accurate placement of new underground installations and avoidance of existing utilities.

CALL YOUR ONE-CALL SYSTEM FIRST

WARNING: Always contact your local One-Call system before the start of your digging project. The BoreAid® system is intended to be used with other utility locating methods, such as the use of the One-Call system and the exposing of existing utilities by potholing.

Locate utilities before drilling. Call 811 (U.S. only) or 1-888-258-0808 (U.S. or Canada) or local utility companies or national regulating authority.

Before you start any digging project, do not forget to call the local One-Call system in your area and any utility company that does not subscribe to the One-Call system. For areas not represented by One-Call Systems International, contact the appropriate utility companies or national regulating authority to locate and mark the underground installations. If you do not call, you may have an accident or suffer injuries; cause interruption of services; damage the environment; or experience job delays.

OSHA CFR 29 1926.651 requires that the estimated location of underground utilities be determined before beginning the excavation or underground drilling operation. When the actual excavation or bore approaches an estimated utility location, the exact location of the underground installation must be determined by a safe, acceptable and dependable method. If the utility cannot be precisely located, it must be shut off by the utility company.

Project Summary

General:	CHPE HDD 3 - Conduit 1
	P1C
	Start Date: 12-10-2021
	End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	KIE
Project Consultant:	CHA/BCE
Designer:	AB
	CHA
Description:	HDD 3 10-inch DR 9 - Conduit 1

Input Summary

Start Coordinate	(0.00, 0.00, 121.00) ft
End Coordinate	(1892.80, 0.00, 127.20) ft
Project Length	1892.80 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 3

Soil Layer #1 USCS, Gravel (G), GP

From Assistant

Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]

Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Clay (C), CL

From Assistant

Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 145.00, Coh: 5.56 [psi]

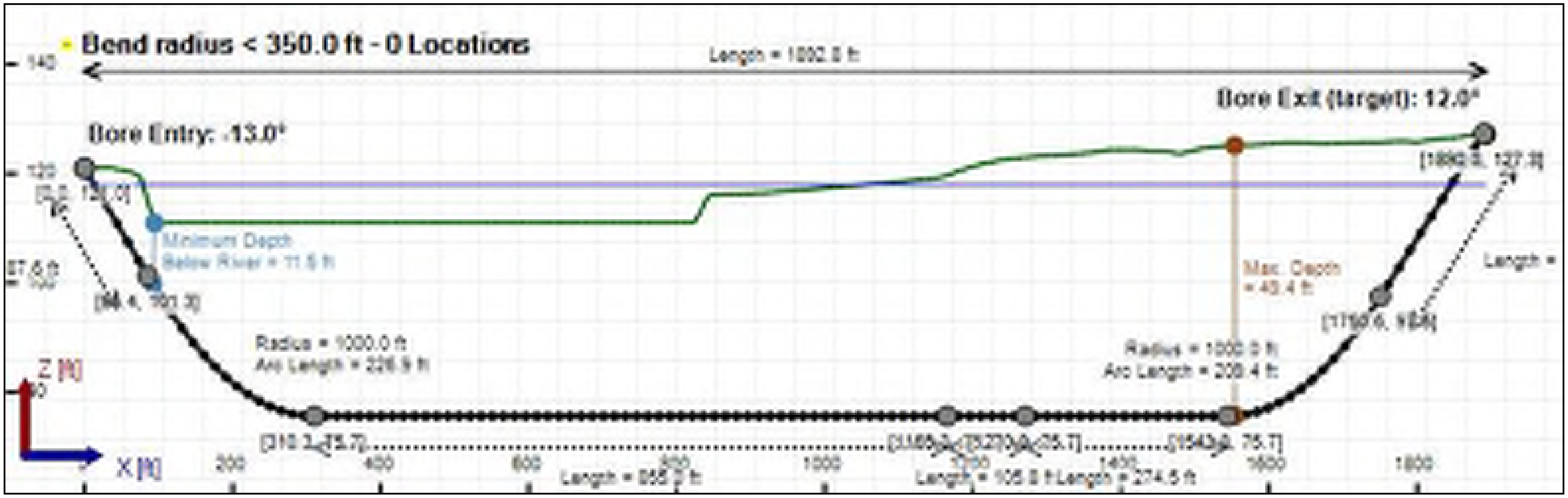
Soil Layer #3 USCS, Clay (C), CH

From Assistant

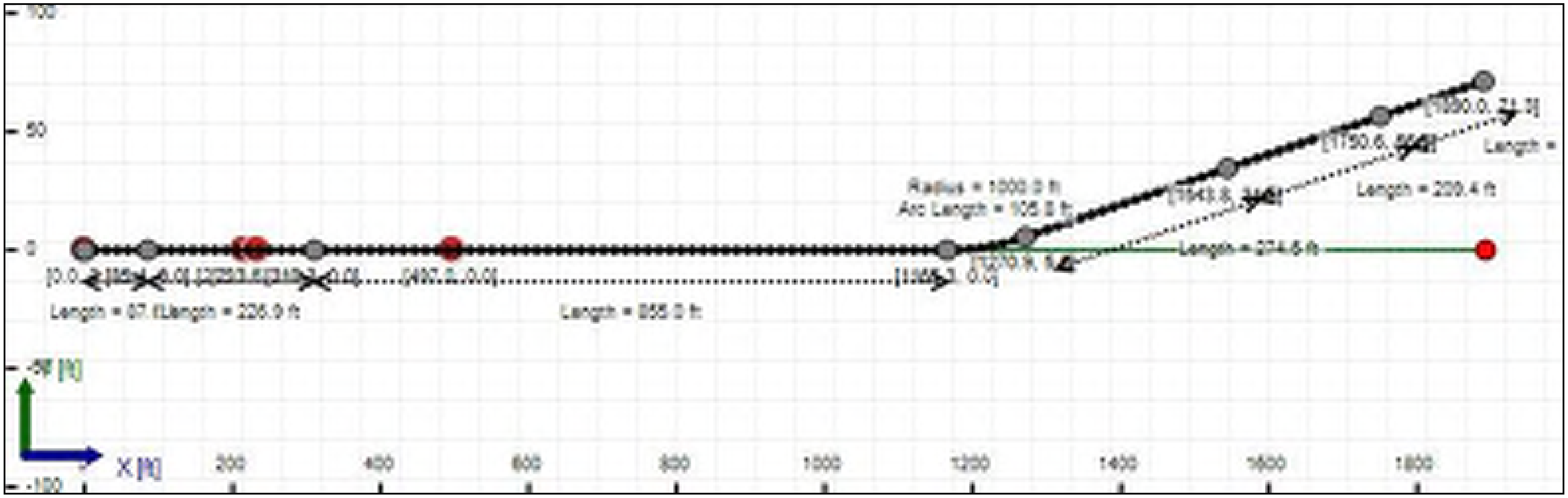
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 145.00, Coh: 3.13 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 1904.99 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 3.32999992370605 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	16.0	22.6
Water Pressure	18.4	18.3
Surface Surcharge	3.3	3.3
Internal Pressure	0.0	0.0
Net Pressure	34.4	40.9
Deflection		
Earth Load Deflection	4.358	6.151
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	4.490	6.283
Compressive Stress [psi]		
Compressive Wall Stress	154.6	184.1

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	32810.7	32810.7
Pullback Stress [psi]	915.0	915.0
Pullback Strain	1.591E-2	1.591E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	915.0	938.2
Tensile Strain	1.591E-2	1.677E-2

Net External Pressure = 25.4 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	4.490	7.5	1.7	OK
Unconstrained Collapse [psi]	34.4	92.5	2.7	OK
Compressive Wall Stress [psi]	154.6	1150.0	7.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	43.9	198.5	4.5	OK
Tensile Stress [psi]	938.2	1200.0	1.3	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	71.182 psi	64.599 psi
1	8.00 in	12.00 in	71.158 psi	64.566 psi
2	12.00 in	16.13 in	71.123 psi	64.519 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

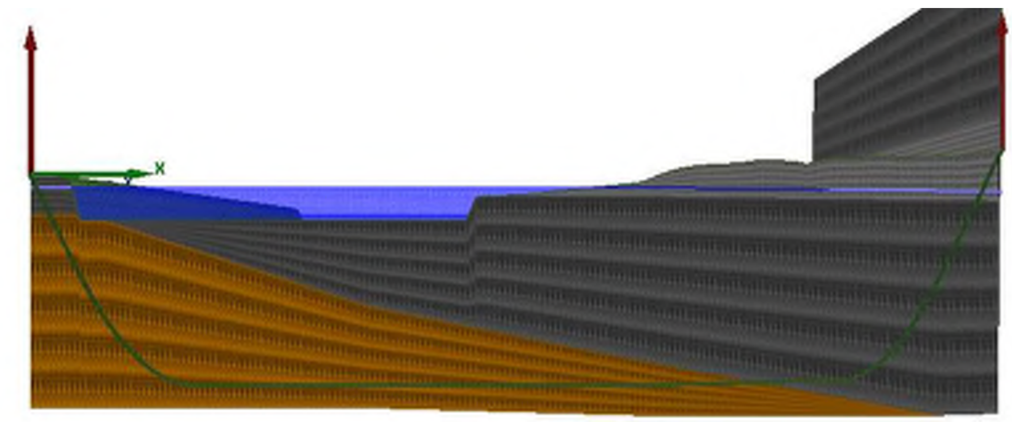
Rheological model: Power-Law

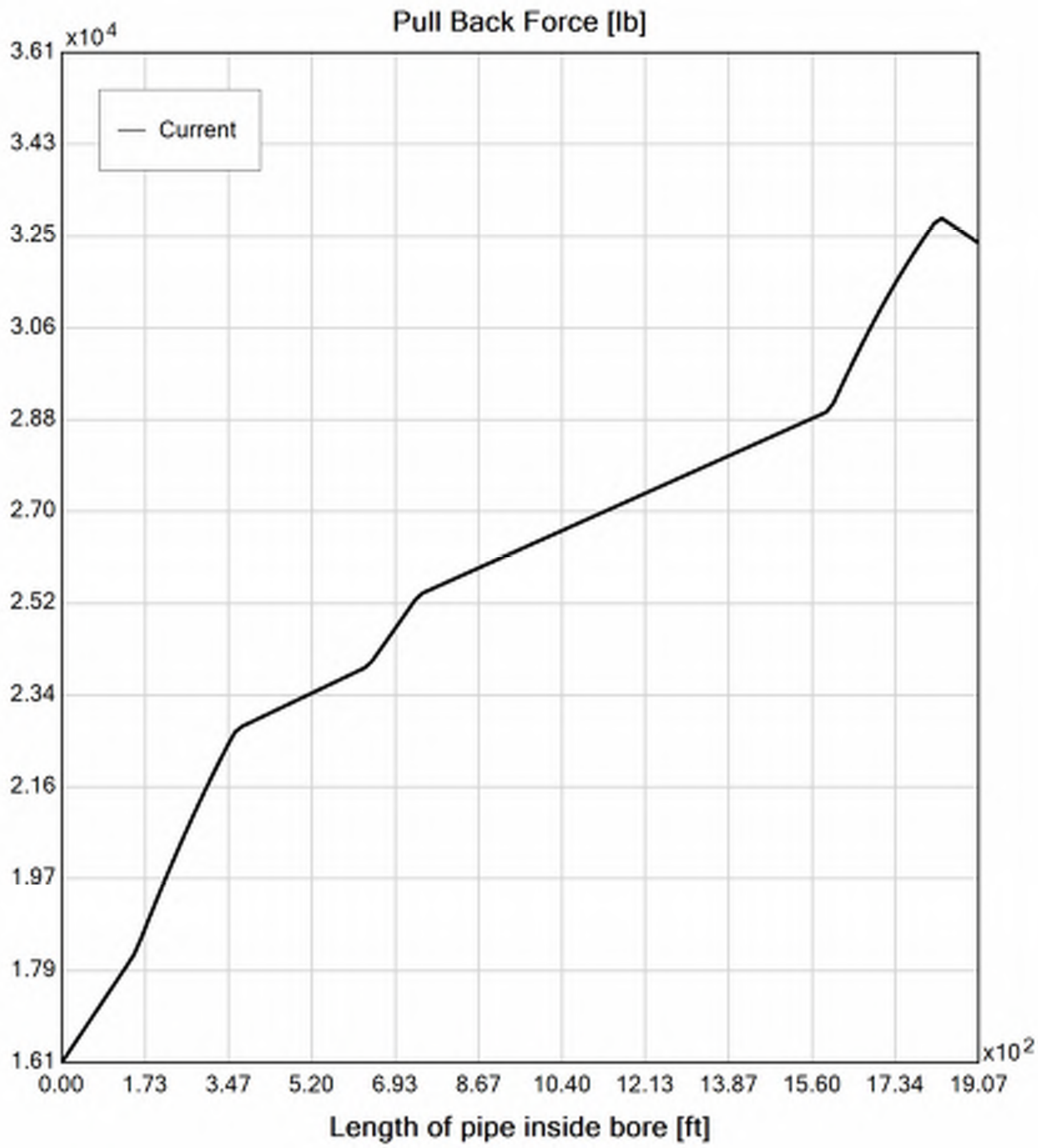
Fluid Consistency Index (K): 63.17

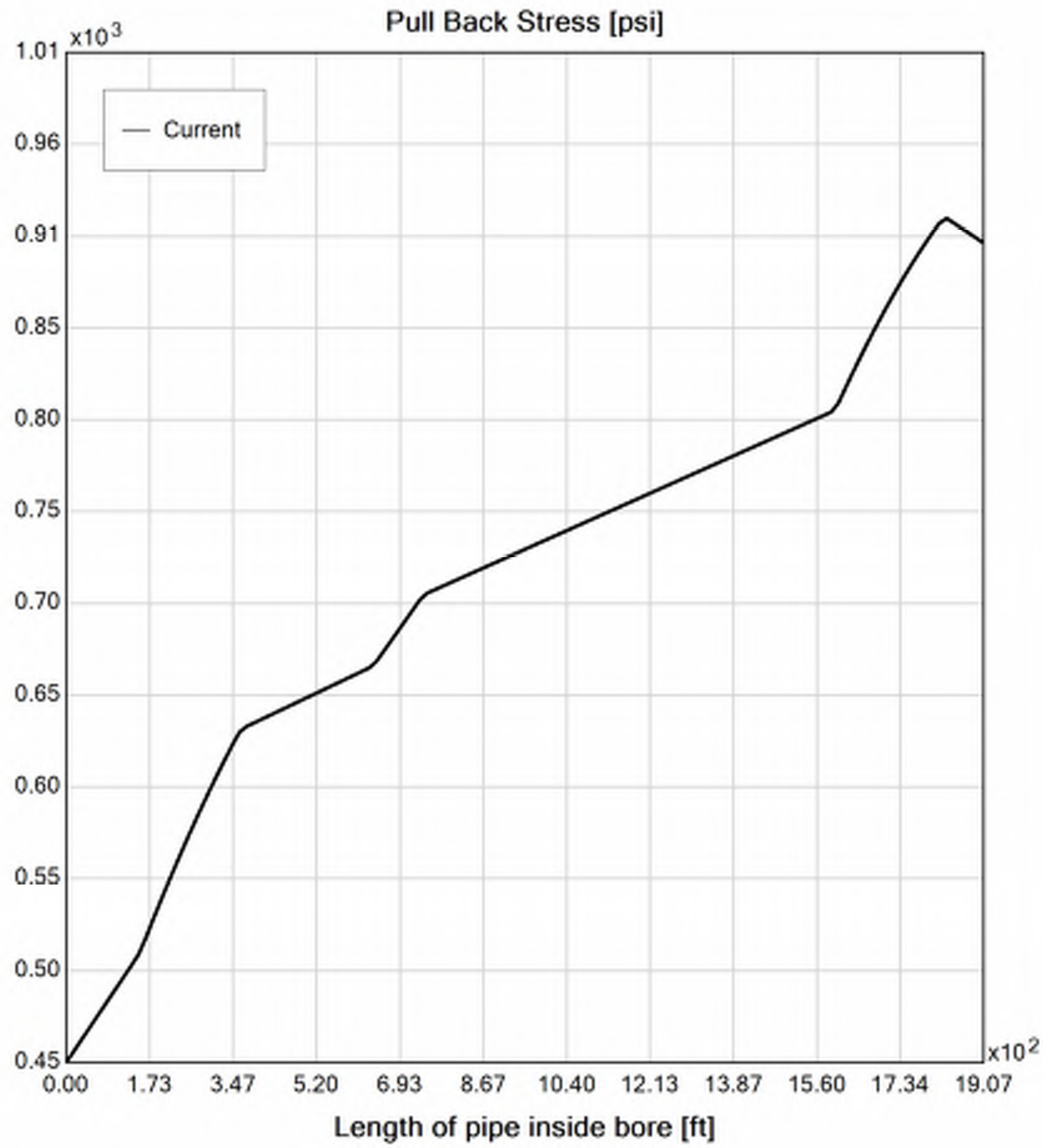
Power Law Exponent (n): 0.14

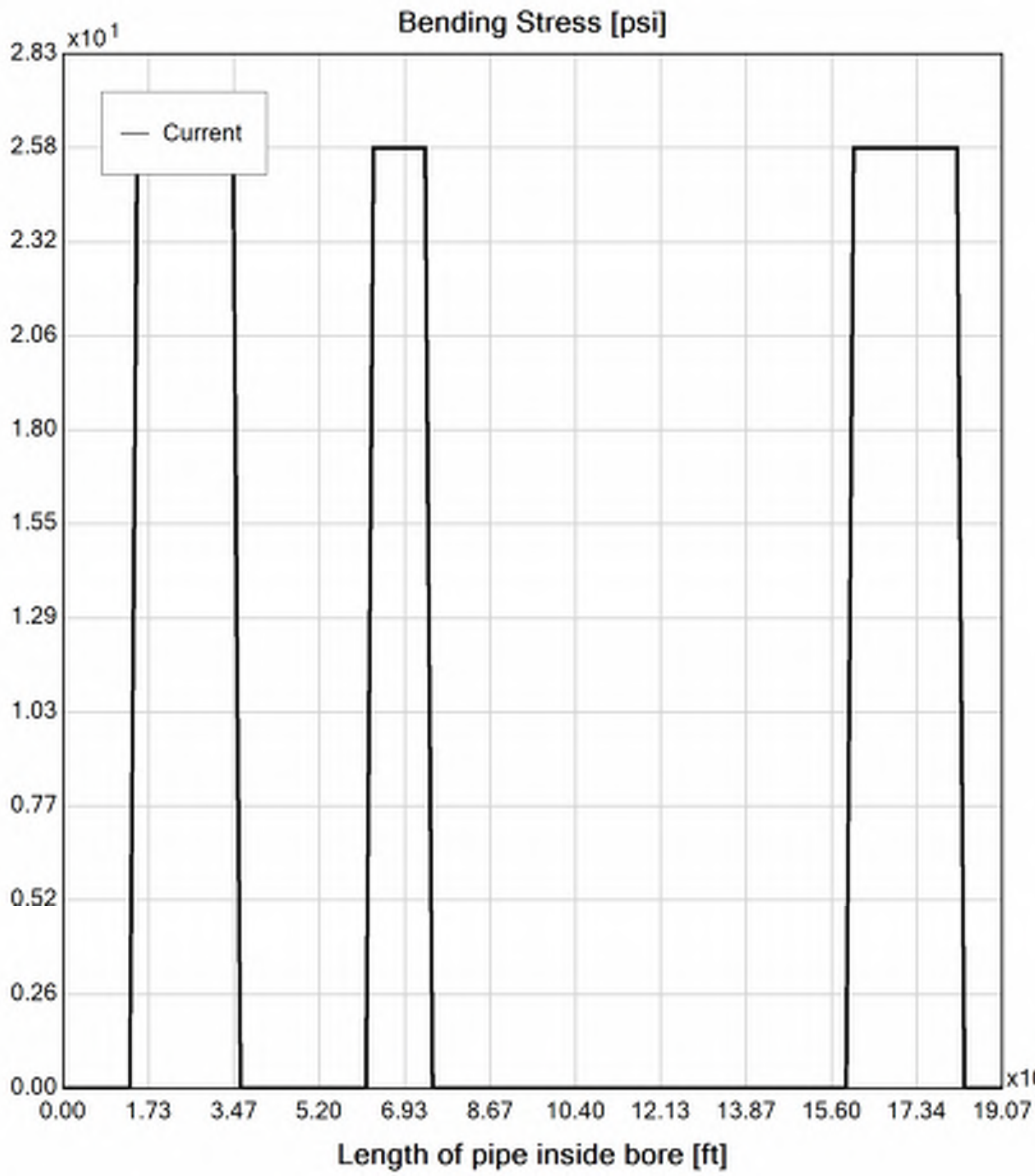
Effective Viscosity (cP): 859.3

Virtual Site

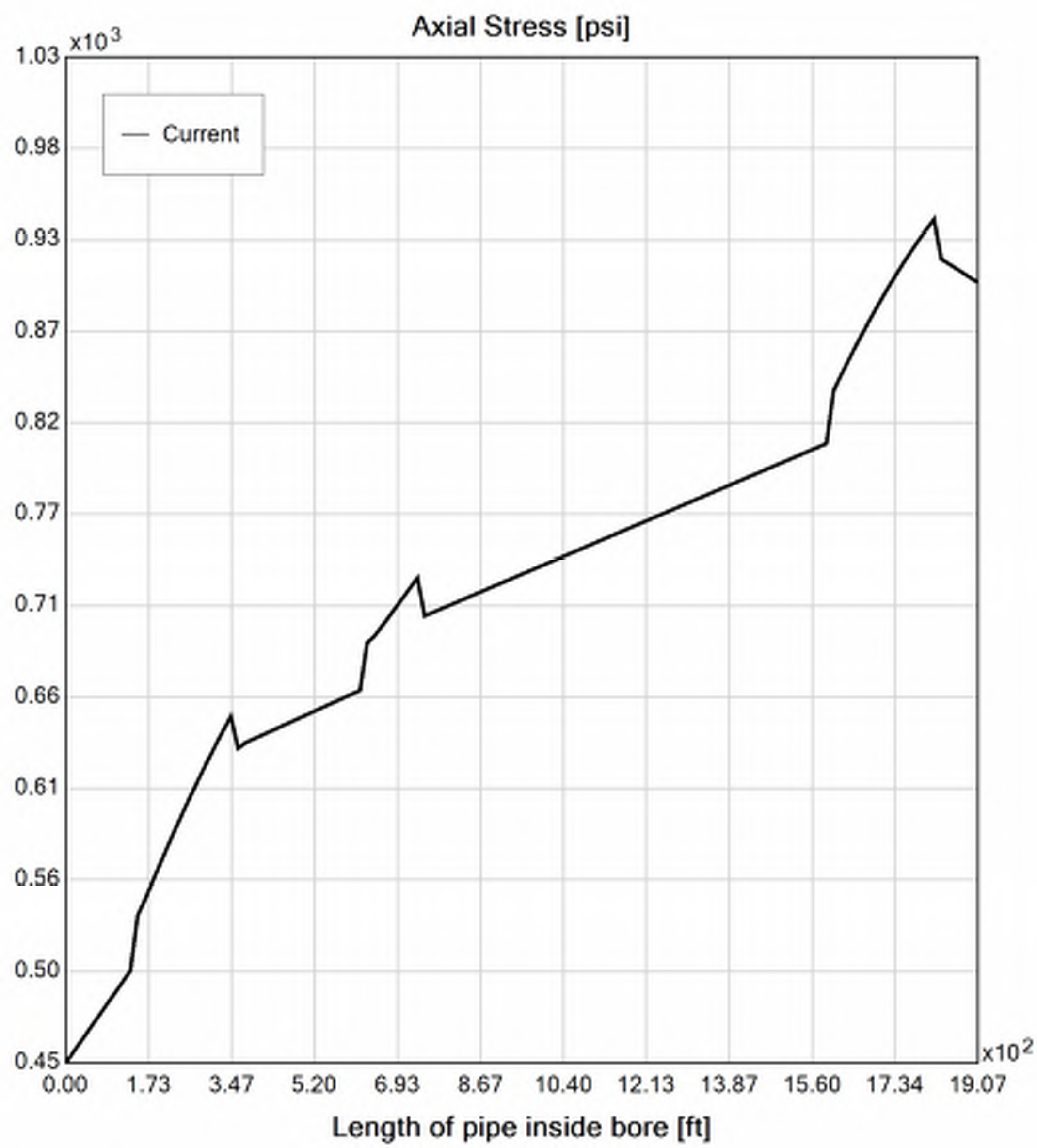


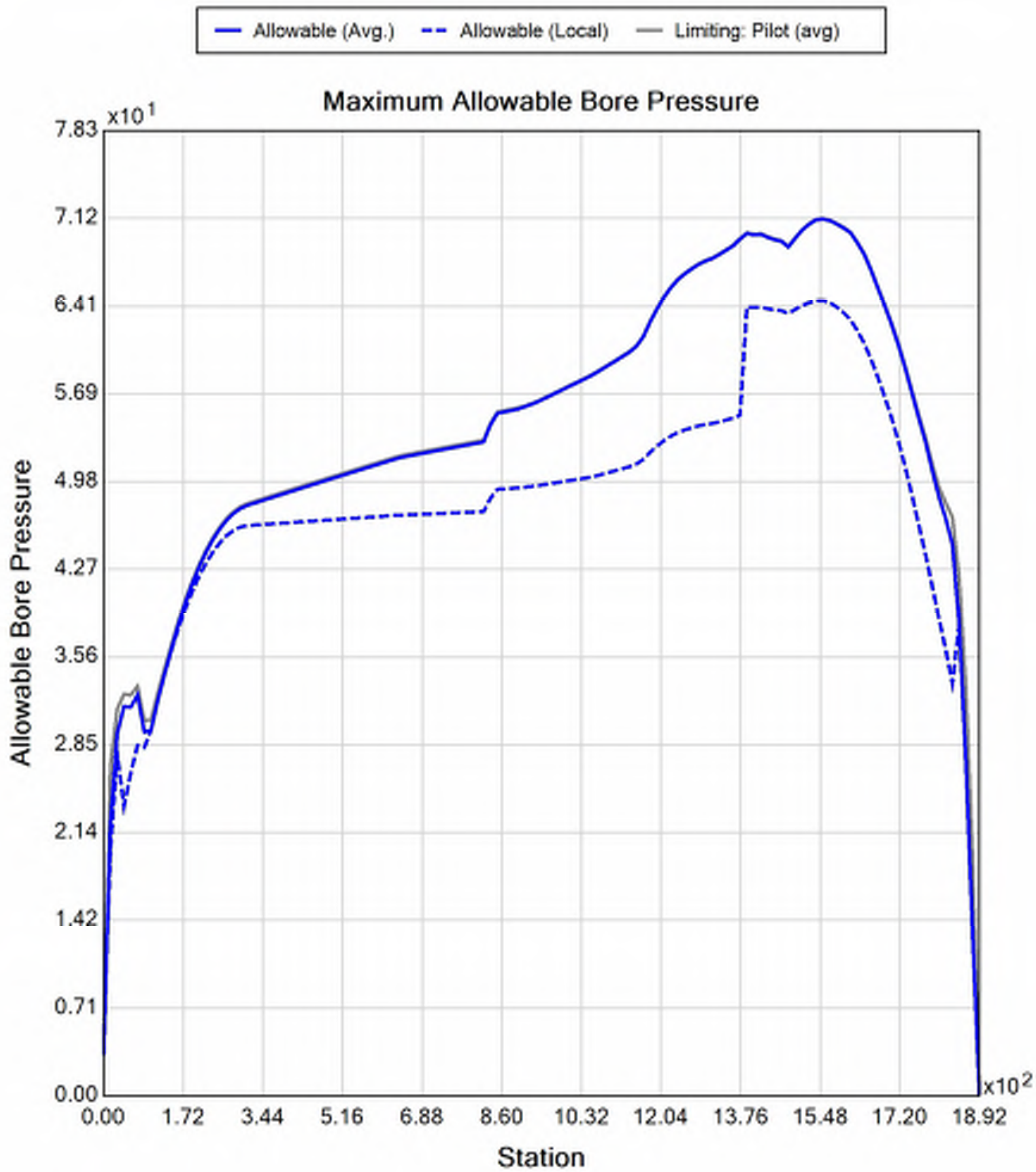

Pull Back Force [lb]
x10^4
3.61
3.43
3.25
3.06
2.88
2.70
2.52
2.34
2.16
1.97
1.79
1.61
Current
x10^2
0.00
1.73
3.47
5.20
6.93
8.67
10.40
12.13
13.87
15.60
17.34
19.07
Length of pipe inside bore [ft]


Pull Back Stress [psi]
x10^3
1.01
0.96
0.91
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
Current
x10^2
0.00
1.73
3.47
5.20
6.93
8.67
10.40
12.13
13.87
15.60
17.34
19.07
Length of pipe inside bore [ft]

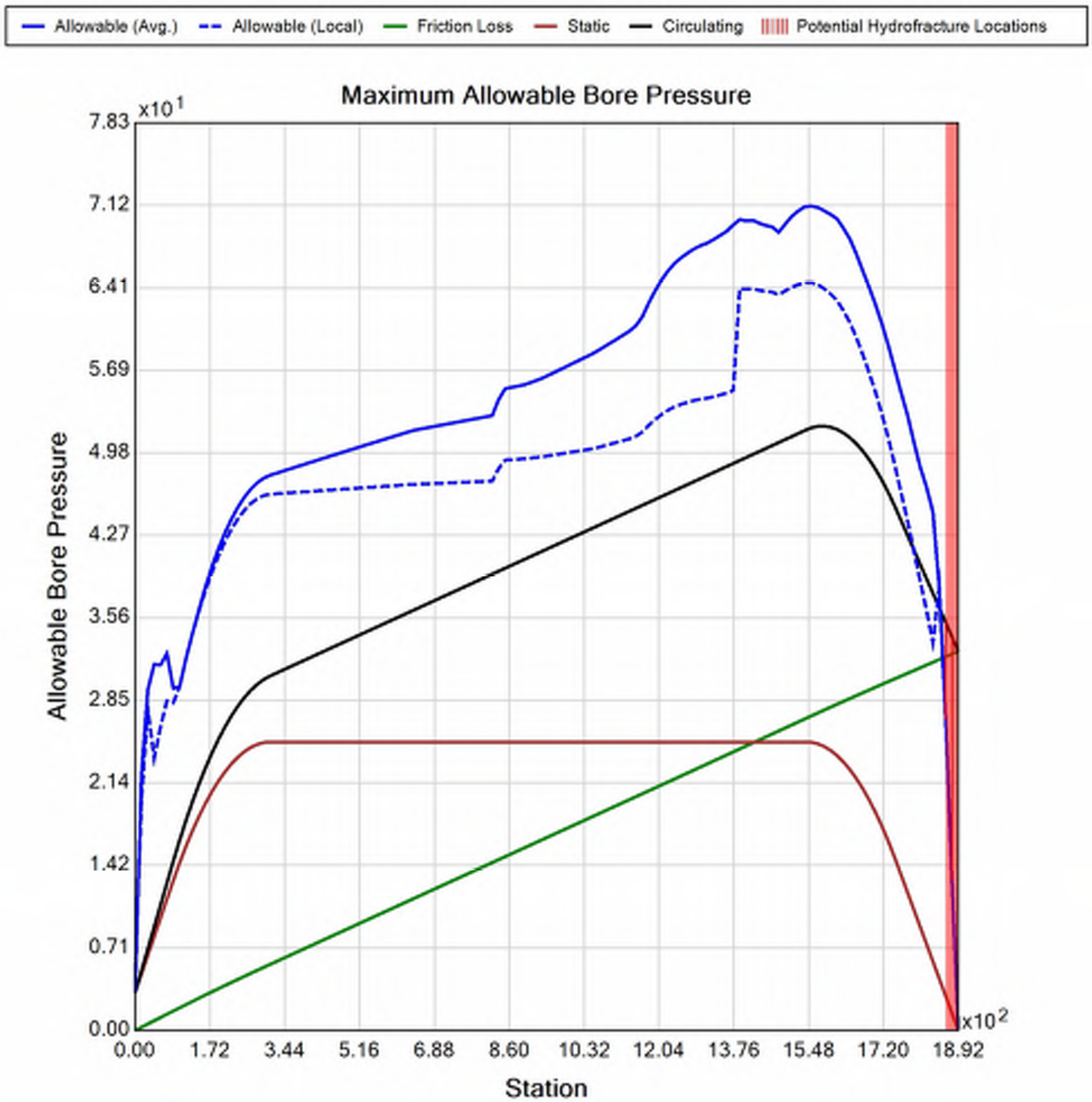


Bending Stress [psi]
x10 1
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
x10 2
0.00
1.73
3.47
5.20
6.93
8.67
10.40
12.13
13.87
15.60
17.34
19.07
Length of pipe inside bore [ft]


Axial Stress [psi]
x10^3
1.03
0.98
0.93
0.87
0.82
0.77
0.71
0.66
0.61
0.56
0.50
0.45
Current
x10^2
0.00
1.73
3.47
5.20
6.93
8.67
10.40
12.13
13.87
15.60
17.34
19.07
Length of pipe inside bore [ft]



Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10^1
7.83
7.12
6.41
5.69
4.98
4.27
3.56
2.85
2.14
1.42
0.71
0.00
Allowable Bore Pressure
0.00
1.72
3.44
5.16
6.88
8.60
10.32
12.04
13.76
15.48
17.20
18.92
x10^2
Station


Allowable (Avg.)
Allowable (Local)
Friction Loss
Static
Circulating
Potential Hydrofracture Locations
Maximum Allowable Bore Pressure
x10^1
7.83
7.12
6.41
5.69
4.98
4.27
3.56
2.85
2.14
1.42
0.71
0.00
Allowable Bore Pressure
0.00
1.72
3.44
5.16
6.88
8.60
10.32
12.04
13.76
15.48
17.20
18.92
x10^2
Station

Generated Output

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Input Summary

Start Coordinate	(0.00, 0.00, 121.00) ft
End Coordinate	(1892.80, 0.00, 127.20) ft
Project Length	1892.80 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 1904.99 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 3.32999992370605 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	16.0	22.6
Water Pressure	18.4	18.3
Surface Surcharge	3.3	3.3
Internal Pressure	0.0	0.0
Net Pressure	34.4	40.9
Deflection		
Earth Load Deflection	4.358	6.151
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	4.388	6.180
Compressive Stress [psi]		
Compressive Wall Stress	154.6	184.1

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1711.1	1711.1
Pullback Stress [psi]	977.7	977.7
Pullback Strain	1.700E-2	1.700E-2
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	977.7	980.8
Tensile Strain	1.700E-2	1.716E-2

Net External Pressure = 25.4 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	4.388	7.5	1.7	OK
Unconstrained Collapse [psi]	34.4	93.3	2.7	OK
Compressive Wall Stress [psi]	154.6	1150.0	7.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	43.9	195.9	4.5	OK
Tensile Stress [psi]	980.8	1200.0	1.2	OK

Generated Output

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Project Summary

General:	CHPE HDD 3 - Conduit 2
	P1C
	Start Date: 12-10-2021
	End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	KIE
Project Consultant:	CHA/BCE
Designer:	AB
	CHA
Description:	HDD 3 10-inch DR 9 - Conduit 2

Input Summary

Start Coordinate	(0.00, 0.00, 121.00) ft
End Coordinate	(1892.80, 0.00, 127.20) ft
Project Length	1892.80 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 3

Soil Layer #1 USCS, Gravel (G), GP

From Assistant

Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]

Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Clay (C), CL

From Assistant

Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 145.00, Coh: 5.56 [psi]

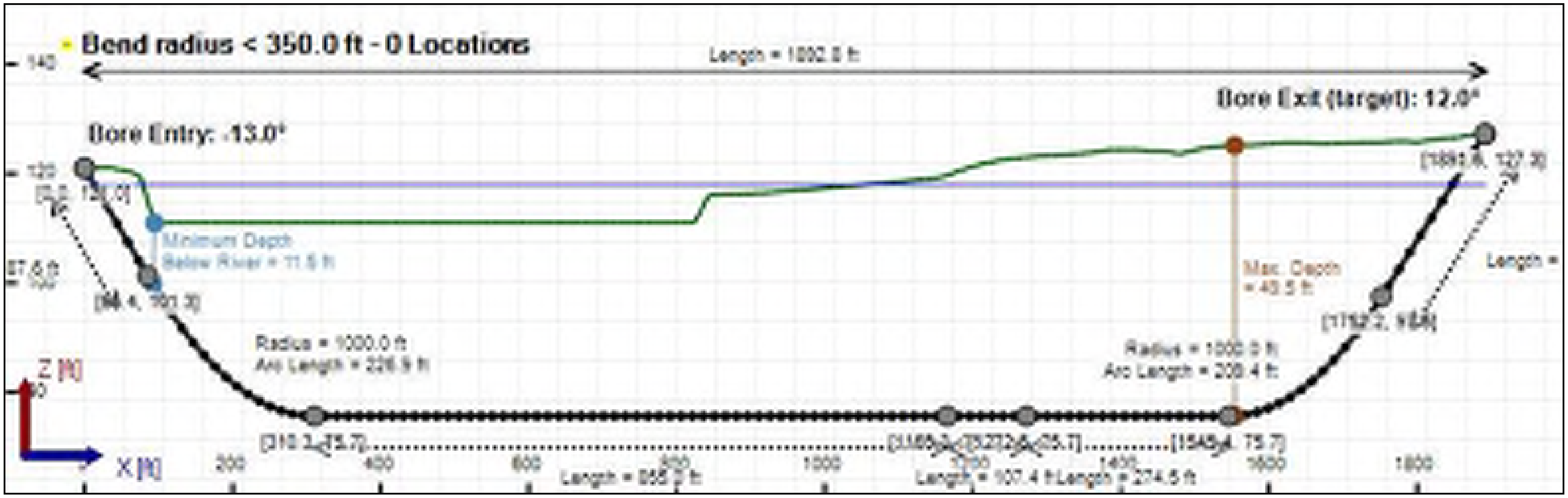
Soil Layer #3 USCS, Clay (C), CH

From Assistant

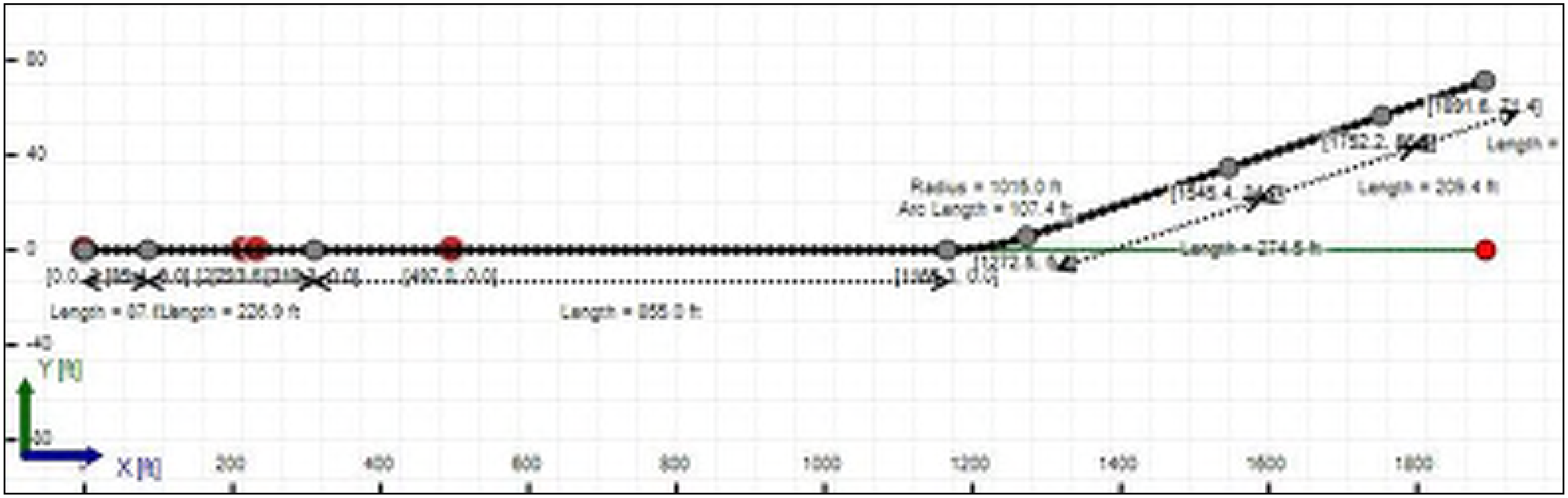
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 145.00, Coh: 3.13 [psi]

Bore Cross-Section View



Bore Plan View



Powered by BoreAid

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 1905.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 3.32999992370605 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	16.0	22.6
Water Pressure	18.4	18.3
Surface Surcharge	3.3	3.3
Internal Pressure	0.0	0.0
Net Pressure	34.4	40.9
Deflection		
Earth Load Deflection	4.358	6.152
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	4.490	6.284
Compressive Stress [psi]		
Compressive Wall Stress	154.6	184.2

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	32786.4	32786.4
Pullback Stress [psi]	914.4	914.4
Pullback Strain	1.590E-2	1.590E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	914.4	937.6
Tensile Strain	1.590E-2	1.675E-2

Net External Pressure = 25.2 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	4.490	7.5	1.7	OK
Unconstrained Collapse [psi]	34.4	92.5	2.7	OK
Compressive Wall Stress [psi]	154.6	1150.0	7.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	43.6	198.6	4.6	OK
Tensile Stress [psi]	937.6	1200.0	1.3	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	71.193 psi	64.610 psi
1	8.00 in	12.00 in	71.169 psi	64.578 psi
2	12.00 in	16.13 in	71.134 psi	64.531 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

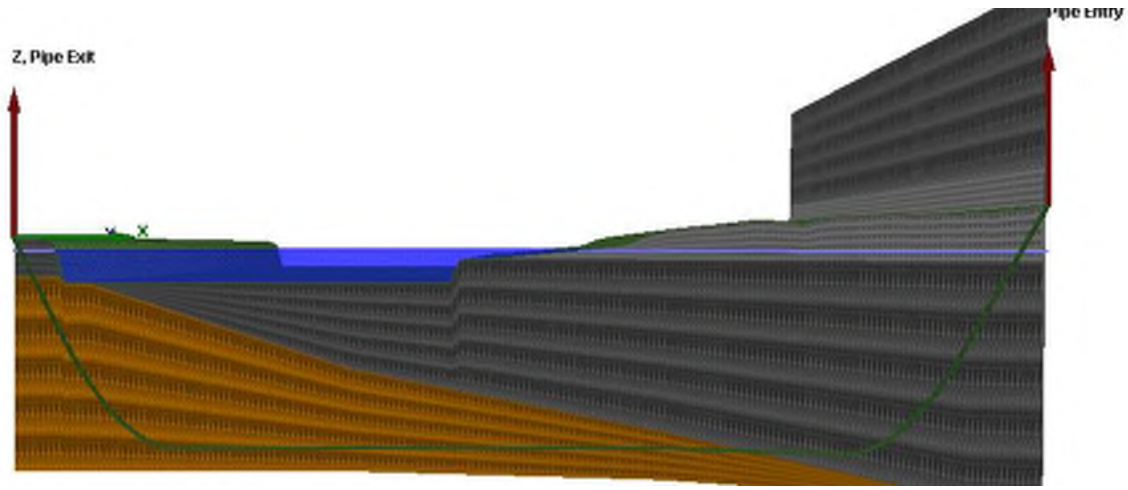
Rheological model: Power-Law

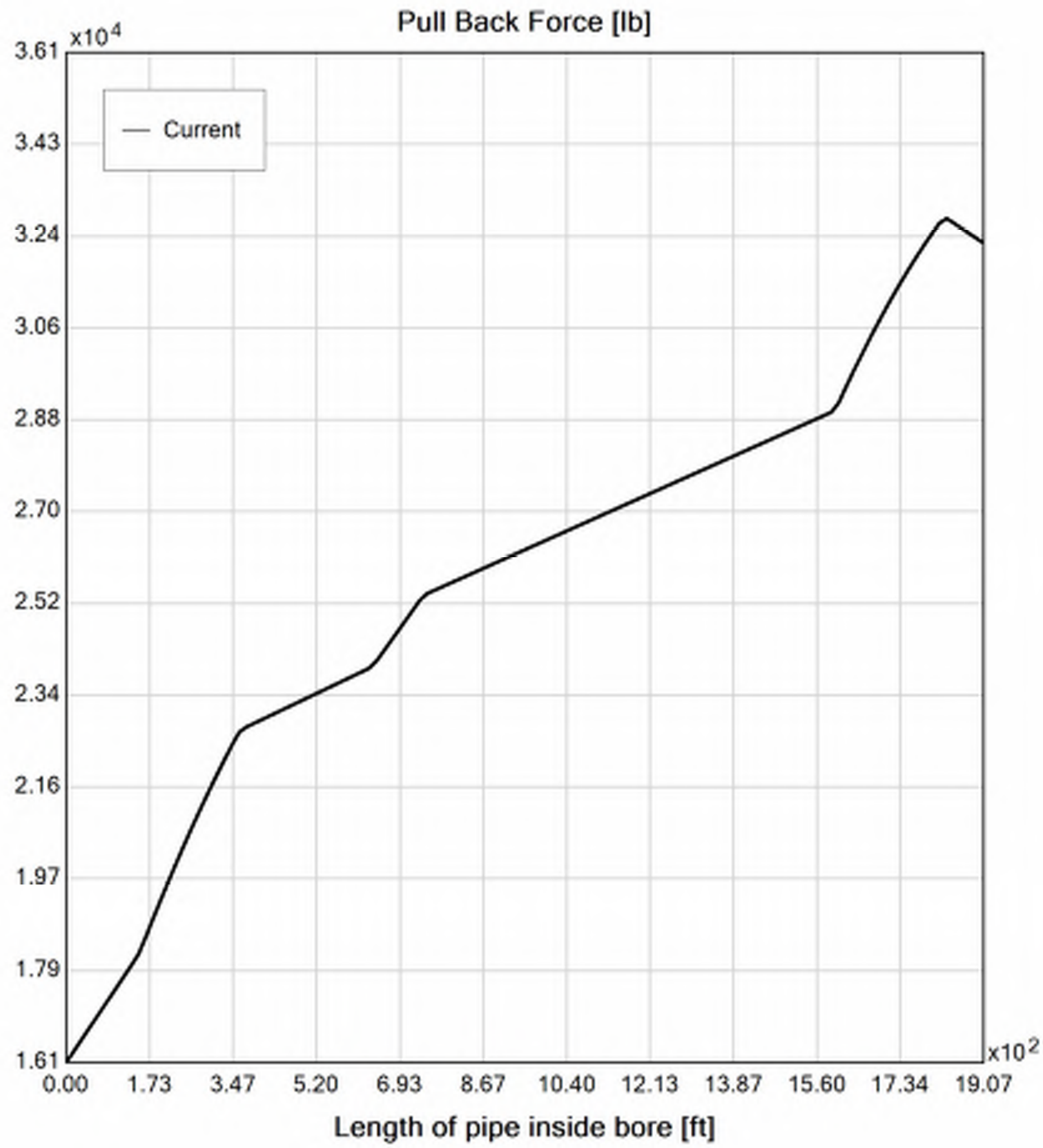
Fluid Consistency Index (K): 63.17

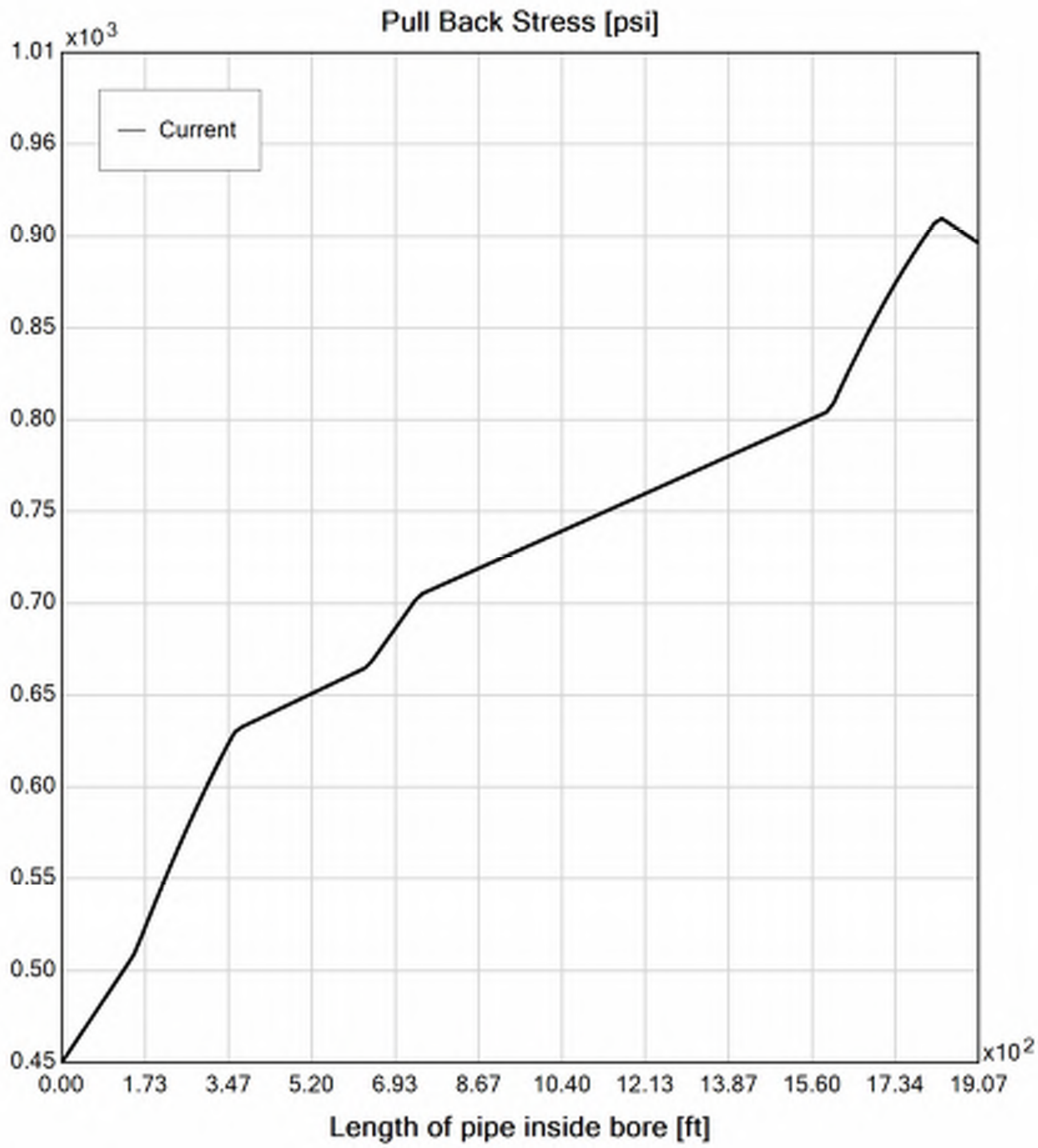
Power Law Exponent (n): 0.14

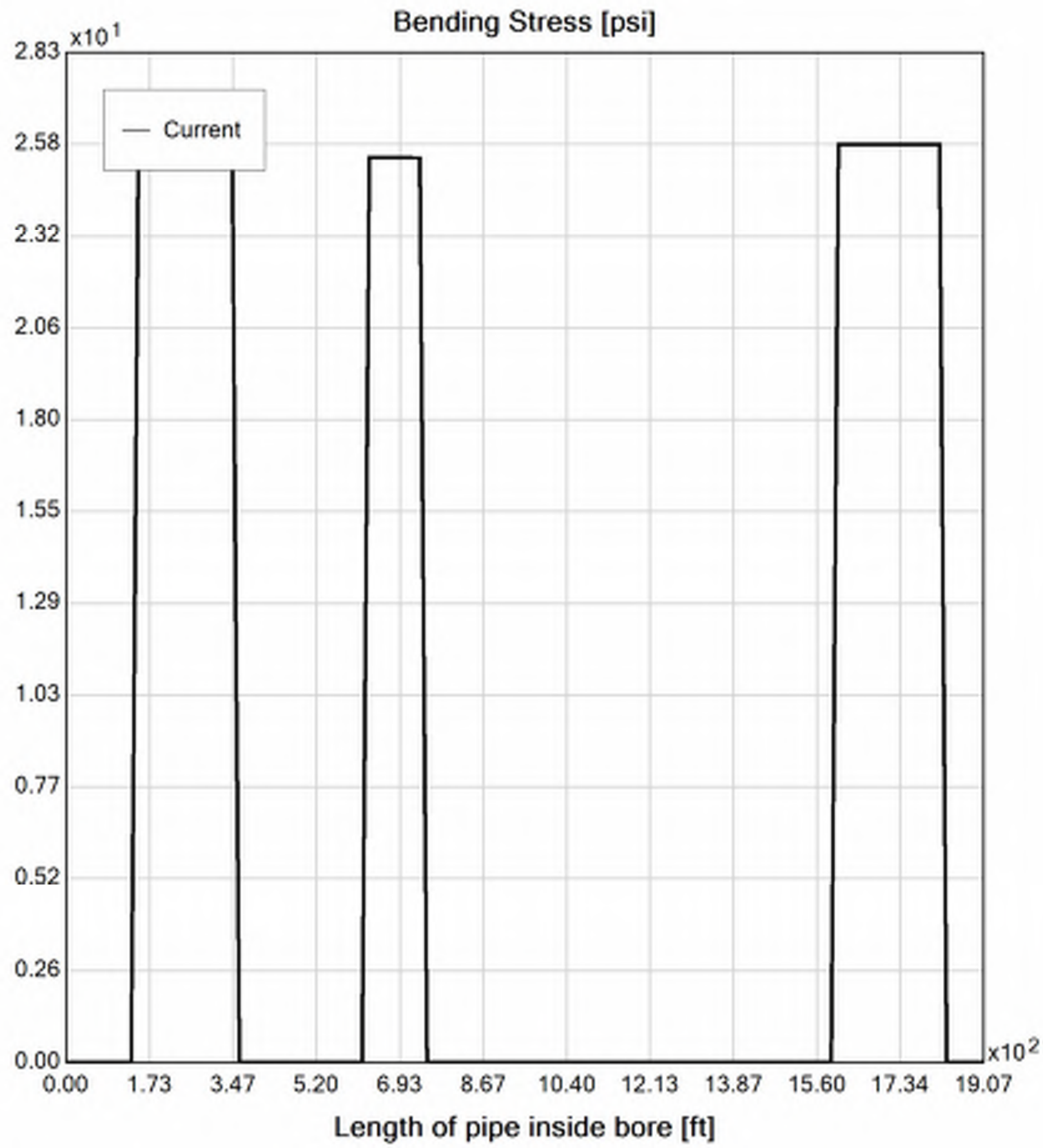
Effective Viscosity (cP): 859.3

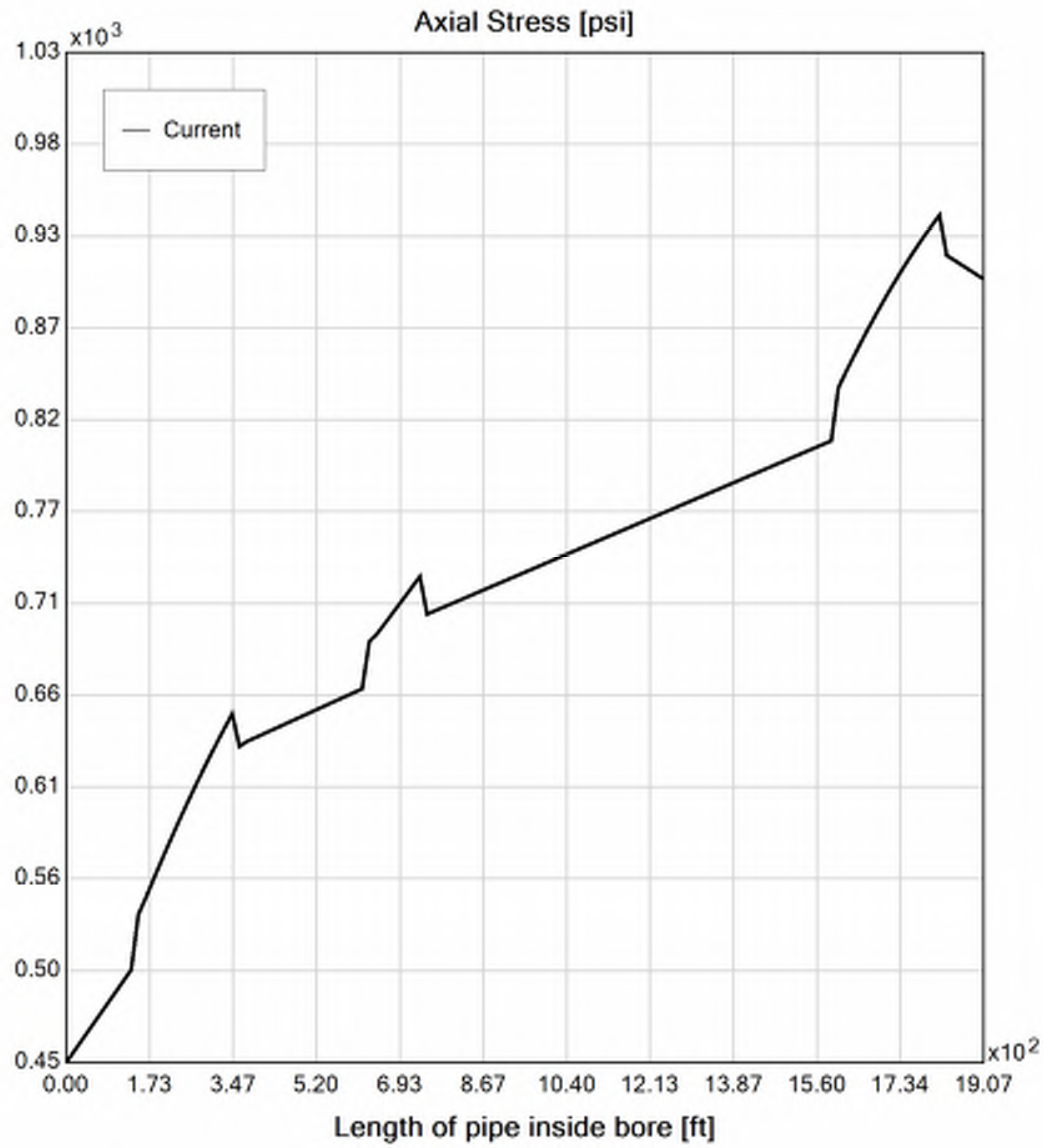
Virtual Site



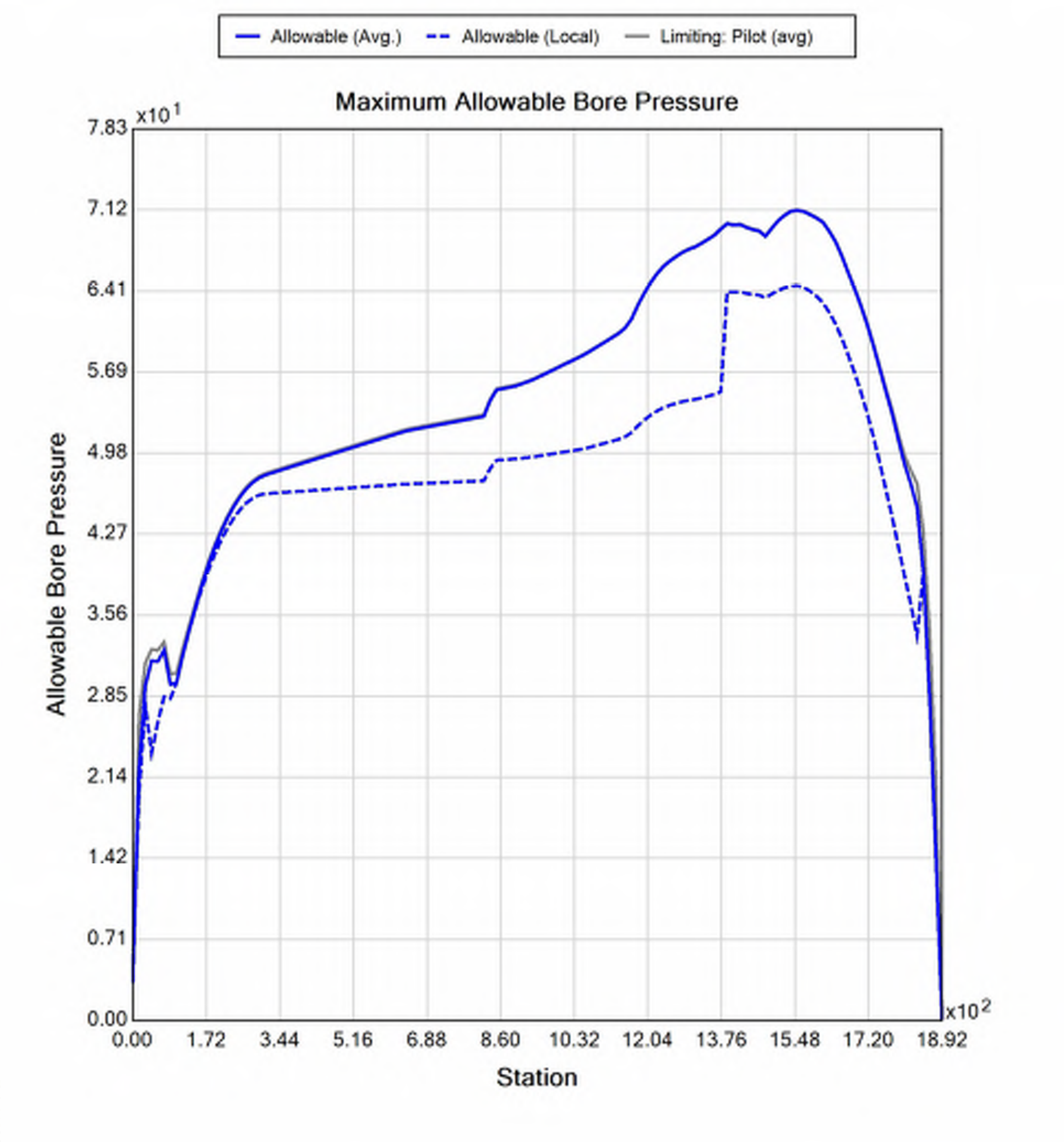

Pull Back Force [lb]
x10^4
3.61
3.43
3.24
3.06
2.88
2.70
2.52
2.34
2.16
1.97
1.79
1.61
Current
0.00
1.73
3.47
5.20
6.93
8.67
10.40
12.13
13.87
15.60
17.34
19.07
x10^2
Length of pipe inside bore [ft]


Pull Back Stress [psi]
x10^3
1.01
0.96
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
Current
x10^2
0.00
1.73
3.47
5.20
6.93
8.67
10.40
12.13
13.87
15.60
17.34
19.07
Length of pipe inside bore [ft]

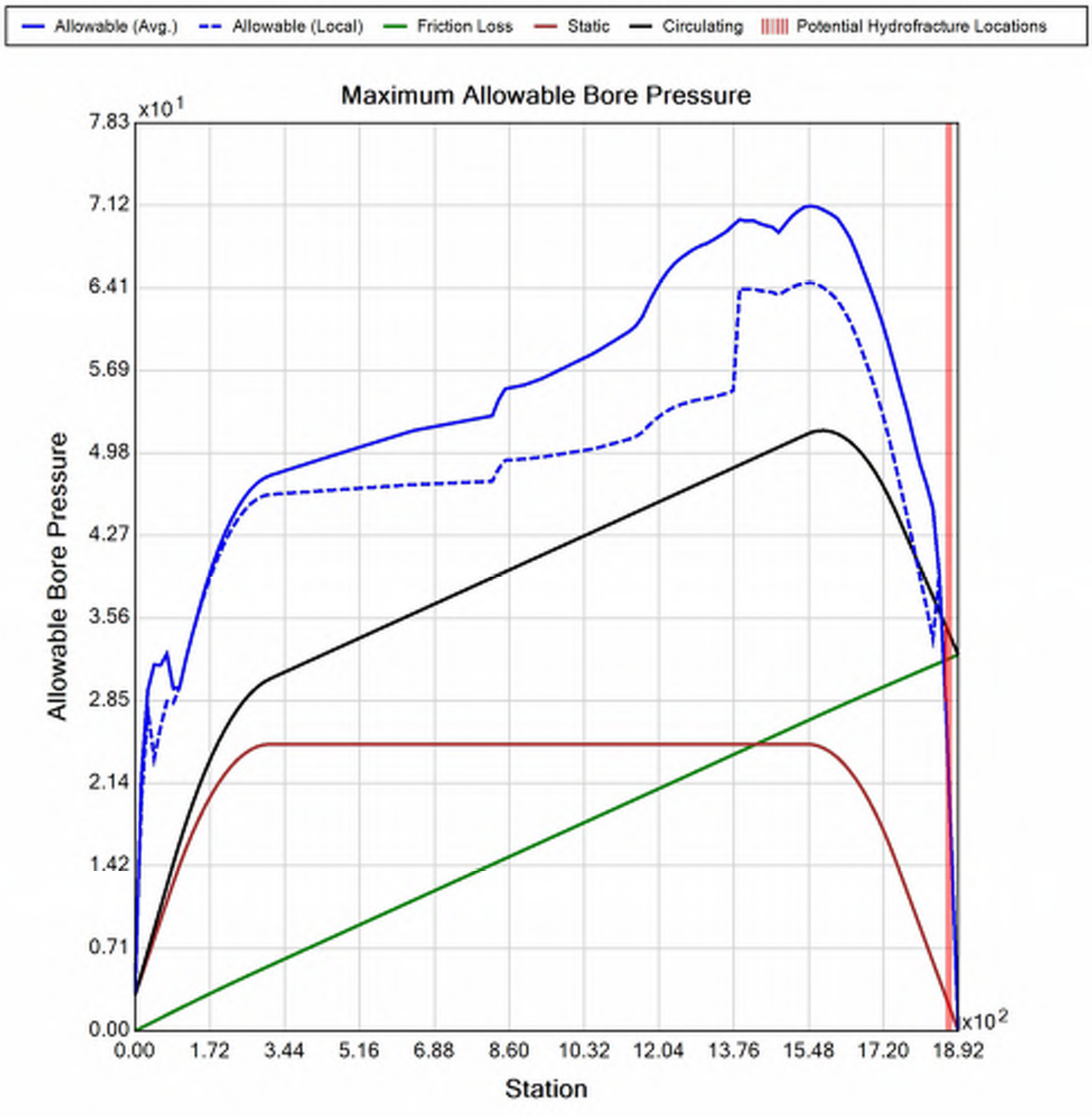

Bending Stress [psi]
x10 1
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
x10 2
0.00
1.73
3.47
5.20
6.93
8.67
10.40
12.13
13.87
15.60
17.34
19.07
Length of pipe inside bore [ft]



Axial Stress [psi]
x10^3
1.03
0.98
0.93
0.87
0.82
0.77
0.71
0.66
0.61
0.56
0.50
0.45
Current
x10^2
0.00
1.73
3.47
5.20
6.93
8.67
10.40
12.13
13.87
15.60
17.34
19.07
Length of pipe inside bore [ft]



Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10^1
7.83
7.12
6.41
5.69
4.98
4.27
3.56
2.85
2.14
1.42
0.71
0.00
Allowable Bore Pressure
0.00
1.72
3.44
5.16
6.88
8.60
10.32
12.04
13.76
15.48
17.20
18.92
x10^2
Station


Allowable (Avg.)
Allowable (Local)
Friction Loss
Static
Circulating
Potential Hydrofracture Locations
Maximum Allowable Bore Pressure
x10^1
7.83
7.12
6.41
5.69
4.98
4.27
3.56
2.85
2.14
1.42
0.71
0.00
Allowable Bore Pressure
0.00
1.72
3.44
5.16
6.88
8.60
10.32
12.04
13.76
15.48
17.20
18.92
x10^2
Station

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Input Summary

Start Coordinate	(0.00, 0.00, 121.00) ft
End Coordinate	(1892.80, 0.00, 127.20) ft
Project Length	1892.80 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 1905.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 3.32999992370605 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	16.0	22.6
Water Pressure	18.4	18.3
Surface Surcharge	3.3	3.3
Internal Pressure	0.0	0.0
Net Pressure	34.4	40.9
Deflection		
Earth Load Deflection	4.358	6.152
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	4.388	6.181
Compressive Stress [psi]		
Compressive Wall Stress	154.6	184.2

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1709.9	1709.9
Pullback Stress [psi]	977.0	977.0
Pullback Strain	1.699E-2	1.699E-2
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	977.0	980.1
Tensile Strain	1.699E-2	1.714E-2

Net External Pressure = 25.2 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	4.388	7.5	1.7	OK
Unconstrained Collapse [psi]	34.4	93.3	2.7	OK
Compressive Wall Stress [psi]	154.6	1150.0	7.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	43.6	196.0	4.5	OK
Tensile Stress [psi]	980.1	1200.0	1.2	OK

Generated Output

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Project Summary

General:	CHPE HDD #4
	P1C
	Start Date: 03-01-2022
	End Date: 03-01-2022
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	
Description:	HDD 4 10-inch DR 9

Input Summary

Start Coordinate	(0.00, 0.00, 122.36) ft
End Coordinate	(631.40, 0.00, 121.70) ft
Project Length	631.40 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 5

Soil Layer #1 USCS, Gravel (G), GM

Depth: 6.00 ft

Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]

Phi: 37.00, S.M.: 1000.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Silt (M), ML

Depth: 2.00 ft

Unit Weight: 80.0000 (dry), 100.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 50.00, Coh: 4.40 [psi]

Soil Layer #3 USCS, Clay (C), CH

Depth: 15.50 ft

Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 300.00, Coh: 5.50 [psi]

Soil Layer #4 USCS, Clay (C), CH

Depth: 6.50 ft

Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 200.00, Coh: 3.10 [psi]

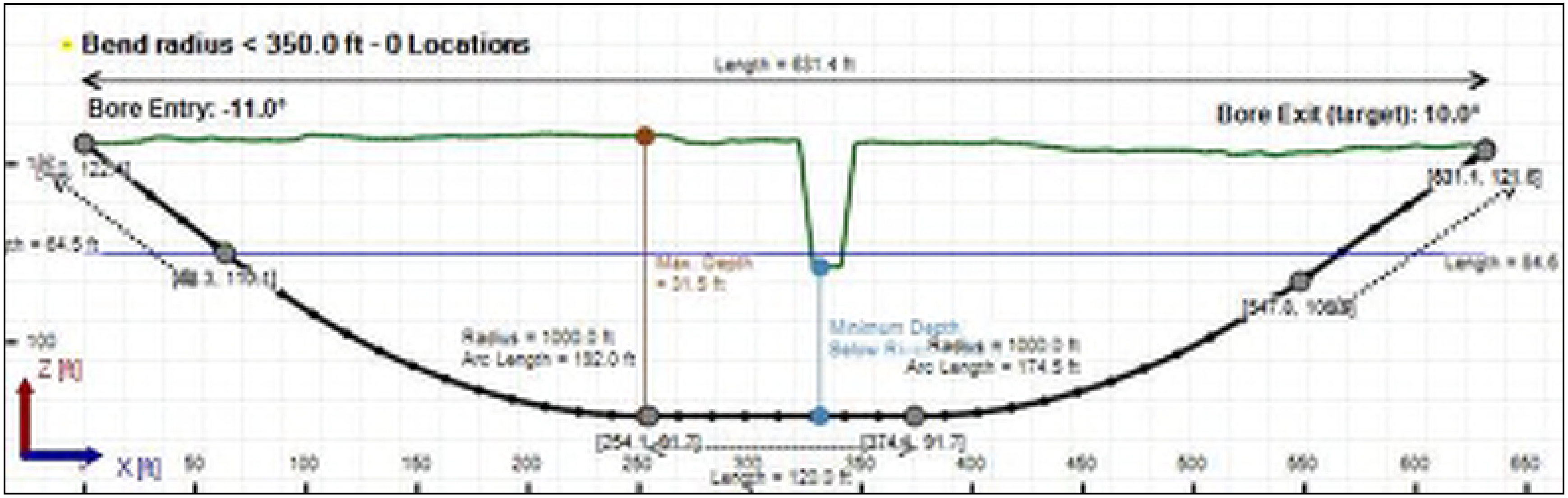
Soil Layer #5 USCS, Clay (C), CH

Depth: 10.00 ft

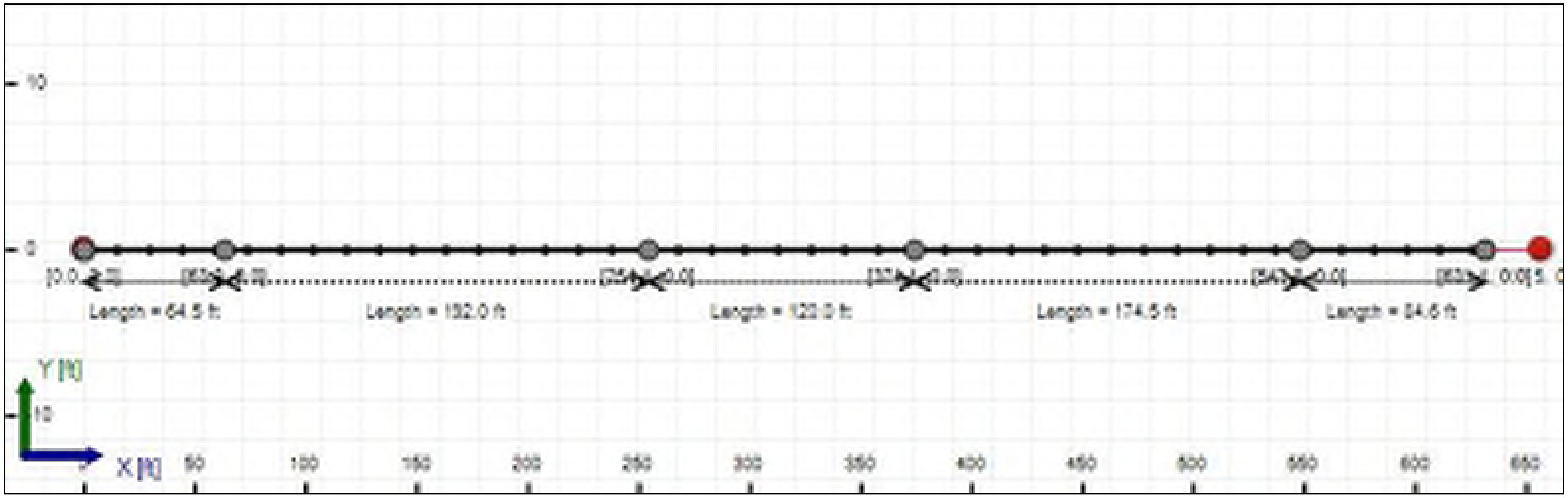
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 200.00, Coh: 3.10 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 645.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	6.8	14.8
Water Pressure	7.9	7.9
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	14.7	22.7
Deflection		
Earth Load Deflection	1.845	4.036
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.978	4.168
Compressive Stress [psi]		
Compressive Wall Stress	66.2	102.3

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	11031.9	11031.9
Pullback Stress [psi]	307.7	307.7
Pullback Strain	5.351E-3	5.351E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	307.7	332.6
Tensile Strain	5.351E-3	6.232E-3

Net External Pressure = 18.0 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.978	7.5	3.8	OK
Unconstrained Collapse [psi]	20.5	115.7	5.6	OK
Compressive Wall Stress [psi]	66.2	1150.0	17.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	30.5	237.4	7.8	OK
Tensile Stress [psi]	332.6	1200.0	3.6	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	61.383 psi	48.194 psi
1	8.00 in	12.00 in	61.145 psi	44.345 psi
2	12.00 in	16.13 in	60.810 psi	43.969 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

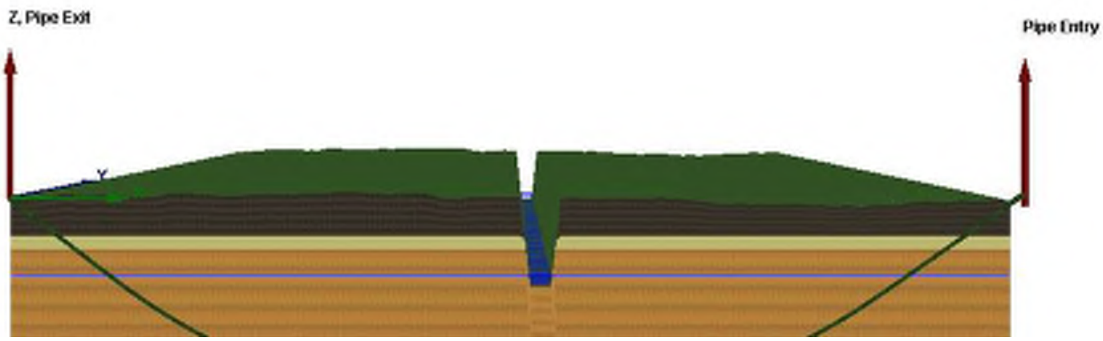
Rheological model: Bingham-Plastic

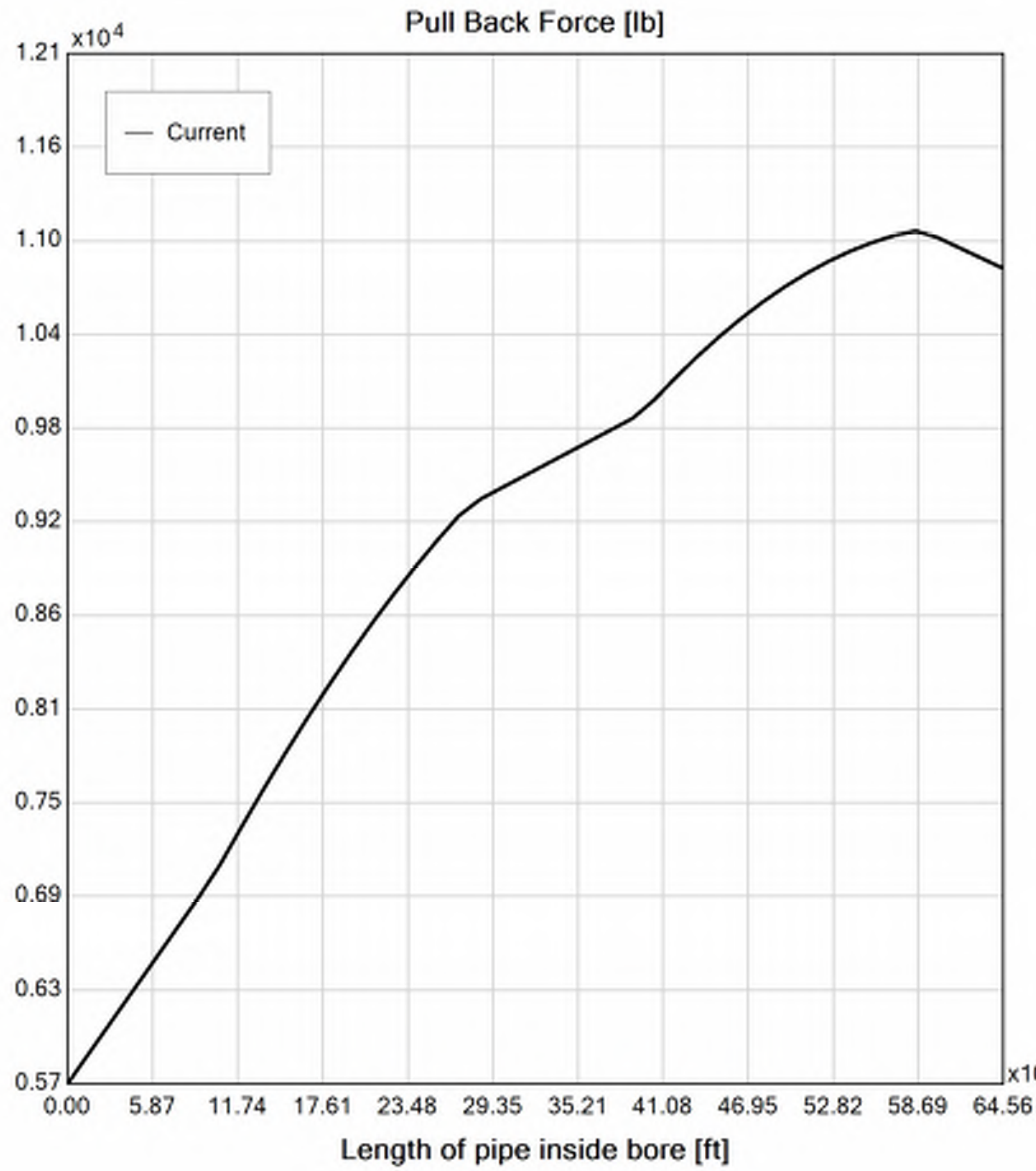
Plastic Viscosity (PV): 25.53

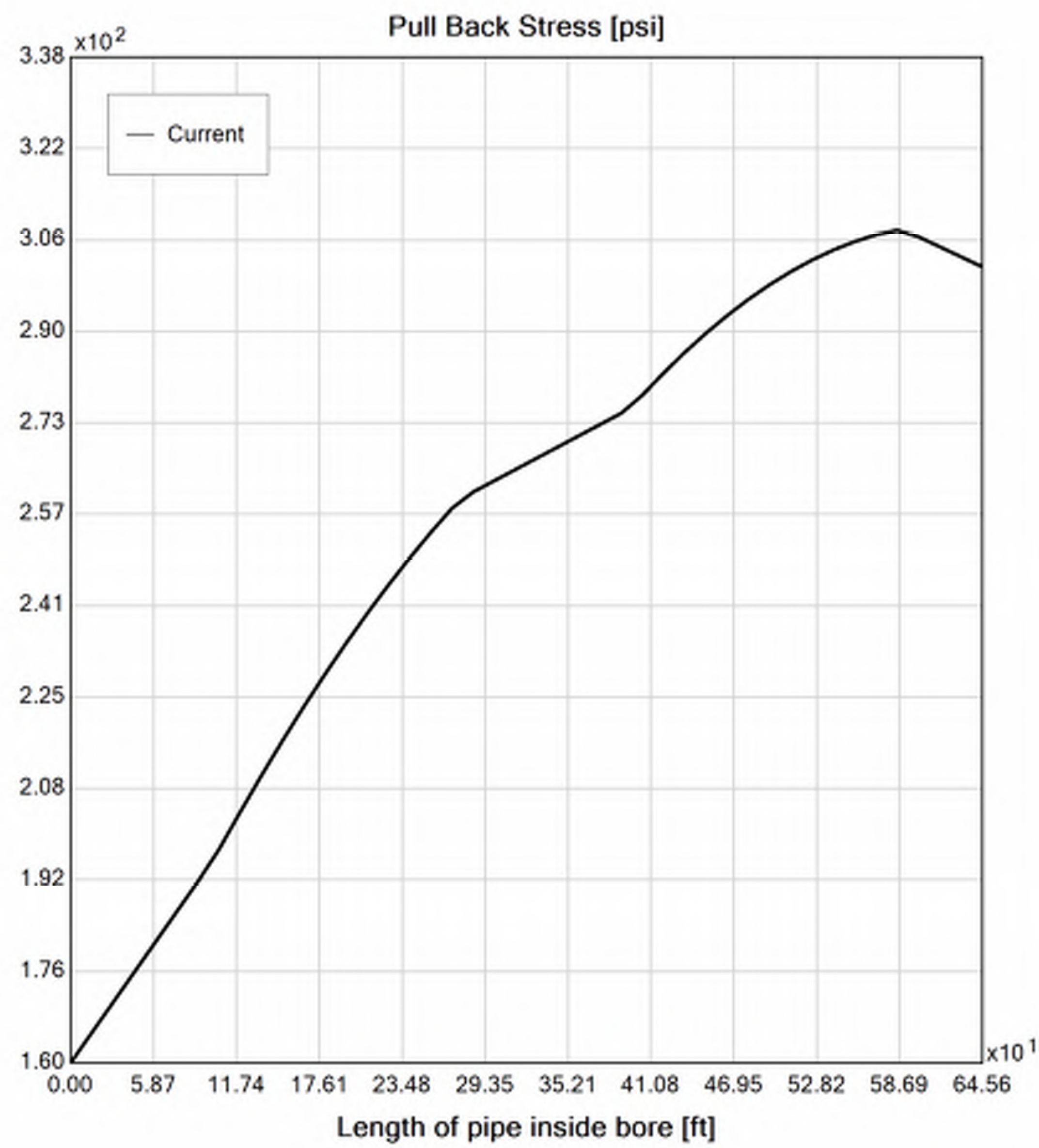
Yield Point (YP): 16.49

Effective Viscosity (cP): 1202.0

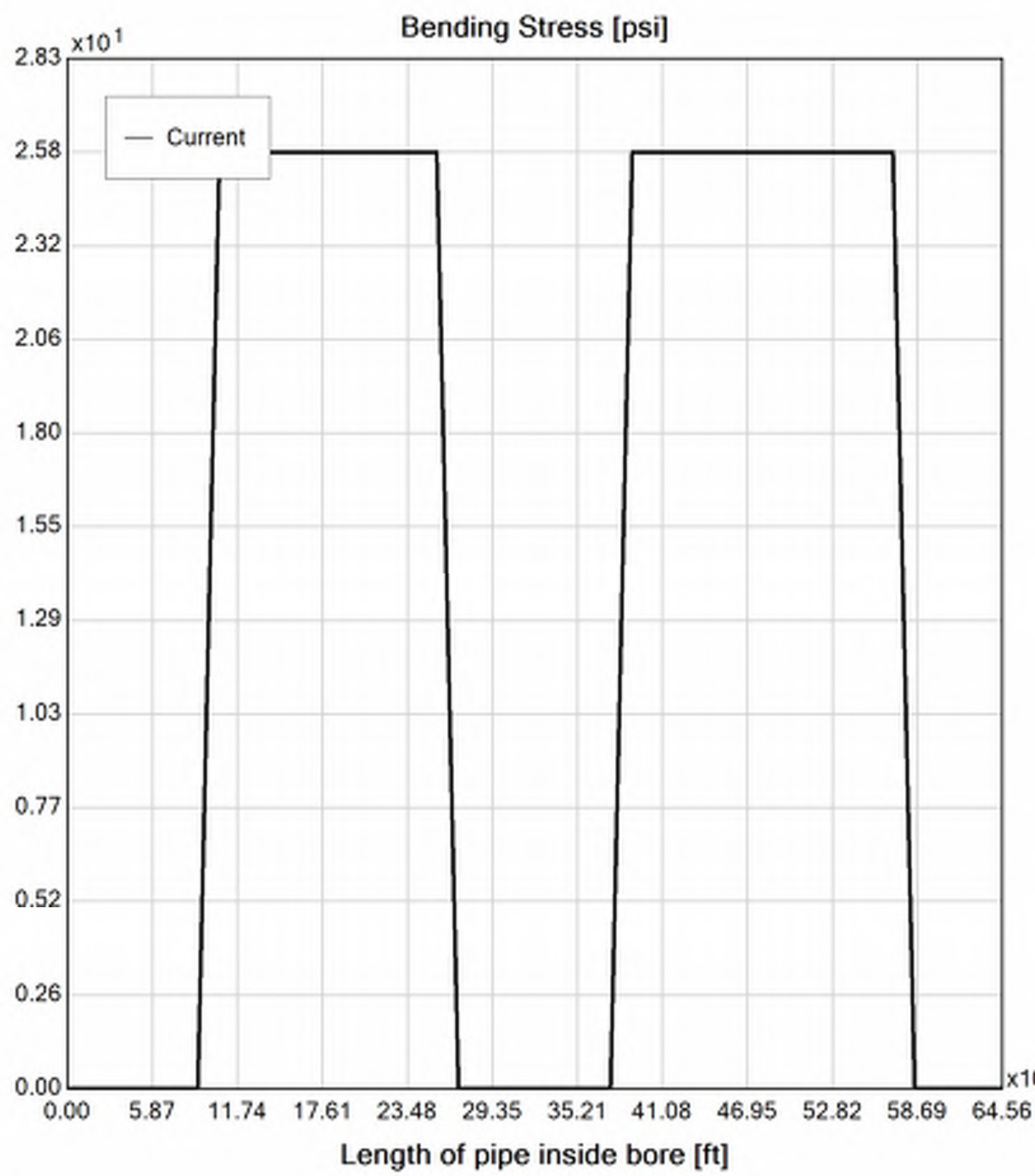
Virtual Site



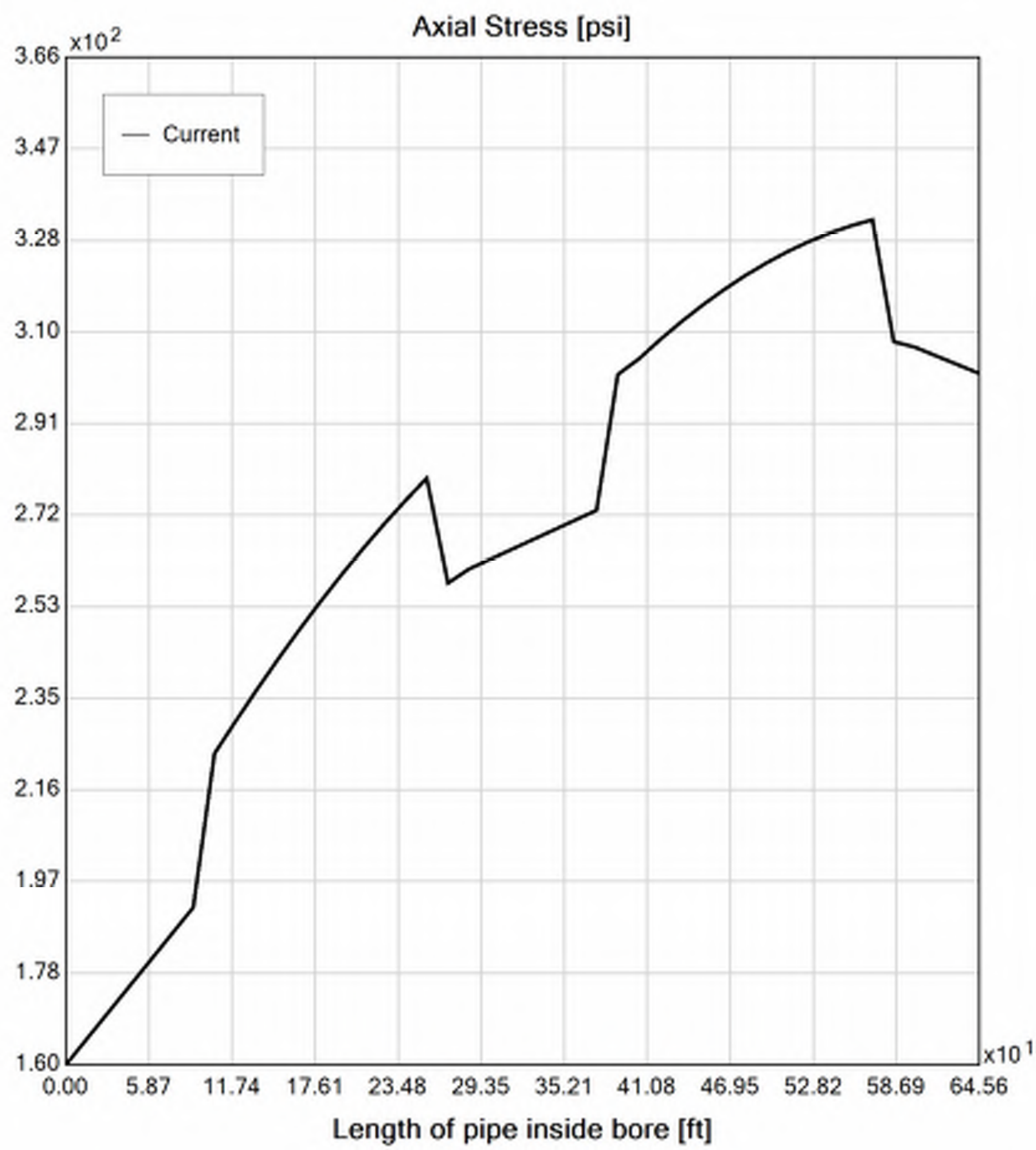

Pull Back Force [lb]
x10^4
1.21
1.16
1.10
1.04
0.98
0.92
0.86
0.81
0.75
0.69
0.63
0.57
Current
x10^1
0.00
5.87
11.74
17.61
23.48
29.35
35.21
41.08
46.95
52.82
58.69
64.56
Length of pipe inside bore [ft]

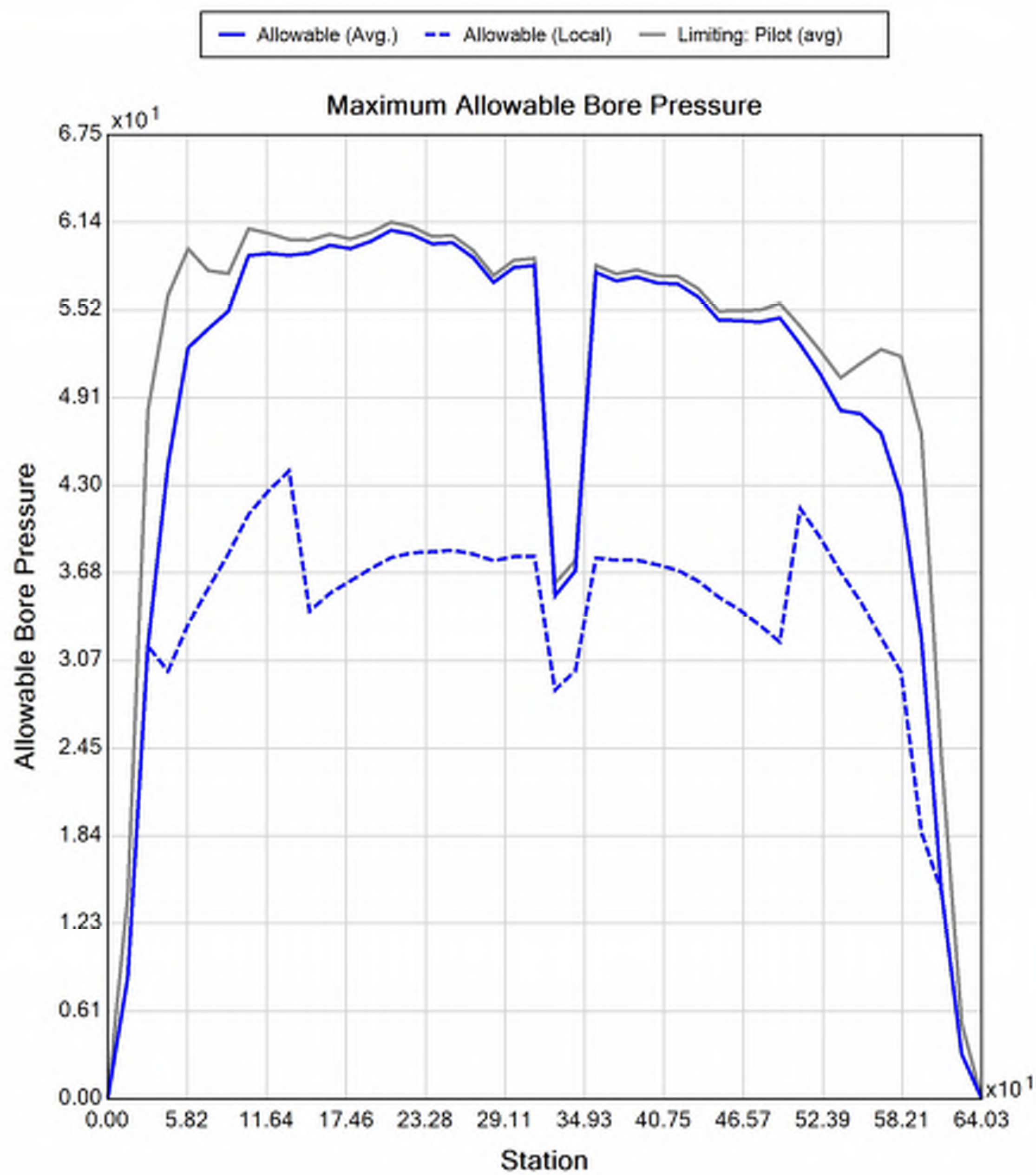


Pull Back Stress [psi]
x10²
Current
3.38
3.22
3.06
2.90
2.73
2.57
2.41
2.25
2.08
1.92
1.76
1.60
0.00
5.87
11.74
17.61
23.48
29.35
35.21
41.08
46.95
52.82
58.69
64.56
x10¹
Length of pipe inside bore [ft]

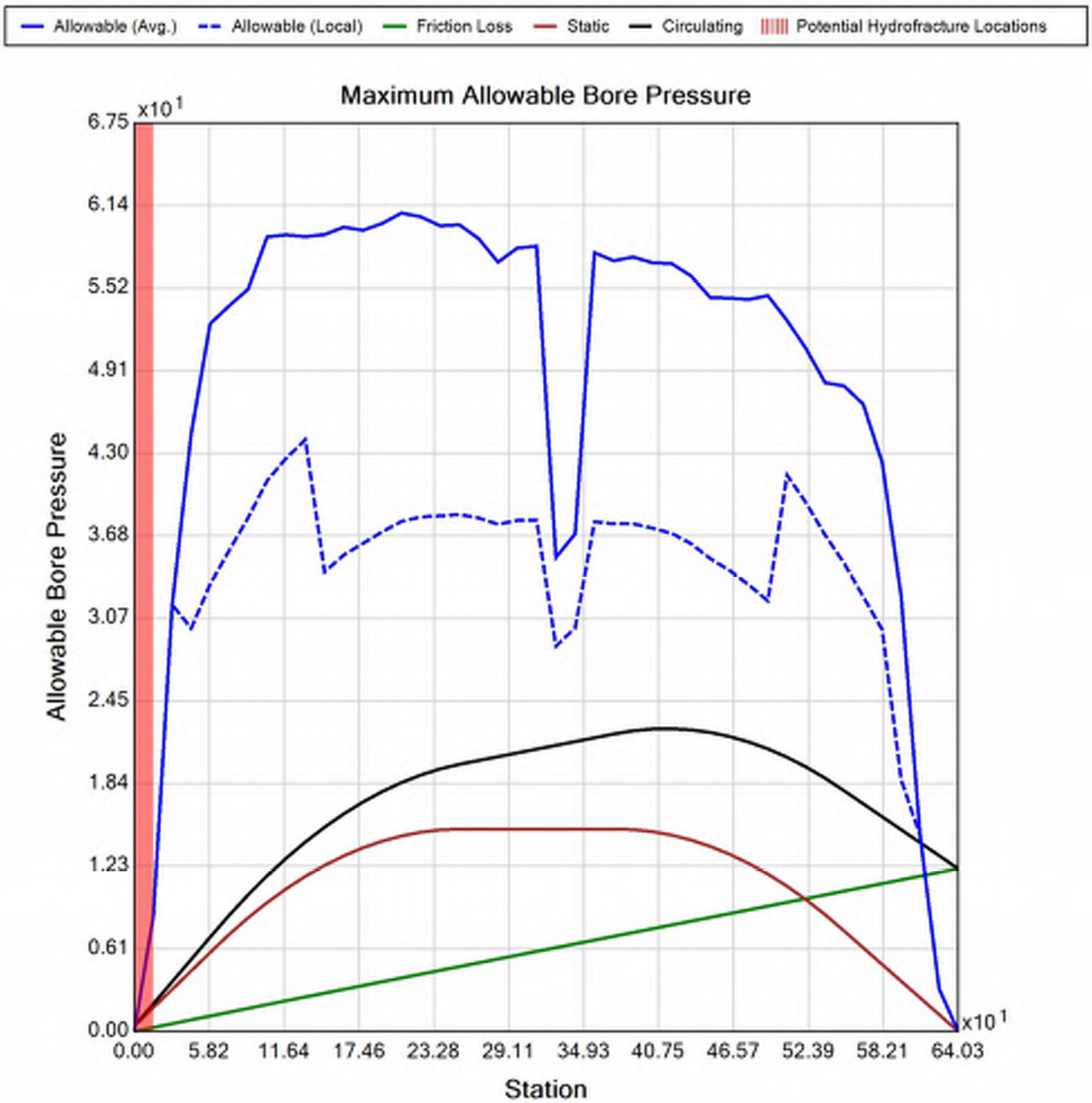


Bending Stress [psi]
x10 1
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
x10 1
0.00
5.87
11.74
17.61
23.48
29.35
35.21
41.08
46.95
52.82
58.69
64.56
Length of pipe inside bore [ft]


Axial Stress [psi]
x10^2
3.66
3.47
3.28
3.10
2.91
2.72
2.53
2.35
2.16
1.97
1.78
1.60
Current
x10^1
0.00
5.87
11.74
17.61
23.48
29.35
35.21
41.08
46.95
52.82
58.69
64.56
Length of pipe inside bore [ft]



Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10 1
6.75
6.14
5.52
4.91
4.30
3.68
3.07
2.45
1.84
1.23
0.61
0.00
Allowable Bore Pressure
0.00
5.82
11.64
17.46
23.28
29.11
34.93
40.75
46.57
52.39
58.21
64.03
x10 1
Station



Allowable (Avg.)
Allowable (Local)
Friction Loss
Static
Circulating
Potential Hydrofracture Locations
Maximum Allowable Bore Pressure
x10 1
6.75
6.14
5.52
4.91
4.30
3.68
3.07
2.45
1.84
1.23
0.61
0.00
Allowable Bore Pressure
0.00
5.82
11.64
17.46
23.28
29.11
34.93
40.75
46.57
52.39
58.21
64.03
x10 1
Station

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Input Summary

Start Coordinate	(0.00, 0.00, 122.36) ft
End Coordinate	(631.40, 0.00, 121.70) ft
Project Length	631.40 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 645.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	6.8	14.8
Water Pressure	7.9	7.9
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	14.7	22.7
Deflection		
Earth Load Deflection	1.845	4.036
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	1.875	4.065
Compressive Stress [psi]		
Compressive Wall Stress	66.2	102.3

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	648.1	648.1
Pullback Stress [psi]	370.3	370.3
Pullback Strain	6.440E-3	6.440E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	370.3	375.2
Tensile Strain	6.440E-3	6.623E-3

Net External Pressure = 18.0 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.875	7.5	4.0	OK
Unconstrained Collapse [psi]	20.5	116.7	5.7	OK
Compressive Wall Stress [psi]	66.2	1150.0	17.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	30.5	235.8	7.7	OK
Tensile Stress [psi]	375.2	1200.0	3.2	OK

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Project Summary

General:	CHPE HDD 4A Conduit 1
	P1C
	Start Date: 02-28-2022
	End Date: 02-28-2022
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	
Description:	HDD 4A 10-inch DR 9 Conduit 1

Input Summary

Start Coordinate	(0.00, 0.00, 115.42) ft
End Coordinate	(760.00, 0.00, 115.33) ft
Project Length	760.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 3

Soil Layer #1 USCS, Gravel (G), GM

Depth: 4.00 ft

Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 100.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Clay (C), CL

Depth: 8.00 ft

Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 200.00, Coh: 7.30 [psi]

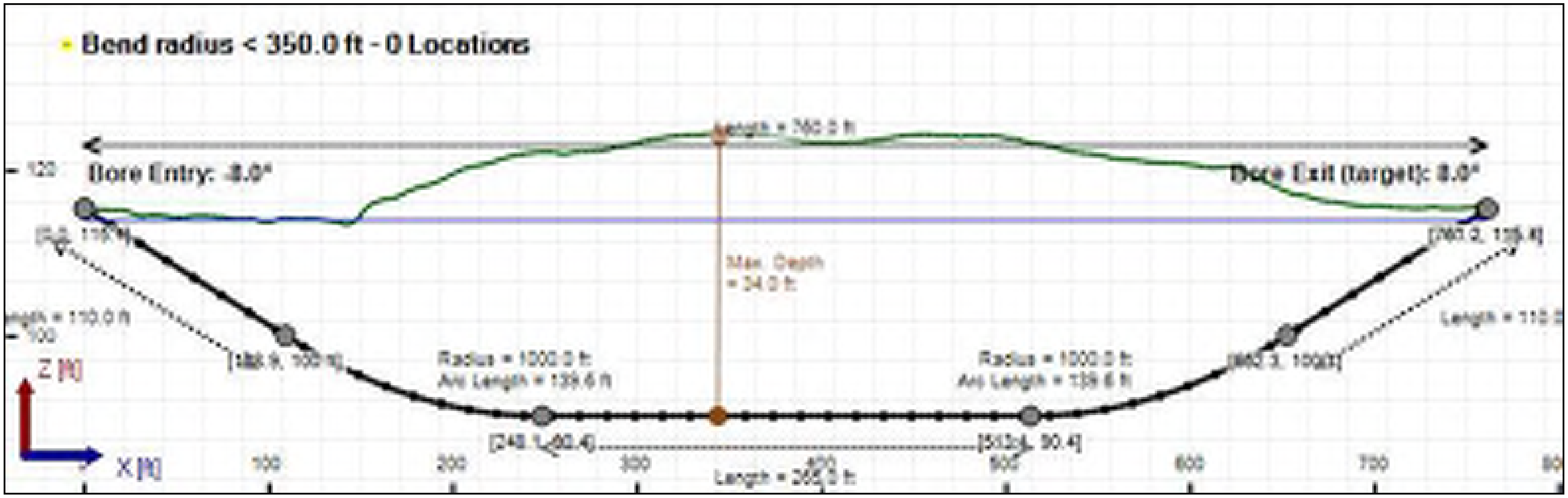
Soil Layer #3 USCS, Clay (C), CH

Depth: 30.00 ft

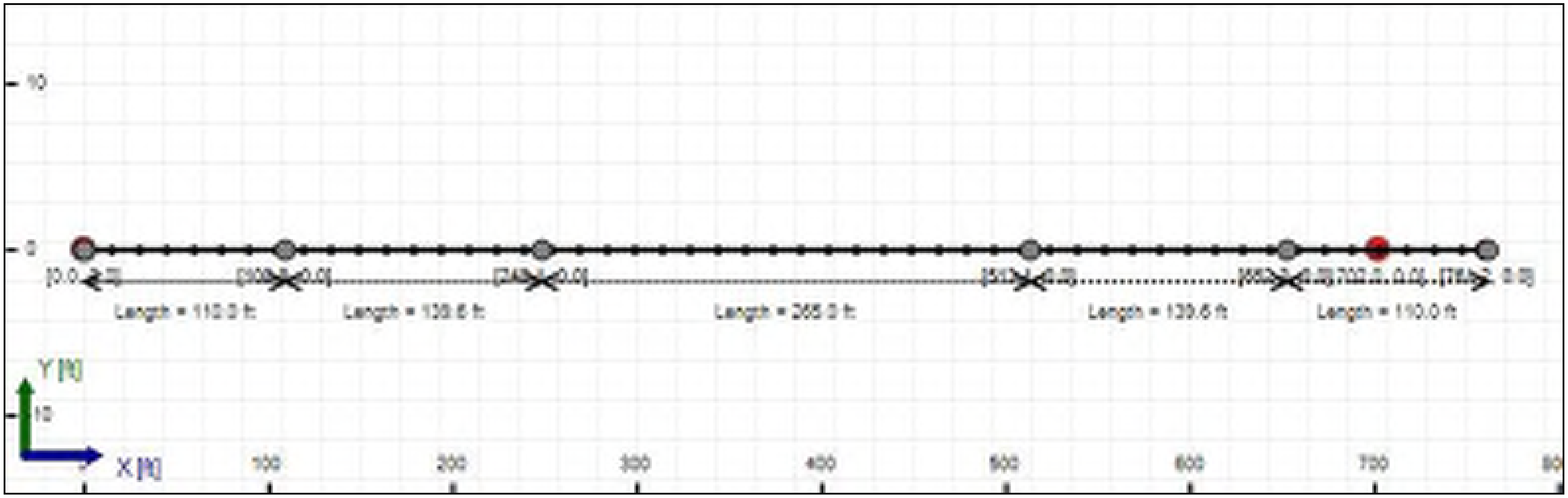
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 200.00, Coh: 8.70 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 765.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	16.1	16.1
Water Pressure	10.2	10.2
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	26.3	26.3
Deflection		
Earth Load Deflection	4.375	4.375
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	4.507	4.507
Compressive Stress [psi]		
Compressive Wall Stress	118.4	118.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	12209.5	12209.5
Pullback Stress [psi]	340.5	340.5
Pullback Strain	5.922E-3	5.922E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	340.5	364.1
Tensile Strain	5.922E-3	6.780E-3

Net External Pressure = 18.2 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	4.507	7.5	1.7	OK
Unconstrained Collapse [psi]	26.3	92.3	3.5	OK
Compressive Wall Stress [psi]	118.4	1150.0	9.7	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	26.3	235.2	8.9	OK
Tensile Stress [psi]	364.1	1200.0	3.3	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	48.848 psi	62.218 psi
1	8.00 in	12.00 in	48.772 psi	62.123 psi
2	12.00 in	16.13 in	48.663 psi	61.987 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

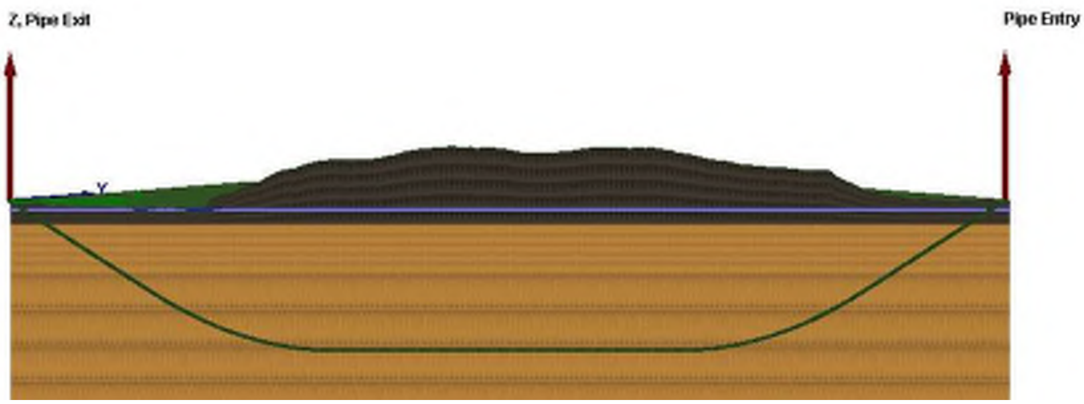
Rheological model: Bingham-Plastic

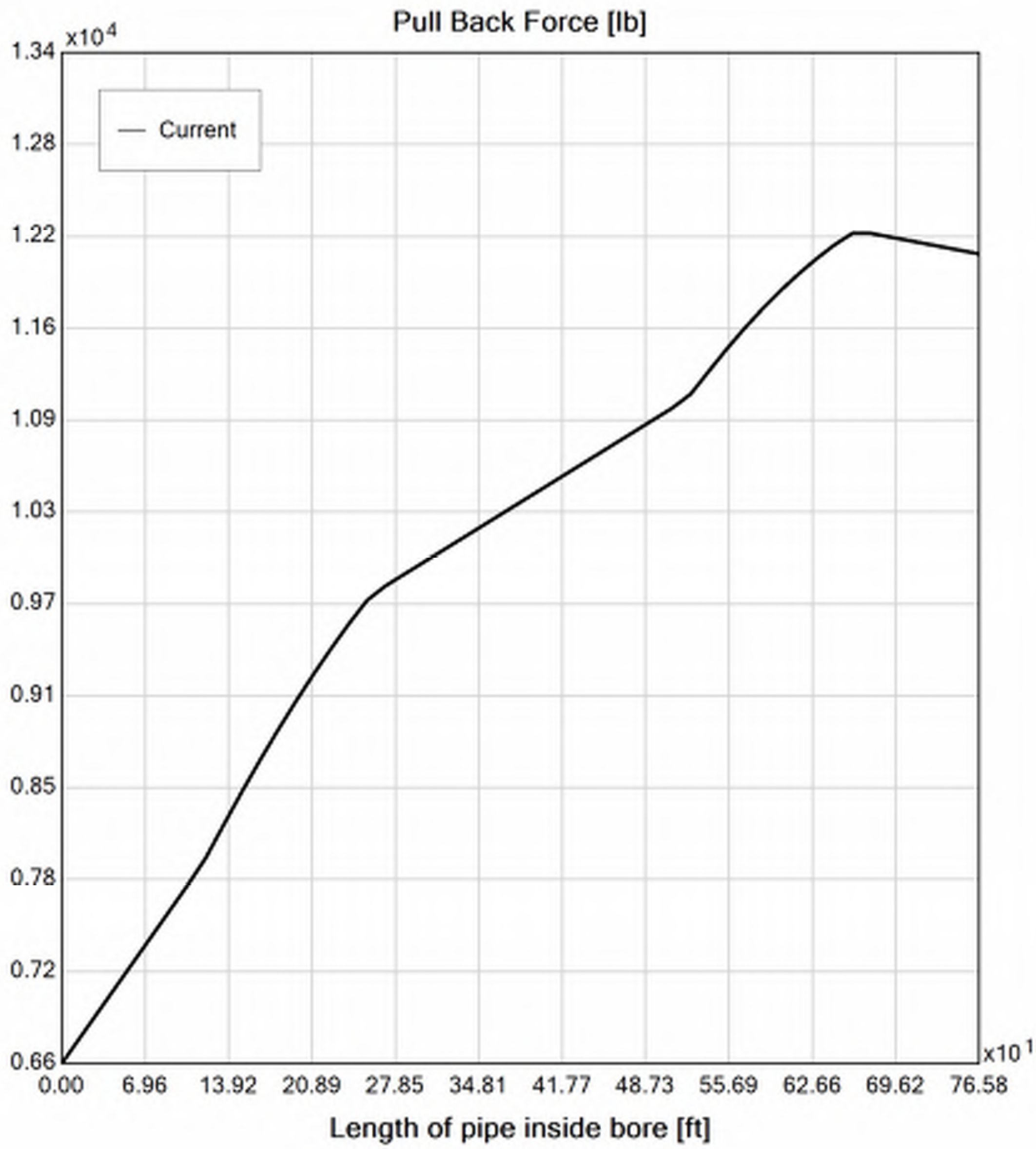
Plastic Viscosity (PV): 25.53

Yield Point (YP): 16.49

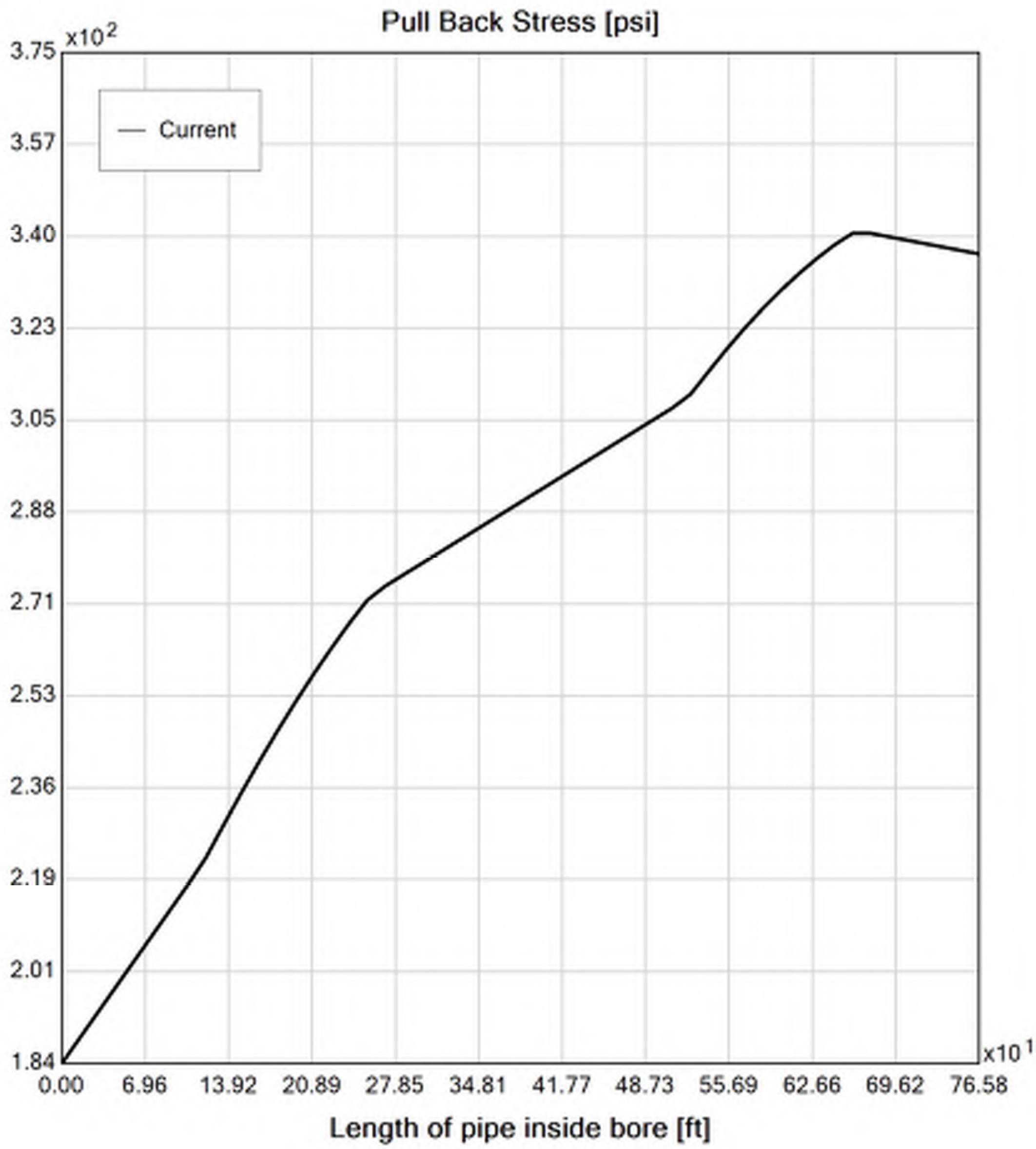
Effective Viscosity (cP): 1202.0

Virtual Site

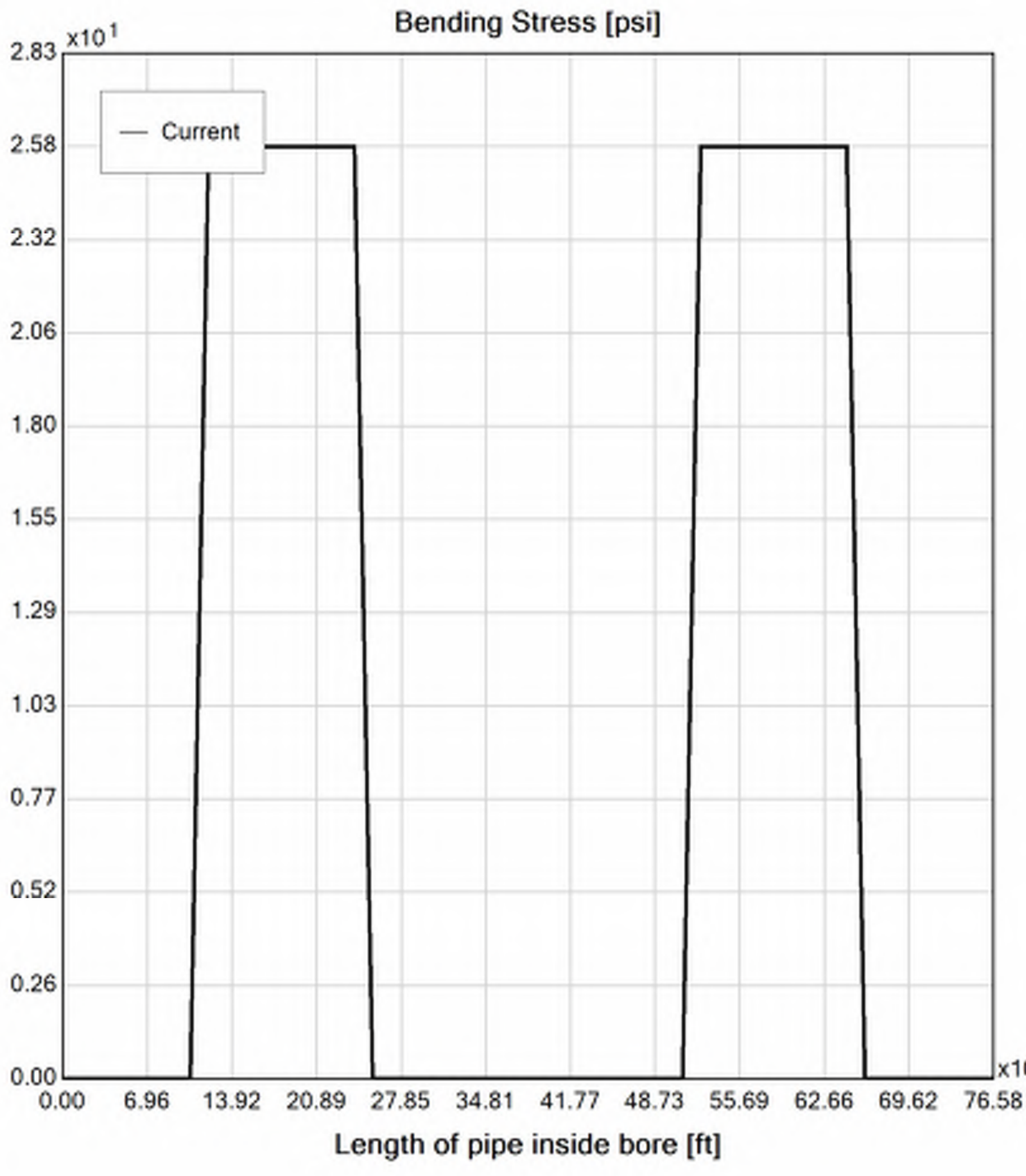




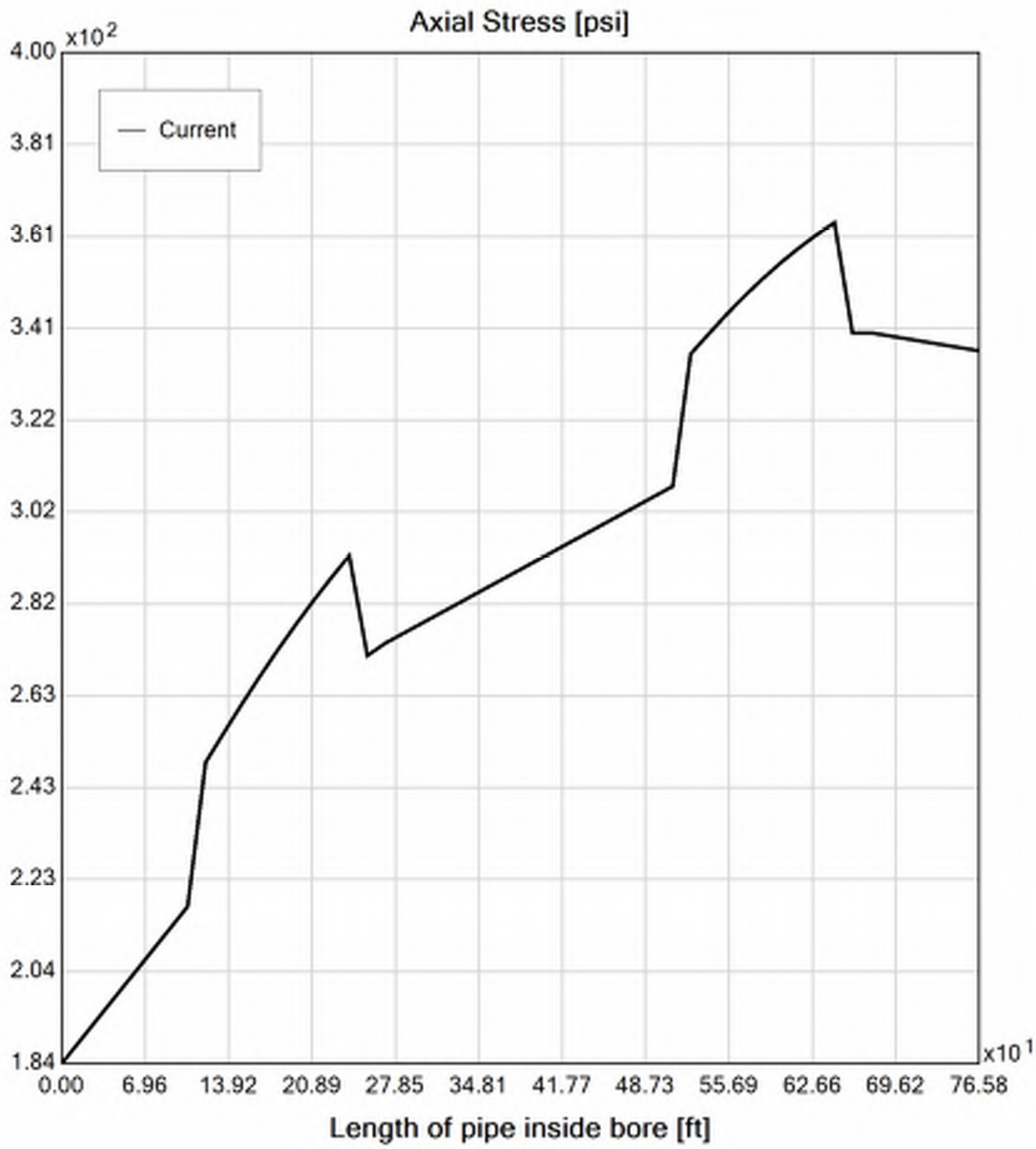
Pull Back Force [lb]
x10^4
1.34
1.28
1.22
1.16
1.09
1.03
0.97
0.91
0.85
0.78
0.72
0.66
Current
x10^1
0.00
6.96
13.92
20.89
27.85
34.81
41.77
48.73
55.69
62.66
69.62
76.58
Length of pipe inside bore [ft]

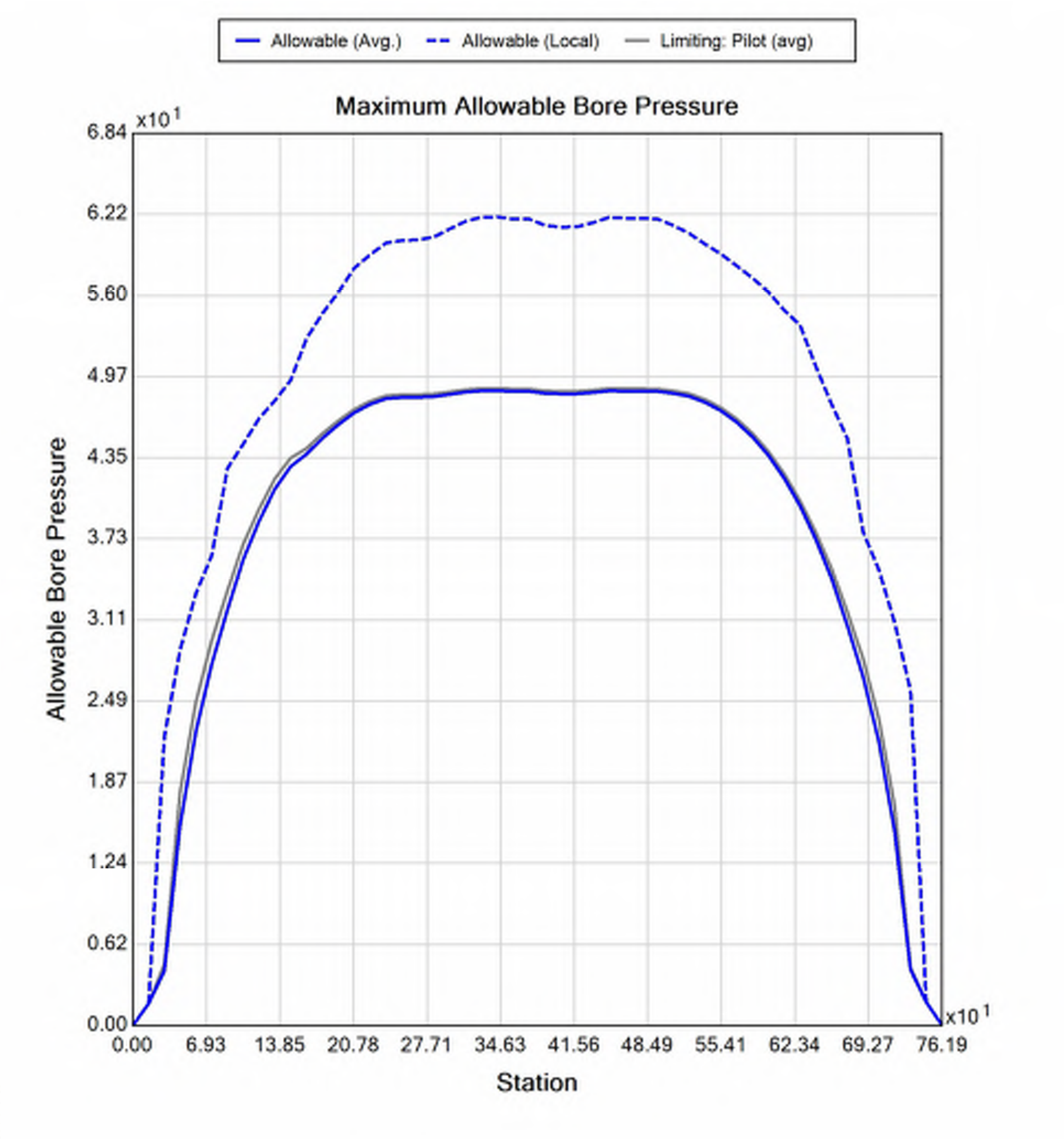


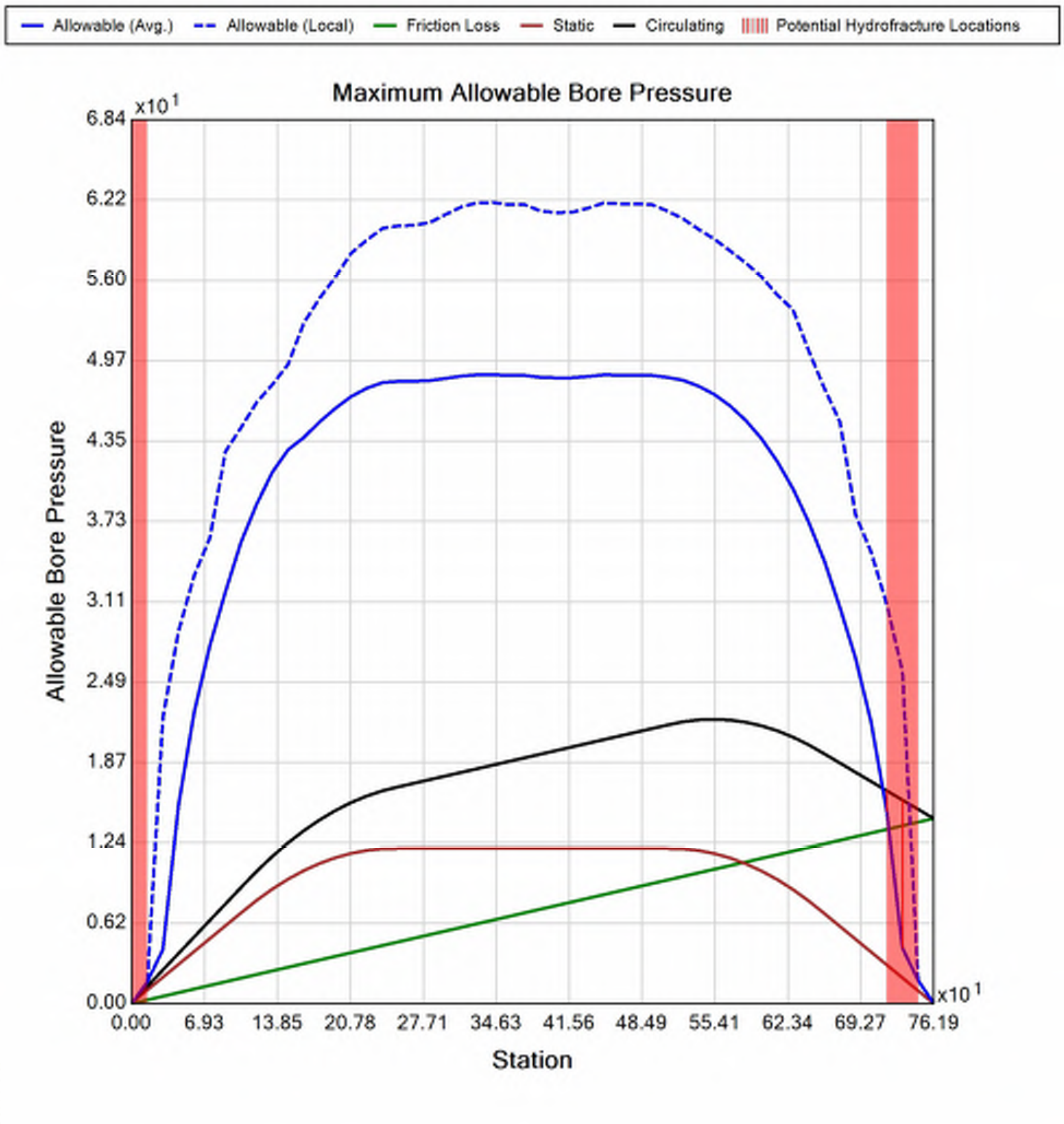
Pull Back Stress [psi]
x10 2
3.75
3.57
3.40
3.23
3.05
2.88
2.71
2.53
2.36
2.19
2.01
1.84
Current
x10 1
0.00
6.96
13.92
20.89
27.85
34.81
41.77
48.73
55.69
62.66
69.62
76.58
Length of pipe inside bore [ft]



Bending Stress [psi]
x10 1
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
x10 1
0.00 6.96 13.92 20.89 27.85 34.81 41.77 48.73 55.69 62.66 69.62 76.58
Length of pipe inside bore [ft]


Axial Stress [psi]
x10 2
4.00
3.81
3.61
3.41
3.22
3.02
2.82
2.63
2.43
2.23
2.04
1.84
Current
x10 1
0.00
6.96
13.92
20.89
27.85
34.81
41.77
48.73
55.69
62.66
69.62
76.58
Length of pipe inside bore [ft]


Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10 1
6.84
6.22
5.60
4.97
4.35
3.73
3.11
2.49
1.87
1.24
0.62
0.00
Allowable Bore Pressure
0.00
6.93
13.85
20.78
27.71
34.63
41.56
48.49
55.41
62.34
69.27
76.19
x10 1
Station



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Generated Output

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Input Summary

Start Coordinate	(0.00, 0.00, 115.42) ft
End Coordinate	(760.00, 0.00, 115.33) ft
Project Length	760.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 765.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	16.1	16.1
Water Pressure	10.2	10.2
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	26.3	26.3
Deflection		
Earth Load Deflection	4.375	4.375
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	4.404	4.404
Compressive Stress [psi]		
Compressive Wall Stress	118.4	118.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	705.5	705.5
Pullback Stress [psi]	403.1	403.1
Pullback Strain	7.011E-3	7.011E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	403.1	406.6
Tensile Strain	7.011E-3	7.171E-3

Net External Pressure = 18.2 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	4.404	7.5	1.7	OK
Unconstrained Collapse [psi]	26.3	93.2	3.5	OK
Compressive Wall Stress [psi]	118.4	1150.0	9.7	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	26.3	233.5	8.9	OK
Tensile Stress [psi]	406.6	1200.0	3.0	OK

Generated Output

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Project Summary

General:	CHPE HDD 4A Conduit 2
	P1C
	Start Date: 02-28-2022
	End Date: 02-28-2022
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	
Description:	HDD 4A 10-inch DR 9 Conduit 2

Input Summary

Start Coordinate	(0.00, 0.00, 113.00) ft
End Coordinate	(730.00, 0.00, 115.56) ft
Project Length	730.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 3

Soil Layer #1 USCS, Gravel (G), GM

From Assistant

Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]

Phi: 34.00, S.M.: 100.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Clay (C), CL

From Assistant

Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 200.00, Coh: 7.30 [psi]

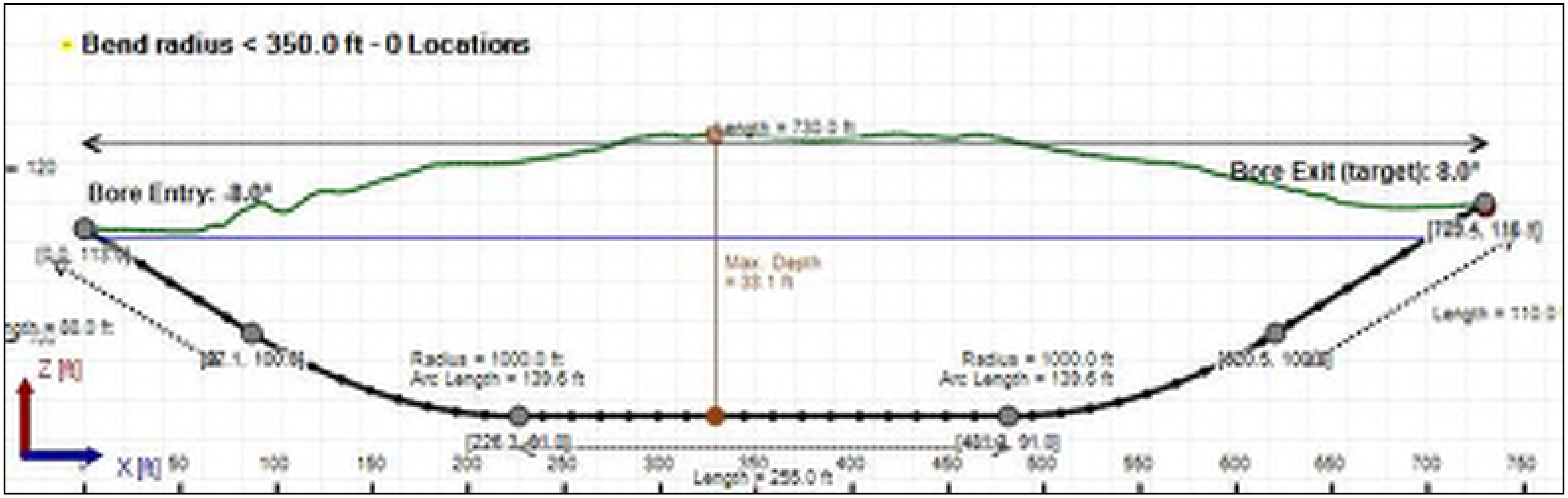
Soil Layer #3 USCS, Clay (C), CH

From Assistant

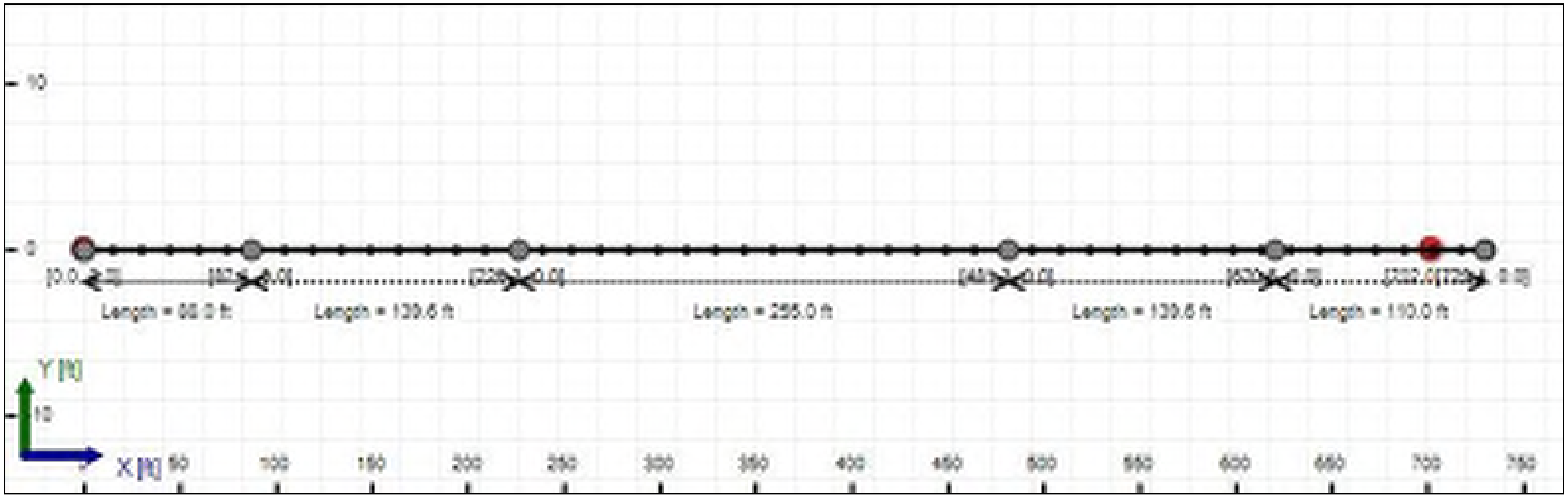
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 200.00, Coh: 8.70 [psi]

Bore Cross-Section View



Bore Plan View



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Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 735.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	4.4	16.3
Water Pressure	9.1	9.1
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	13.5	25.4
Deflection		
Earth Load Deflection	1.206	4.452
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.338	4.584
Compressive Stress [psi]		
Compressive Wall Stress	60.8	114.5

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	11912.9	11912.9
Pullback Stress [psi]	332.2	332.2
Pullback Strain	5.778E-3	5.778E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	332.2	356.8
Tensile Strain	5.778E-3	6.654E-3

Net External Pressure = 19.0 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.338	7.5	5.6	OK
Unconstrained Collapse [psi]	16.5	122.5	7.4	OK
Compressive Wall Stress [psi]	60.8	1150.0	18.9	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	26.5	235.8	8.9	OK
Tensile Stress [psi]	356.8	1200.0	3.4	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	67.541 psi	61.353 psi
1	8.00 in	12.00 in	67.462 psi	61.253 psi
2	12.00 in	16.13 in	67.349 psi	61.110 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

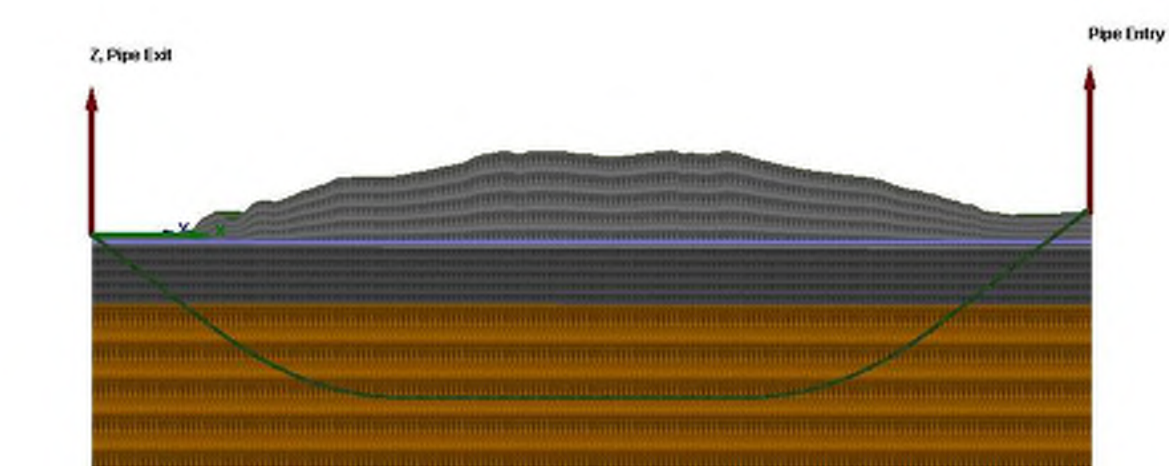
Rheological model: Bingham-Plastic

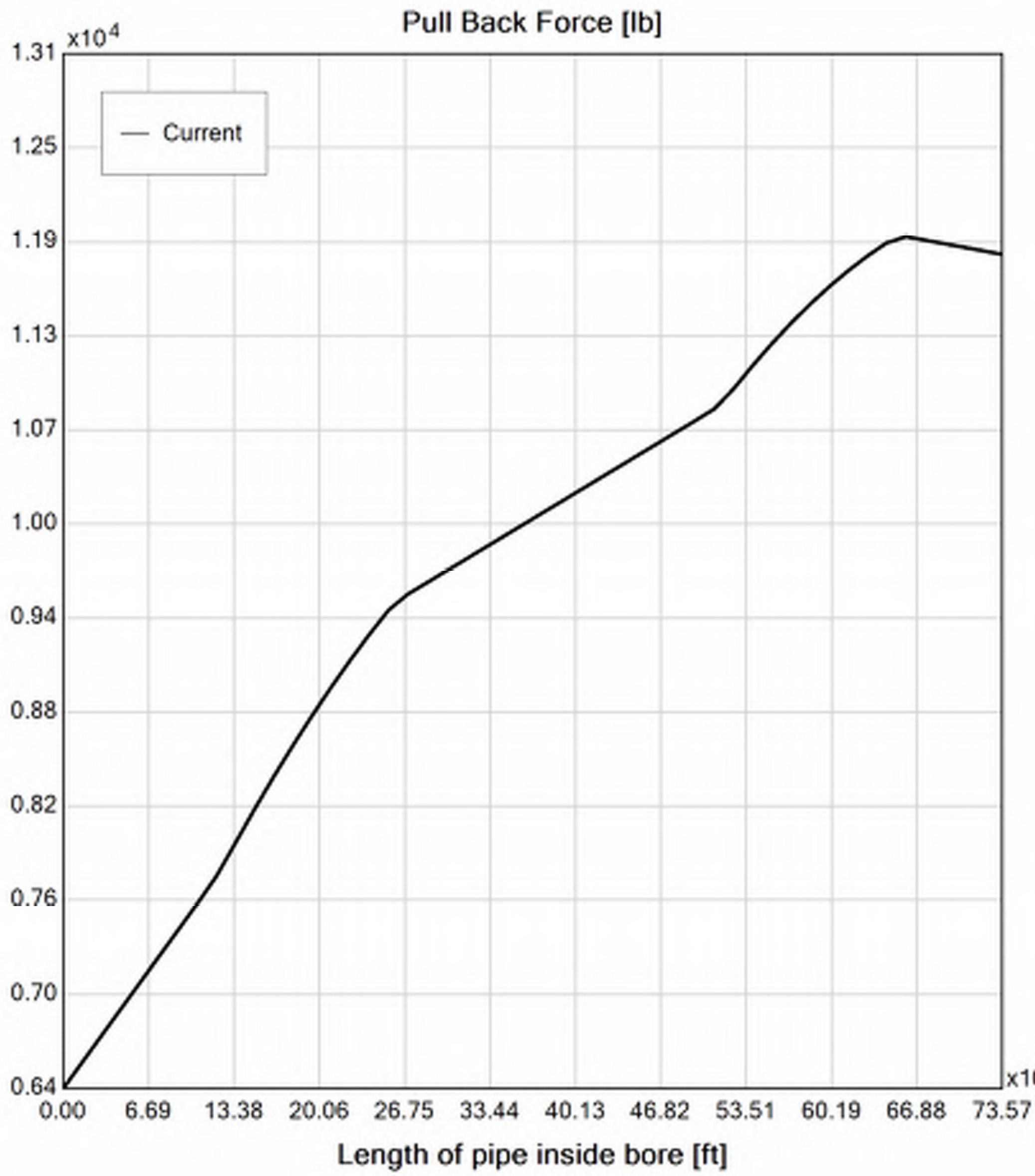
Plastic Viscosity (PV): 25.53

Yield Point (YP): 16.49

Effective Viscosity (cP): 1202.0

Virtual Site





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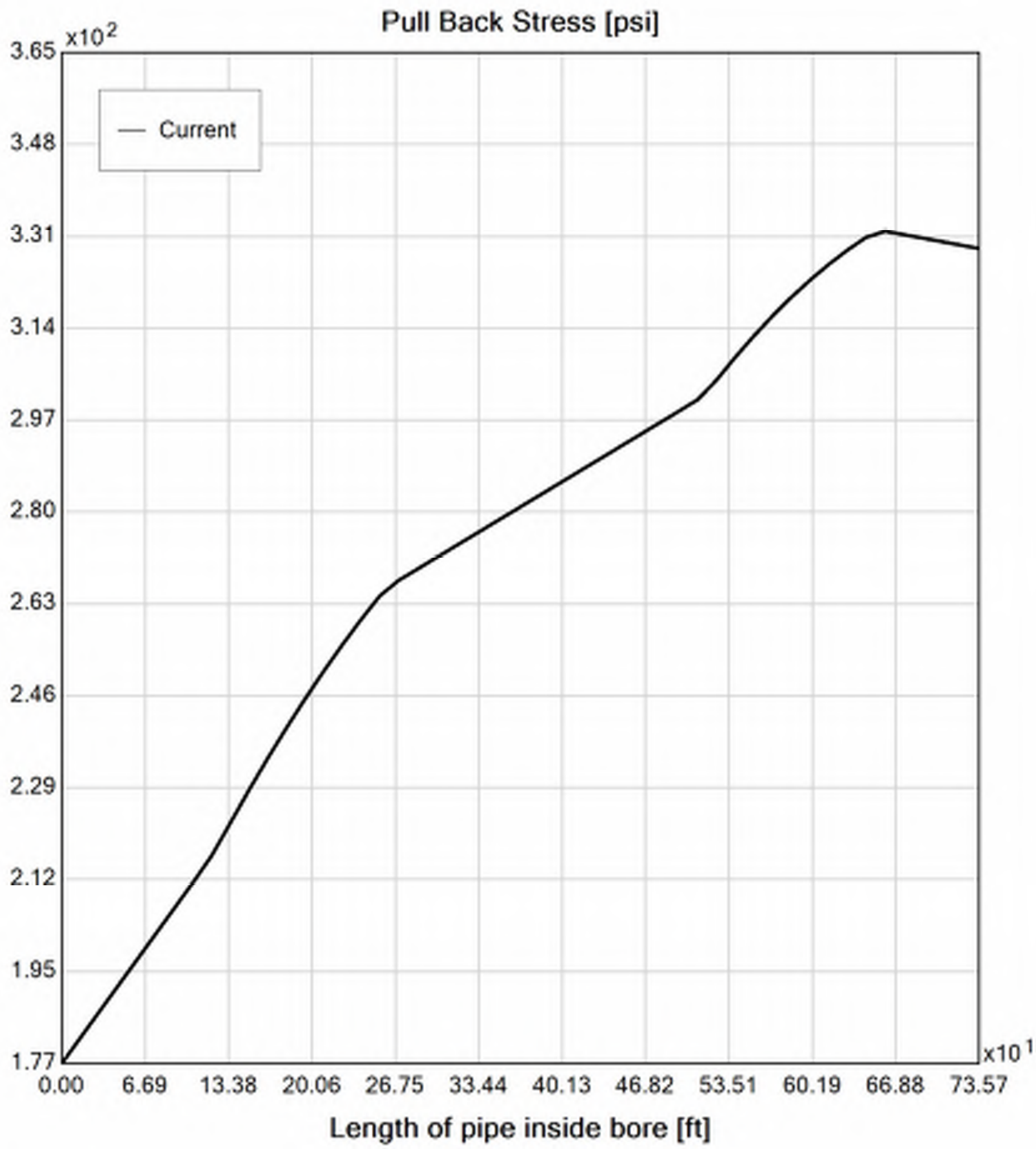
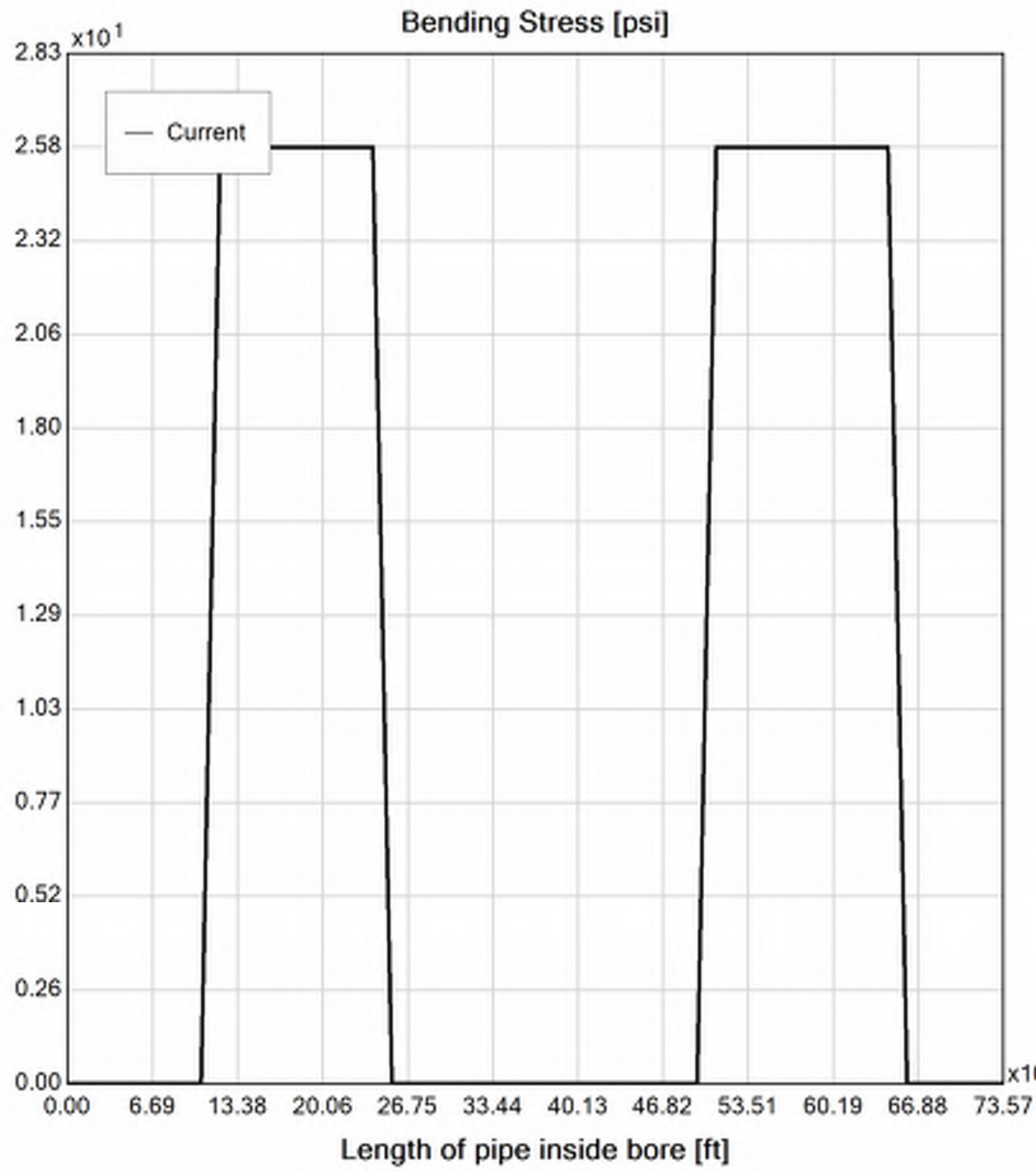
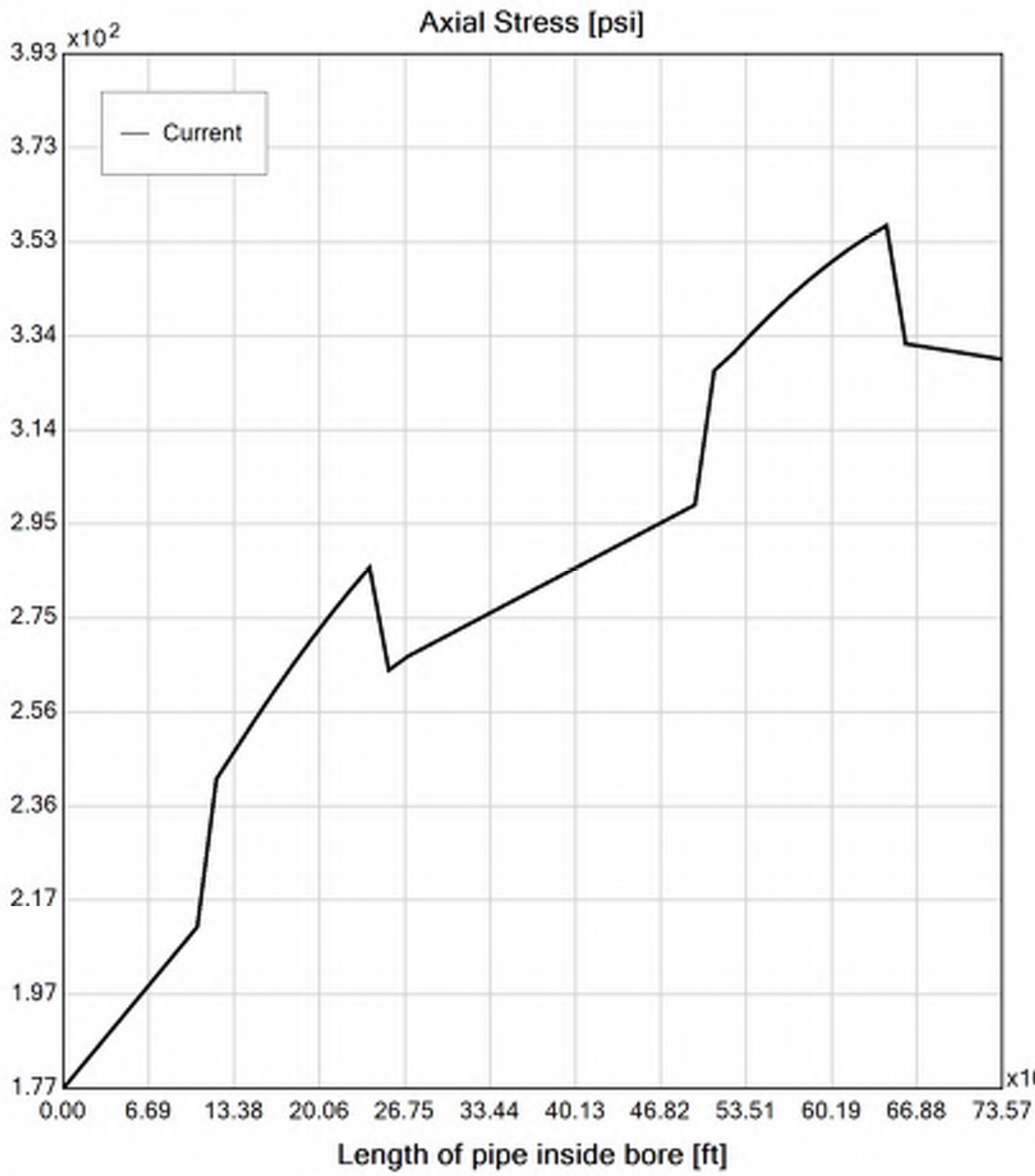
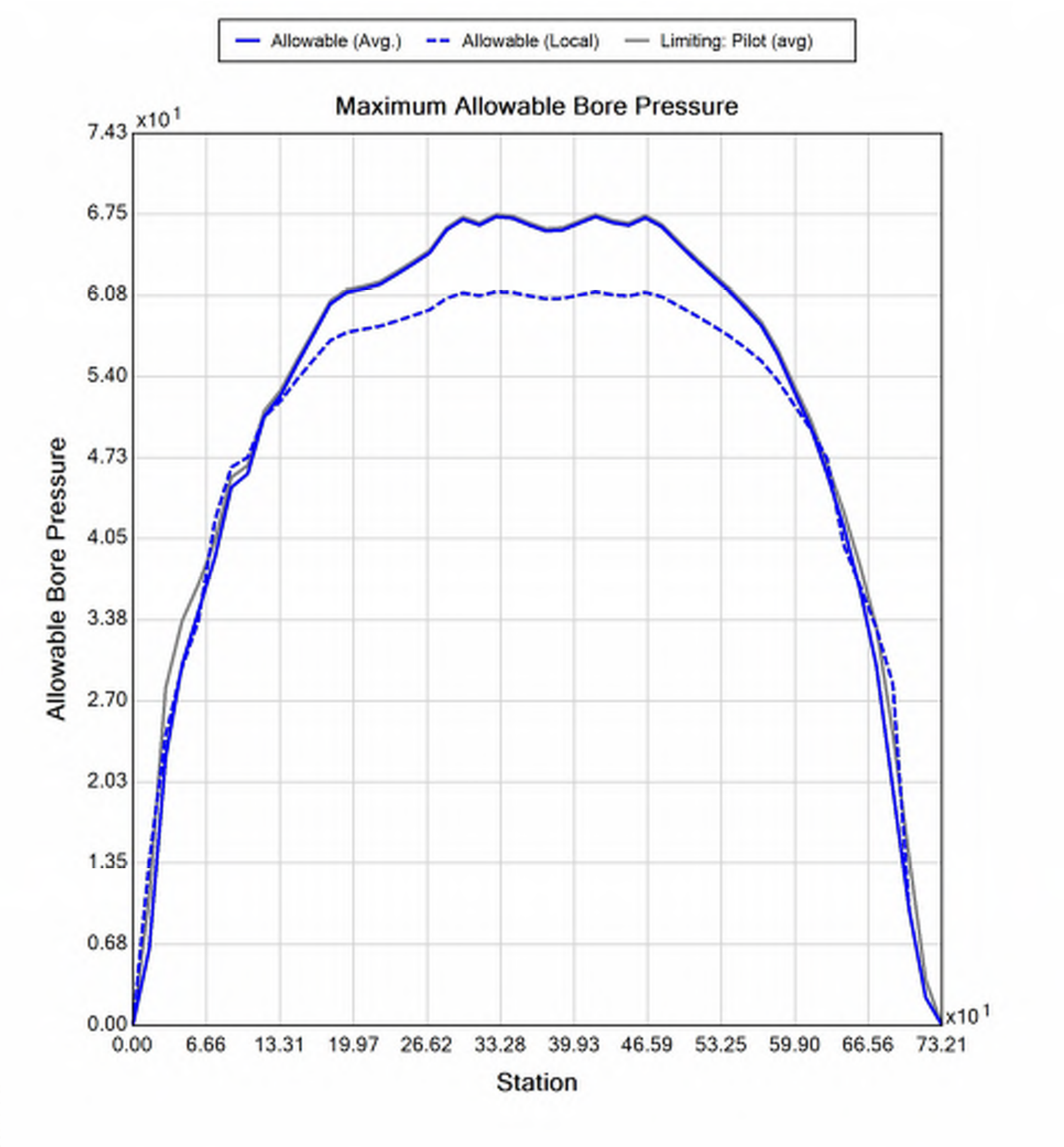

Pull Back Stress [psi]
x10 2
3.65
3.48
3.31
3.14
2.97
2.80
2.63
2.46
2.29
2.12
1.95
1.77
Current
x10 1
0.00
6.69
13.38
20.06
26.75
33.44
40.13
46.82
53.51
60.19
66.88
73.57
Length of pipe inside bore [ft]

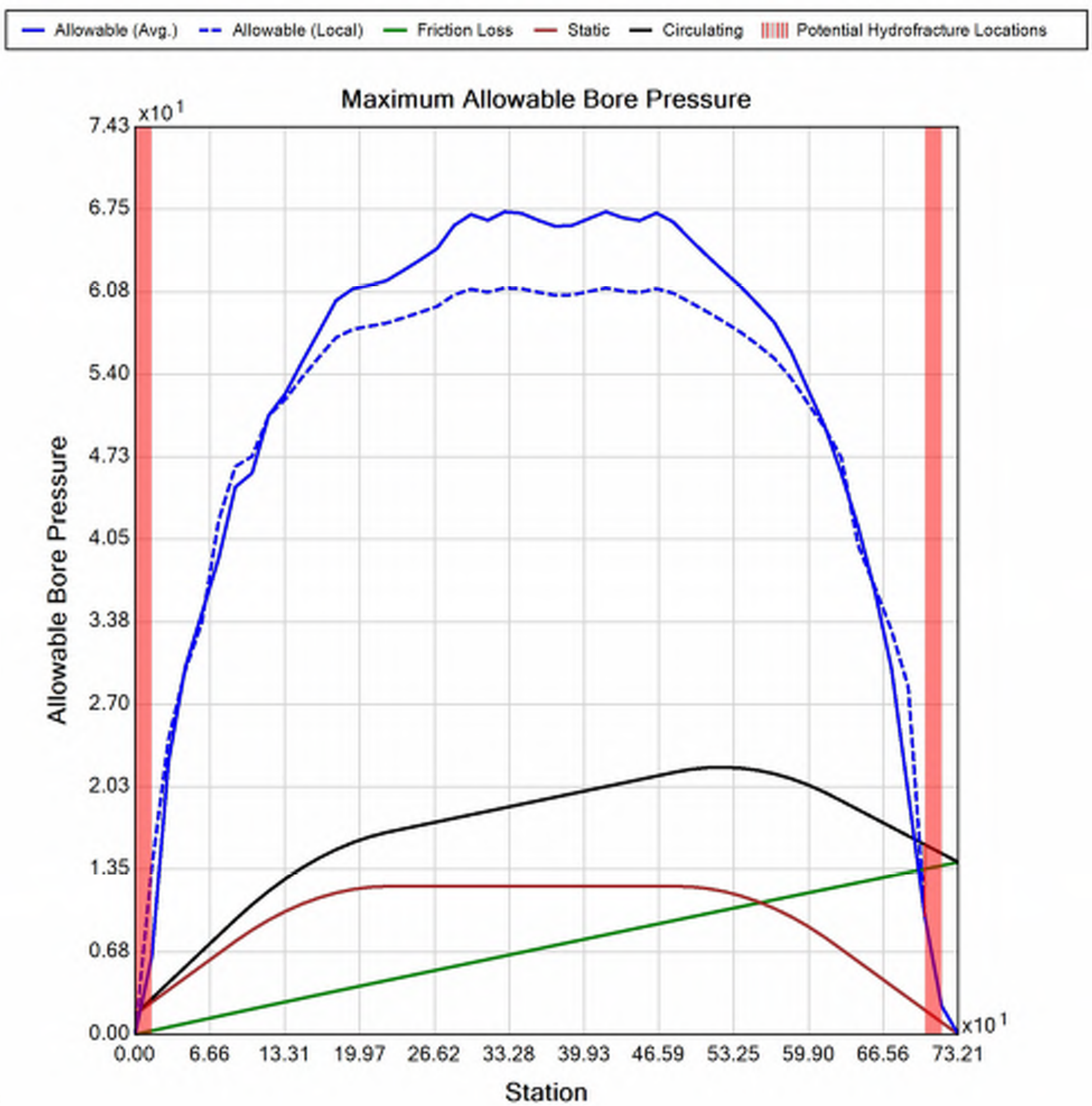


Bending Stress [psi]
x10 1
Current
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
x10 1
0.00
6.69
13.38
20.06
26.75
33.44
40.13
46.82
53.51
60.19
66.88
73.57
Length of pipe inside bore [ft]



Axial Stress [psi]
x10^2
3.93
3.73
3.53
3.34
3.14
2.95
2.75
2.56
2.36
2.17
1.97
1.77
Current
0.00
6.69
13.38
20.06
26.75
33.44
40.13
46.82
53.51
60.19
66.88
73.57
x10^1
Length of pipe inside bore [ft]


Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10 1
7.43
6.75
6.08
5.40
4.73
4.05
3.38
2.70
2.03
1.35
0.68
0.00
Allowable Bore Pressure
0.00
6.66
13.31
19.97
26.62
33.28
39.93
46.59
53.25
59.90
66.56
73.21
x10 1
Station



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Input Summary

Start Coordinate	(0.00, 0.00, 113.00) ft
End Coordinate	(730.00, 0.00, 115.56) ft
Project Length	730.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 735.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	1.9	16.3
Water Pressure	9.1	9.1
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	10.9	25.4
Deflection		
Earth Load Deflection	0.552	4.452
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	0.582	4.481
Compressive Stress [psi]		
Compressive Wall Stress	49.2	114.5

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	691.1	691.1
Pullback Stress [psi]	394.9	394.9
Pullback Strain	6.867E-3	6.867E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	394.9	399.4
Tensile Strain	6.867E-3	7.045E-3

Net External Pressure = 19.0 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.582	7.5	12.9	OK
Unconstrained Collapse [psi]	16.5	131.7	8.0	OK
Compressive Wall Stress [psi]	49.2	1150.0	23.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	26.5	234.1	8.8	OK
Tensile Stress [psi]	399.4	1200.0	3.0	OK

Generated Output

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Project Summary

General:	CHPE HDD 5
	P1C
	Start Date: 02-28-2022
	End Date: 02-28-2022
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	
Description:	HDD 5 10-inch DR 9

Input Summary

Start Coordinate	(0.00, 0.00, 123.02) ft
End Coordinate	(710.00, 0.00, 122.00) ft
Project Length	710.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 3

Soil Layer #1 USCS, Gravel (G), GM

Depth: 4.00 ft

Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 100.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Clay (C), CL

Depth: 8.00 ft

Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 200.00, Coh: 7.30 [psi]

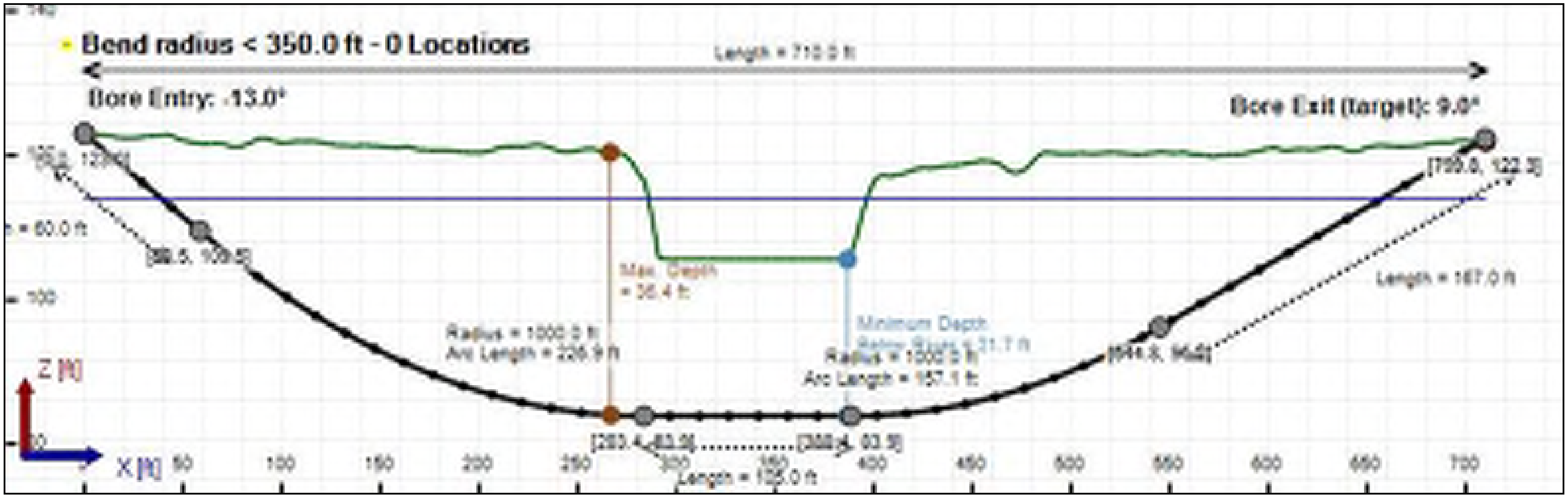
Soil Layer #3 USCS, Clay (C), CH

Depth: 30.00 ft

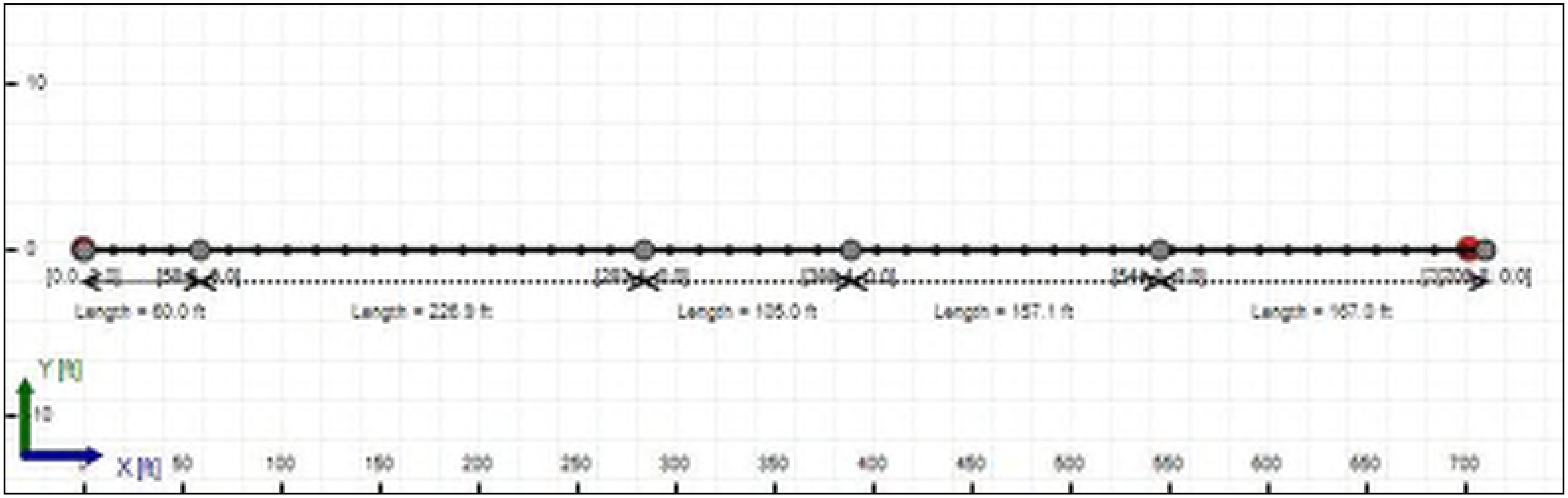
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 200.00, Coh: 8.70 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 720.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	11.6	11.6
Water Pressure	12.8	12.8
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	24.5	24.5
Deflection		
Earth Load Deflection	3.183	3.183
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	3.315	3.315
Compressive Stress [psi]		
Compressive Wall Stress	110.1	110.1

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	12466.7	12466.7
Pullback Stress [psi]	347.7	347.7
Pullback Strain	6.047E-3	6.047E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	347.7	372.7
Tensile Strain	6.047E-3	6.930E-3

Net External Pressure = 18.8 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	3.315	7.5	2.3	OK
Unconstrained Collapse [psi]	25.4	103.3	4.1	OK
Compressive Wall Stress [psi]	110.1	1150.0	10.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	35.4	235.3	6.6	OK
Tensile Stress [psi]	372.7	1200.0	3.2	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	58.142 psi	60.390 psi
1	8.00 in	12.00 in	58.061 psi	60.307 psi
2	12.00 in	16.13 in	57.944 psi	60.188 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

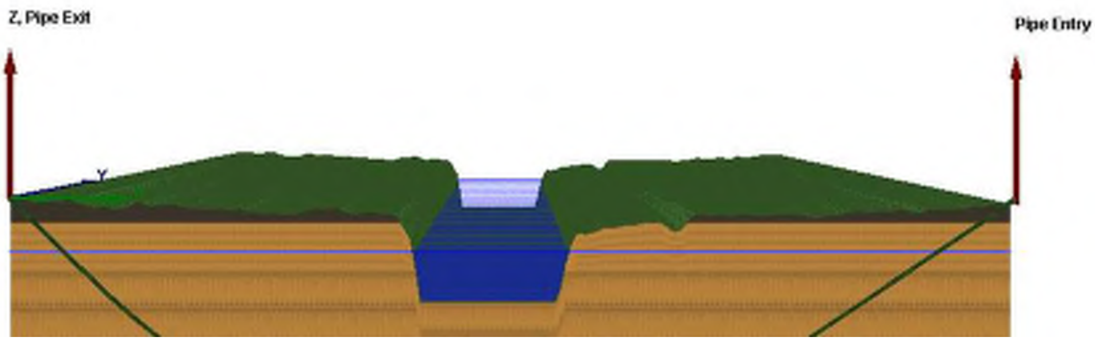
Rheological model: Bingham-Plastic

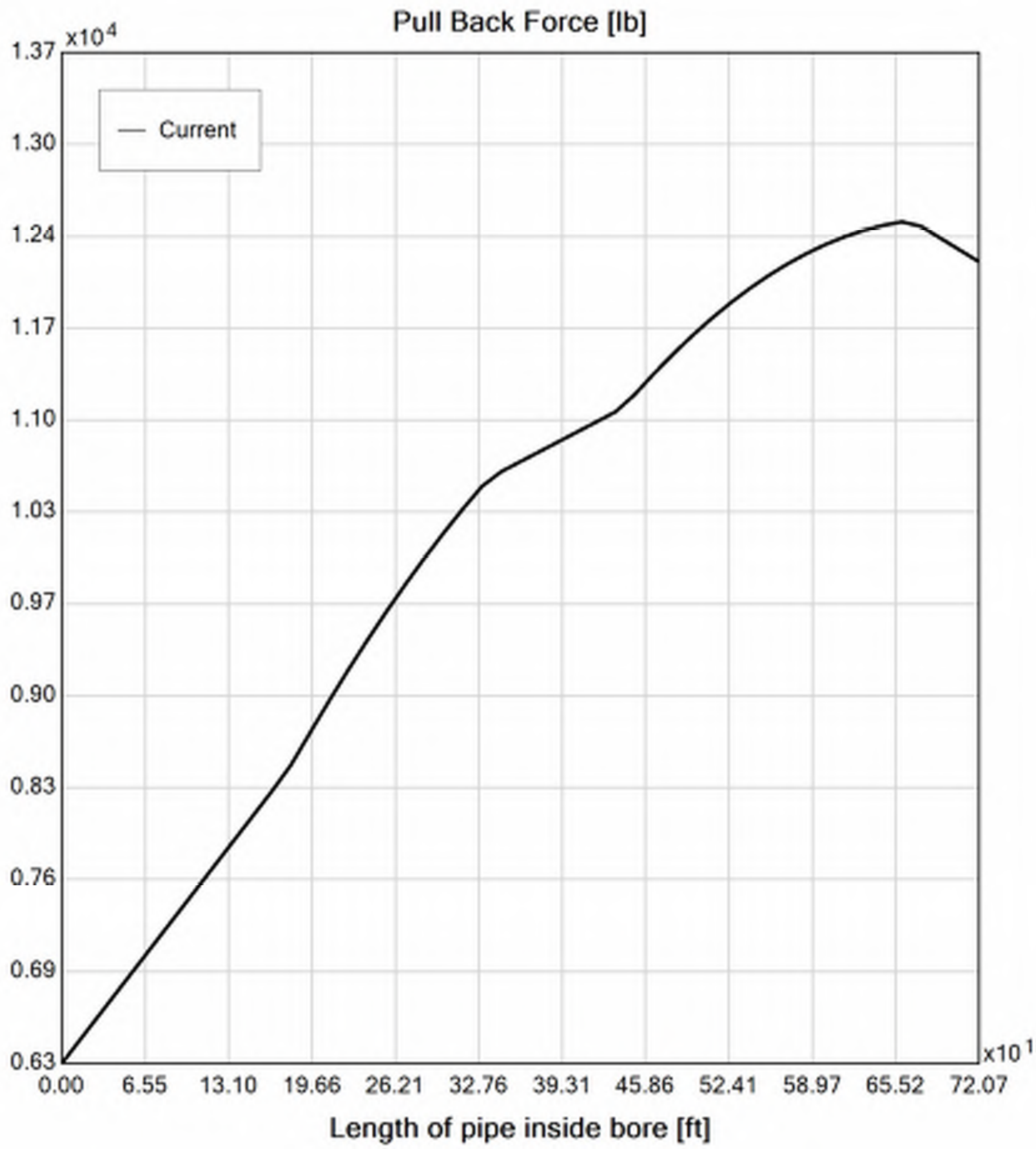
Plastic Viscosity (PV): 25.53

Yield Point (YP): 16.49

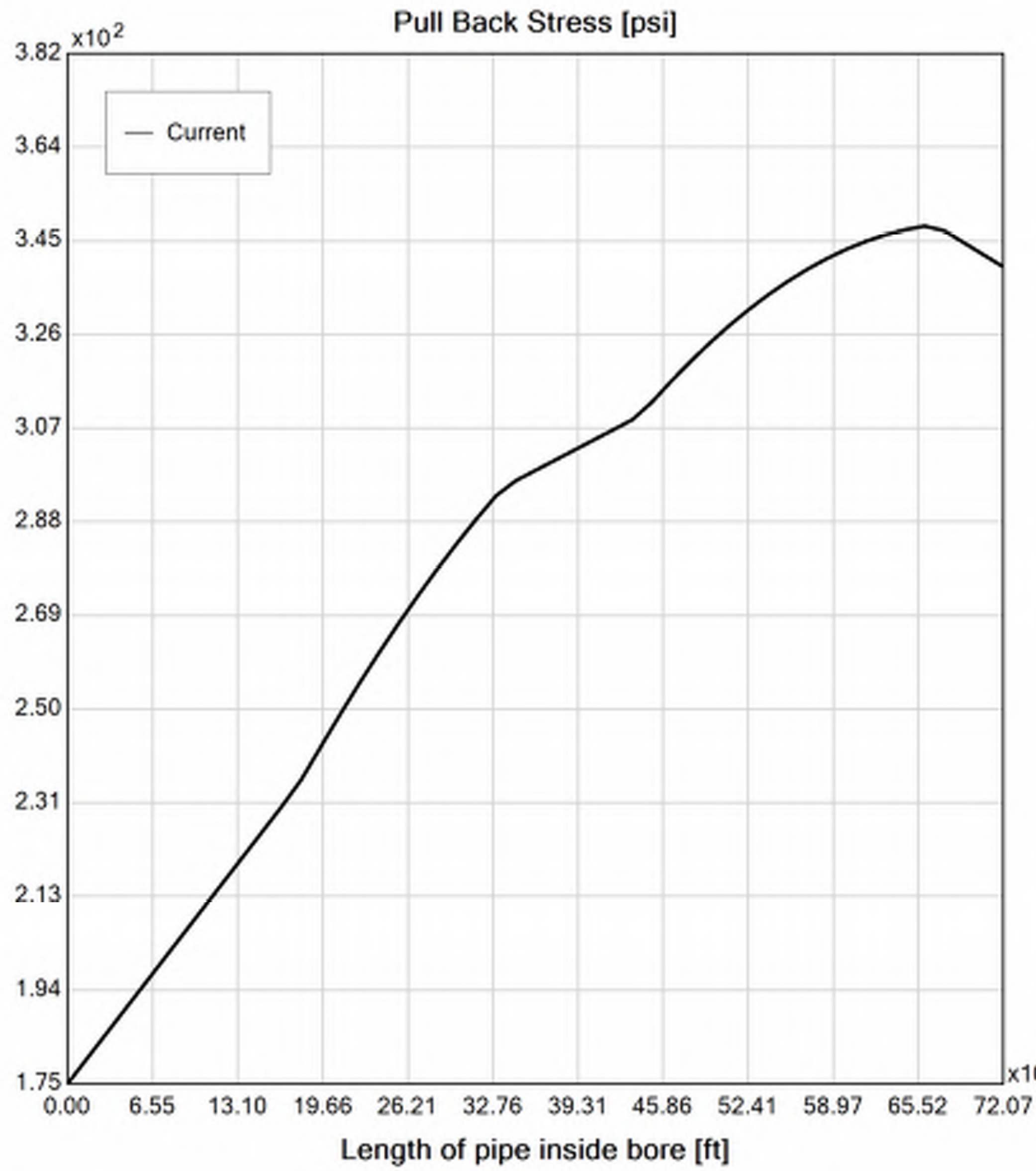
Effective Viscosity (cP): 1202.0

Virtual Site

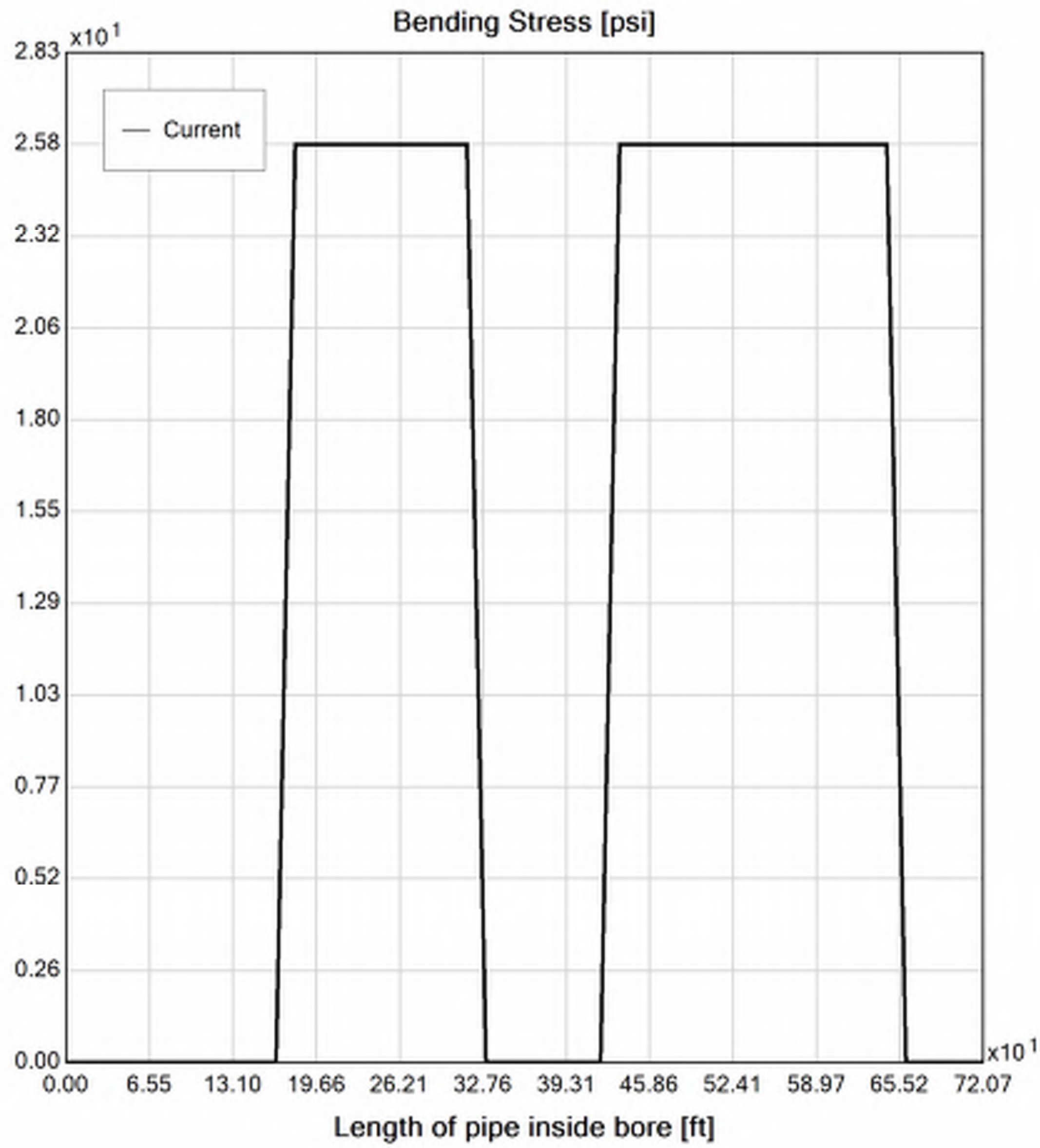


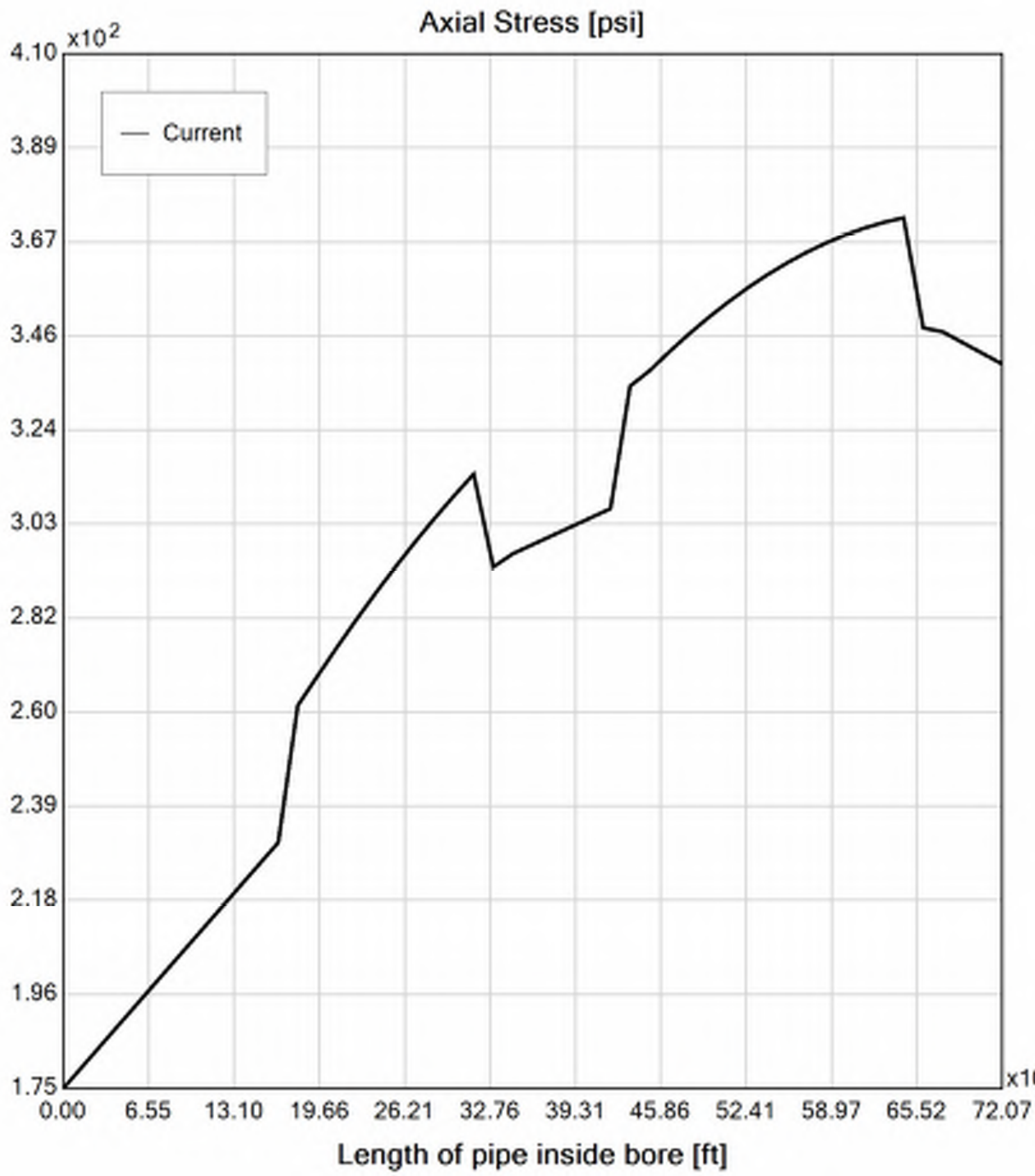


Pull Back Force [lb]
x10^4
1.37
1.30
1.24
1.17
1.10
1.03
0.97
0.90
0.83
0.76
0.69
0.63
Current
x10^1
0.00
6.55
13.10
19.66
26.21
32.76
39.31
45.86
52.41
58.97
65.52
72.07
Length of pipe inside bore [ft]

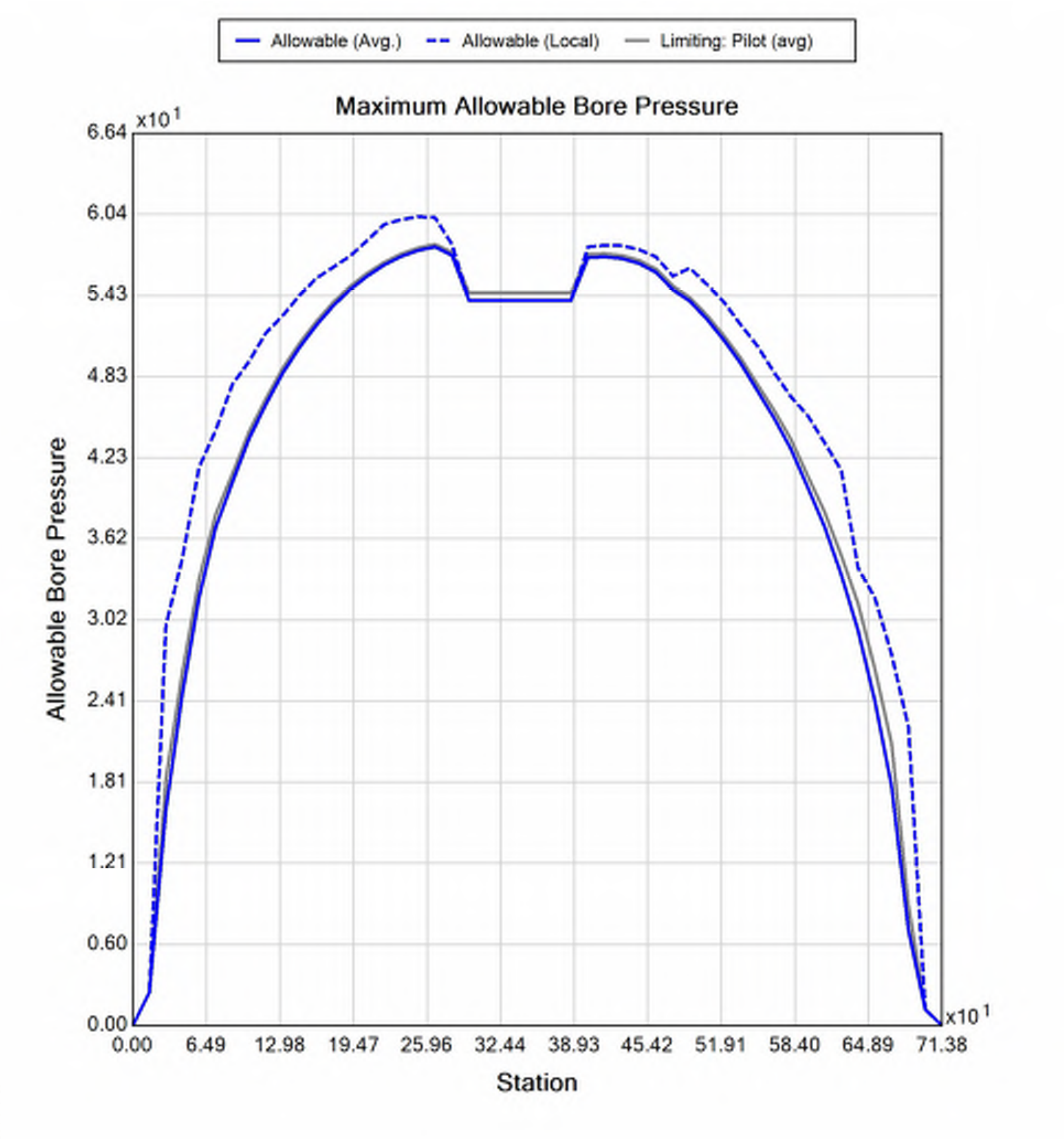


Pull Back Stress [psi]
x10^2
3.82
3.64
3.45
3.26
3.07
2.88
2.69
2.50
2.31
2.13
1.94
1.75
Current
0.00
6.55
13.10
19.66
26.21
32.76
39.31
45.86
52.41
58.97
65.52
72.07
x10^1
Length of pipe inside bore [ft]


Bending Stress [psi]
x10 1
Current
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
0.00
6.55
13.10
19.66
26.21
32.76
39.31
45.86
52.41
58.97
65.52
72.07
x10 1
Length of pipe inside bore [ft]



Axial Stress [psi]
x10²
4.10
3.89
3.67
3.46
3.24
3.03
2.82
2.60
2.39
2.18
1.96
1.75
Current
x10¹
0.00
6.55
13.10
19.66
26.21
32.76
39.31
45.86
52.41
58.97
65.52
72.07
Length of pipe inside bore [ft]



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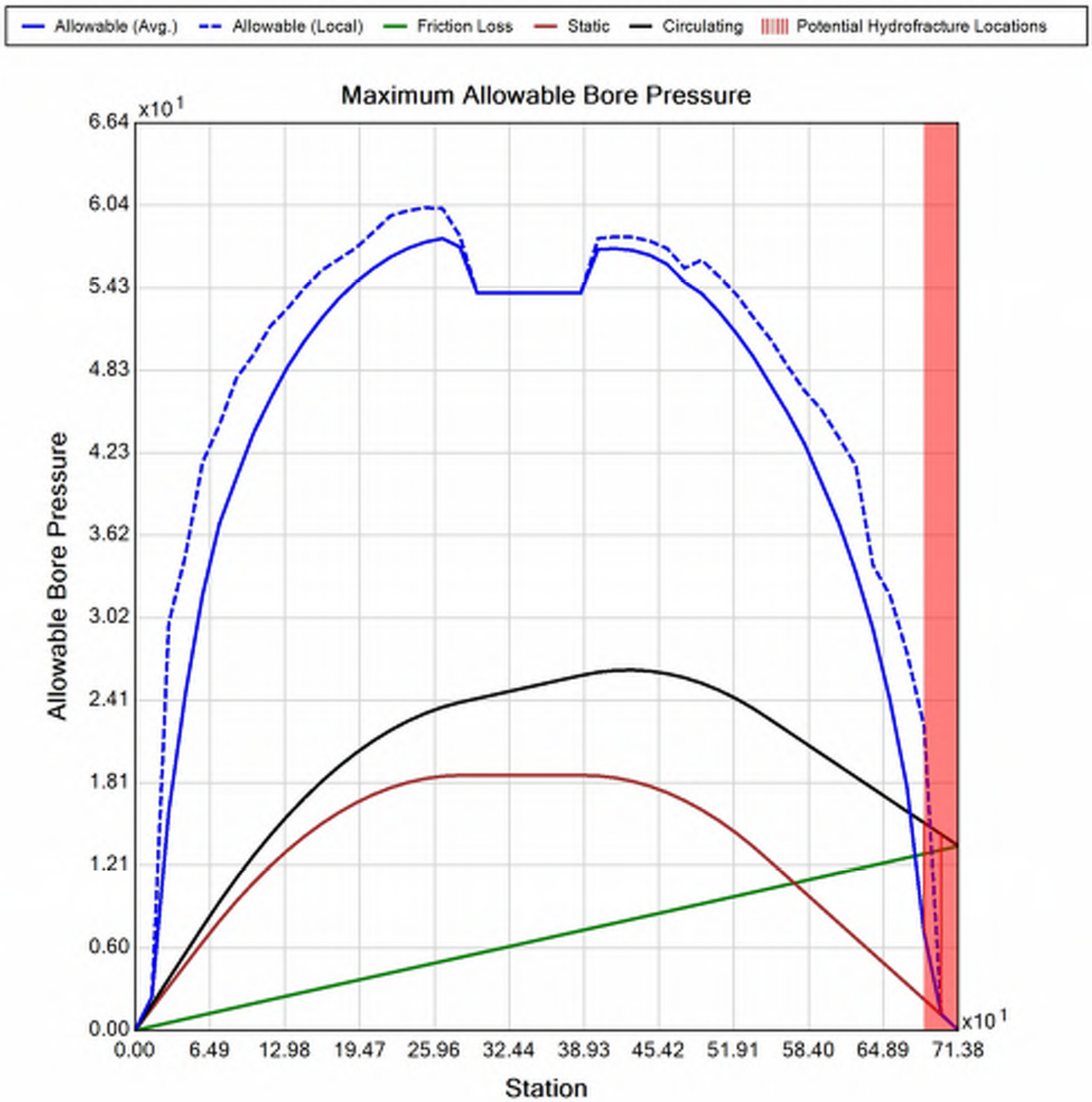

Allowable (Avg.)
Allowable (Local)
Friction Loss
Static
Circulating
Potential Hydrofracture Locations
Maximum Allowable Bore Pressure
x10 1
6.64
6.04
5.43
4.83
4.23
3.62
3.02
2.41
1.81
1.21
0.60
0.00
Allowable Bore Pressure
0.00
6.49
12.98
19.47
25.96
32.44
38.93
45.42
51.91
58.40
64.89
71.38
x10 1
Station

Generated Output

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Input Summary

Start Coordinate	(0.00, 0.00, 123.02) ft
End Coordinate	(710.00, 0.00, 122.00) ft
Project Length	710.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 720.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	11.6	11.6
Water Pressure	12.8	12.8
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	24.5	24.5
Deflection		
Earth Load Deflection	3.183	3.183
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	3.212	3.212
Compressive Stress [psi]		
Compressive Wall Stress	110.1	110.1

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	718.1	718.1
Pullback Stress [psi]	410.3	410.3
Pullback Strain	7.136E-3	7.136E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	410.3	415.2
Tensile Strain	7.136E-3	7.321E-3

Net External Pressure = 18.8 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	3.212	7.5	2.3	OK
Unconstrained Collapse [psi]	25.4	104.3	4.1	OK
Compressive Wall Stress [psi]	110.1	1150.0	10.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	35.4	233.6	6.6	OK
Tensile Stress [psi]	415.2	1200.0	2.9	OK

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Project Summary

General:	CHPE HDD 6 Conduit 1
	P1C
	Start Date: 02-24-2022
	End Date: 02-24-2022
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	
Description:	HDD 6 10-inch DR 9 Conduit 1

Input Summary

Start Coordinate	(0.00, 0.00, 116.44) ft
End Coordinate	(1450.00, 0.00, 120.00) ft
Project Length	1450.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 5

Soil Layer #1 USCS, Silt (M), ML
From Assistant
Unit Weight: 80.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 28.00, S.M.: 50.00, Coh: 0.00 [psi]

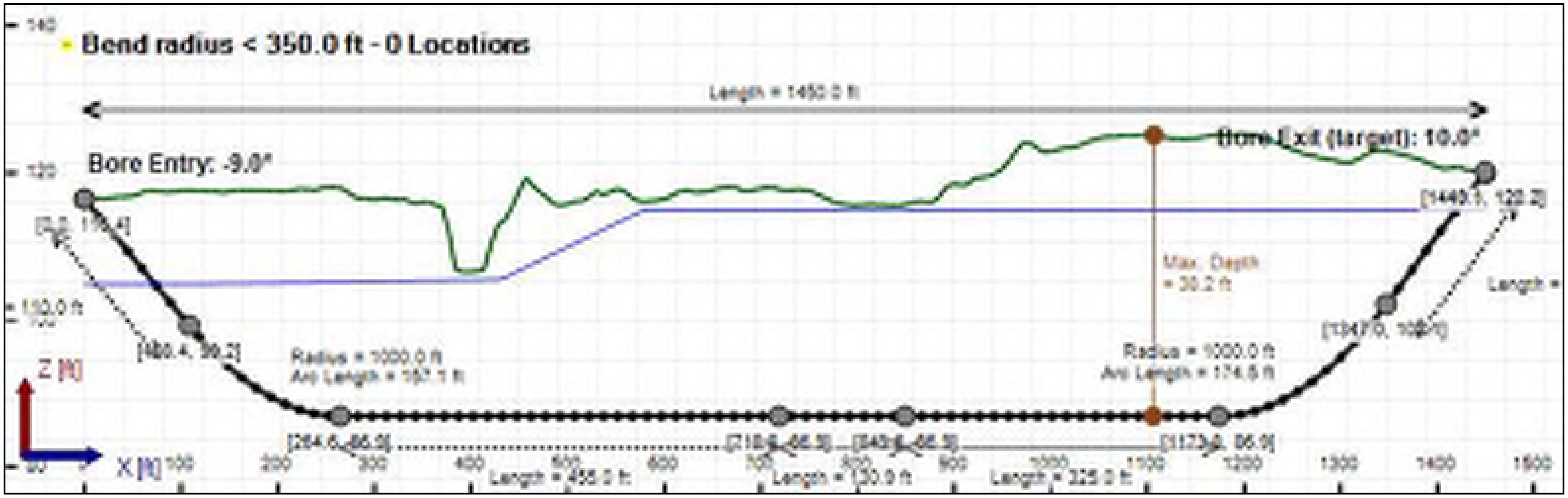
Soil Layer #2 USCS, Clay (C), CL
From Assistant
Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 300.00, Coh: 5.50 [psi]

Soil Layer #3 USCS, Silt (M), ML
From Assistant
Unit Weight: 80.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 28.00, S.M.: 50.00, Coh: 0.00 [psi]

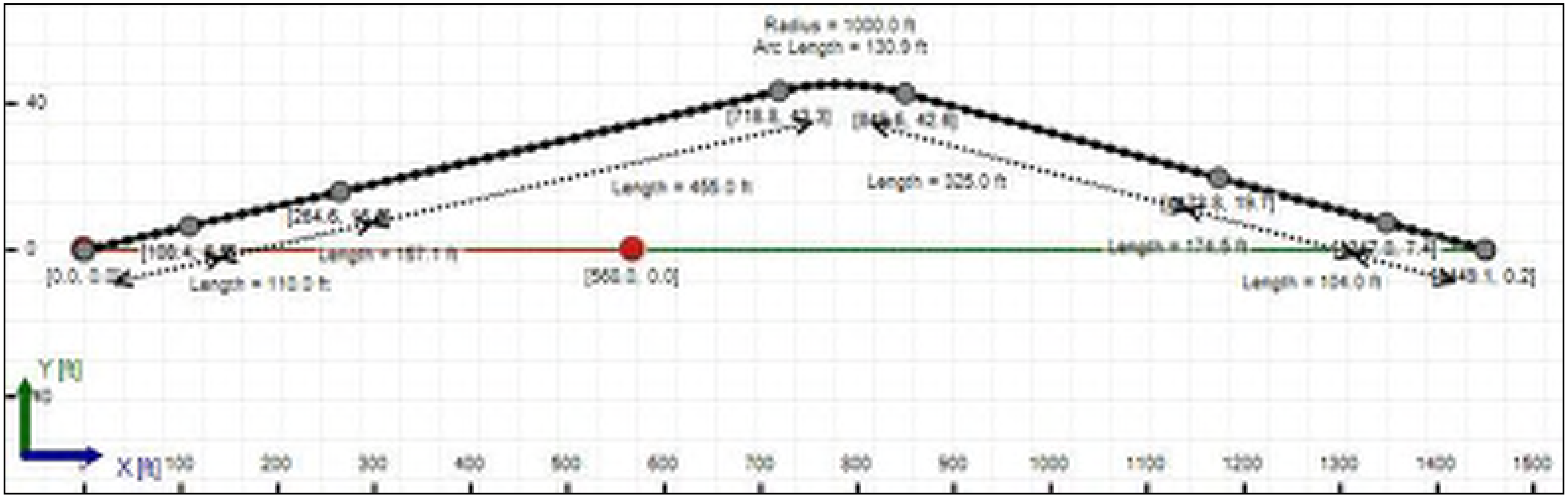
Soil Layer #4 USCS, Sand (S), SP
From Assistant
Unit Weight: 110.0000 (dry), 125.0000 (sat) [lb/ft3]
Phi: 34.00, S.M.: 500.00, Coh: 0.00 [psi]

Soil Layer #5 USCS, Clay (C), CL
From Assistant
Unit Weight: 75.0000 (dry), 105.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 250.00, Coh: 4.30 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 1470.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	3.2	14.7
Water Pressure	12.2	12.2
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	15.4	26.8
Deflection		
Earth Load Deflection	1.319	3.996
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.451	4.128
Compressive Stress [psi]		
Compressive Wall Stress	69.1	120.8

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	24270.3	24270.3
Pullback Stress [psi]	676.9	676.9
Pullback Strain	1.177E-2	1.177E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	676.9	698.1
Tensile Strain	1.177E-2	1.259E-2

Net External Pressure = 23.1 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.451	7.5	5.2	OK
Unconstrained Collapse [psi]	23.1	123.6	5.3	OK
Compressive Wall Stress [psi]	69.1	1150.0	16.6	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	33.1	213.7	6.5	OK
Tensile Stress [psi]	698.1	1200.0	1.7	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	74.281 psi	86.738 psi
1	8.00 in	12.00 in	73.926 psi	85.613 psi
2	12.00 in	16.13 in	73.427 psi	84.200 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

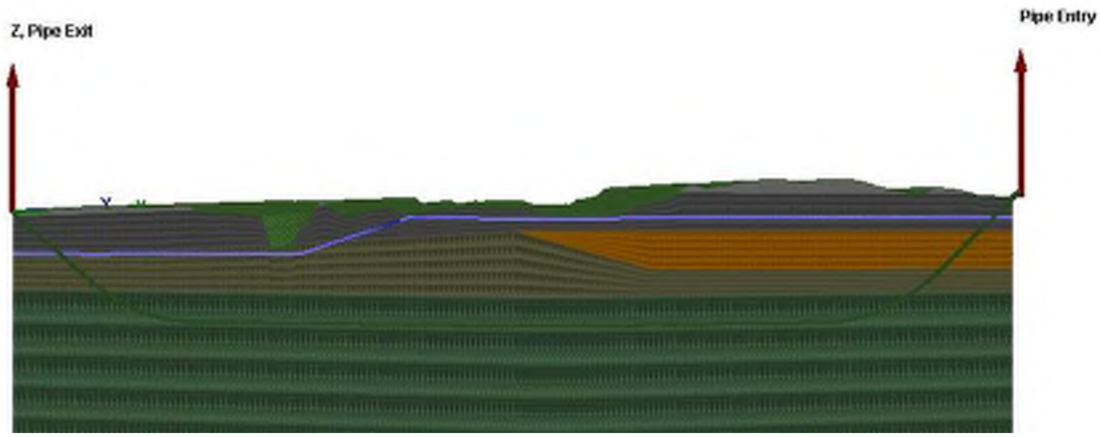
Rheological model: Bingham-Plastic

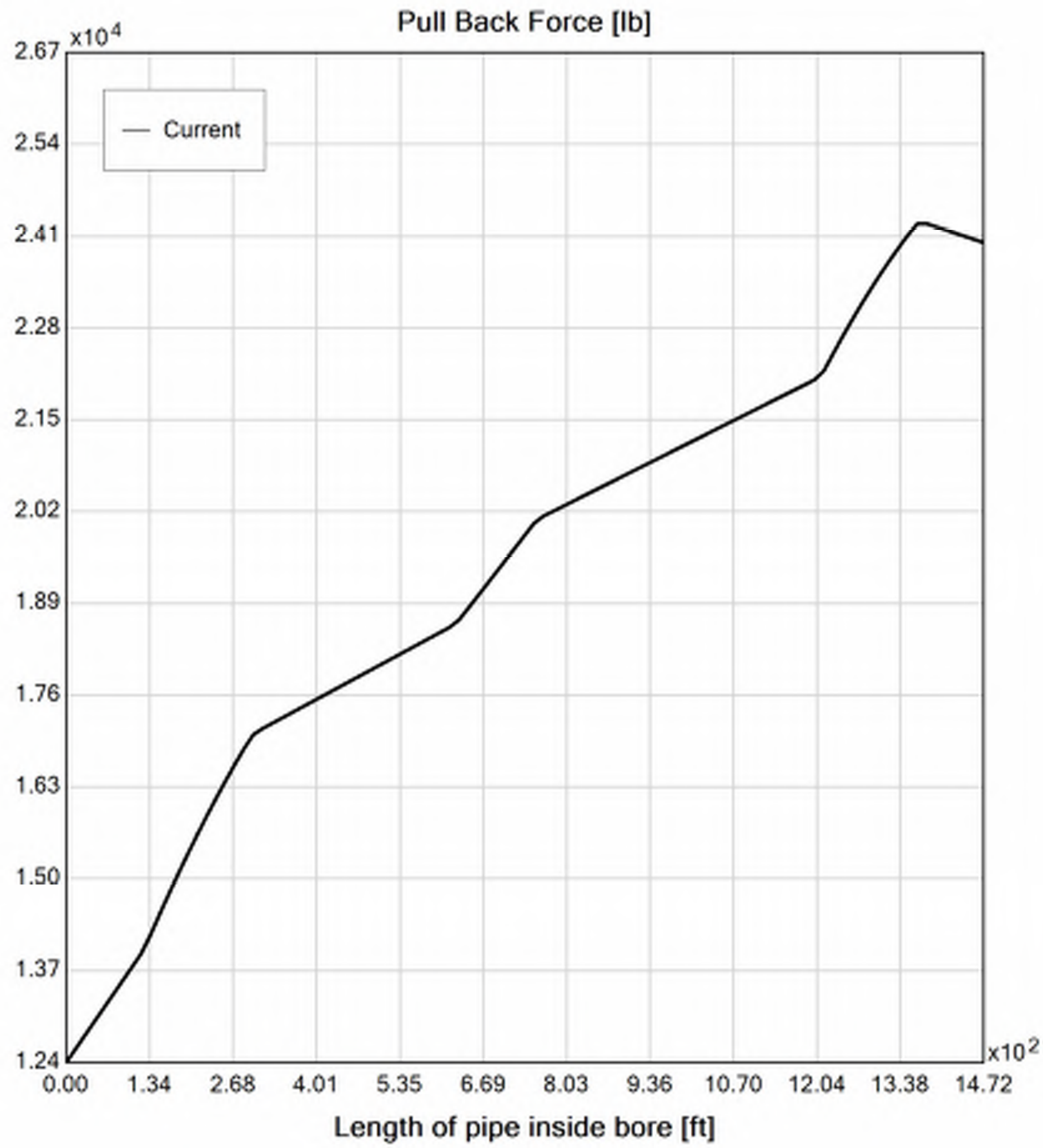
Plastic Viscosity (PV): 25.53

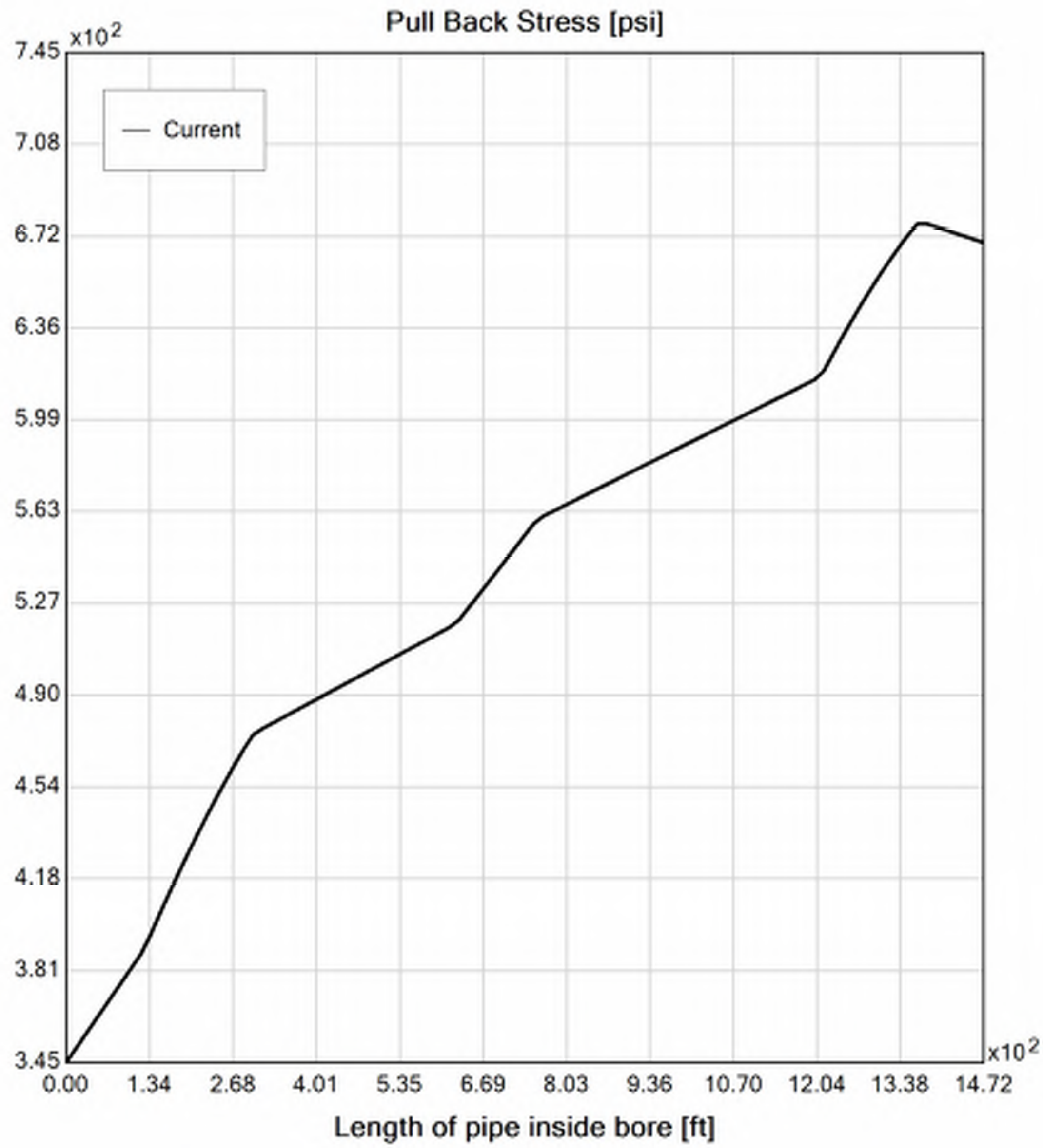
Yield Point (YP): 16.49

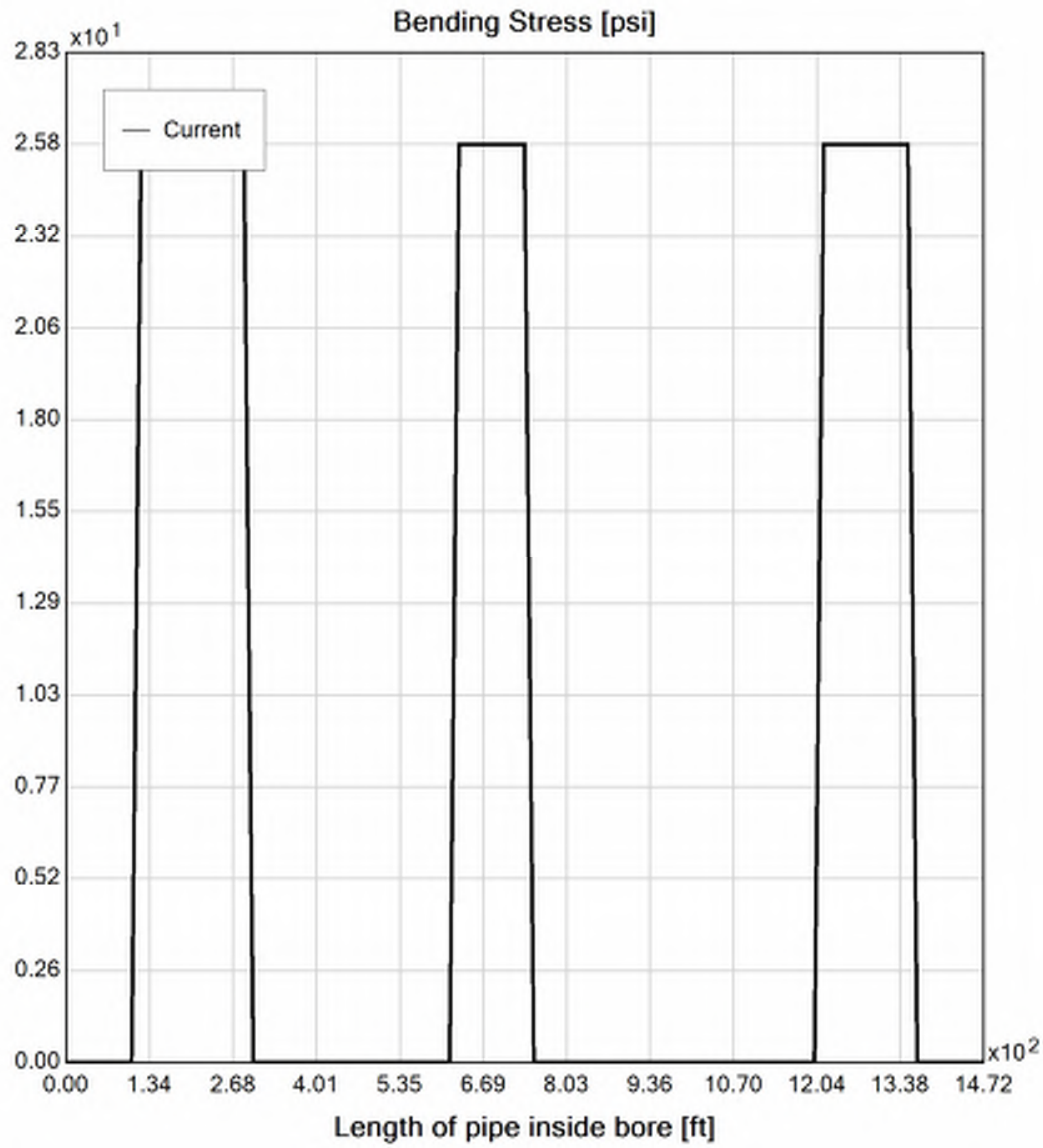
Effective Viscosity (cP): 1202.0

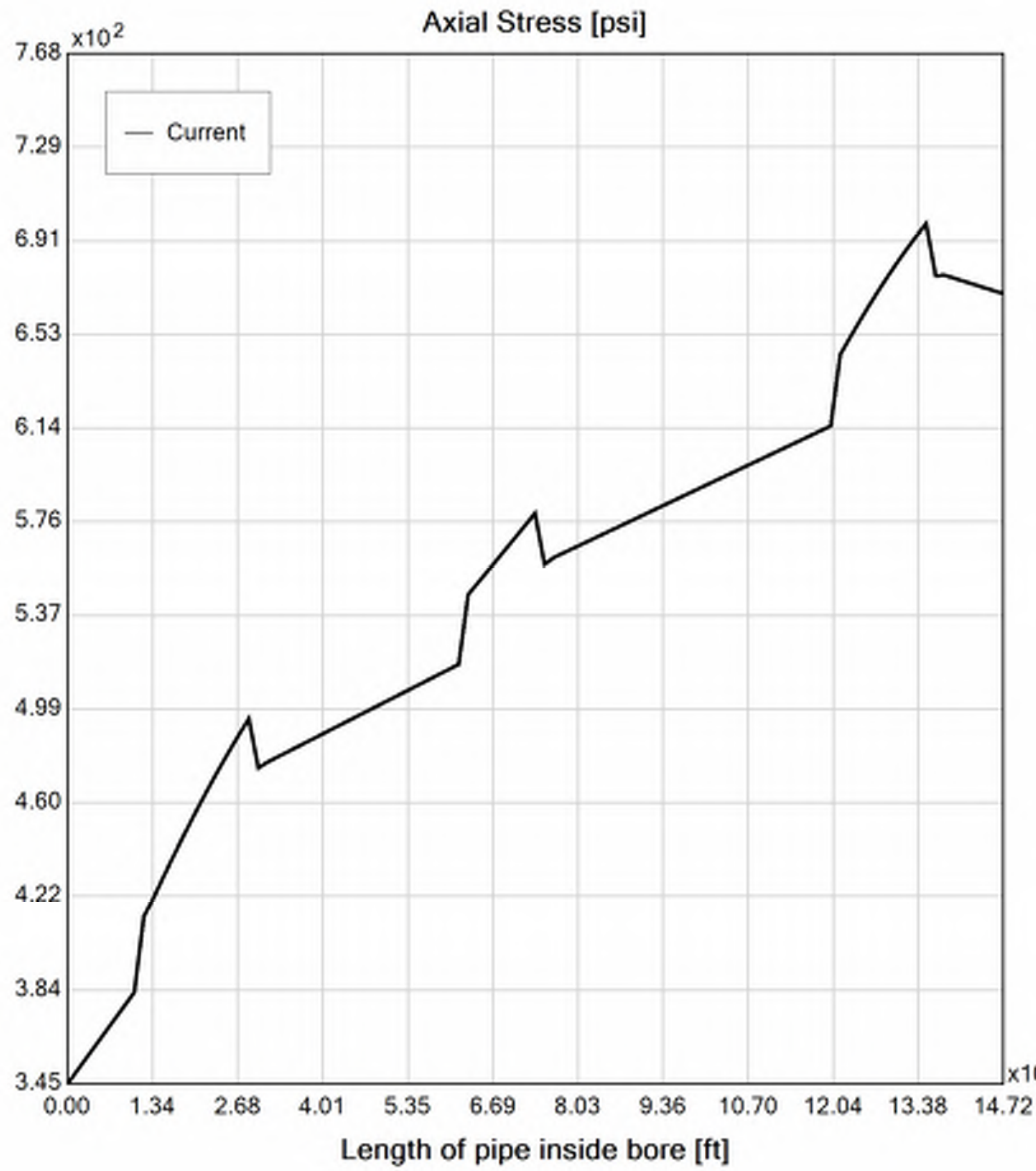
Virtual Site



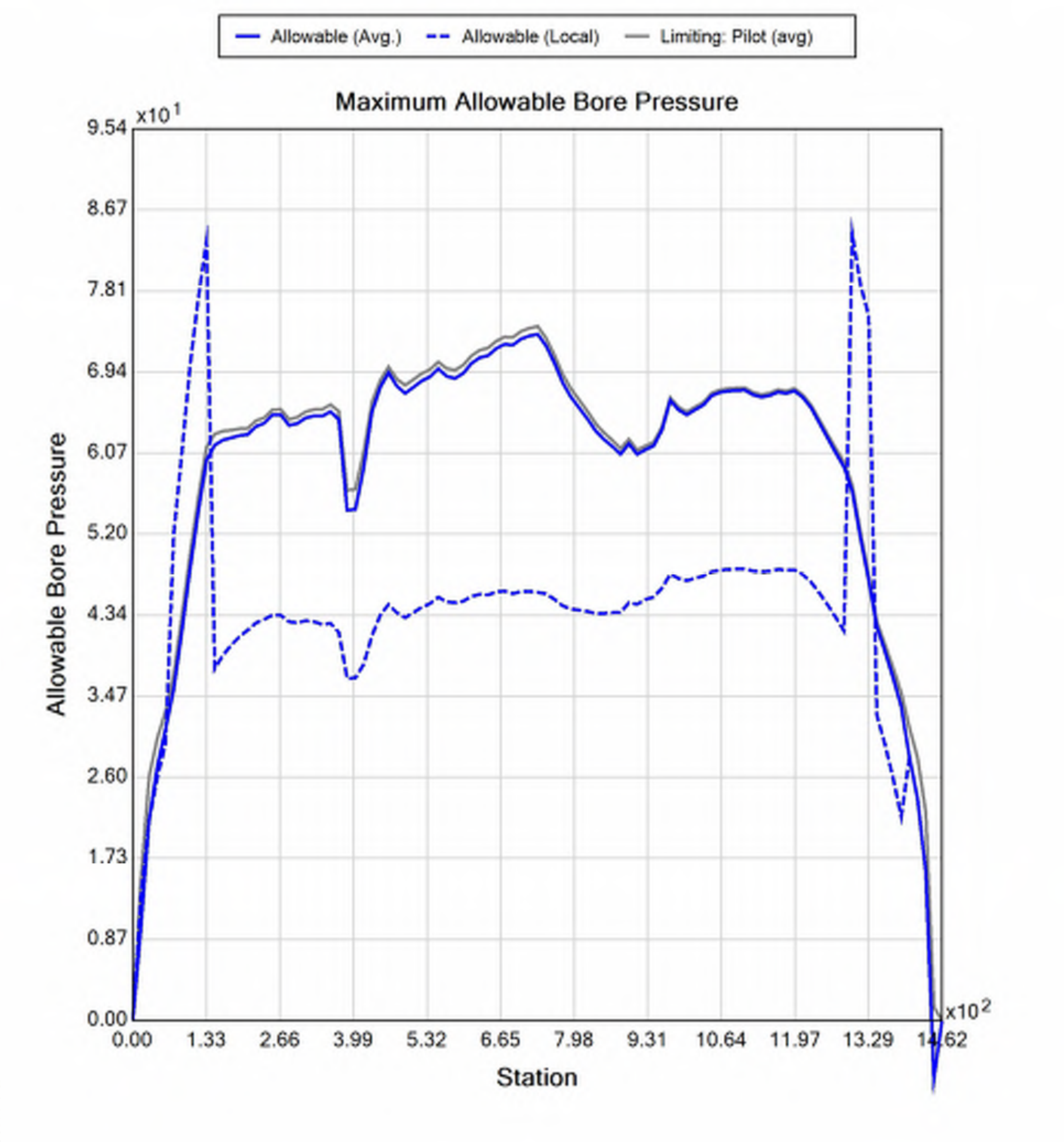

Pull Back Force [lb]
x10^4
2.67
2.54
2.41
2.28
2.15
2.02
1.89
1.76
1.63
1.50
1.37
1.24
Current
x10^2
0.00
1.34
2.68
4.01
5.35
6.69
8.03
9.36
10.70
12.04
13.38
14.72
Length of pipe inside bore [ft]

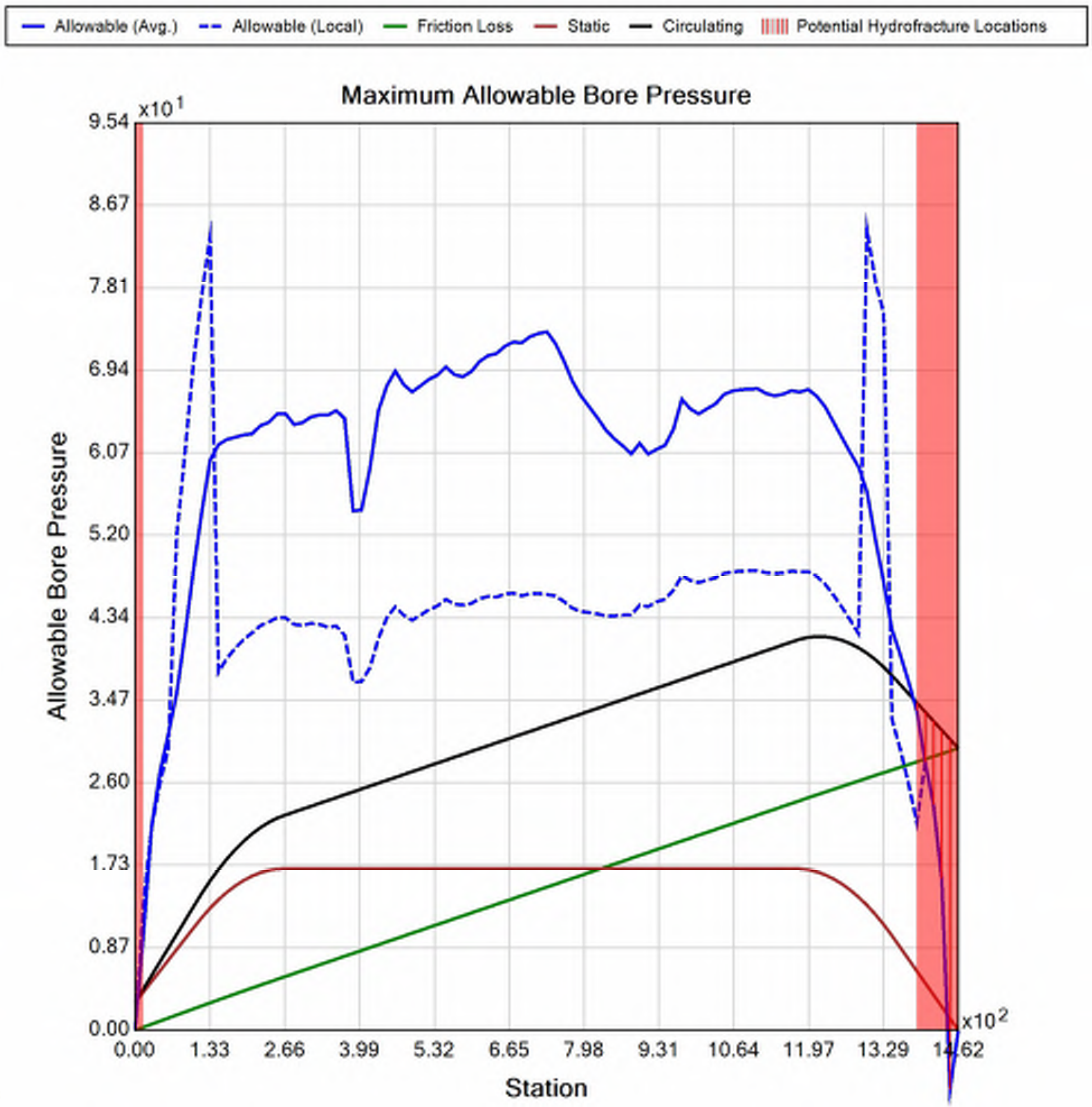

Pull Back Stress [psi]
x10^2
7.45
7.08
6.72
6.36
5.99
5.63
5.27
4.90
4.54
4.18
3.81
3.45
Current
0.00
1.34
2.68
4.01
5.35
6.69
8.03
9.36
10.70
12.04
13.38
14.72
x10^2
Length of pipe inside bore [ft]


Bending Stress [psi]
x10^1
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
x10^2
0.00
1.34
2.68
4.01
5.35
6.69
8.03
9.36
10.70
12.04
13.38
14.72
Length of pipe inside bore [ft]



Axial Stress [psi]
x10^2
7.68
7.29
6.91
6.53
6.14
5.76
5.37
4.99
4.60
4.22
3.84
3.45
Current
0.00
1.34
2.68
4.01
5.35
6.69
8.03
9.36
10.70
12.04
13.38
14.72
x10^2
Length of pipe inside bore [ft]


Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10^1
9.54
8.67
7.81
6.94
6.07
5.20
4.34
3.47
2.60
1.73
0.87
0.00
Allowable Bore Pressure
0.00
1.33
2.66
3.99
5.32
6.65
7.98
9.31
10.64
11.97
13.29
14.62
x10^2
Station



Allowable (Avg.)
Allowable (Local)
Friction Loss
Static
Circulating
Potential Hydrofracture Locations
Maximum Allowable Bore Pressure
x10^1
9.54
8.67
7.81
6.94
6.07
5.20
4.34
3.47
2.60
1.73
0.87
0.00
Allowable Bore Pressure
x10^2
0.00
1.33
2.66
3.99
5.32
6.65
7.98
9.31
10.64
11.97
13.29
14.62
Station

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Input Summary

Start Coordinate	(0.00, 0.00, 116.44) ft
End Coordinate	(1450.00, 0.00, 120.00) ft
Project Length	1450.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 1470.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	1.3	14.7
Water Pressure	12.2	12.2
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	13.4	26.8
Deflection		
Earth Load Deflection	1.119	3.996
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	1.148	4.025
Compressive Stress [psi]		
Compressive Wall Stress	60.5	120.8

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1294.2	1294.2
Pullback Stress [psi]	739.5	739.5
Pullback Strain	1.286E-2	1.286E-2
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	739.5	740.6
Tensile Strain	1.286E-2	1.298E-2

Net External Pressure = 23.1 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.148	7.5	6.5	OK
Unconstrained Collapse [psi]	23.1	132.3	5.7	OK
Compressive Wall Stress [psi]	60.5	1150.0	19.0	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	33.1	211.5	6.4	OK
Tensile Stress [psi]	740.6	1200.0	1.6	OK

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Project Summary

General:	CHPE HDD 6 Conduit 2
	P1C
	Start Date: 02-24-2022
	End Date: 02-24-2022
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	
Description:	HDD 6 10-inch DR 9 Conduit 2

Input Summary

Start Coordinate	(0.00, 0.00, 116.44) ft
End Coordinate	(1435.00, 0.00, 120.00) ft
Project Length	1435.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 5

Soil Layer #1 USCS, Silt (M), ML
From Assistant
Unit Weight: 80.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 28.00, S.M.: 50.00, Coh: 0.00 [psi]

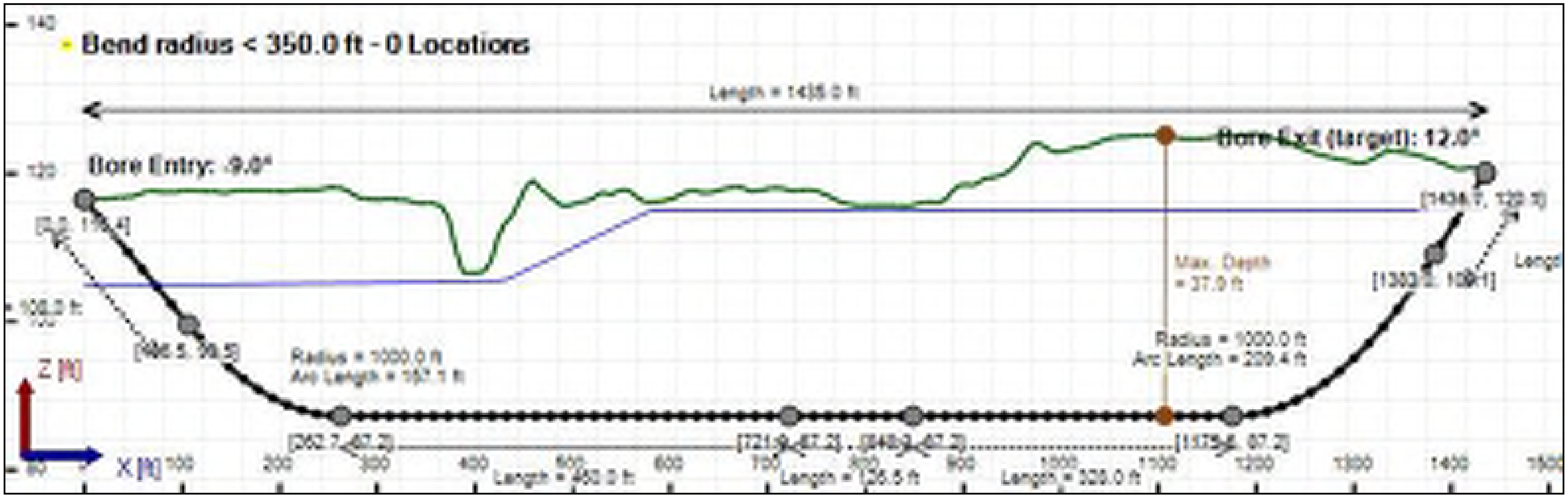
Soil Layer #2 USCS, Clay (C), CL
From Assistant
Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 300.00, Coh: 5.50 [psi]

Soil Layer #3 USCS, Silt (M), ML
From Assistant
Unit Weight: 80.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 28.00, S.M.: 50.00, Coh: 0.00 [psi]

Soil Layer #4 USCS, Sand (S), SP
From Assistant
Unit Weight: 110.0000 (dry), 125.0000 (sat) [lb/ft3]
Phi: 34.00, S.M.: 500.00, Coh: 0.00 [psi]

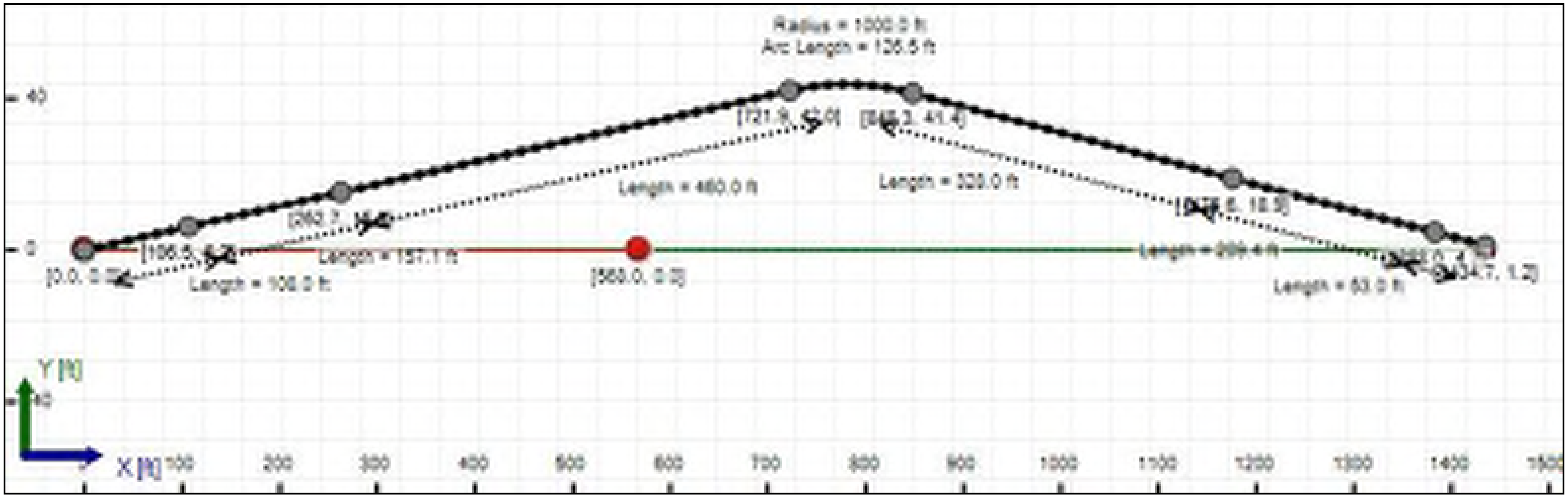
Soil Layer #5 USCS, Clay (C), CL
From Assistant
Unit Weight: 75.0000 (dry), 105.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 250.00, Coh: 4.30 [psi]

Bore Cross-Section View



Powered by BoreAid

Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 1455.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	3.2	14.6
Water Pressure	12.0	12.0
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	15.2	26.6
Deflection		
Earth Load Deflection	1.319	3.974
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.451	4.106
Compressive Stress [psi]		
Compressive Wall Stress	68.5	119.7

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	24251.7	24251.7
Pullback Stress [psi]	676.3	676.3
Pullback Strain	1.176E-2	1.176E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	676.3	697.0
Tensile Strain	1.176E-2	1.257E-2

Net External Pressure = 23.3 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.451	7.5	5.2	OK
Unconstrained Collapse [psi]	23.1	123.7	5.3	OK
Compressive Wall Stress [psi]	68.5	1150.0	16.8	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	33.1	213.8	6.5	OK
Tensile Stress [psi]	697.0	1200.0	1.7	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	74.231 psi	86.601 psi
1	8.00 in	12.00 in	73.865 psi	85.299 psi
2	12.00 in	16.13 in	73.350 psi	83.874 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

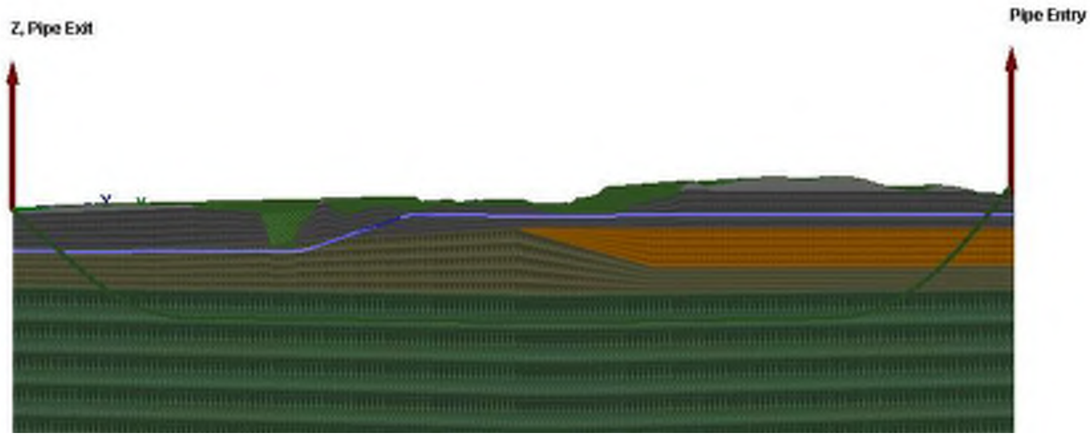
Rheological model: Bingham-Plastic

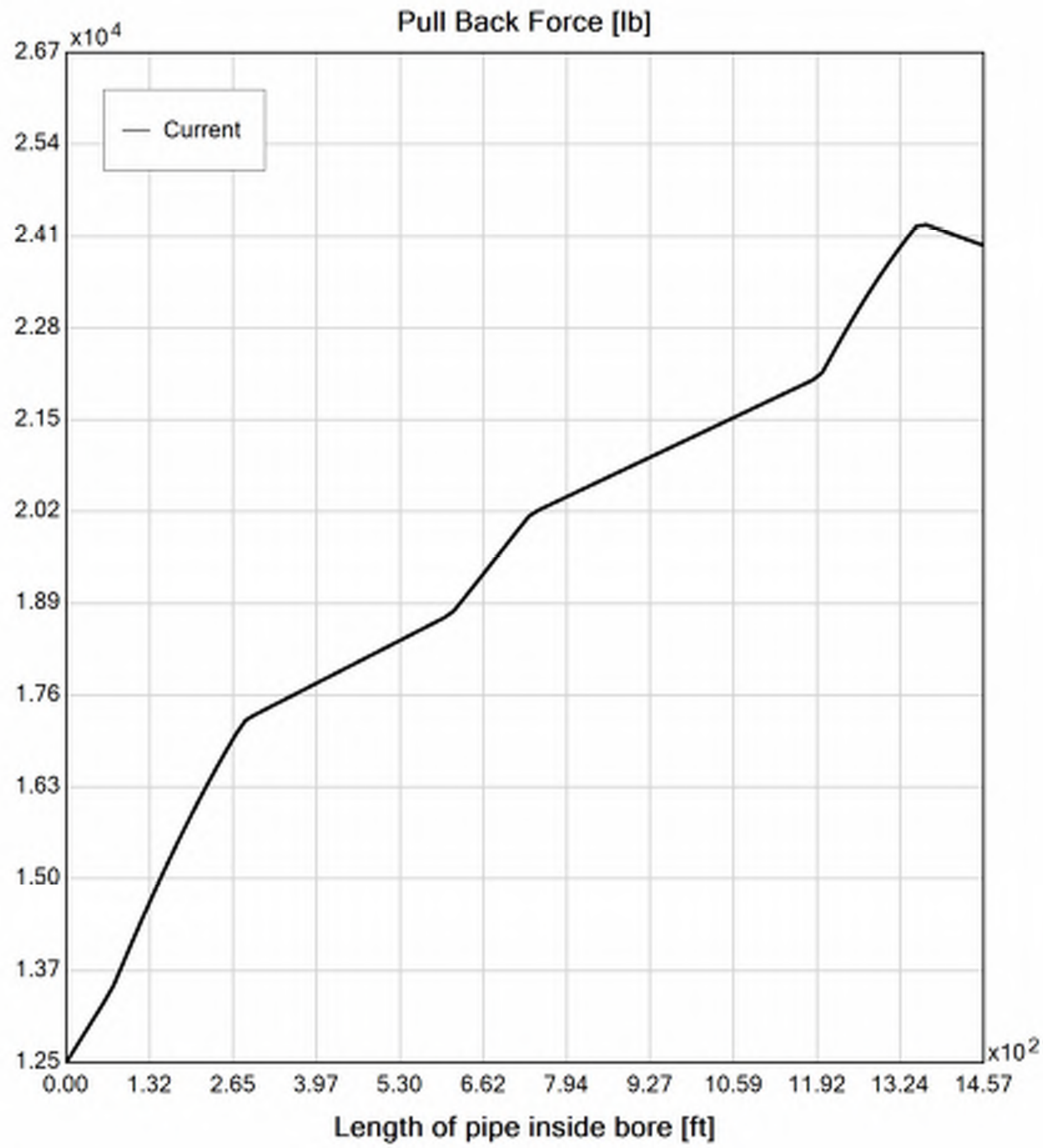
Plastic Viscosity (PV): 25.53

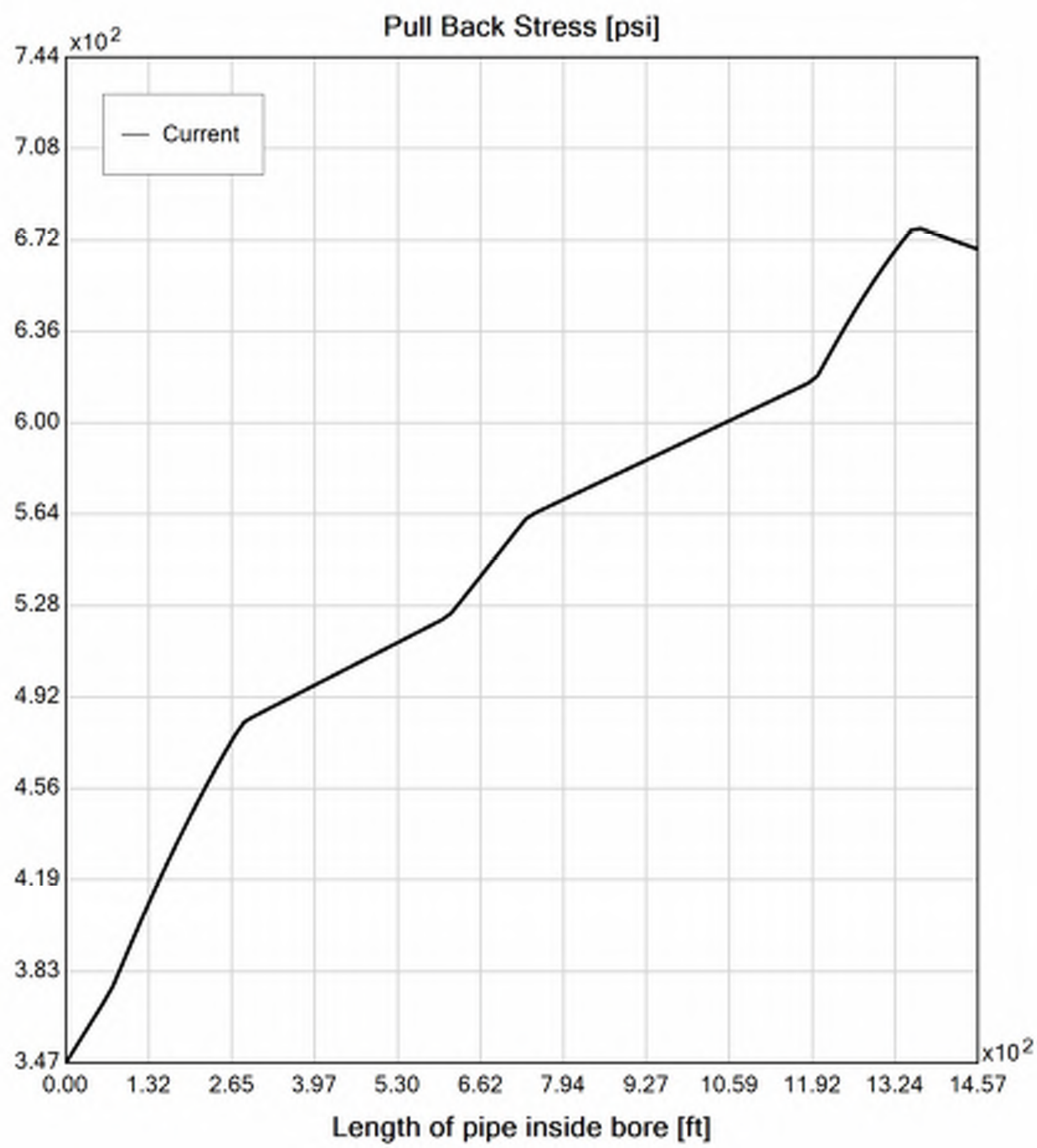
Yield Point (YP): 16.49

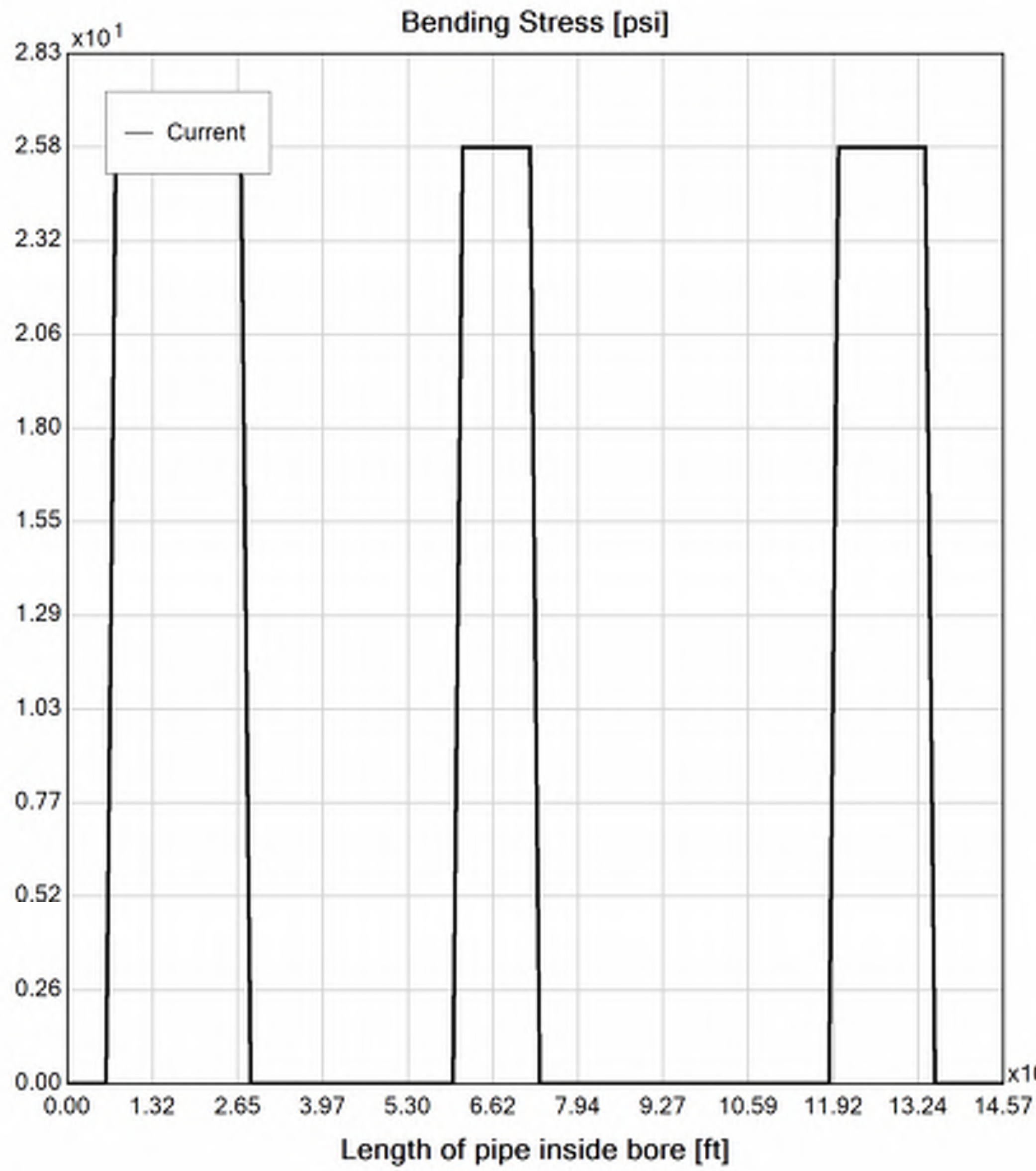
Effective Viscosity (cP): 1202.0

Virtual Site

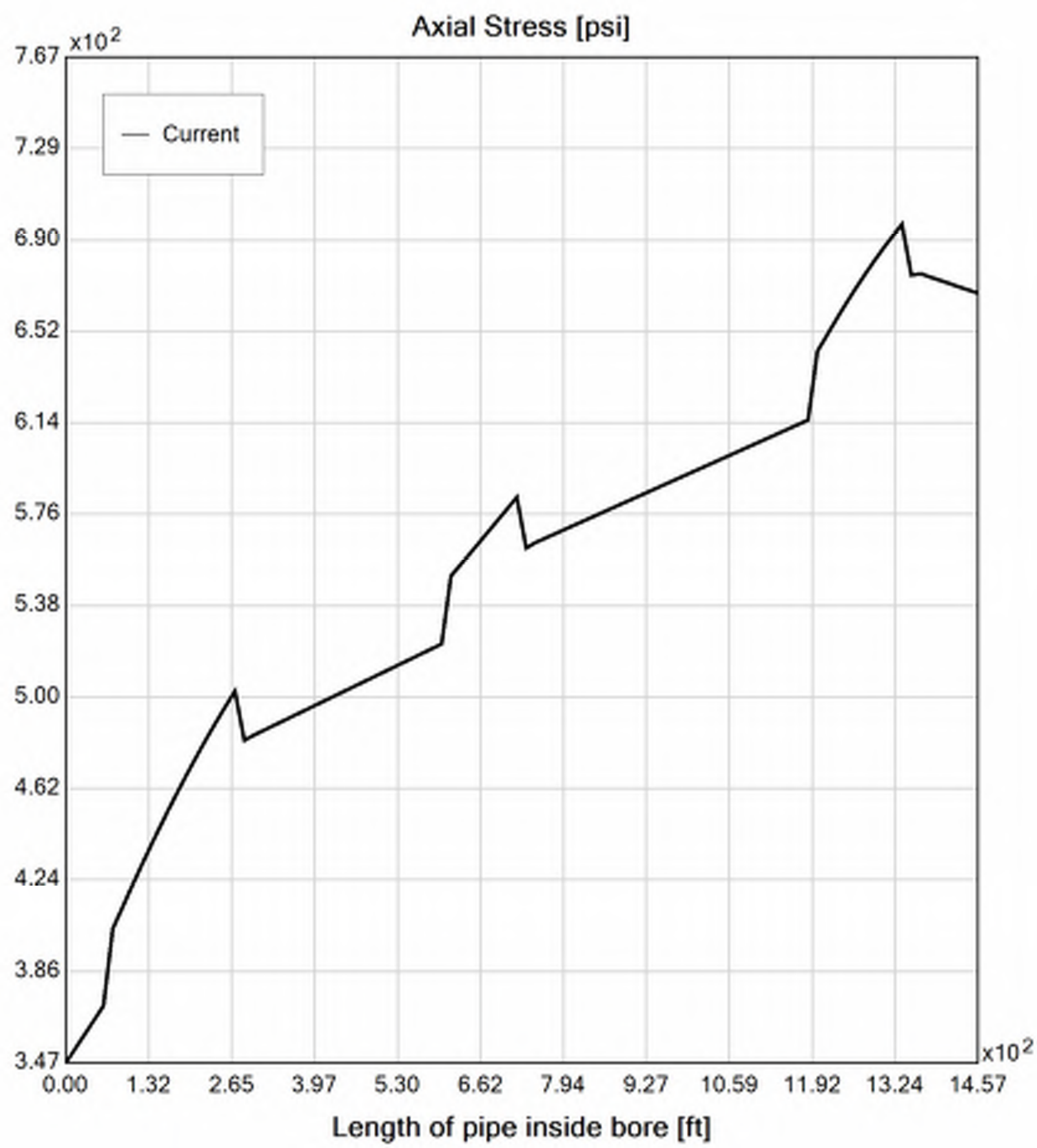


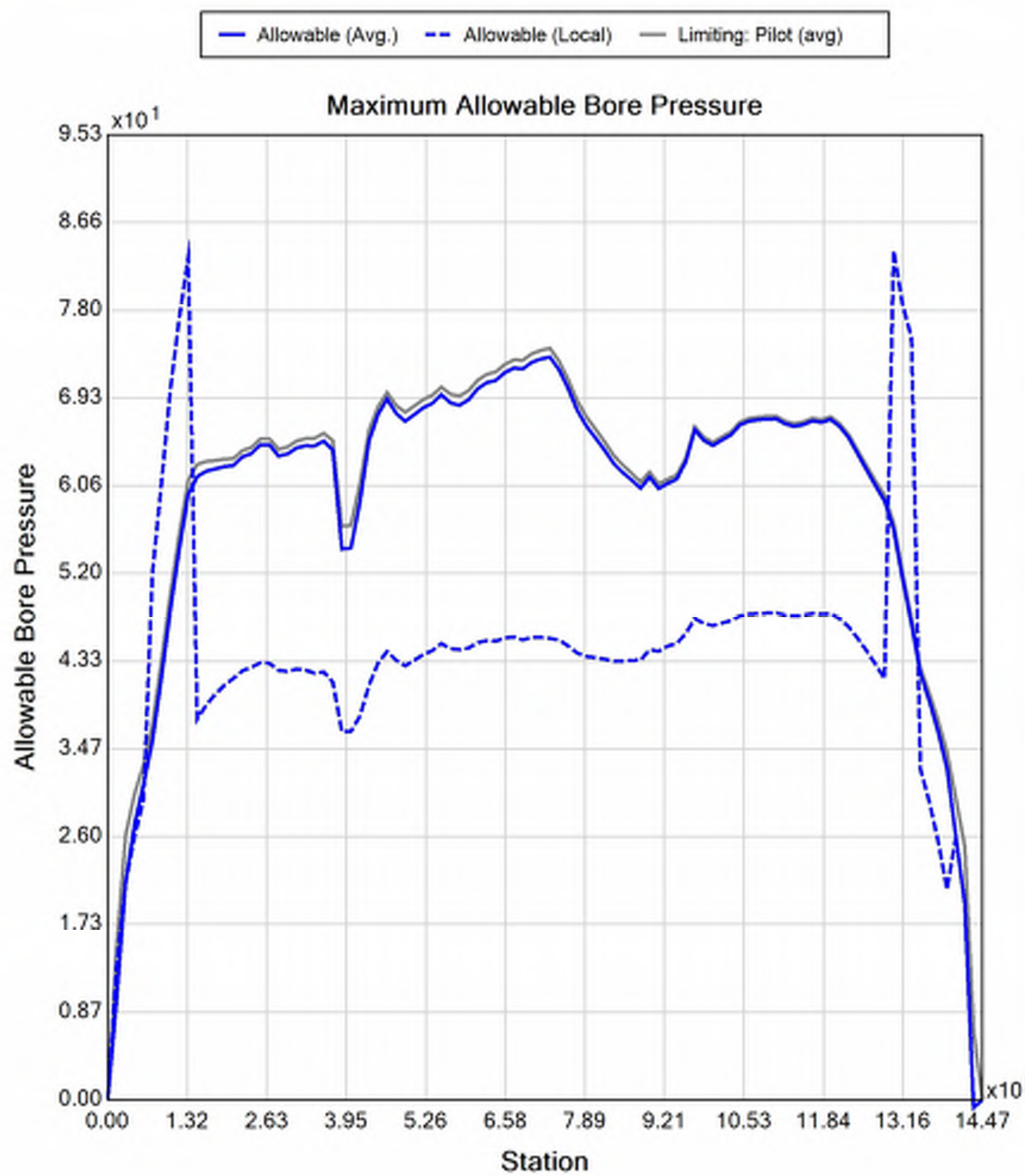

Pull Back Force [lb]
x10^4
2.67
2.54
2.41
2.28
2.15
2.02
1.89
1.76
1.63
1.50
1.37
1.25
— Current
x10^2
0.00
1.32
2.65
3.97
5.30
6.62
7.94
9.27
10.59
11.92
13.24
14.57
Length of pipe inside bore [ft]

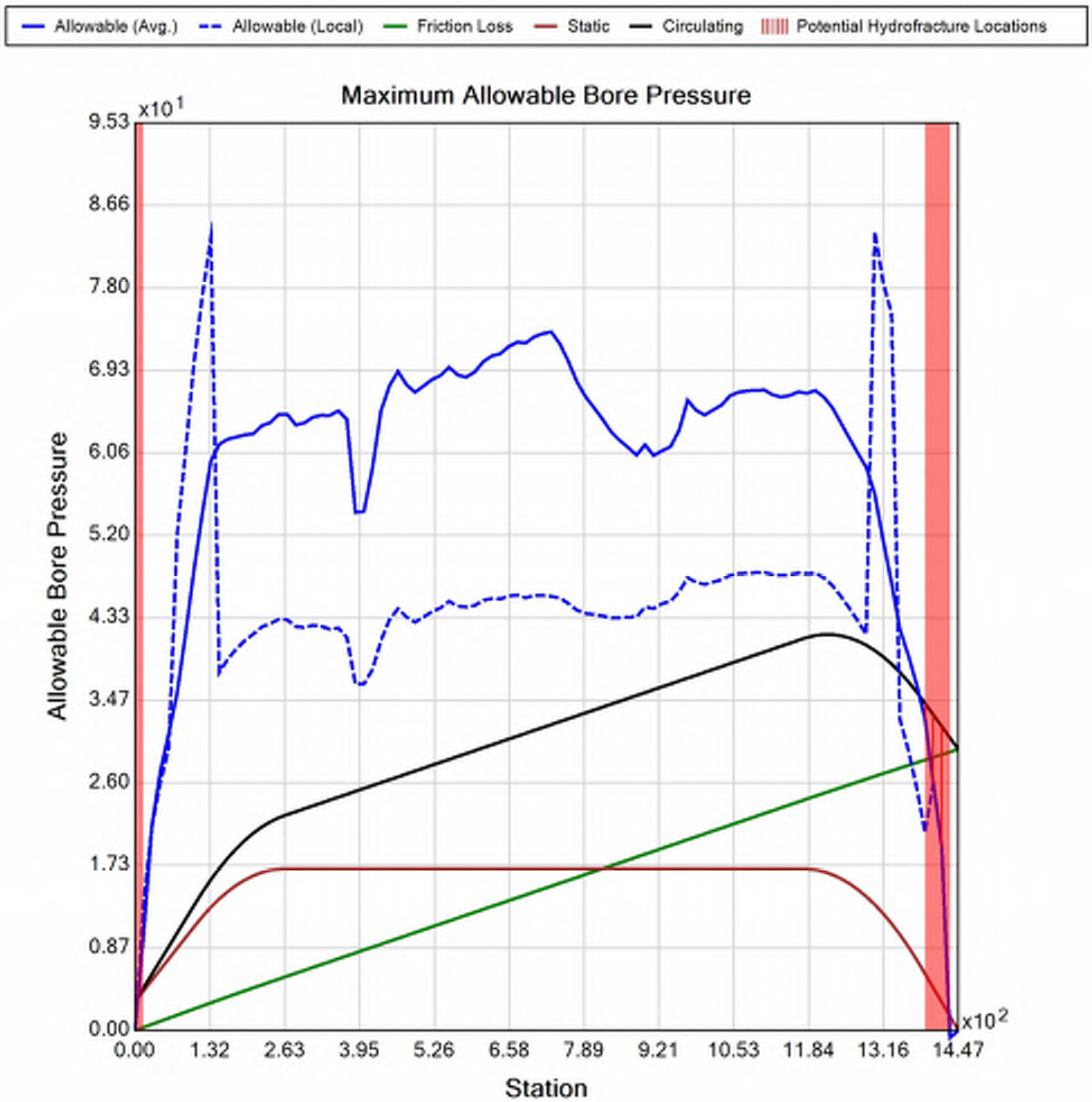

Pull Back Stress [psi]
x10^2
7.44
7.08
6.72
6.36
6.00
5.64
5.28
4.92
4.56
4.19
3.83
3.47
Current
x10^2
0.00
1.32
2.65
3.97
5.30
6.62
7.94
9.27
10.59
11.92
13.24
14.57
Length of pipe inside bore [ft]



Bending Stress [psi]
x10^1
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
x10^2
0.00
1.32
2.65
3.97
5.30
6.62
7.94
9.27
10.59
11.92
13.24
14.57
Length of pipe inside bore [ft]


Axial Stress [psi]
x10^2
7.67
7.29
6.90
6.52
6.14
5.76
5.38
5.00
4.62
4.24
3.86
3.47
Current
0.00 1.32 2.65 3.97 5.30 6.62 7.94 9.27 10.59 11.92 13.24 14.57
x10^2
Length of pipe inside bore [ft]


Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10^1
9.53
8.66
7.80
6.93
6.06
5.20
4.33
3.47
2.60
1.73
0.87
0.00
Allowable Bore Pressure
x10^2
0.00
1.32
2.63
3.95
5.26
6.58
7.89
9.21
10.53
11.84
13.16
14.47
Station



Allowable (Avg.)
Allowable (Local)
Friction Loss
Static
Circulating
Potential Hydrofracture Locations
Maximum Allowable Bore Pressure
x10^1
9.53
8.66
7.80
6.93
6.06
5.20
4.33
3.47
2.60
1.73
0.87
0.00
Allowable Bore Pressure
0.00
1.32
2.63
3.95
5.26
6.58
7.89
9.21
10.53
11.84
13.16
14.47
x10^2
Station

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Input Summary

Start Coordinate	(0.00, 0.00, 116.44) ft
End Coordinate	(1435.00, 0.00, 120.00) ft
Project Length	1435.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 1455.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	1.3	14.6
Water Pressure	12.0	12.0
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	13.3	26.6
Deflection		
Earth Load Deflection	0.998	3.974
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	1.028	4.003
Compressive Stress [psi]		
Compressive Wall Stress	59.9	119.7

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1293.3	1293.3
Pullback Stress [psi]	739.0	739.0
Pullback Strain	1.285E-2	1.285E-2
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	739.0	739.5
Tensile Strain	1.285E-2	1.296E-2

Net External Pressure = 23.3 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.028	7.5	7.3	OK
Unconstrained Collapse [psi]	23.1	132.3	5.7	OK
Compressive Wall Stress [psi]	59.9	1150.0	19.2	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	33.1	211.5	6.4	OK
Tensile Stress [psi]	739.5	1200.0	1.6	OK

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Project Summary

General:	CHPE HDD 7
	P1C
	Start Date: 02-23-2022
	End Date: 02-23-2022
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	MCS
	CHA
Description:	

Input Summary

Start Coordinate	(0.00, 0.00, 118.40) ft
End Coordinate	(1305.00, 0.00, 124.40) ft
Project Length	1305.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 4

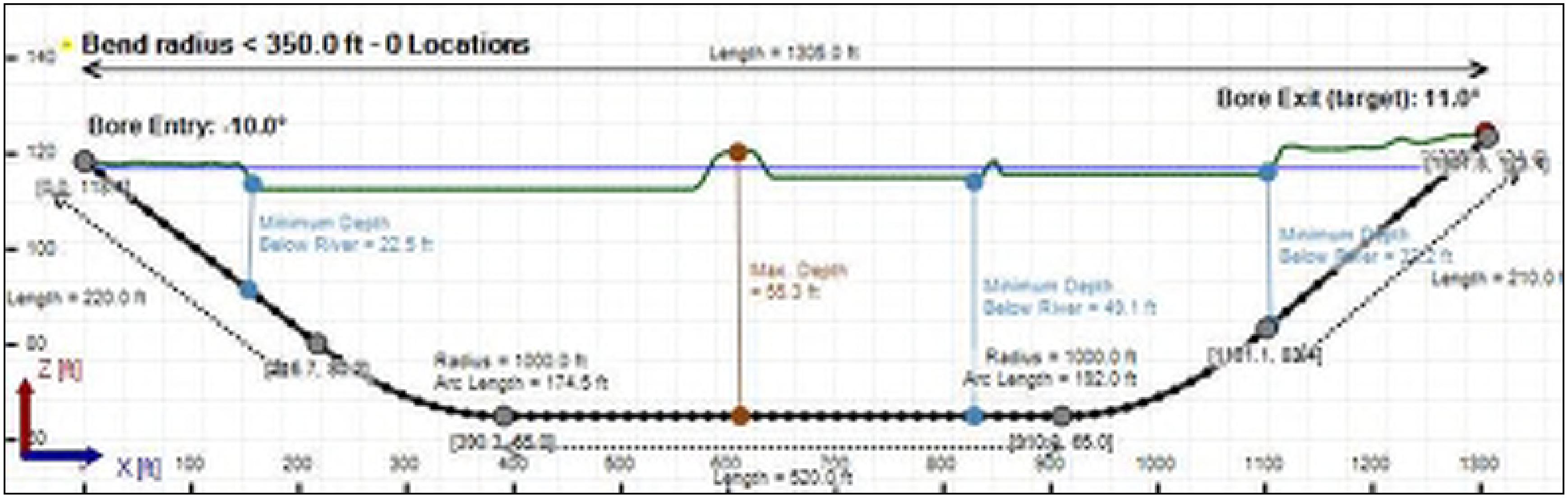
Soil Layer #1 USCS, Sand (S), SP
From Assistant
Unit Weight: 110.0000 (dry), 125.0000 (sat) [lb/ft3]
Phi: 34.00, S.M.: 500.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Clay (C), CL
From Assistant
Unit Weight: 100.0000 (dry), 120.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 400.00, Coh: 5.60 [psi]

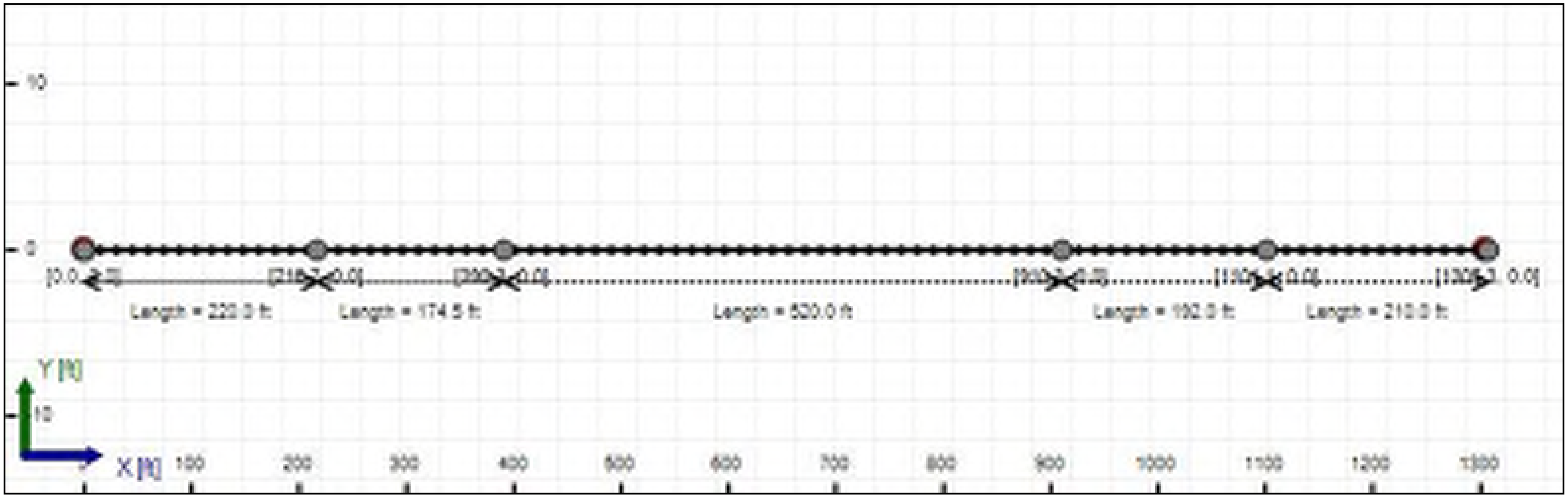
Soil Layer #3 USCS, Clay (C), CH
From Assistant
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 200.00, Coh: 3.10 [psi]

Soil Layer #4 USCS, Clay (C), CH
From Assistant
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 200.00, Coh: 3.10 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 1320.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	15.1	18.1
Water Pressure	22.5	22.5
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	37.6	40.7
Deflection		
Earth Load Deflection	4.110	4.937
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	4.242	5.069
Compressive Stress [psi]		
Compressive Wall Stress	169.3	183.0

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	22294.6	22294.6
Pullback Stress [psi]	621.8	621.8
Pullback Strain	1.081E-2	1.081E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	621.8	644.7
Tensile Strain	1.081E-2	1.166E-2

Net External Pressure = 37.4 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	4.242	7.5	1.8	OK
Unconstrained Collapse [psi]	38.4	94.5	2.5	OK
Compressive Wall Stress [psi]	169.3	1150.0	6.8	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	48.4	218.0	4.5	OK
Tensile Stress [psi]	644.7	1200.0	1.9	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	63.019 psi	56.674 psi
1	8.00 in	12.00 in	62.989 psi	56.638 psi
2	12.00 in	16.13 in	62.945 psi	56.587 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 25.00 US (liquid) gallon/min

Drill Fluid Density: 68.670 lb/ft3

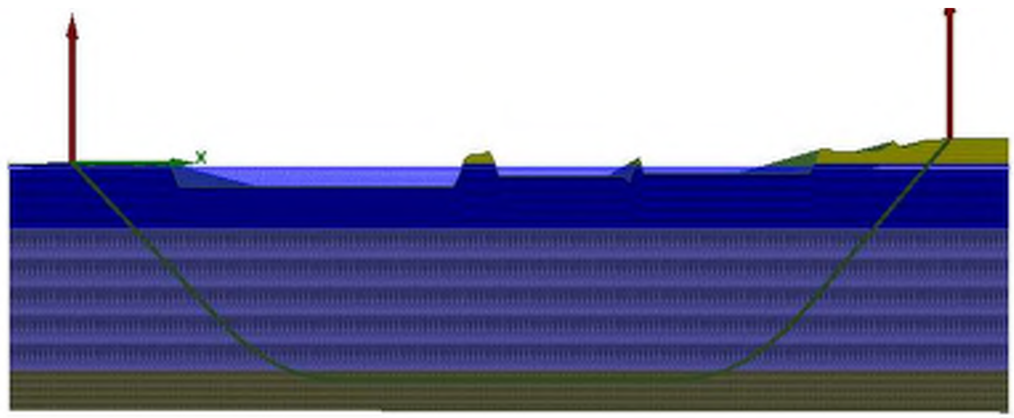
Rheological model: Bingham-Plastic

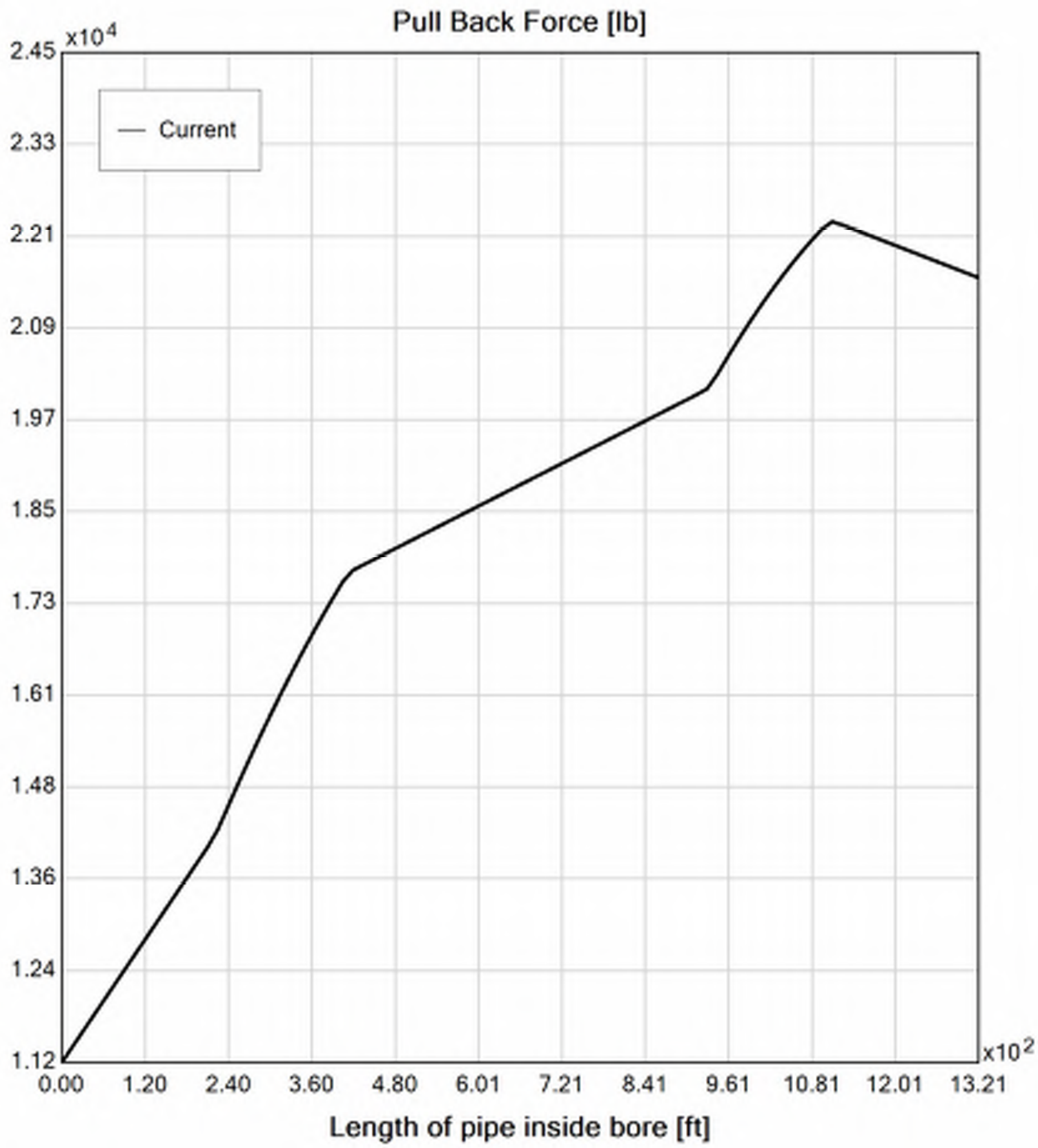
Plastic Viscosity (PV): 25.53

Yield Point (YP): 16.49

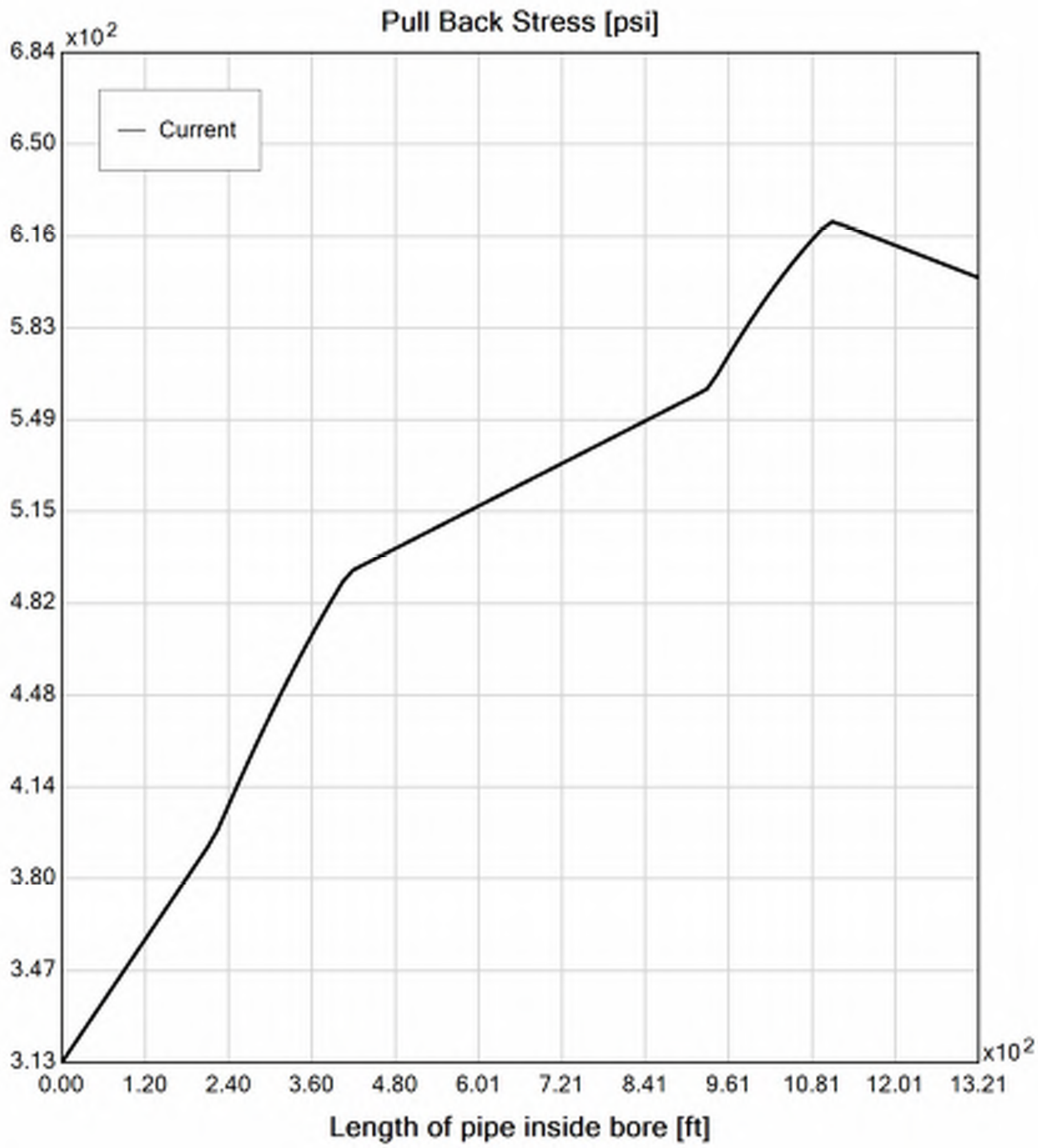
Effective Viscosity (cP): 1907.9

Virtual Site

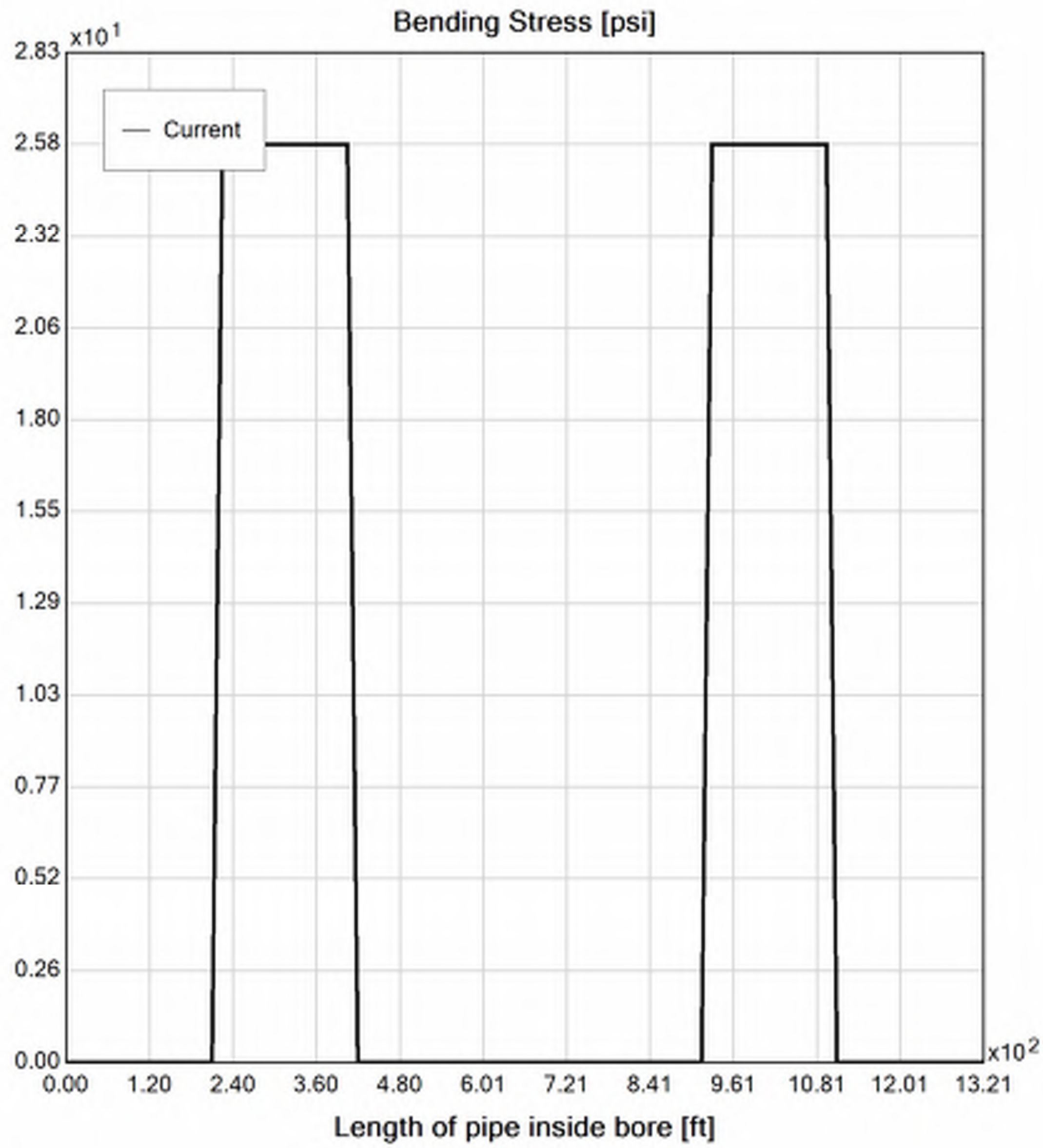


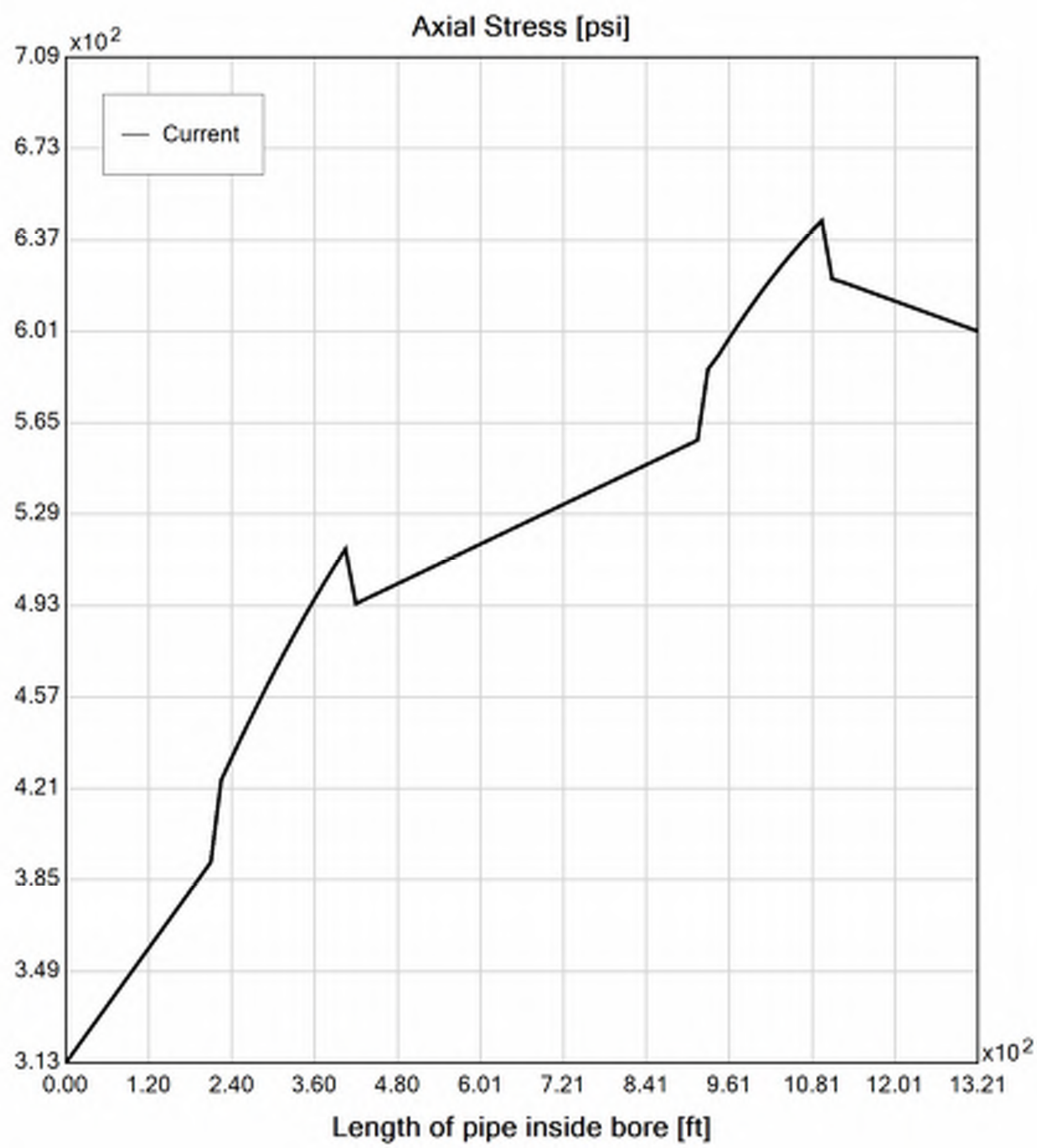


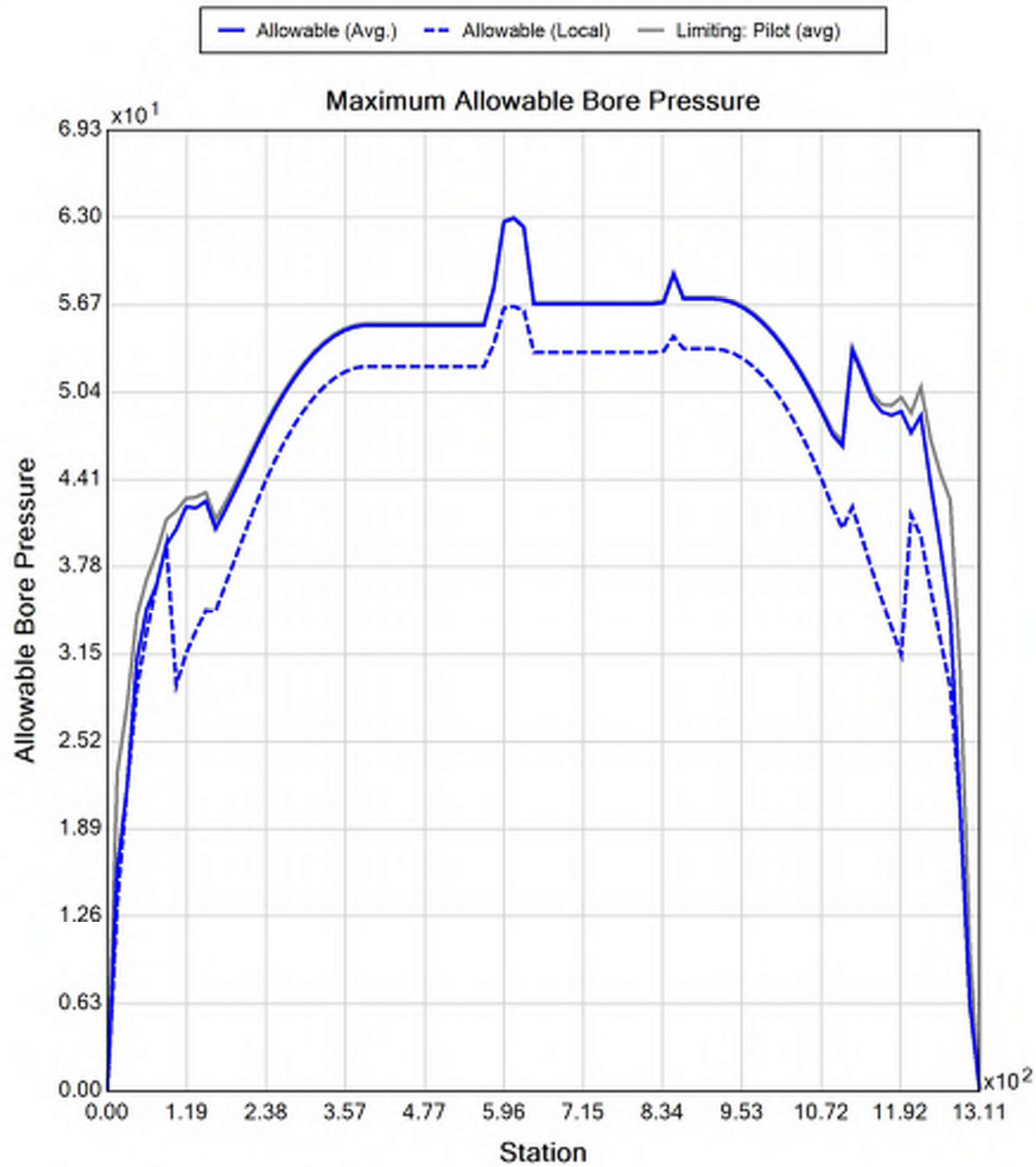
Pull Back Force [lb]
x10^4
2.45
2.33
2.21
2.09
1.97
1.85
1.73
1.61
1.48
1.36
1.24
1.12
Current
0.00
1.20
2.40
3.60
4.80
6.01
7.21
8.41
9.61
10.81
12.01
13.21
x10^2
Length of pipe inside bore [ft]



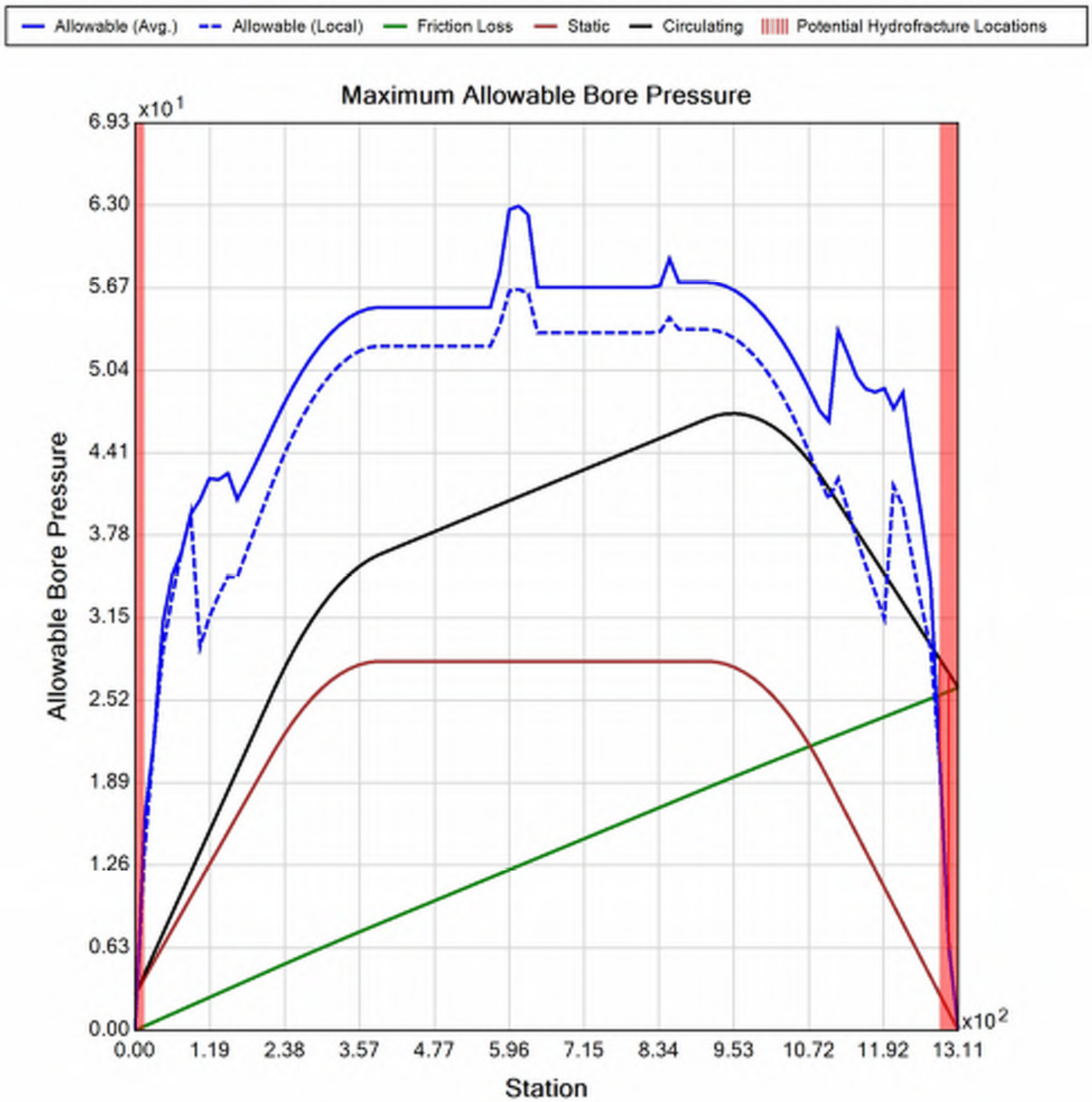
Pull Back Stress [psi]
x10^2
6.84
6.50
6.16
5.83
5.49
5.15
4.82
4.48
4.14
3.80
3.47
3.13
Current
0.00
1.20
2.40
3.60
4.80
6.01
7.21
8.41
9.61
10.81
12.01
13.21
x10^2
Length of pipe inside bore [ft]


Bending Stress [psi]
x10¹
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
0.00
1.20
2.40
3.60
4.80
6.01
7.21
8.41
9.61
10.81
12.01
13.21
x10²
Length of pipe inside bore [ft]


Axial Stress [psi]
x10^2
7.09
6.73
6.37
6.01
5.65
5.29
4.93
4.57
4.21
3.85
3.49
3.13
Current
0.00
1.20
2.40
3.60
4.80
6.01
7.21
8.41
9.61
10.81
12.01
13.21
x10^2
Length of pipe inside bore [ft]



Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10¹
6.93
6.30
5.67
5.04
4.41
3.78
3.15
2.52
1.89
1.26
0.63
0.00
Allowable Bore Pressure
0.00
1.19
2.38
3.57
4.77
5.96
7.15
8.34
9.53
10.72
11.92
13.11
x10²
Station



Powered by BoreAid

Generated Output

WARNING: The accuracy of the data obtained by the BoreAid® system is highly dependent upon accurate data gathering, data input and proper use of the software. Vermeer is not responsible for that information. BoreAid® data is not intended to replace the need for future on-site utility locating, measuring and verification procedures, which are essential for accurate placement of new underground installations and avoidance of existing utilities.

CALL YOUR ONE-CALL SYSTEM FIRST

WARNING: Always contact your local One-Call system before the start of your digging project. The BoreAid® system is intended to be used with other utility locating methods, such as the use of the One-Call system and the exposing of existing utilities by potholing.

Locate utilities before drilling. Call 811 (U.S. only) or 1-888-258-0808 (U.S. or Canada) or local utility companies or national regulating authority.

Before you start any digging project, do not forget to call the local One-Call system in your area and any utility company that does not subscribe to the One-Call system. For areas not represented by One-Call Systems International, contact the appropriate utility companies or national regulating authority to locate and mark the underground installations. If you do not call, you may have an accident or suffer injuries; cause interruption of services; damage the environment; or experience job delays.

OSHA CFR 29 1926.651 requires that the estimated location of underground utilities be determined before beginning the excavation or underground drilling operation. When the actual excavation or bore approaches an estimated utility location, the exact location of the underground installation must be determined by a safe, acceptable and dependable method. If the utility cannot be precisely located, it must be shut off by the utility company.

Input Summary

Start Coordinate	(0.00, 0.00, 118.40) ft
End Coordinate	(1305.00, 0.00, 124.40) ft
Project Length	1305.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 1320.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	15.1	18.1
Water Pressure	22.5	22.5
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	37.6	40.7
Deflection		
Earth Load Deflection	4.110	4.937
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	4.139	4.966
Compressive Stress [psi]		
Compressive Wall Stress	169.3	183.0

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1197.8	1197.8
Pullback Stress [psi]	684.4	684.4
Pullback Strain	1.190E-2	1.190E-2
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	684.4	687.3
Tensile Strain	1.190E-2	1.205E-2

Net External Pressure = 37.4 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	4.139	7.5	1.8	OK
Unconstrained Collapse [psi]	38.4	95.4	2.5	OK
Compressive Wall Stress [psi]	169.3	1150.0	6.8	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	48.4	215.9	4.5	OK
Tensile Stress [psi]	687.3	1200.0	1.7	OK

Generated Output

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OSHA CFR 29 1926.651 requires that the estimated location of underground utilities be determined before beginning the excavation or underground drilling operation. When the actual excavation or bore approaches an estimated utility location, the exact location of the underground installation must be determined by a safe, acceptable and dependable method. If the utility cannot be precisely located, it must be shut off by the utility company.

Project Summary

General:	CHPE HDD 8 Conduit 1
	P1C
	Start Date: 12-10-2021
	End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	
Description:	HDD 8 Conduit 1 10-inch DR 9

Input Summary

Start Coordinate	(0.00, 0.00, 130.11) ft
End Coordinate	(800.00, 0.00, 130.00) ft
Project Length	800.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 2

Soil Layer #1 USCS, Sand (S), SP

Depth: 6.00 ft

Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]

Phi: 30.00, S.M.: 200.00, Coh: 0.00 [psi]

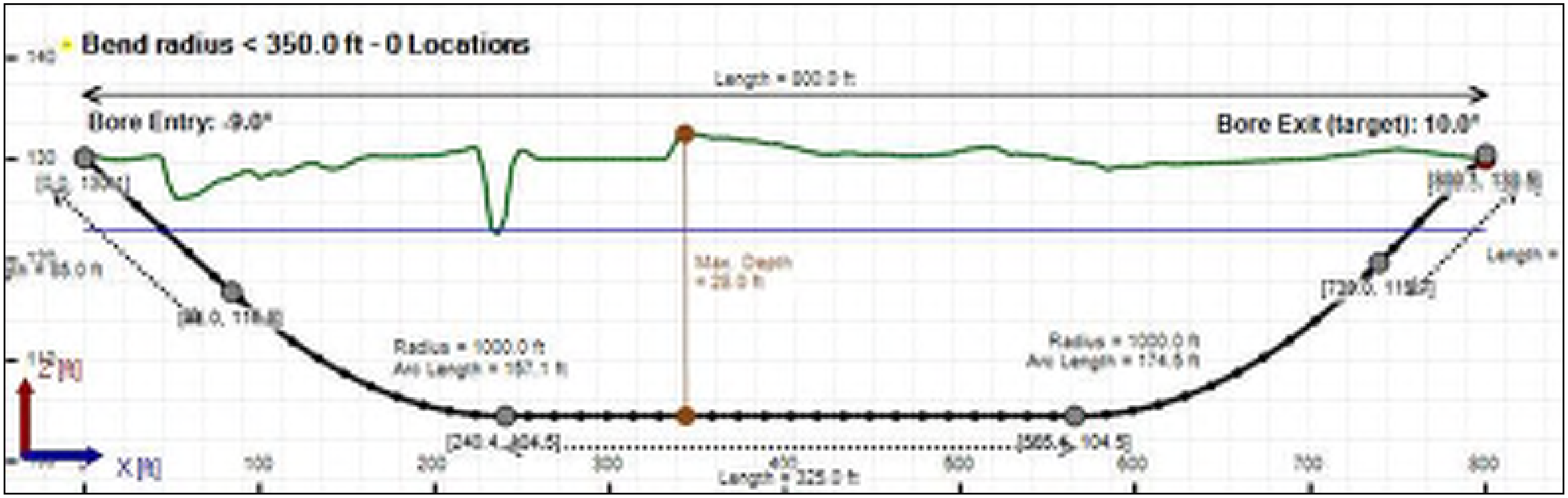
Soil Layer #2 USCS, Clay (C), CH

Depth: 25.00 ft

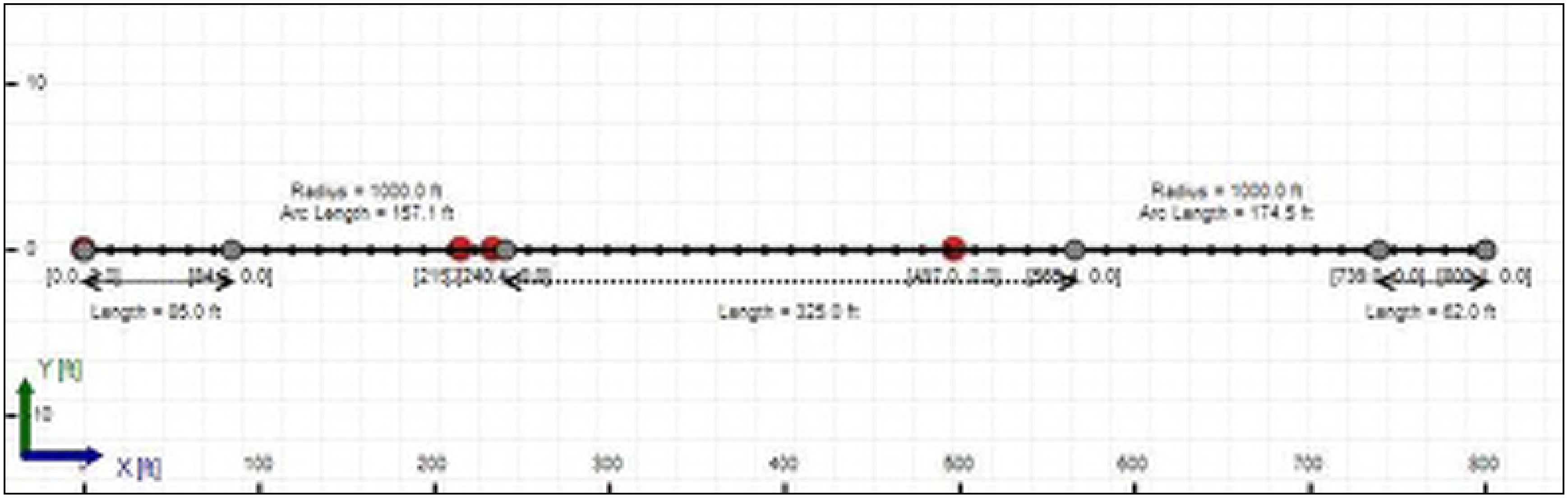
Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 300.00, Coh: 8.70 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 810.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	6.3	12.8
Water Pressure	8.0	8.0
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	14.4	20.9
Deflection		
Earth Load Deflection	1.728	3.499
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.860	3.631
Compressive Stress [psi]		
Compressive Wall Stress	64.6	93.9

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	13251.4	13251.4
Pullback Stress [psi]	369.6	369.6
Pullback Strain	6.427E-3	6.427E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	369.6	393.9
Tensile Strain	6.427E-3	7.298E-3

Net External Pressure = 18.6 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.860	7.5	4.0	OK
Unconstrained Collapse [psi]	17.6	116.9	6.6	OK
Compressive Wall Stress [psi]	64.6	1150.0	17.8	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	27.6	233.7	8.5	OK
Tensile Stress [psi]	393.9	1200.0	3.0	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	64.880 psi	60.219 psi
1	8.00 in	12.00 in	64.710 psi	60.013 psi
2	12.00 in	16.13 in	64.468 psi	59.722 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 0.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

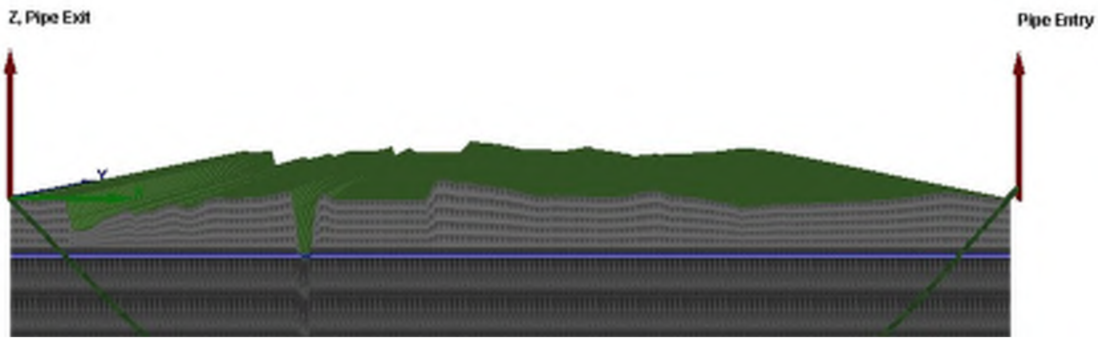
Rheological model: Bingham-Plastic

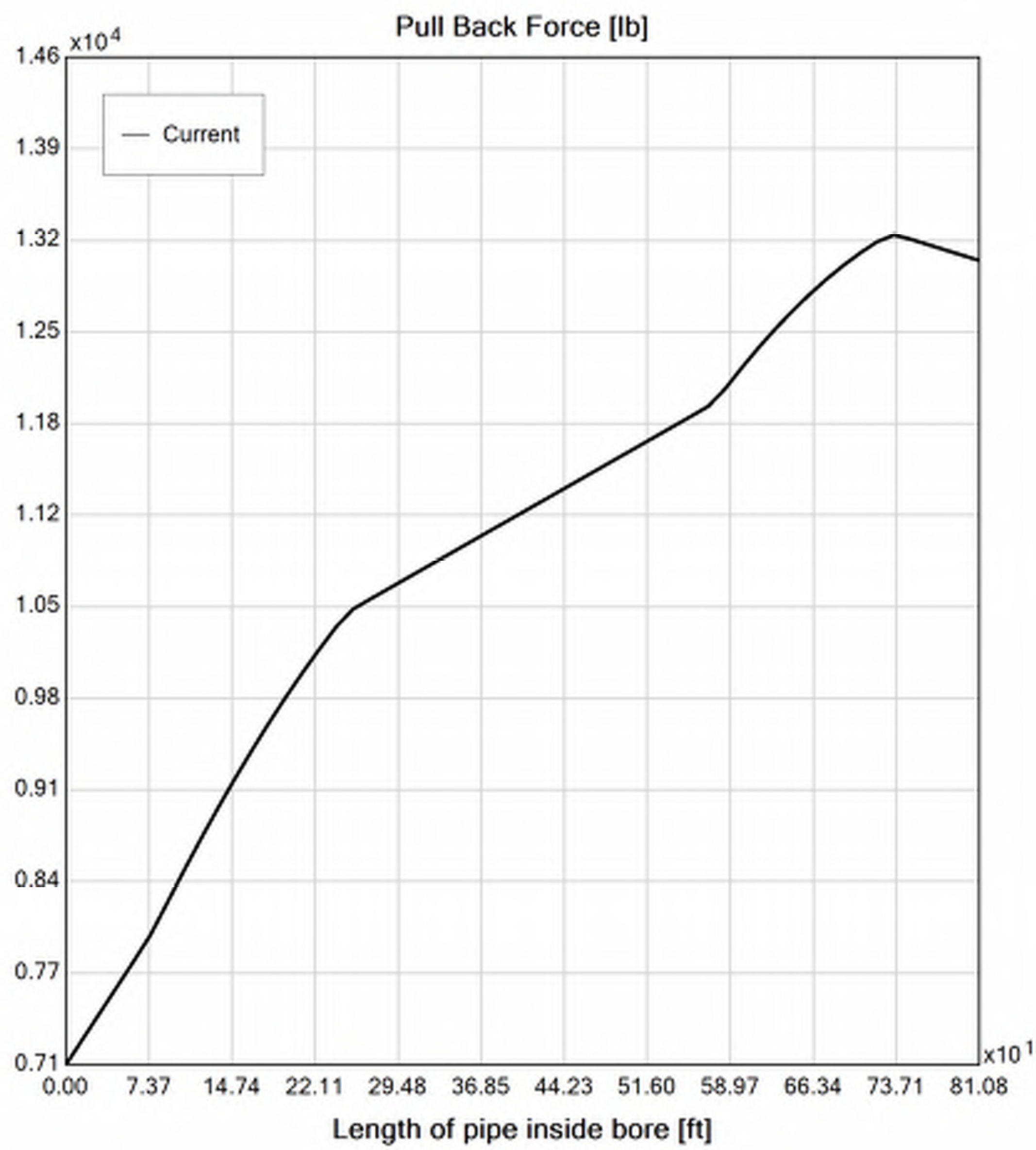
Plastic Viscosity (PV): 25.53

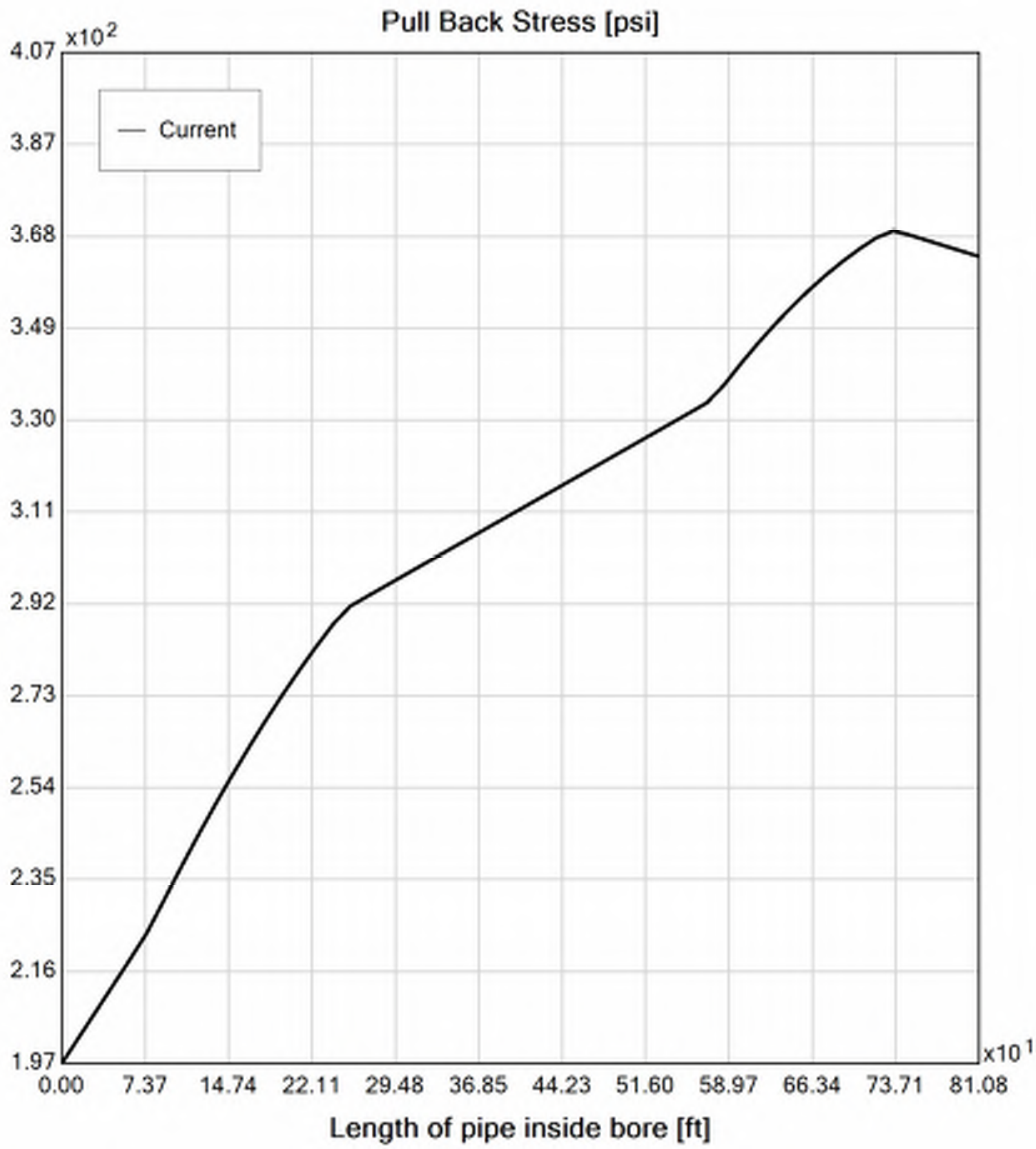
Yield Point (YP): 16.49

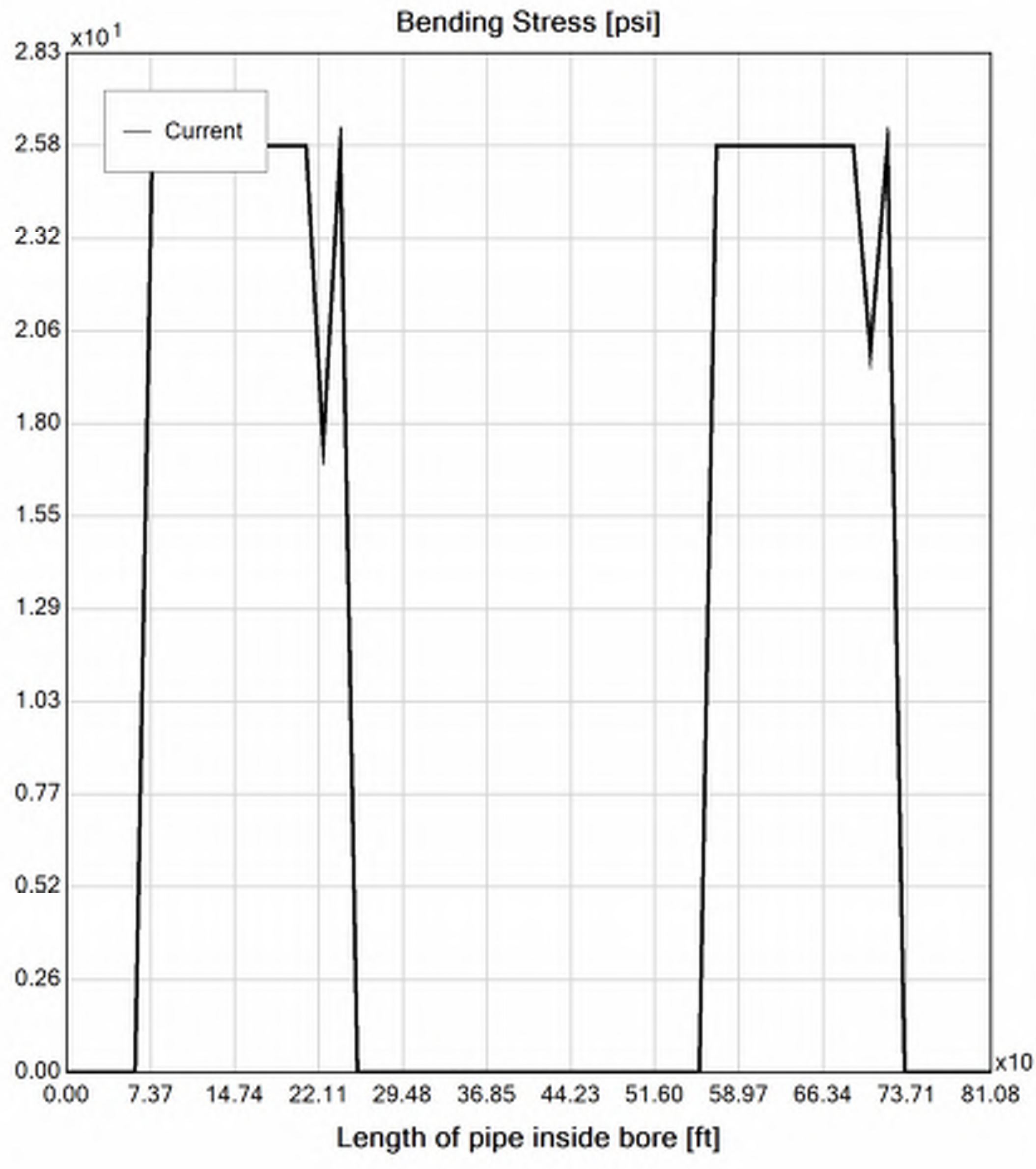
Effective Viscosity (cP): Infinity

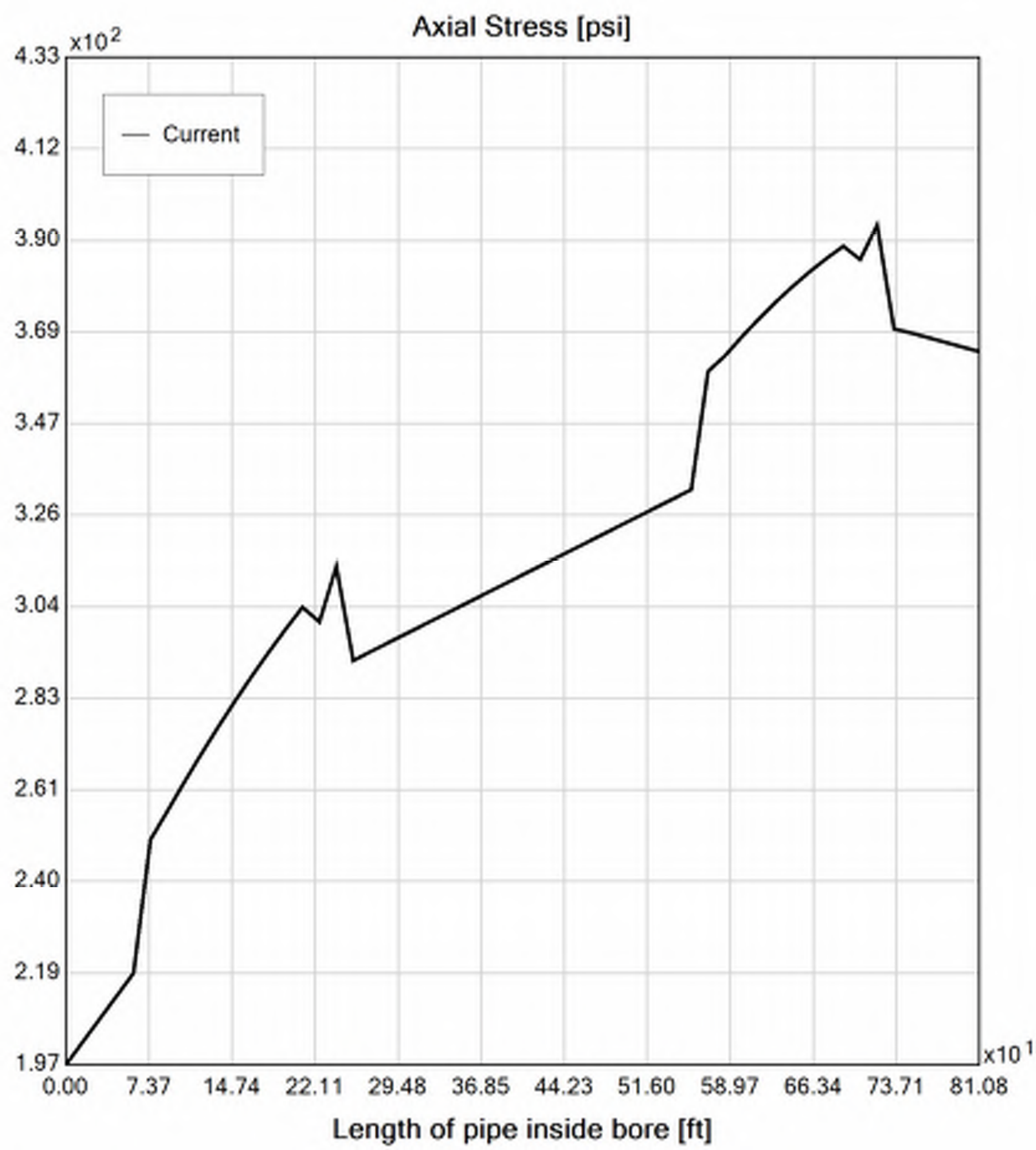
Virtual Site



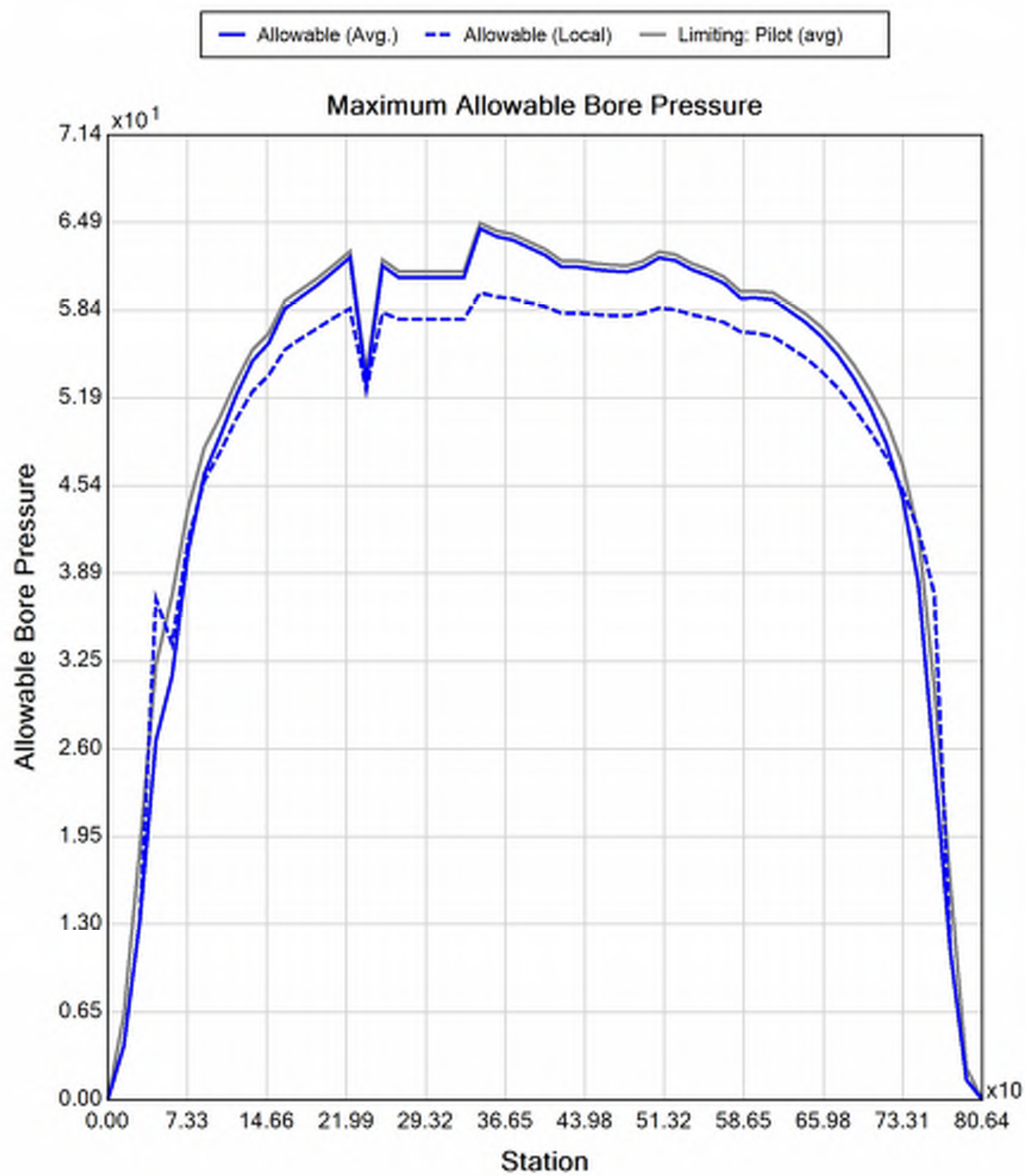

Pull Back Force [lb]
x10^4
1.46
1.39
1.32
1.25
1.18
1.12
1.05
0.98
0.91
0.84
0.77
0.71
Current
x10^1
0.00
7.37
14.74
22.11
29.48
36.85
44.23
51.60
58.97
66.34
73.71
81.08
Length of pipe inside bore [ft]


Pull Back Stress [psi]
x10 2
4.07
3.87
3.68
3.49
3.30
3.11
2.92
2.73
2.54
2.35
2.16
1.97
Current
x10 1
0.00 7.37 14.74 22.11 29.48 36.85 44.23 51.60 58.97 66.34 73.71 81.08
Length of pipe inside bore [ft]

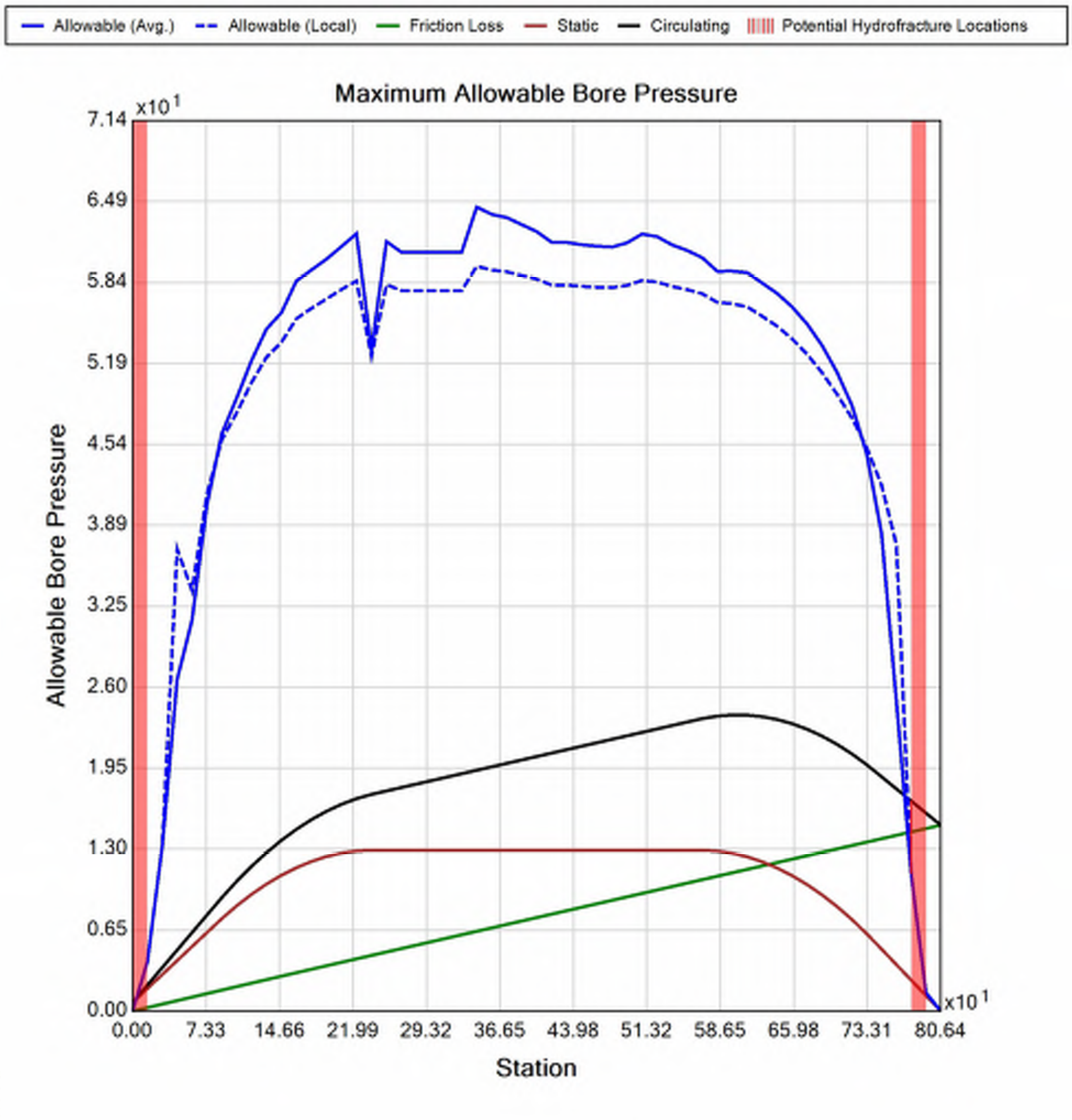

Bending Stress [psi]
x10 1
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
x10 1
0.00
7.37
14.74
22.11
29.48
36.85
44.23
51.60
58.97
66.34
73.71
81.08
Length of pipe inside bore [ft]



Axial Stress [psi]
x10^2
4.33
4.12
3.90
3.69
3.47
3.26
3.04
2.83
2.61
2.40
2.19
1.97
Current
x10^1
0.00
7.37
14.74
22.11
29.48
36.85
44.23
51.60
58.97
66.34
73.71
81.08
Length of pipe inside bore [ft]



Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10 1
7.14
6.49
5.84
5.19
4.54
3.89
3.25
2.60
1.95
1.30
0.65
0.00
Allowable Bore Pressure
0.00
7.33
14.66
21.99
29.32
36.65
43.98
51.32
58.65
65.98
73.31
80.64
x10 1
Station



Allowable (Avg.)
Allowable (Local)
Friction Loss
Static
Circulating
Potential Hydrofracture Locations
Maximum Allowable Bore Pressure
x10 1
7.14
6.49
5.84
5.19
4.54
3.89
3.25
2.60
1.95
1.30
0.65
0.00
Allowable Bore Pressure
0.00
7.33
14.66
21.99
29.32
36.65
43.98
51.32
58.65
65.98
73.31
80.64
x10 1
Station

Generated Output

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Input Summary

Start Coordinate	(0.00, 0.00, 130.11) ft
End Coordinate	(800.00, 0.00, 130.00) ft
Project Length	800.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 810.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	6.3	12.8
Water Pressure	8.0	8.0
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	14.3	20.9
Deflection		
Earth Load Deflection	1.724	3.499
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	1.753	3.528
Compressive Stress [psi]		
Compressive Wall Stress	64.6	93.9

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	756.4	756.4
Pullback Stress [psi]	432.2	432.2
Pullback Strain	7.516E-3	7.516E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	432.2	436.5
Tensile Strain	7.516E-3	7.690E-3

Net External Pressure = 18.6 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.753	7.5	4.3	OK
Unconstrained Collapse [psi]	17.6	118.0	6.7	OK
Compressive Wall Stress [psi]	64.6	1150.0	17.8	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	27.6	231.9	8.4	OK
Tensile Stress [psi]	436.5	1200.0	2.7	OK

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Generated Output

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OSHA CFR 29 1926.651 requires that the estimated location of underground utilities be determined before beginning the excavation or underground drilling operation. When the actual excavation or bore approaches an estimated utility location, the exact location of the underground installation must be determined by a safe, acceptable and dependable method. If the utility cannot be precisely located, it must be shut off by the utility company.

Project Summary

General:	HDD #8 - Conduit 2 Start Date: 12-10-2021 End Date: 12-10-2021
Designer:	TAR CHA
Description:	

Input Summary

Start Coordinate	(0.00, 0.00, 130.11) ft
End Coordinate	(626.20, 0.00, 129.50) ft
Project Length	626.20 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 2

Soil Layer #1 USCS, Sand (S), SP

Depth: 6.00 ft

Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]

Phi: 30.00, S.M.: 200.00, Coh: 0.00 [psi]

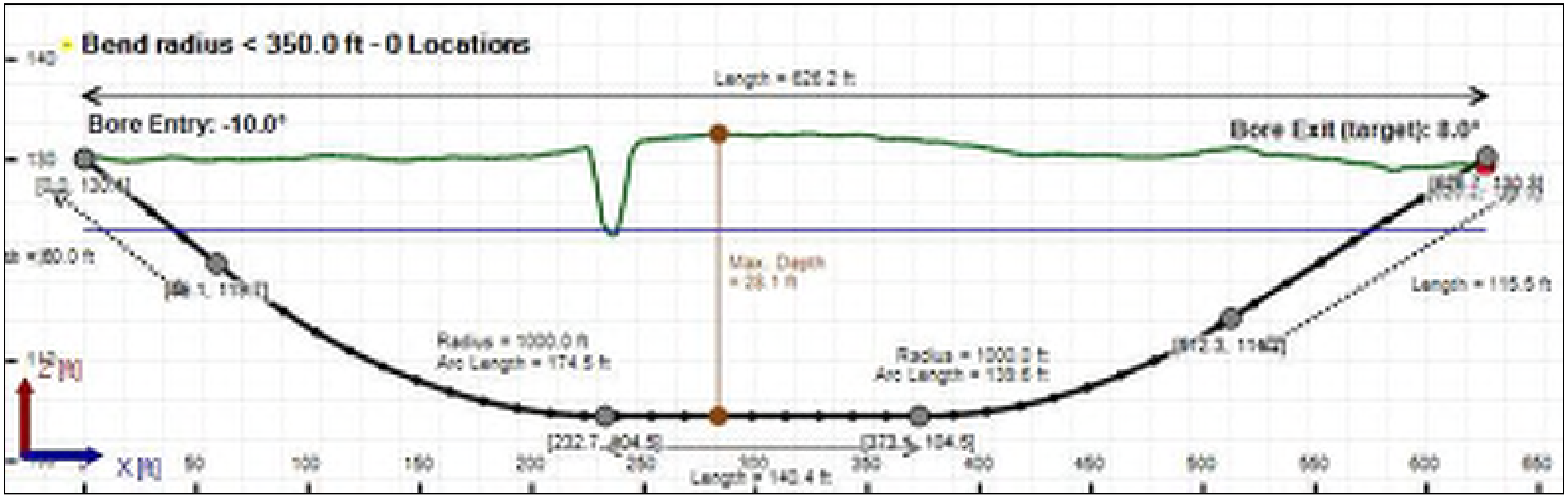
Soil Layer #2 USCS, Clay (C), CH

Depth: 25.00 ft

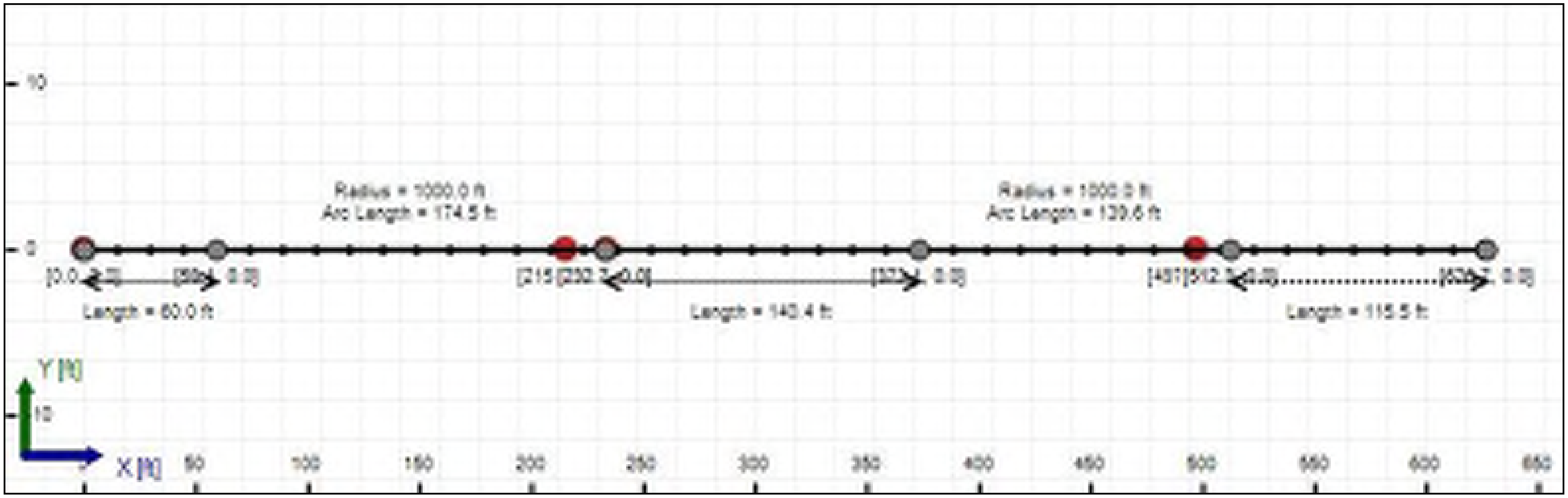
Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 300.00, Coh: 8.70 [psi]

Bore Cross-Section View



Bore Plan View



Powered by BoreAid

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 630.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	5.9	13.0
Water Pressure	8.0	8.0
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	14.0	21.0
Deflection		
Earth Load Deflection	1.620	3.530
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.752	3.662
Compressive Stress [psi]		
Compressive Wall Stress	62.9	94.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	10437.4	10437.4
Pullback Stress [psi]	291.1	291.1
Pullback Strain	5.062E-3	5.062E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	291.1	314.0
Tensile Strain	5.062E-3	5.908E-3

Net External Pressure = 16.9 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.752	7.5	4.3	OK
Unconstrained Collapse [psi]	16.8	118.0	7.0	OK
Compressive Wall Stress [psi]	62.9	1150.0	18.3	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	26.7	238.3	8.9	OK
Tensile Stress [psi]	314.0	1200.0	3.8	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	65.109 psi	60.334 psi
1	8.00 in	12.00 in	64.940 psi	60.130 psi
2	12.00 in	16.13 in	64.700 psi	59.842 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

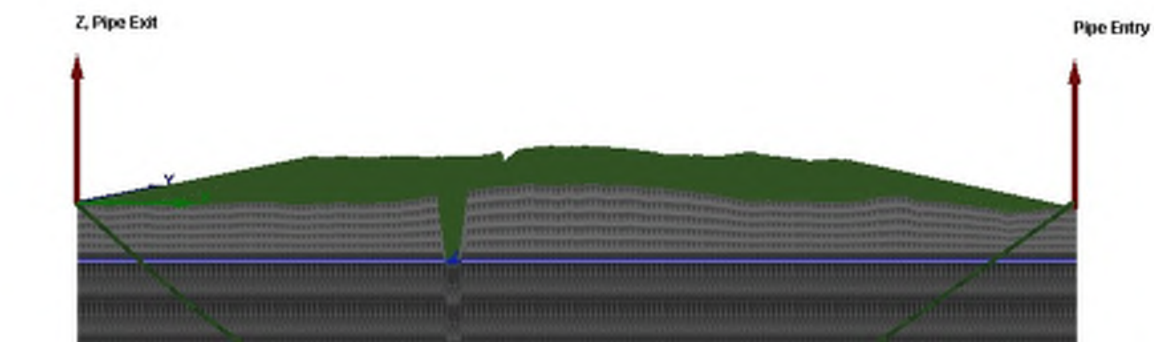
Rheological model: Bingham-Plastic

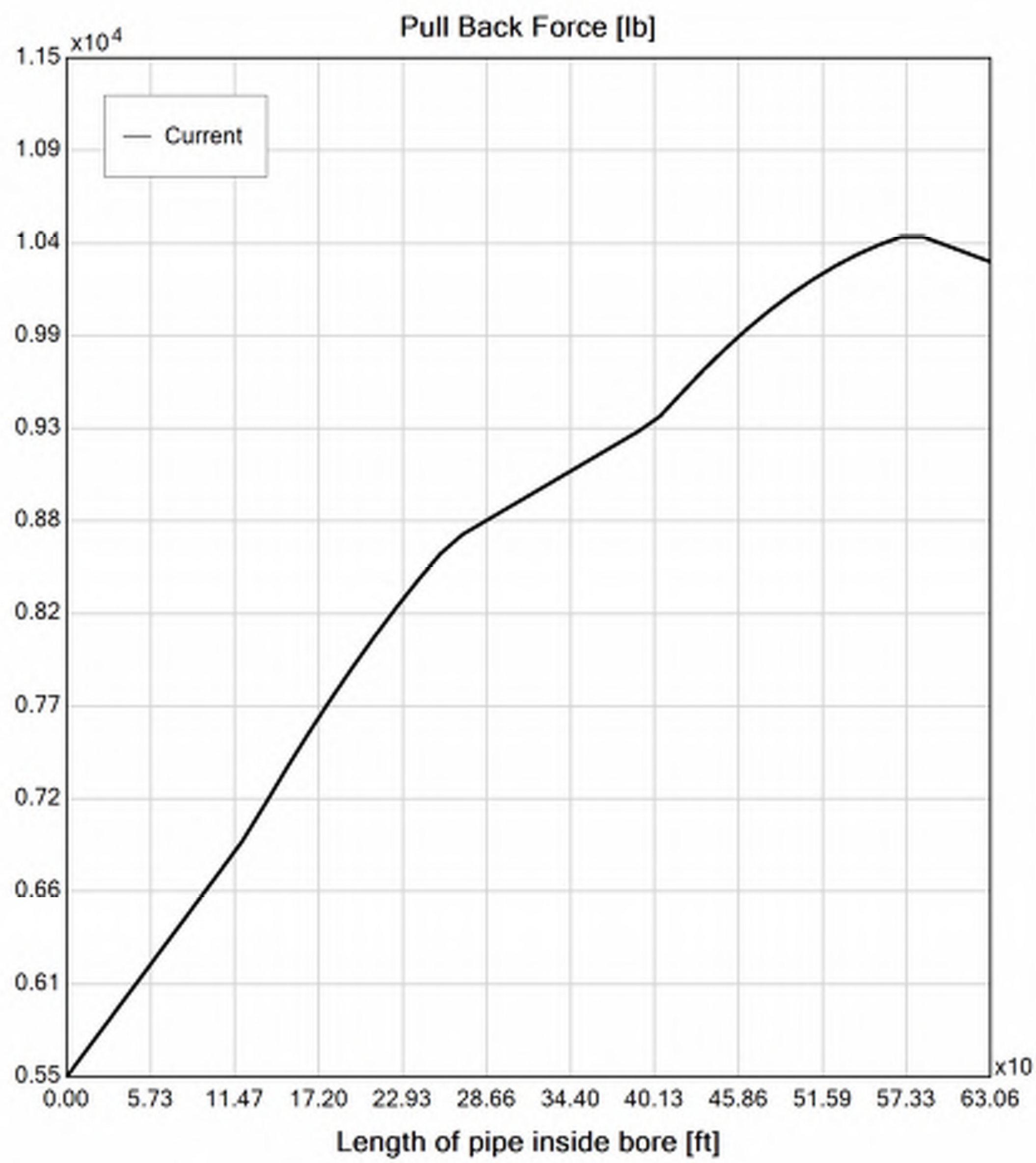
Plastic Viscosity (PV): 25.53

Yield Point (YP): 16.49

Effective Viscosity (cP): 1202.0

Virtual Site





Pull Back Force [lb]
x10^4
1.15
1.09
1.04
0.99
0.93
0.88
0.82
0.77
0.72
0.66
0.61
0.55
Current
x10^1
0.00
5.73
11.47
17.20
22.93
28.66
34.40
40.13
45.86
51.59
57.33
63.06
Length of pipe inside bore [ft]