Stantec Consulting Services Inc.
11687 Lebanon Road, Cincinnati OH 45241-2012

July 7, 2022
File: 173620122

Attention: Brian Toombs, PE
Burgess & Niple
5085 Reed Road
Columbus, Ohio 43220

Reference: Report of Geotechnical Exploration (FINAL)
BRO-32-4.16
PID No. 110478

Dear Mr. Toombs,

Stantec Consulting Services Inc. (Stantec) has completed the Report of Geotechnical Exploration (FINAL) for the safety improvement project near mileage 4.16 of State Route 32 in Brown County, Ohio. The enclosed report contains a brief description of the site, geologic conditions encountered, the scope of work performed, and geotechnical recommendations for the proposed safety improvement project.

Regards,

Stantec Consulting Services Inc.

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Attachment: Report of Geotechnical Exploration (FINAL)

STATE OF OHIO
ERIC M. KISTNER
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REGISTERED
PROFESSIONAL ENGINEER
7-7-22

Stantec

Report of Geotechnical Exploration - FINAL BRO-32-4.16 Safety Improvements

PID No. 110478

Brown County, Ohio

July 7, 2022

Prepared for:

Burgess & Niple, Inc.

Prepared by:

Stantec Consulting Services Inc.
Cincinnati, Ohio

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Executive Summary

The Ohio Department of Transportation (ODOT) is planning a new interchange for State Route (SR) 32 near Mount Orab, Ohio in Brown County. The project starts at the intersection of SR 32 and Bodman Road and continues east to the intersection of Brooks-Malott Road near straight-line mileage (SLM) 4.16. The improvement project at SR 32 includes a diamond interchange with two new connecting roads named Bruce Lunsford Way and Homan Way, new culverts, modification to the two existing intersections, and a 2-span bridge across SR 32. Stantec Consulting Services Inc. (Stantec) was contracted by Burgess & Niple to perform the geotechnical exploration for this project.

Borings were advanced to provide subsurface geotechnical data for the proposed bridge, MSE wall bridge abutments, embankments, culverts, new and widened roadway, and subgrade. The site was underlain by an upper layer of soft to stiff cohesive soil that typically classified as clay (A-7-6), silty clay (A-6b), and silt and clay (A-6a) that was approximately 8 to 13 feet deep. This soil was underlain by hard glacial till soil that typically classified as sandy silt (A-4a) and silt and clay (A-6a). Thinner layers of silt (A-4b) and elastic clay (A-7-5) were observed in isolated areas of the project. Groundwater in the form of perched aquifers was observed intermittently across the site. Bedrock consisting of limestone with interbedded shale was encountered at the Homan Way culvert at a depth of about 23 feet, however, elsewhere across the site, bedrock was not encountered in borings advanced to depths of 20 to 50 feet.

The recommended seismic site class for the Bruce Lunsford Way bridge over SR 32 based on the average N-value for the upper 100 feet is Site Class D (stiff soil). It is recommended that the bridge substructures be supported by closed-end steel pipe piles that penetrate the hard glacial till layer. The bridge abutments will consist of MSE walls. Estimated pile lengths for the bridge are 60 feet for the abutments (includes pile length through the MSE) and 45 feet for the pier. Because of the potential for downdrag, a 3-month waiting period is recommended after MSE wall construction before final pile driving is performed. Recommended MSE wall strap lengths range from 13 to 35 feet, with the controlling factor being sliding. Like the pile driving, a 3-month waiting period is recommended before installation of the facing panels due to the potential for differential settlement. Actual waiting periods should be based on the actual settlement curves obtained from settlement platforms, as interpreted by a geotechnical engineer.

Based on slope stability analyses, embankment slopes on the project are recommended to be 2:1 (horizontal to vertical) or flatter. For pavement design, a CBR value of 5 is recommended for design and it is recommended that global subgrade stabilization be performed. This stabilization can consist of 12 inches of excavation and replacement with geogrid and granular backfill, 18 inches of excavation and replacement with geotextile fabric and granular backfill, or 14 inches of chemical stabilization using lime. Special accommodations are recommended for two areas of silt (A-4b) and one area of elastic clay (A-7-5) encountered at subgrade along proposed Ramps NE and SE and Homan Way.

1.0 INTRODUCTION

The Ohio Department of Transportation (ODOT) is planning a new interchange for State Route (SR) 32 near Mount Orab, Ohio in Brown County. The project starts at the intersection of SR 32 and Bodman Road and continues east to the intersection of Brooks-Malott Road near straight-line mileage (SLM) 4.16. The improvement project at SR 32 includes a diamond interchange with two new connecting roads named Bruce Lunsford Way and Homan Way, new culverts, modification to the two existing intersections, and a 2- or 4-span bridge across SR 32. Stantec Consulting Services Inc. (Stantec) was contracted by Burgess & Niple to perform the geotechnical exploration for this project. Figure 1 shows the site vicinity.

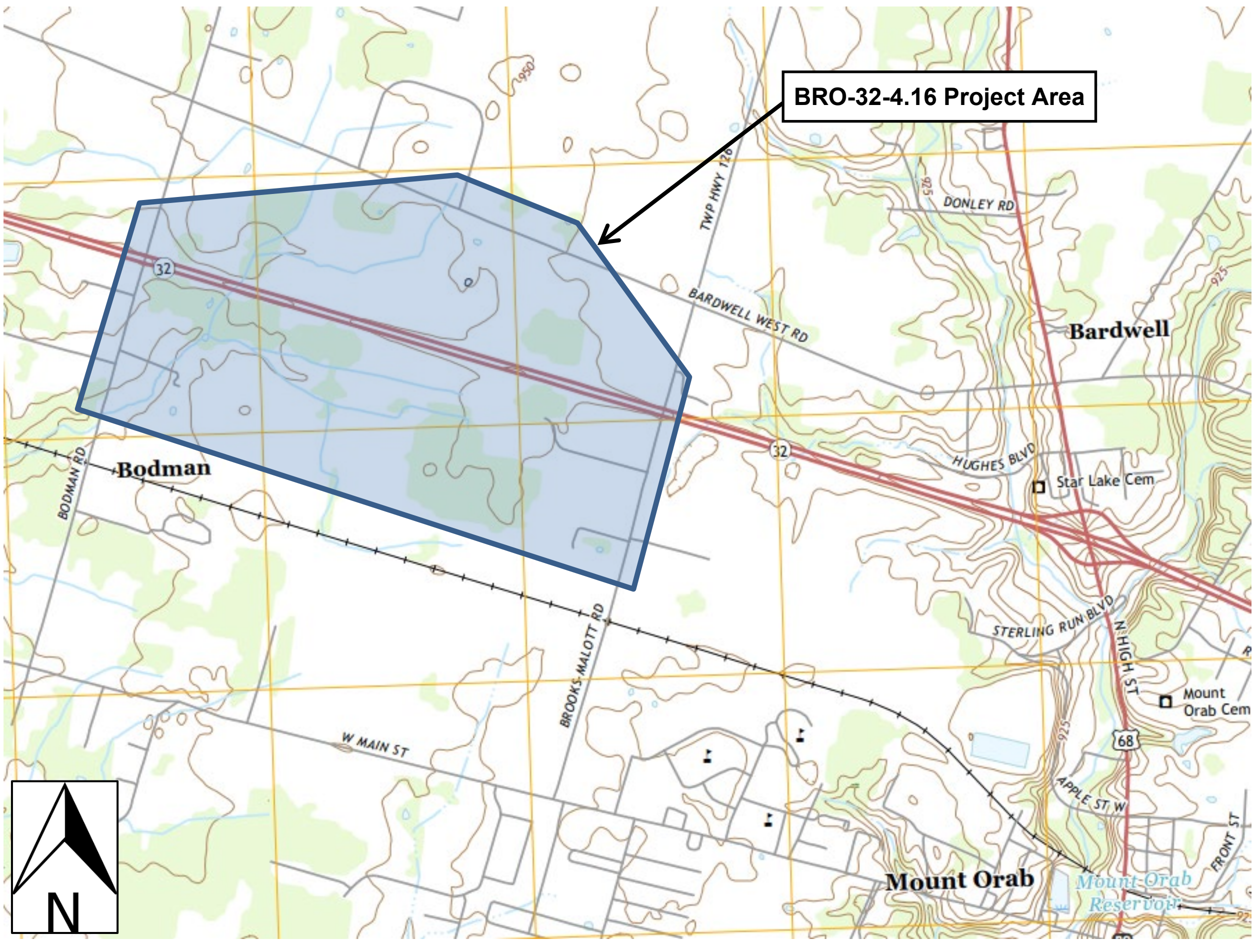


Figure 1. Site Vicinity
(Portion of USGS Topographic Map, Mount Orab Quadrangle 2019, Not to Scale)

2.0 GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1 GENERAL

The Physiographic Regions of Ohio Map (Ohio Department of Natural Resources (ODNR), 1998) indicates that project is located within the Illinoian region of the Till Plains. The Illinoian region is described as rolling ground moraine of older till generally lacking ice-constructional features such as moraines, kames, and eskers. The plain contains many buried valleys and possesses modern valleys alternating between broad floodplains and bedrock gorges. This region has moderately low relief (generally 50 feet) with elevations of 600 to 1,100 feet.

2.2 SOIL GEOLOGY

According to the Quaternary Geology of Ohio map (ODNR, 1999), the project site is underlain by flat, relatively continuous ground moraine deposited during the Illinoian period. The soil survey (Web Soil Survey of Brown County, Ohio, United States Department of Agriculture (USDA), 2020) indicates that the project site is underlain primarily by soils from the Clermont silt loam and Blanchester silty clay loam complexes. The typical profile of the Clermont silt loam complex consists primarily of silt loam, silty clay loam, and clay loam and are poorly drained with a very low to moderately high capacity to transmit water. The typical profile of the Blanchester silty clay loam complex consists primarily of silty clay loam and silty clay. The soil tends to be poorly drained with a very low to moderately high capacity to transmit water. The Drift Thickness Map of Ohio (ODNR, 2004) shows the project site is in a region of Brown County where up to 50 feet of glacial drift can be expected.

2.3 BEDROCK GEOLOGY

Bedrock mapping (*Reconnaissance Bedrock Geology of the Mount Orab, Ohio Quadrangle* [ODNR, 1994]) and Descriptions of Geologic Map Units (ODNR, 2011) indicates that the overburden soils at the project site are underlain primarily by sedimentary bedrock from the Waynesville and Arnheim Formations, Undivided group from the Ordovician age. The Waynesville Formation consists of interbedded shale (70%) and limestone (30%). The bedrock is gray to bluish gray that weathers light gray, planar to irregular, thin to thick bedded, and is between 90 and 120 feet thick. The Arnheim Formation consists of interbedded shale (60%) and limestone (40%). The bedrock is gray to bluish gray that weathers to light gray, planar, wavy, irregular to nodular, thin to thick bedded, and is between 50 to 100 feet thick. Online bedrock topography available at ODNR's website shows that the top of bedrock ranges from Elevation 880 to 920 within the project footprint, which is approximately 20 to 65 feet below the surface.

According to the *Mines of Ohio* online application (ODNR), there are two industrial limestone mines located within 10 miles of the project, but no industrial mines (or other mines) within 5 miles of the project. The Ohio Karst Areas map (ODNR, 2009) indicates there are many probable karst areas in southeastern Brown County and one north of the project site, but no karst areas are within 10 miles of the project site.

2.4 SEISMIC

Overall, Ohio has a relatively limited amount of seismic activity. A review of USGS online earthquake application shows that 3 recorded earthquakes have occurred with epicenters within approximately 30 miles of the site. These earthquakes were recorded in 1812, 1995, and 2019 and ranged in magnitude from 2.5 to 4.4 according to the Richter Scale. None of these past earthquake epicenters were within 10 miles of the site.

2.5 HYDROLOGY

Indian Camp Run and its tributaries traverse the alignment of Homan Way south of SR 32 in several places. The tributaries of Indian Camp Run also extend north of SR 32. Also, north of SR 32, a tributary to Crane Creek crosses the project corridor. Indian Camp Run flows west to Todd Run, which flows west to East Fork Little Miami River near Williamsburg. Crane Creek also flows west to East Fork Little Miami River.

Delineated wetland areas are present in various locations, most notably along proposed Homan Way east of proposed Bruce Lunsford Way. The wetland areas are shown on the soil profile drawings in Appendix A.

2.6 HYDROGEOLOGY

The *AGWQMP Well Locations and Major Aquifer Types* map issued by the Ohio EPA shows that the aquifer lithology in the site vicinity is within interbedded carbonate shale. The *Groundwater Resources of Ohio* map by ODNR shows yields of under 5 gallons per minute for aquifers in Brown County, Ohio.

A search was performed using the online ODNR Ohio Water Wells Map. According to the map, two water wells are located within the project footprint. One located south of SR 32 reports a static water level of 23 feet in limestone. The other, which is located north of SR 32, reports a static water level of 18 feet in shale and sandstone.

A search of the online ODNR Oil & Gas Well Locator shows one permitted gas well in Brown County and several oil or gas wells in surrounding counties, however, the wells appear to not have been drilled and little information is provided.

2.7 RECONNAISSANCE

Stantec representatives visited the site on June 10, 2020. The area surrounding the project site can be described as primarily agricultural with some areas classified as wetlands. The existing pavement condition of SR 32 was fair, with cracking observed primarily in parallel and transverse direction with the alignment of the road. The median and areas immediately beyond the paved shoulders were grass covered. A line of trees was observed both north and south of SR 32 just beyond the shoulder ditch on the western portion of the project. This tree line is not present closer to Brooks-Malott Road. Areas of ponded water were observed along the shoulder ditch south of SR 32.

3.0 EXPLORATION

3.1 HISTORIC EXPLORATION PROGRAMS

The ODOT Traffic Information Management System (TIMS) provides information for one project performed at the project site. Borings were advanced in 1968 for the four-lane SR 32 from Williamsburg to Mt. Orab, Ohio. The report mentioned rather poor surface drainage along the alignment and an underlying dense glacial till. Perched water was observed in some areas, as well as small ponds. The borings from this exploration are not shown on the plans because they were advanced along centerline of SR 32 and have no impact on the design of the current project.

3.2 PROJECT EXPLORATION PROGRAM

Four borings were advanced by CTL Engineering Inc. (CTL) near the proposed bridge location from March 19 to 24, 2015 using a track-mounted drill rig. The energy ratio (ER) of the automatic hammer and drill rod system was measured to be 81.2 percent on October 29, 2013.

A total of 52 borings were advanced on June 16 through July 14, 2020 by Central Star Drilling to obtain geotechnical data for the proposed safety improvements. Eight additional borings were completed on October 26, 2020 within wetland areas. Boring locations are shown on the site plan in the geotechnical drawings provided in Appendix A. A complete set of boring logs along with photos of rock core samples are provided in Appendix B.

The borings were advanced in accordance with ODOT Specifications for Geotechnical Explorations (SGE). The borings were performed with a Dietrich D50 track-mounted drill rig (Central Star Drilling) using 2¼-inch inside diameter (ID) hollow stem augers to advance the borings through soil. Standard Penetration Test (SPT) sampling was performed at various intervals to collect samples below the existing ground surface. The 2¼ hollow stem augers were used to help advance the borings through the hard glacial till that underlies the site. Undisturbed Shelby tube (ST) samples were obtained at selected intervals in the upper weaker soils layer during the exploration. The energy ratio (ER) of the automatic hammer and drill rod system was measured to be 86.8 percent on November 26, 2019.

The SPT is performed by advancing a split-spoon sampler, 18 inches in length, with a 140-pound automatic hammer dropping 30 inches at select depth intervals in the boring. The number of hammer blows needed to advance the sampler each 6-inch increment is recorded. The blow count from the first 6-inch increment is discarded due to ground disturbance at the bottom of the borehole. The sum of the blow counts from the last two 6-inch increments is called the field N-value (N_{field}). The field N-value is corrected to an equivalent rod energy ratio of 60 percent (N_{60}) according to the equation below.

$$N_{60} = N_{field}\left(\frac{ER}{60}\right)$$

The depths/elevations of the SPTs with the corresponding N_{60}-values are shown on the boring logs in Appendix A.

The materials encountered were logged by the drill crew, with particular attention given to soil type, consistency, and moisture content. The borings were checked for the presence of groundwater during drilling and at its conclusion with the depth of water recorded. The borings were backfilled/sealed according the ODOT SGE.

The soil samples obtained from the borings were returned to a geotechnical laboratory for visual classification and tested for water content. Engineering classification testing was performed on samples reflecting each of the main soil horizons. The engineering classification tests conducted on the samples were sieve and hydrometer analysis (ASTM D 422) and Atterberg limits (ASTM D 4318). The samples were classified according to the ODOT classification method. Sulfate content testing was performed on one sample from roadway borings in accordance with the Colormetric Method (ODOT Supplement 1122).

Undisturbed Shelby tube samples were subjected to unconfined compressive strength tests (ASTM D 2166), unconsolidated-undrained triaxial compressive strength tests (ASTM D 2850), consolidated-undrained triaxial compressive strength tests (ASTM D 4767), and one-dimensional consolidation tests (ASTM D 2435).

4.0 FINDINGS

4.1 BRIDGE AND APPROACH EMBANKMENT BORINGS

Three borings, B-001-0-20 (rear abutment), B-002-0-20 (pier), and B-003-0-20 (forward abutment), were advanced along the proposed Bruce Lunsford Way bridge over SR 32. These borings were advanced to depths of 50 feet. Approach embankment borings B-058-0-20, B-058-1-20, and B-058-2-20 were positioned along the rear approach embankment section with maximum fill depth. Borings B-059-0-20, B059-1-20, and B-059-2-20 were located along the forward approach embankment section with maximum fill depth. The approach embankment borings were advanced to depths of 30 feet.

Surface elevations of the bridge and approach embankment borings ranged from an elevation of 944 to 948 feet. Topsoil depths ranged from 0.2 to 1.0 feet. Below the topsoil, cohesive soil was observed that classified as silt and clay (A-6a), silty clay (A-6b), or clay (A-7-6). Water contents varied from 10 to 26 percent and SPT N_{60} values ranged from 4 to 26. Liquid limits ranged from 31 to 64 and plasticity indices varied from 14 to 42. Unconsolidated-undrained (UU) triaxial tests yielded undrained shear strengths ranging from 0.6 to 0.9 tons per square foot (1,200 to 1,800 pounds per square foot), with an average of 0.8 tons per square foot (1,600 pounds per square foot). Unconfined compressive strengths ranged from 0.4 to 1.6 tons per square foot (800 to 3,200 pounds per square foot), with an average of 0.9 tons per square foot (1,800 pounds per square foot). A consolidated-undrained triaxial test yielded a drained cohesion of 0.2 tons per square foot (400 pounds per square foot) and drained internal friction angle of 27.9 degrees.

Hard glacial till was encountered in these borings below the soil described above at depths ranging from 8 to 16 feet (Elevation 937 to 931). The glacial till classified as sandy silt (A-4a), silt and clay (A-6a), and silt (A-4b). Water contents ranged from 5 to 20 percent and SPT N_{60} values varied from 35 to over 100. The borings were terminated in this material. Liquid limits ranged from 20 to 36 and plasticity indices varied from 6 to 13. One sample tested as non-plastic. Because of the hardness of the material, undisturbed Shelby tube samples were unable to be obtained from this layer for shear strength testing. ODOT performed pressure testing in March of 2021 at depths ranging from 22.8 to 32.8 feet near boring B-001-0-20 to better estimate the strength of this material. These tests indicated strengths ranging from about 200 to 350 psi (about 30,000 to 50,000 psf) within the elastic range of the material.

Bedrock was not encountered in the borings. Groundwater was encountered in six of the nine borings at depths ranging from 8.5 to 23 feet. Water contents below the observed groundwater in the borings do not reflect saturated conditions. The groundwater encountered in the borings does not appear to be a static aquifer. It is likely that groundwater exists in perched conditions within silt layers or possibly thin sand seams that were not detected in the borings.

CTL Engineering Inc. advanced four borings at the originally proposed location of the overpass bridge, which was about 100 feet west of the current proposed location. The borings locations are shown on the soil profile drawings in Appendix A and with the boring logs in Appendix B. Like the Stantec borings, an upper layer of medium stiff to stiff cohesive soil that classified as clay (A-7-6) or silty clay (A-6b) was encountered to a depth of about 8 to 15 feet. A 5-foot thick layer of hard silt (A-4b) was observed underlying the weathered glacial till in two of the borings. Below these layers, hard glacial till that classified as silt and clay (A-6a) or sandy silt (A-4a) was encountered to the boring termination depths. Bedrock was not observed in the borings. Groundwater was encountered at depths ranging from 7 to 24 feet in the borings. Unconfined compressive strengths ranged from 0.4 to 1.6 tons per square foot (800 to 3,200 pounds per square foot), with an average of 0.9 tons per square foot (1,800 pounds per square foot). A consolidated-undrained triaxial test yielded a drained cohesion of 0.15 tons per square foot (305 pounds per square foot) and drained internal friction angle of 30 degrees.

4.2 SUBGRADE AND ROADWAY BORINGS

The results borings with surface elevations within about 10 feet of proposed grade are summarized on Geotechnical Bulletin 1 (GB 1) *Plan Subgrades* spreadsheet in Appendix H. These borings were advanced to depths ranging from 6 to 10 feet. Topsoil ranged from 1 to 5 inches in thickness with an average of 2 inches. Soils consisted primarily of silt and clay (A-6a), clay (A-7-6), and silty clay (A-6b), with lesser amounts of silt (A-4b), and elastic clay (A-7-5). Water contents ranged from 8 to 31 percent with an average of 20 percent, as compared to an average optimum water content of 17 for these soils. SPT N_{60} values varied from 3 to 93 with an average of 17. Liquid limits ranged from 21 to 66 with an average of 42 and plasticity indices varied from 6 to 45 with an average of 22. Classification group indices ranged from 6 to 20 with an average of 13. The GB1 spreadsheet reports that 62 percent of the subgrade soil is unstable and/or unsuitable and requires subgrade stabilization.

Unsuitable soil that classified as A-4b (silt) was encountered at subgrade elevation in borings B-027-0-20 from the surface to a depth of 1.5 feet and in B-028-0-20 from the surface to a depth of 3 feet. These borings are located along the proposed alignments of Ramp SE (B-027) and Ramp NE (B-028). Unsuitable soil classified as A-7-5 (elastic clay) was observed in boring B-061-0-20 from the surface to a depth of 5.0 feet. This boring is located along the proposed alignment of Bruce Lunsford Way.

In areas with proposed embankment thicknesses of approximately 10 feet or greater, 20-foot deep borings were advanced to explore the suitability of the foundation soils to support these embankments. Boring B-019-0-20 (Ramp SW), B-020-0-20 (Ramp NW), B-021-0-20 (Ramp SE), B-022-0-20 (Ramp NE), and B-057-0-20 (Bruce Lunsford

Way) fit into this category. Like the other deeper borings on the project, two primary soil horizons were observed; an upper soft to very stiff cohesive soil underlain by hard glacial till. Bedrock was not encountered in the borings and perched groundwater was observed in B-057-0-20 at a depth of 10.5 feet, but not in the other borings.

The upper layer classified as clay (A-7-6), silt and clay (A-6a), and silty clay (A-6b). Water contents varied from 15 to 31 percent and SPT N_{60} values ranged from 4 to 22. The lowest N_{60} value from each boring, which ranged from 4 to 7, was typically from a depth of 1.0 to 2.5 feet. Liquid limits ranged from 30 to 49 and plasticity indices varied from 23 to 25. The hard glacial till was encountered at depths ranging from 8 to 11 feet and classified as sandy silt (A-4a) or silt and clay (A-6a). Water contents varied from 7 to 13 percent and SPT N_{60} values ranged from 32 to over 100.

4.3 CULVERT BORINGS

Two borings, B-038-0-20 and B-038-1-20, were advanced along the proposed Homan Way alignment for a culvert at Station 308+82. The invert elevation of the culvert is 929.6 feet and the surface elevations of the borings are 931.6 feet. Topsoil depth was one foot in these borings. Below the topsoil, cohesive soil was observed that classified as silt and clay (A-6a), silty clay (A-6b), or clay (A-7-6). Water contents varied from 9 to 27 percent and SPT N_{60} values ranged from 6 to over 100. Most N_{60} values were over 17 except for the first tests in each boring at depths of 1.0 to 2.5 feet, for which values of 6 and 7 were recorded. Liquid limits ranged from 26 to 51 and plasticity indices varied from 11 to 28.

Bedrock was encountered in both borings at a depth of 23.0 feet in B-038-0-20 (elevation 908.6 feet) and in B-038-1-20 (elevation 909.5 feet). The bedrock was described as interbedded limestone and shale with approximately 80 percent limestone. Groundwater was observed in B-038-0-20 at a depth of 28.5 feet (Elevation 903.1) and in B-038-1-20 at a depth of 23.5 feet (Elevation 909.0 feet) within the bedrock. The borings were terminated in bedrock after performing five feet of rock coring.

5.0 ANALYSIS AND RECOMMENDATIONS

5.1 GENERAL

The recommendations that follow are based on the information discussed in this report and the interpretation of the subsurface conditions encountered at the site during our fieldwork. If future design changes are made, Stantec should be notified so that such changes can be reviewed and recommendations amended as necessary.

These conclusions and recommendations are based on data and subsurface conditions from the borings advanced during this exploration using the degree of care and skill ordinarily exercised under similar circumstances by competent members of the engineering profession. No warranties can be made regarding the continuity of conditions.

Applicable ODOT Geotechnical Engineering Design Checklists have been completed and are included in Appendix J.

5.2 BRUCE LUNSFORD WAY BRIDGE OVER SR 32

5.2.1 Seismic Site Class

A seismic site class evaluation was performed based on methodology presented in AASHTO LRFD Section 3.10.3.1. The average N-value for the upper 100 feet was determined to be 45.1. According to AASHTO LRFD Table 3.10.3.1-1, Site Class D (stiff soil) is recommended. The derivation of the average N-value is presented in Appendix C.

5.2.2 Pile Capacity Analysis

The pile capacity analyses were performed using the computer program APILE Version 2019 and based on pile cap configuration data from the Stage 2 bridge design plans. Guidelines in the current AASHTO LRFD and ODOT Bridge Design Manual (BDM) were followed. Pile drivability analyses were performed using the computer program GRLWEAP Version 2010. The following assumptions were made in the pile capacity and driving models:

- The piles supporting the bridge consist of cast-in-place closed-end steel pipe piles, 12-inch outside diameter at the abutments and 14-inch diameter at the pier. Unfactored loading on the piles was provided by the structural engineer as 187 kip per piles at the abutments and 240 kips per pile at the pier. These loads were divided by a resistance factor of 0.7 (assuming dynamic load testing during construction) to arrive at ultimate bearing values (UBVs) of 267 kips per pile at the abutments and 343 kips per pile at the pier.

- Axial pile capacity was estimated using the FHWA Method in the APILE program, which follows the guidance in the AASHTO LRFD. For the FHWA Method, pile tip resistance is taken as nine times the undrained shear strength). Side resistance (skin friction) is estimated using Tomlinson's α-Method for cohesive soil (1980 revision).

- The undrained shear strengths of cohesive soils were estimated considering results of SPT N-values, hand penetrometer measurements, unconfined compressive strength testing, and unconsolidated-undrained triaxial compression testing. Additionally, the ODOT Office of Geotechnical Engineering (OGE) provided guidance on the selection of the undrained shear strength for the hard glacial till that underlies the site.

- Side resistance gained from sand placed around the pile after driving through the MSE wall sleeve was ignored, except for when estimating dragload.

The analysis output for pile capacity using APILE is included in Appendix D and analysis output for drivability using GRLWEAP is included in Appendix E. Table 1 provides a summary of the estimated capacities and pile tip elevations for each substructure element based on the static analyses. Settlement of the piles at working loads were estimated to be 0.3 inches at the abutments and 0.2 inches at the pier.

Table 1. Estimated Tip Elevations and Pile Lengths for CIP Steel Pipe Piles

Substructure Element	Base of Pile Cap Elevation (feet)	Pile Diameter (inches)	Estimated Pile Tip Elevation (feet)	UBV (kips)	*Estimated Pile Length (feet)
Rear Abutment	962.8	12	919.7	267	45
Pier	946.0	14	914.3	343	35
Forward Abutment	962.6	12	917.8	267	50

*Pile length estimated by assuming a one-foot pile embedment into the pile cap and rounding up to the next 5-foot interval (with a minimum increase of 1 foot or next 5 foot-interval).

The settlement analysis, discussed in Section 5.2.4, predicts the potential of greater than 0.4 inches of settlement of the foundation soils surrounding the piles. According ODOT BDM 2020, downdrag and drag load should be considered in the design of the piles. The piles will be sleeved through the MSE embankment (described in Section 5.3) to eliminate downdrag and drag load from the reinforced zone. It is anticipated that a 3-month waiting period will be implemented after completion of the MSE to allow settlement to occur. The settlement calculations predict that the consolidation settlement remaining after this waiting period will be either less than 0.4 inches, or within less than 9 days of being below the 0.4 inches of settlement remaining. Actual waiting periods should be based on the actual settlement curves obtained from settlement platforms, as interpreted by a geotechnical engineer.

Drivability analyses performed using GRLWEAP indicate a typical pile driving hammer with 43.24 foot-kips of rated energy (i.e. Delmag D 19-42) should be appropriate to achieve the UBV pile resistances presented in Table 1. The maximum computed stresses during driving were estimated to be below the allowable driving stress (0.9 of the yield stress) for the cast-in-place steel pipe piles with a yield stress of 45 kips per square inch for Grade 3 steel and wall thicknesses of 0.312 inch for the abutment piles and 0.4 inch for the pier piles. Maximum driving stresses of 38 kips per square inch and a maximum blow count of 54 blows per foot were estimated.

5.2.3 MSE Walls

Based on the preliminary plans, Mechanically Stabilized Earth (MSE) retaining walls are planned for the two abutments for Bridge 32-0359 (Bruce Lunsford Way over SR 32). Analysis of the MSE walls was performed in general accordance with ODOT Supplemental Specification 840, Mechanically Stabilized Earth Walls, dated January 18, 2019 and AASHTO LRFD Bridge Design Specifications, 8th edition, 2017. The maximum wall height was determined based on the proposed roadway elevation at the abutment and an embedment depth of 3-feet as required by AASHTO 11.10.2.2 and for frost penetration. The top of levelling pad for the MSE wall face will be at an elevation 947.25 at the rear abutment and at 945.63 at the forward abutment. The planned rear and forward MSE faces will be about 25.76 and 27.10 feet high, respectively. The bridge will be supported by driven piling sleeved through the MSE wall. The embankment side slopes transverse to the road and bridge will have a maximum 2:1 (horizontal to vertical) slope.

In evaluating the design for a "gravity-type" reinforced soil retaining wall (MSE), the external and internal stability should be analyzed. The internal stability analysis will be performed by the wall designer/manufacturer. The external stability analysis for eccentricity, sliding, bearing resistance and global stability considered the subsurface conditions, the height of the MSE wall and an initial minimum reinforced length of 0.7 times the height of the wall. The reinforcement length was increased in increments of 0.5 feet. Stantec utilized the computer program MSEW Version 3.0 in the analysis of the MSE walls for sliding and limiting eccentricity. Bearing was analyzed using the factored load output from MSEW and Slope/W by GeoStudio, 2018 to model the two-layered foundation soils (MSEW models only a single layer foundation soil). Global stability was also analyzed using Slope/W. The MSE wall analyses are presented in Appendix F.

In accordance with ODOT SS 840, the reinforced fill portion of the wall was assumed to have an internal friction angle (φ) equal to 34 degrees, a cohesion of 0, and a unit weight of 120 pounds per cubic foot (pcf). The retained soil was assumed have an internal friction angle (φ) equal to 30 degrees, a cohesion of 0, and a unit weight of 120 pcf. The subsurface conditions beneath the walls were estimated based on the test borings and laboratory test results performed for the bridge foundations. Stantec also used ODOT Geotechnical Bulletin GB2, dated January 17, 2020, to establish soil parameters for the analyses. The subgrade conditions for both the forward and rear abutments are anticipated to consist of natural silty clay. The table below summarizes the soil conditions used in the MSE wall analyses.

Table 2. Summary of Soil Parameters for MSE Wall Analyses

Material Type	Short Term (Undrained)		Long Term (Drained)	
	Friction Angle (φ-degrees)	Cohesion (c-psf)	Friction Angle (φ-degrees)	Cohesion (c-psf)
Reinforced Fill	34	0/3,000[2]	34	0/3,000[2]
Retained Fill	30	0	30	0
Embankment Fill	0	2,000	26	200
Upper Clay and Silty Clay	0	1,000/1,600[1]	23/28[1]	0/150[1]
Lower Silt and Clay/Sandy Silt (Glacial Till)	0	12,000	32	400

[1] First figure used for sliding analysis; second used for bearing analysis.
[2] First figure used for all analyses; second used for global stability analyses to force critical failure surface outside of reinforced zone.

For external stability, the following four standard modes of failure are typically evaluated:

1) sliding using a resistance factor (φ = 1);
2) limiting eccentricity (overturning);
3) bearing capacity using a resistance factor (φ = 0.65); and
4) global stability using a resistance factor (φ = 0.65).

With LRFD, the goal is to have the factored resistance greater than the factored load. The term capacity to demand ratio, CDR, is used to quantify the ratio of the factored resistance to the factored load. CDR values of one or greater indicate acceptable results. The global stability analyses display the results as a factor of safety. The inverse of the factor of safety is equivalent to the resistance factor. The bearing CDR was taken as 0.65 times the Slope/W factor of safety. For global stability, a factor of safety (FS) greater than 1.5 is required.

Table 3. Summary of External Stability Analysis – Short Term (Undrained)

MSE Wall CDR Values		Sliding	Limiting Eccentricity	Bearing[1]	Global Stability
Wall Location & Backslope	**Approx. Max. Height & Reinforcement Length**	CDR ≥ 1	e/L ≤ 0.333	CDR ≥ 1	FS ≥ 1.5
Rear Abutment Level Backslope	Wall Height: 25.76 ft Strap Length: 35 ft	1.48	0.0579	1.1	2.52
Forward Abutment Level Backslope	Wall Height: 27.11 ft Strap Length: 35 ft	1.35	0.0634	1.0	2.40
Rear Sloped Wall Level Backslope	Wall Height: 17.1 ft Strap Length: 13 ft	1.40	0.1565	1.2	3.99
Forward Sloped Wall Level Backslope	Wall Height: 18.47 ft Strap Length: 14 ft	1.30	0.1565	1.1	3.75

[1] Bearing CDR in MSEW analysis results not used. The bearing analysis was performed using slope stability software to model the two layers of foundation soil more accurately. Value in table is from limit equilibrium analysis.

Table 4. Summary of External Stability Analysis – Long Term (Drained)

MSE Wall CDR Values		Sliding	Limiting Eccentricity	Bearing[1]	Global Stability
Wall Location & Backslope	**Approx. Max. Height & Reinforcement Length**	CDR ≥ 1	e/L ≤ 0.333	CDR ≥ 1	FS ≥ 1.5
Rear Abutment Level Backslope	Wall Height: 25.76 ft Strap Length: 35 ft	1.94	0.0579	4.3	2.47
Forward Abutment Level Backslope	Wall Height: 27.11 ft Strap Length: 35 ft	1.86	0.0634	4.1	2.38
Rear Sloped Wall Level Backslope	Wall Height: 17.1 ft Strap Length: 13 ft	1.22	0.1565	2.0	2.35
Forward Sloped Wall Level Backslope	Wall Height: 18.47 ft Strap Length: 14 ft	1.22	0.1565	1.9	2.28

[1] Bearing CDR in MSEW analysis results not used. The bearing analysis was performed using slope stability software to model the two layers of foundation soil more accurately. Value in table is from limit equilibrium analysis.

The MSE wall analyses indicate that sliding controls the design of the reinforcement length. The analyses using the natural clay soils for support of the walls results in reinforcement lengths of up to 1.3 times the wall height for the forward abutment. This strap length could be reduced to be closer to the more common 0.7 times the height of the wall by performing ground improvement such as undercut and replace or stone columns.

Based on FHWA NHI-10-024 (MSE Walls), concrete-faced MSE structures using discrete articulating panels can accommodate maximum longitudinal differential settlements of about 1 inch per 100 feet, without the introduction of special sliding joints between panels. The walls range from about 120 to 125 feet long, however, the maximum differential settlement will occur between the center and the edge, or half of the total length. The resulting maximum tolerable differential settlement is 0.6 inches. The settlement calculations described in Section 5.2.4 predicts 3 to 5 inches of differential total settlement from the wall center to edge. About 25 percent of that settlement is immediate settlement, so the estimated differential consolidation settlement is 2 to 4 inches. About 85 percent of the consolidation settlement will need to occur to have a remaining settlement of 0.6 inches. This 85 percent of settlement is predicted to occur within 100 days, or about 3 months. Actual waiting periods should be based on the settlement curves obtained from settlement platforms, as interpreted by a geotechnical engineer.

MSE walls shall be constructed in accordance with the current ODOT Supplemental Specification SS 840. SS 840 requires a minimum 1-foot undercut and replacement with select granular fill atop filter fabric, as well as an underdrain below the toe of the MSE wall.

5.2.4 Settlement

Settlement analyses were performed for the rear and forward approach embankment, consisting of MSE walls. Subsurface conditions were based on the results of borings near these stations and soil parameters were based on the results of three one-dimensional consolidation tests, two performed by Stantec (one at each approach) and one performed by CTL. The results of the consolidation testing were significantly different between the Stantec and CTL tests. The CTL test was performed on a sample that classified as silty clay (A-6b) and the Stantec tests were performed on samples from soil layers that classified as silt and clay (A-6a) and silt (A-4b). The results from the borings indicate that the foundation soils have a similar range in soil properties. Thus, it was decided to run the settlement analyses at each approach once using the CTL test results for the upper layer and again using the Stantec test results and report a range of the estimated settlement. The table below shows a comparison between the CTL and Stantec consolidation testing results.

Table 5. Comparison of CTL and Stantec One-Dimensional Consolidation Test Results

Laboratory and Boring Number	Sample Depth (feet)	Initial Void Ratio	Preconsolidation Pressure (tsf)	Compression Index (C_c)	Recompression Index (C_r)	Coefficient of Consolidation (C_v, ft^2/day)
B-001-0-15 (CTL)	6.5-8.5	0.73	1.6	0.11	0.027	0.101
B-058-1-20 (Stantec)	8.8-9.0	0.69	4.5	0.31	0.070	6.0
B-059-0-20 (Stantec)	8.1-8.2	0.48	4.0	0.21	0.065	4.0

An immediate settlement of 1 to 2 inches was predicted. Settlement calculations are provided in Appendix G. The results of the consolidation settlement predictions are summarized in the following table.

Table 6. Summary of Settlement Analyses at Rear and Forward Approaches and Abutments

Approach Embankment	Estimated Consolidation Settlement (inches)			*Time Until Less than 0.4 Inches Settlement Remaining (days)
	At Piles	At MSE Wall Face	At Maximum Embankment Height	
Rear Approach	3 to 5	2 to 4	3 to 6	20 to 87
Forward Approach	3 to 6	2 to 5	4 to 7	19 to 98

*This value is estimated to predict the waiting period before piles can be driven without considering drag load, as described in Section 5.2.2. Actual waiting periods should be based on the actual settlement curves obtained from settlement platforms, as interpreted by a geotechnical engineer.

To monitor the consolidation, settlement platforms are recommended in accordance with ODOT GB 4, “Guidelines for the use of Geotechnical Instrumentation.” The reading of these platforms will allow construction to proceed once the Engineer has determined that sufficient settlement has occurred. Two platforms are recommended at Station 412+10 (rear approach), one just beyond the left shoulder and one just beyond the right shoulder. Two platforms are also recommended at Station 414+30, one just beyond the left shoulder and one just beyond the right shoulder.

5.3 ROADWAY

5.3.1 Subgrade

The ODOT GB1 outlines a procedure for estimating the method and limits of subgrade treatment that will be required to stabilize pavement subgrade prior to construction of the pavement section. The procedure is based upon the results of the borings, field testing, and laboratory testing. A subgrade analysis was completed in accordance with GB1 for 36 borings along the ramp tie-ins, Homan Way, Bruce Lunsford Way, Bodman Road, Mercy Boulevard, and Shaw Drive. The subgrade analysis spreadsheet is provided in Appendix H.

A design CBR of 5 should be used for pavement design based on the GB1 subgrade analysis spreadsheet. Global subgrade stabilization is recommended when the proposed subgrade elevation is less than 3 feet higher than existing grade. If the project is utilizing a pavement thickness credit, subgrade treatment should be assumed beneath all paved surfaces, regardless of embankment thickness. The recommended subgrade stabilization options are as follows:

- Excavate and replace (Item 204) to a depth of 18 inches with geotextile. The excavation should extend to a depth of 18 inches below proposed subgrade and 18 inches beyond the edge of the surface of the pavement, paved shoulders, or paved medians including new curbs and gutters. Item 204 Granular Material Type B or C should be used as the replacement material. Item 204 Geotextile Fabric should be placed at the bottom of the excavation.

- Excavate and replace (Item 204) to a depth of 12 inches with geogrid. The excavation should extend to a depth of 12 inches below proposed subgrade and 18 inches beyond the edge of the surface of the pavement, paved shoulders, or paved medians including new curbs and gutters. Item 204 Granular Material Type B or C should be used as the replacement material. Geogrid should be placed at the bottom of the excavation. Item 204 Geotextile Fabric should be placed at the bottom of the excavation, before placement of the geogrid, because the Type B and C aggregates do not meet the natural filter criteria for the subgrade.

- Chemical stabilization (Item 206) to a depth of 14 inches with lime. The stabilization should extend to a depth of 14 inches below proposed subgrade and 18 inches beyond the edge of the surface of the pavement, paved shoulders, or paved medians including under new curbs and gutters. With an estimated rate of 5 percent, the quantity of lime should be about 60 pounds per square yard.

- “Unsuitable Subgrade” was encountered in borings B-027 and B-028 (A-4b, silt) and B-045 (A-7-5, elastic clay). These conditions should be addressed as follows:

    - If the excavation and replacement option is selected for subgrade stabilization, the excavation should be extended to a depth of 36 inches below top of proposed subgrade on Ramp NE from 612+00 to 615+00, Ramp SE from 811+00 to 814+00, and Homan Way from Station 331+00 to 337+00 to account for the unsuitable subgrade.

    - If the chemical stabilization option is selected for subgrade stabilization, the 14 inches of lime stabilization being used globally on the project is sufficient. It is recommended, however, that it be assumed that 25 percent of the stabilization on Ramp NE from 612+00 to 615+00 and Ramp SE from 811+00 to 814+00 will fail the proof roll due to the lime not being compatible with the A-4b (silt) soil, and therefore not providing adequate stabilization. It should further be assumed that 25 percent of the stabilization on Homan Way from Station 331+00 to 337+00 will fail the proof roll due to the lime not being compatible with the A-7-5 (elastic clay) soil. It should be assumed that these areas will need to be undercut to a depth of 36 inches with Item 204 Geotextile Fabric placed at the base of the excavation and backfilled with Item 204 Granular Material Type B or C, with quantities added as a contingency. Actual quantities and depth of undercuts will be determined during construction.

5.3.2 Embankment Stability

Embankment heights for the project range from less than a foot to approximately 28 feet for the bridge approaches. Stability analysis was performed at Stations 411+50 and 415+00, just beyond the proposed MSE bridge approaches, using Geostudio SLOPE/W assuming 2:1 (horizontal to vertical) slopes. Soil parameters were developed based on SPT N_{60}-values and undisturbed laboratory testing. The parameter derivations and results of the embankment stability analyses are provided in Appendix I and are summarized in Table 7. The factors of safety calculated for short term (total stress) stability using undrained strength parameters and long term (effective stress) stability using drained strength parameters are provided in Table 8.

Table 7. Summary of Soil Parameters for Embankment Stability Analyses

Material Type	Short Term (Undrained)		Long Term (Drained)	
	Friction Angle (φ-degrees)	Cohesion (c-psf)	Friction Angle (φ-degrees)	Cohesion (c-psf)
Embankment Fill	0	2,000	26	200
Upper Clay and Silty Clay	0	1,600	28	150
Lower Silt and Clay/Sandy Silt (Glacial Till)	0	12,000	32	400

Table 8. Results of Embankment Stability Analyses

Station	Short Term Stability Factor of Safety	Long Term Stability Factor of Safety
411+50	3.0	1.8
415+00	3.0	1.8

Based on the results of these analyses, 2:1 (horizontal to vertical) slopes or flatter are recommended for embankment slopes along the alignment. Proof Rolling should be performed to test the stability and compaction of the subgrade and equipment should conform to the guidelines set forth in CMS Item 204.06. The borings indicate that near-surface soils (mostly upper 4 feet) receiving embankment may be soft and unsuitable for placement of compacted embankment above this material. The conditions of the near-surface soils at the site may be dependent on the season in which the earthwork is being performed. Proof Rolling should be performed before embankment placement to identify either widespread or isolated soft conditions before fill placement. Soft conditions should be addressed at the direction of the Engineer. An average topsoil thickness of 1 foot should be assumed.

5.3.3 Culvert at Homan Way Station 308+82

Spread footings are recommended to support the headwalls required for the proposed culvert below Homan Way at Station 308+82. The proposed headwall dimensions are being designed consistent with ODOT's HW-1.1 (Standard Bridge Drawings Full-Height Headwalls). At the estimated bearing elevation, it is anticipated that the footings for the headwalls will by supported by silt and clay (A-6a) soil that meets or exceeds the minimum design criteria required for use of the standard drawing.

APPENDIX A

Geotechnical Drawings

PROJECT DESCRIPTION

THIS PROJECT CONSISTS OF A NEW INTERCHANGE FOR STATE ROUTE (SR 32) NEAR MOUNT ORAB, OHIO IN BROWN COUNTY. THE PROJECT STARTS AT THE INTERSECTION OF SR 32 AND BODMAN ROAD AND CONTINUES EAST TO THE INTERSECTION OF BROOKS-MALOTT ROAD NEAR STRAIGHT-LINE MILAGE (SLM 4.16). THE PROJECT INCLUDES A DIAMOND INTERCHANGE WITH TWO NEW CONNECTING ROADS NAMED BRUCE LUNDSFORD WAY AND HOMAN WAY, A TWO-SPAN BRIDGE OVER SR 32 WITH MSE WALL ABUTMENTS, NEW CULVERTS, AND MODIFICATIONS TO EXISTING INTERSECTIONS.

HISTORIC RECORDS

ONE HISTORICAL GEOTECHNICAL EXPLORATION WAS PERFORMED WITHIN ONE MILE OF THE PROJECT SITE. BORINGS WERE ADVANCED IN 1968 FOR THE FOUR-LANE SR 32 FROM WILLIAMSBURG TO MT. ORAB, OHIO. THE REPORT MENTIONED RATHER POOR SURFACE DRAINAGE ALONG THE ALIGNMENT AND AN UNDERLYING DENSE GLACIAL TILL. PERCHED WATER WAS OBSERVED IN SOME AREAS, AS WELL AS SMALL PONDS. THE BORINGS FROM THIS EXPLORATION ARE NOT SHOWN ON THE PLANS BECAUSE THEY WERE ADVANCED ALONG CENTERLINE OF SR 32 AND HAVE NO IMPACT ON THE DESIGN OF THE CURRENT PROJECT.

GEOLOGY

THE PROJECT SITE IS LOCATED WITHIN ILLINOIAN REGION OF THE TILL PLAINS. THE ILLINOIAN REGION IS DESCRIBED AS ROLLING GROUND MORAINE OF OLDER TILL GENERALLY LACKING ICE-CONSTRUCTIONAL FEATURES SUCH AS MORAINES, KAMES, AND ESKERS. THE PLAIN CONTAINS MANY BURIED VALLEYS AND POSSESSES MODERN VALLEYS ALTERNATING BETWEEN BROAD FLOODPLAINS AND BEDROCK GORGES. THIS REGION HAS MODERATELY LOW RELIEF (GENERALLY 50 FEET) WITH ELEVATIONS OF 600 TO 1,100 FEET. OVERBURDEN SOILS AT THE PROJECT SITE ARE UNDERLAIN PRIMARILY BY SEDIMENTARY BEDROCK OF THE WAYNESVILLE AND ARNHEIM FORMATIONS, UNDIVIDED GROUP FROM THE ORDOVICIAN AGE.

RECONNAISSANCE

STANTEC REPRESENTATIVES VISITED THE SITE ON JUNE 10, 2020. THE AREA SURROUNDING THE PROJECT SITE CAN BE DESCRIBED AS PRIMARILY AGRICULTURAL WITH SOME AREAS CLASSIFIED AS WETLANDS. THE EXISTING PAVEMENT CONDITION OF SR 32 WAS FAIR, WITH CRACKING OBSERVED PRIMARILY IN PARALLEL AND TRANSVERSE DIRECTION WITH THE ALIGNMENT OF THE ROAD. THE MEDIAN AND AREAS IMMEDIATELY BEYOND THE PAVED SHOULDERS WERE GRASS COVERED. A LINE OF TREES WAS OBSERVED BOTH NORTH AND SOUTH OF SR 32 JUST BEYOND THE SHOULDER DITCH ON THE WESTERN PORTION OF THE PROJECT. THIS TREE LINE IS NOT PRESENT CLOSER TO BROOKS-MALOTT ROAD. AREAS OF PONDED WATER WERE OBSERVED ALONG THE SHOULDER DITCH SOUTH OF SR 32.

SUBSURFACE EXPLORATION

A TOTAL OF 60 BORINGS WERE ADVANCED ON JUNE 16 THROUGH OCTOBER 26, 2020 TO OBTAIN GEOTECHNICAL DATA FOR THE PROPOSED SAFETY IMPROVEMENTS. THESE BORINGS WERE DRILLED WITH A TRACK-MOUNTED DRILL RIG USING 2.25-INCH I.D. HOLLOW-STEM AUGERS. DISTURBED SOIL SAMPLES WERE OBTAINED IN ACCORDANCE WITH THE STANDARD PENETRATION TEST (AASHTO T206) AT VARIOUS INTERVALS TO COLLECT SAMPLES BELOW THE EXISTING GROUND SURFACE. THE AUTOMATIC SAMPLING HAMMER WAS CALIBRATED ON NOVEMBER 26, 2019 AND HAS A DRILL ROD ENERGY RATIO (ER) OF 86.8 PERCENT. UNDISTURBED SHELBY TUBE (ST) SAMPLES WERE OBTAINED AT SELECTED INTERVALS DURING THE EXPLORATION. ROCK CORING WAS PERFORMED IN TWO BORINGS USING NQ2-SIZE EQUIPMENT.

FOUR BORINGS WERE ADVANCED BY CTL ENGINEERING ON MARCH 19 THROUGH MARCH 24, 2015 FOR THE PRELIMINARY SUBSURFACE INVESTIGATION. THESE BORINGS WERE ADVANCED WITH A TRACK-MOUNTED DRILL RIG UTILIZING HOLLOW-STEM AUGERS. SOIL SAMPLES WERE OBTAINED IN ACCORDANCE WITH THE STANDARD PENETRATION TEST.

EXPLORATION FINDINGS

TOPSOIL WAS OBSERVED WITH THICKNESS RANGING BETWEEN 0.2 AND 1.0 FEET. THE SOILS ENCOUNTERED CONSISTED PRIMARILY OF MEDIUM STIFF TO STIFF WEATHERED GLACIAL TILL CLASSIFYING PRIMARILY AS A-7-6, A-6A, AND A-6B OVERLYING HARD GLACIAL TILL CLASSIFYING AS A-4A AND A-6A. BEDROCK WAS ENCOUNTERED IN BOTH CULVERT BORINGS AND WAS DESCRIBED AS INTERBEDDED LIMESTONE AND SHALE WITH APPROXIMATELY 80% LIMESTONE. BEDROCK WAS NOT ENCOUNTERED ELSE-WHERE ON THE PROJECT. NO STATIC GROUNDWATER WAS ENCOUNTERED DURING THE EXPLORATION. HOWEVER, PERCHED GROUNDWATER CONDITIONS DUE TO SILT LAYERS OR POSSIBLY THIN SAND SEAMS THAT WERE NOT DETECTED IN THE BORINGS WERE OBSERVED AT VARIOUS DEPTHS, WHERE ENCOUNTERED.

CTL BORINGS ENCOUNTERED 3 TO 6 INCHES OF TOPSOIL OVERLYING FILL MATERIAL DESCRIBED AS SILTY CLAY (A-6B) OR CLAY (A-7-6). BELOW THE FILL, SOILS DESCRIBED AS GLACIAL TILL DEPOSITS WERE OBSERVED TO THE END OF THE DRILLED DEPTH.

SPECIFICATIONS

THIS GEOTECHNICAL EXPLORATION WAS PERFORMED IN ACCORDANCE WITH THE STATE OF OHIO, DEPARTMENT OF TRANSPORTATION, OFFICE OF GEOTECHNICAL ENGINEERING, SPECIFICATIONS FOR GEOTECHNICAL EXPLORATIONS, DATED JANUARY 2020.

AVAILABLE INFORMATION

THE SOIL, BEDROCK AND GROUNDWATER INFORMATION COLLECTED FOR THIS SUBSURFCE EXPLORATION THAT CAN BE CONVENIENTLY DISPLAYED ON THE SOIL PROFILE SHEETS HAS BEEN PRESENTED. GEOTECHNICAL REPORTS, IF PREPARED, ARE AVAILABLE FOR REVIEW ON THE OFFICE OF CONTRACT SALES WEBSITE.

LEGEND

DESCRIPTION	ODOT CLASS	CLASSIFIED MECH.	CLASSIFIED VISUAL
SANDY SILT	A-4a	30	54
SILT	A-4b	5	4
SILT AND CLAY	A-6a	39	41
SILTY CLAY	A-6b	26	18
ELASTIC CLAY	A-7-5	1	1
CLAY	A-7-6	60	64
	TOTAL	161	182
INTERBEDDED SHALE AND LIMESTONE	VISUAL		
SOD AND/OR TOPSOIL = X = APPROXIMATE THICKNESS	VISUAL		
PAVEMENT OR BASE = X = APPROXIMATE THICKNESS	VISUAL		

BORING LOCATION - PLAN VIEW

DRIVE SAMPLE AND/OR ROCK CORE BORING PLOTTED TO VERTICAL SCALE ONLY. HORIZONTAL BAR INDICATES A CHANGE IN STRATIGRAPHY.

N_{60} INDICATES STANDARD PENETRATION RESISTANCE NORMALIZED TO 60% DRILL ROD ENERGY RATIO.

X/Y/D" NUMBER OF BLOWS FOR STANDARD PENETRATION TEST (SPT):
X= NUMBER OF BLOWS FOR 6 INCHES (UNCORRECTED).
Y/D"= NUMBER OF BLOWS (UNCORRECTED) FOR D" OF PENETRATION AT REFUSAL.

WC INDICATES WATER CONTENT IN PERCENT.

NP INDICATES A NON-PLASTIC SAMPLE.

SS INDICATES A SPLIT SPOON SAMPLE, STANDARD PENETRATION TEST.

ST INDICATES A SHELBY TUBE SAMPLE.

INDICATES FREE WATER ELEVATION.

INDICATES STATIC WATER ELEVATION.

TR INDICATES THE TOP OF ROCK

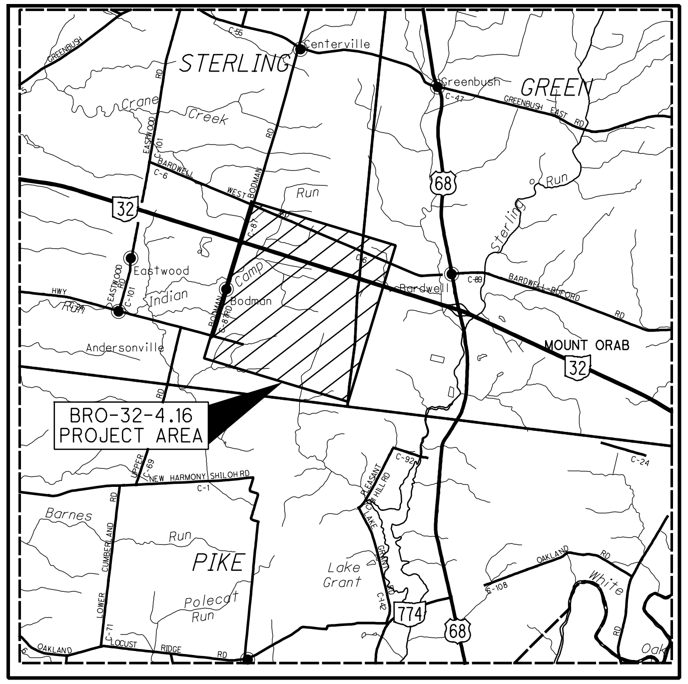
● INDICATES A PLASTIC SOIL WITH WATER CONTENT GREATER THAN LIQUID LIMIT MINUS THREE.

RECON. - JS & MF 06/10/20

DRILLING - CTL/LC 3/15 (CENTRAL STAR)
TS & JS 06/20 - 07/20 & 10/20

DRAWN - MJ 08/20 & 12/20, 03/21 & 7/22

REVIEWED - EK 12/20, 7/22



LOCATION MAP

SCALE IN MILES

0 1 2 3 4

N

PARTICLE SIZE DEFINITIONS

	12"		3"		2.0 mm		0.42 mm		0.074 mm		0.005 mm	
BOULDERS		COBBLES		GRAVEL		COARSE SAND		FINE SAND		SILT		CLAY
					No. 10 SIEVE		No. 40 SIEVE		No. 200 SIEVE			

DESIGN AGENCY

Stantec
11687 Lebanon Road
Cincinnati, Ohio 45241
(513) 842-8200

PID NO. 110478

SOIL PROFILE

BRO-32-4.16

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INDEX OF SHEETS

SUMMARY OF SOIL TEST DATA, SHEETS 3-6

LAB TEST DATA, SHEETS 7-12

LOCATION FROM STA.	TO STA.	PLAN VIEW SHEET	PROFILE SHEET	CROSS SECTION SHEET	CUT MAX	FILL MAX	STRUCTURES INCLUDED BRIDGE NO.	STRUCTURES INCLUDED SFN
BRUCE LUNSFORD WAY								
400+00	413+00	13	13	35	- FT.	28 FT.	N/A	N/A
412+26.46	414+09	14	14	-	- FT.	-	BRO-32-0359	0800084
413+00	427+50	15	15	36	- FT.	28 FT.	N/A	N/A
427+50	430+19	16	16	-	- FT.	<3 FT.	N/A	N/A
HOMAN WAY								
302+00	317+00	17	17	-	- FT.	8 FT.	N/A	N/A
308+71.18	308+93.35	18	18	-	- FT.	-	BRO-000-1111	TBD
317+00	332+00	19	19	-	- FT.	<3 FT.	N/A	N/A
332+00	347+00	20	20	-	- FT.	<3 FT.	N/A	N/A
347+00	361+00	21	21	-	- FT.	<3 FT.	N/A	N/A
361+00	368+00	22	22	-	- FT.	<2 FT.	N/A	N/A
S.R. 32								
168+00	175+00	23	23	-	- FT.	-	N/A	N/A
RAMP NW								
500+00	513+38.58	24	24	-	- FT.	22 FT.	N/A	N/A
RAMP NE								
600+00	614+00	25	25	-	- FT.	22 FT.	N/A	N/A
614+00	618+84.21	26	26	-	- FT.	22 FT.	N/A	N/A
RAMP SW								
700+00	713+00	27	27	-	- FT.	25 FT.	N/A	N/A
713+00	717+31.97	28	28	-	- FT.	25 FT.	N/A	N/A
RAMP SE								
800+00	812+60.87	29	29	-	- FT.	25 FT.	N/A	N/A
S.R. 32								
205+00	215+00	30	30	-	- FT.	-	N/A	N/A
BODMAN ROAD								
13+00	28+00	31	31	-	- FT.	-	N/A	N/A
MERCY BLVD.								
50+00	59+00	32	32	-	- FT.	<2 FT.	N/A	N/A
SHAW DRIVE								
20+00	24+41.40	33	33	-	- FT.	<2 FT.	N/A	N/A
BROOKS MALOTT ROAD								
13+00	28+00	34	34	-	- FT.	-	N/A	N/A

BORING LOGS, SHEETS 37-45

DRAWN MSJ CHECKED EMK

SOIL PROFILE
INDEX OF SHEETS

BRO-32-4.16

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SUMMARY OF SOIL TEST DATA
BODMAN ROAD

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-009-0-20	00.00 - 01.50	SS-1	9	50	-	32	10	14	30	14	40	25	15	17	A-6a (3)	
STA. 24+56, 17' RT.	01.50 - 03.00	SS-2	3	78	0.5	SAME AS SS-3								29	A-7-6 (VISUAL)	453
LATITUDE = 39.050548	03.00 - 04.50	SS-3	7	78	0.5	3	3	13	36	45	47	18	29	22	A-7-6 (17)	
LONGITUDE = -83.963356	04.50 - 06.00	SS-4	10	78	3	SAME AS SS-3								22	A-7-6 (VISUAL)	

SUMMARY OF SOIL TEST DATA
S.R. 32

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-010-0-20	00.00 - 01.50	SS-1	27	67	-	SAME AS SS-2								10	A-6a (VISUAL)	844
STA. 169+90, 65' LT.	01.50 - 03.00	SS-2	20	78	-	5	3	9	56	27	29	18	11	14	A-6a (8)	
LATITUDE = 39.050411	03.00 - 04.50	SS-3	9	78	1.5	4	2	6	47	41	39	24	15	24	A-6a (10)	
LONGITUDE = -83.956299	04.50 - 06.00	SS-4	10	78	2	SAME AS SS-3								20	A-6a (VISUAL)	
B-012-0-20	00.00 - 01.50	SS-1	7	78	1	3	2	8	46	41	46	23	23	17	A-7-6 (14)	
STA. 174+03, 69' LT.	01.50 - 03.00	SS-2	10	78	3	SAME AS SS-1								23	A-7-6 (VISUAL)	<100
LATITUDE = 39.050098	03.00 - 04.50	SS-3	10	78	2	0	2	12	53	33	29	18	11	17	A-6a (8)	
LONGITUDE = -83.954901	04.50 - 06.00	SS-4	6	78	1	SAME AS SS-3								30	A-6a (VISUAL)	

SUMMARY OF SOIL TEST DATA
RAMP NW

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-014-0-20	00.00 - 01.50	SS-1	20	78	-	3	5	14	47	31	29	17	12	14	A-6a (9)	
STA. 500+00, 1' RT.	01.50 - 03.00	SS-2	10	78	1.5	SAME AS SS-1								18	A-6a (VISUAL)	<100
LATITUDE = 39.049741	03.00 - 04.50	SS-3	12	67	1	SAME AS SS-1								24	A-6a (VISUAL)	
LONGITUDE = -83.953232	04.50 - 06.00	SS-4	12	78	1.5	2	3	14	38	43	52	20	32	21	A-7-6 (18)	
B-016-0-20	01.00 - 02.50	SS-1	4	78	0.5	SAME AS SS-3								30	A-7-6 (VISUAL)	3302
STA. 503+00, 1' RT.	03.50 - 05.00	SS-2	13	67	1.5	3	1	10	46	40	38	20	18	25	A-6b (11)	
LATITUDE = 39.04957	06.00 - 07.50	SS-3	13	78	2	2	2	14	31	51	49	25	24	22	A-7-6 (15)	
LONGITUDE = -83.9522	08.50 - 10.00	SS-4	77	78	4.5	SAME AS SS-3								9	A-7-6 (VISUAL)	
B-018-0-20	01.00 - 02.50	SS-1	6	78	0.5	2	2	10	41	45	46	20	26	25	A-7-6 (16)	
STA. 507+00, 1' RT.	03.50 - 05.00	SS-2	12	78	1.5	SAME AS SS-1								24	A-7-6 (VISUAL)	
LATITUDE = 39.049631	06.00 - 07.50	SS-3	13	67	4	6	2	15	33	44	46	17	29	20	A-7-6 (17)	
LONGITUDE = -83.950798	08.50 - 10.00	SS-4	23	78	4	SAME AS SS-3								13	A-7-6 (VISUAL)	
B-020-0-20	01.00 - 02.50	SS-1	7	78	1	SAME AS SS-3								22	A-6b (VISUAL)	
STA. 511+00, CL	03.50 - 05.00	SS-2	13	78	1.5	SAME AS SS-3								25	A-6b (VISUAL)	
LATITUDE = 39.049645	06.00 - 07.50	SS-3	12	78	2	5	3	12	39	41	40	19	21	23	A-6b (12)	
LONGITUDE = -83.949403	08.50 - 10.00	SS-4	13	78	1	5	3	12	39	41	40	19	21	22	A-6b (12)	
	11.00 - 12.50	SS-5	87	78	4.5	SAME AS SS-7								9	A-4a (VISUAL)	
	13.50 - 15.00	SS-6	22/50/5"	82	4.5	SAME AS SS-7								10	A-4a (VISUAL)	
	16.00 - 17.50	SS-7	124	78	4.5	13	5	8	48	26	24	16	8	9	A-4a (8)	
	18.50 - 20.00	SS-8	75	78	4	13	5	8	48	26	24	16	8	13	A-4a (8)	

SUMMARY OF SOIL TEST DATA
RAMP SW

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-011-0-20	00.00 - 01.50	SS-1	14	78	-	10	7	13	37	33	33	16	17	10	A-6b (10)	
STA. 700+00, 1' RT.	01.50 - 03.00	SS-2	6	78	1	SAME AS SS-4								23	A-7-6 (VISUAL)	1020
LATITUDE = 39.04972	03.00 - 04.50	SS-3	7	78	2	SAME AS SS-4								22	A-7-6 (VISUAL)	
LONGITUDE = -83.954929	04.50 - 06.00	SS-4	7	78	0.5	0	1	7	39	53	48	28	20	24	A-7-6 (14)	
B-013-0-20	00.00 - 01.50	SS-1	12	78	3	SAME AS SS-2								13	A-6a (VISUAL)	<100
STA. 704+00, 1' RT.	01.50 - 03.00	SS-2	14	78	2	7	5	16	41	31	31	19	12	15	A-6a (8)	
LATITUDE = 39.049405	03.00 - 04.50	SS-3	14	78	-	0	3	12	55	30	27	20	7	17	A-4b (8)	
LONGITUDE = -83.953579	04.50 - 06.00	SS-4	14	78	1.5	SAME AS SS-3								16	A-4b (VISUAL)	
B-015-0-20	01.00 - 02.50	SS-1	6	78	4.5	SAME AS SS-2								22	A-7-6 (VISUAL)	295
STA. 707+50, 1' RT.	03.50 - 05.00	SS-2	16	78	4.5	0	2	16	36	46	46	23	23	21	A-7-6 (14)	
LATITUDE = 39.049067	06.00 - 07.50	SS-3	16	78	3	13	2	12	25	48	54	21	33	24	A-7-6 (18)	
LONGITUDE = -83.952426	08.50 - 10.00	SS-4	41	78	4.5	SAME AS SS-3								11	A-7-6 (VISUAL)	

SUMMARY OF SOIL TEST DATA
RAMP SW (CONTINUED)

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-017-0-20	01.00 - 02.50	SS-1	7	56	1.25	SAME AS SS-2								31	A-7-6 (VISUAL)	220
STA. 712+00, 2' RT.	03.50 - 05.00	SS-2	17	94	2.25	12	3	14	29	42	56	29	27	22	A-7-6 (17)	
LATITUDE = 39.048422	06.00 - 07.50	SS-3	13	100	1	SAME AS SS-2								23	A-7-6 (VISUAL)	
LONGITUDE = -83.951085	08.50 - 10.00	SS-4	16	100	-	11	6	17	39	27	33	19	14	22	A-6a (8)	
B-019-0-20	01.00 - 02.50	SS-1	7	83	1.25	SAME AS SS-3								25	A-7-6 (VISUAL)	
STA. 715+50, CL	03.50 - 05.00	SS-2	16	94	2.25	SAME AS SS-3								24	A-7-6 (VISUAL)	
LATITUDE = 39.04787	06.00 - 07.50	SS-3	12	94	1.75	10	3	16	30	41	49	26	23	22	A-7-6 (14)	
LONGITUDE = -83.950085	08.50 - 10.00	SS-4	22	100	1.75	11	12	21	36	20	30	17	13	17	A-6a (5)	
	11.00 - 12.50	SS-5	94	100	4.5	SAME AS SS-7								9	A-4a (VISUAL)	
	13.50 - 15.00	SS-6	127	100	4.5	SAME AS SS-7								8	A-4a (VISUAL)	
	16.00 - 17.50	SS-7	85	100	4.5	14	13	18	31	24	25	15	10	8	A-4a (4)	
	18.50 - 20.00	SS-8	101	100	4.5	SAME AS SS-7								8	A-4a (VISUAL)	

SUMMARY OF SOIL TEST DATA
RAMP SE

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-021-0-20	01.00 - 02.50	SS-1	7	89	1.25	SAME AS SS-2								24	A-7-6 (VISUAL)	
STA. 802+00, CL	03.50 - 05.00	SS-2	7	89	1	4	2	11	44	39	47	20	27	31	A-7-6 (16)	
LATITUDE = 39.049311	06.00 - 07.50	SS-3	13	83	3	6	5	19	31	39	39	18	21	15	A-6b (11)	
LONGITUDE = -83.94829	08.50 - 10.00	SS-4	32	83	4.5	SAME AS SS-5								11	A-6a (VISUAL)	
	11.00 - 12.50	SS-5	84	100	4	17	11	18	31	23	25	14	11	8	A-6a (4)	
	13.50 - 15.00	SS-6	65	100	4.5	SAME AS SS-5								9	A-6a (VISUAL)	
	16.00 - 17.50	SS-7	72	100	4.5	SAME AS SS-5								8	A-6a (VISUAL)	
	18.50 - 20.00	SS-8	85	100	4.5	SAME AS SS-5								8	A-6a (VISUAL)	
B-023-0-20	01.00 - 02.50	SS-1	9	83	1.5	SAME AS SS-2								19	A-7-6 (VISUAL)	391
STA. 806+00, 1' RT.	03.50 - 05.00	SS-2	9	67	3	3	3	13	37	44	50	21	29	21	A-7-6 (18)	
LATITUDE = 39.048636	06.00 - 07.50	SS-3	35	100	4.5	SAME AS SS-2								15	A-7-6 (VISUAL)	
LONGITUDE = -83.946764	08.50 - 10.00	SS-4	67	100	4.5	14	12	18	36	20	26	14	12	10	A-6a (5)	
B-025-0-20	01.00 - 02.50	SS-1	9	78	1.5	SAME AS SS-2								25	A-7-6 (VISUAL)	133
STA. 810+50, 1' RT.	03.50 - 05.00	SS-2	17	78	2	3	5	16	27	49	51	28	23	18	A-7-6 (15)	
LATITUDE = 39.047497	06.00 - 07.50	SS-3	41	78	4.5	11	9	21	32	27	28	17	11	12	A-6a (5)	
LONGITUDE = -83.947445	08.50 - 10.00	SS-4	78	78	4.5	SAME AS SS-3								8	A-6a (VISUAL)	
B-027-0-20	00.00 - 01.50	SS-1	12	78	-	SAME AS SS-2								15	A-4b (VISUAL)	<100
STA. 812+50, 1' RT.	01.50 - 03.00	SS-2	7	78	1	1	3	15	54	27	25	17	8	19	A-4b (8)	
LATITUDE = 39.047559	03.00 - 04.50	SS-3	12	78	2	1	3	12	51	33	31	19	12	19	A-6a (9)	
LONGITUDE = -83.945872	04.50 - 06.00	SS-4	12	78	2.5	SAME AS SS-3								29	A-6a (VISUAL)	

SUMMARY OF SOIL TEST DATA
S.R. 32

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-029-0-20	00.00 - 01.50	SS-1	13	78	4	SAME AS SS-2								15	A-6a (VISUAL)	<100
STA. 206+72, 68' RT.	01.50 - 03.00	SS-2	9	78	2	0	3	11	58	28	30	18	12	20	A-6a (9)	
LATITUDE = 39.047193	03.00 - 04.50	SS-3	10	78	2.25	SAME AS SS-2								19	A-6a (VISUAL)	
LONGITUDE = -83.944002	04.50 - 06.00	SS-4	7	78	0	3	3	8	45	41	40	24	16	31	A-6b (10)	
B-031-0-20	00.00 - 01.50	SS-1	23	78	4.5	SAME AS SS-2								11	A-6b (VISUAL)	<100
STA 213+03, 73' RT.	01.50 - 03.00	SS-2	10	78	1.5	2	6	16	42	34	34	18	16	16	A-6b (10)	
LATITUDE = 39.046688	03.00 - 04.50	SS-3	20	78	2	SAME AS SS-2								16	A-6b (VISUAL)	
LONGITUDE = -83.941876	04.50 - 06.00	SS-4	10	78	1	0	1	7	55	37	48	19	29	30	A-7-6 (17)	

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CHECKED EMK

SOIL PROFILE
SUMMARY OF SOIL TEST DATA

BRO-32-4.16

SUMMARY OF SOIL TEST DATA
RAMP NE

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-022-0-20	01.00 - 02.50	SS-1	6	78	1.75	1	3	11	42	43	44	26	18	18	A-7-6 (12)	
STA. 601+00, CL	03.50 - 05.00	SS-2	9	67	1	1	3	11	42	43	44	26	18	31	A-7-6 (12)	
LATITUDE = 39.047487	06.00 - 07.50	SS-3	14	78	2.25	SAME AS SS-2								19	A-7-6 (VISUAL)	
LONGITUDE = -83.948834	08.50 - 10.00	SS-4	71	100	4.5	SAME AS SS-6								9	A-4a (VISUAL)	
	11.00 - 12.50	SS-5	75	78	4.5	SAME AS SS-6								9	A-4a (VISUAL)	
	13.50 - 15.00	SS-6	104	100	4.5	12	12	19	35	22	24	14	10	7	A-4a (4)	
	16.00 - 17.50	SS-7	59	100	4.5	12	12	19	35	22	24	14	10	9	A-4a (4)	
	18.50 - 20.00	SS-8	30/50/5"	82	4.5	SAME AS SS-7								8	A-4a (VISUAL)	
B-024-0-20	01.00 - 02.50	SS-1	6	100	3	1	3	12	58	26	32	19	13	23	A-6a (9)	
STA. 606+00, 15' LT.	03.50 - 05.00	SS-2	13	100	3	SAME AS SS-1								24	A-6a (VISUAL)	250
LATITUDE = 39.047335	06.00 - 07.50	SS-3	12	100	4	3	4	19	36	38	37	20	17	19	A-6b (11)	
LONGITUDE = -83.945662	08.50 - 10.00	SS-4	67	100	4.5	SAME AS SS-3								10	A-6b (VISUAL)	
B-026-0-20	01.00 - 02.50	SS-1	4	78	3.5	SAME AS SS-2								24	A-7-6 (VISUAL)	
STA. 611+06, 17' LT.	03.50 - 05.00	SS-2	10	78	1.5	2	3	13	28	54	58	23	35	28	A-7-6 (20)	
LATITUDE = 39.047975	06.00 - 07.50	SS-3	14	78	1.5	2	3	14	32	49	55	26	29	20	A-7-6 (19)	
LONGITUDE = -83.945222	08.50 - 10.00	SS-4	46	78	4.5	SAME AS B-022-0-20 SS-6								10	A-4a (VISUAL)	
B-028-0-20	00.00 - 01.50	SS-1	17	67	4	SAME AS SS-2								15	A-4b (VISUAL)	<100
STA. 613+56, 4' LT.	01.50 - 03.00	SS-2	20	78	4.5	1	3	17	53	26	26	16	10	16	A-4b (8)	
LATITUDE = 39.047705	03.00 - 04.50	SS-3	10	78	2	0	2	11	50	37	38	18	20	20	A-6b (12)	
LONGITUDE = -83.944413	04.50 - 06.00	SS-4	13	78	1	SAME AS SS-3								19	A-6b (VISUAL)	
B-030-0-20	00.00 - 01.50	SS-1	14	78	4.5	13	6	13	34	34	35	16	19	13	A-6b (10)	
STA. 617+06, 1' RT.	01.50 - 03.00	SS-2	16	78	2	SAME AS SS-1								18	A-6b (VISUAL)	1273
LATITUDE = 39.047398	03.00 - 04.50	SS-3	12	67	3	1	3	11	53	32	29	17	12	18	A-6a (9)	
LONGITUDE = -83.943246	04.50 - 06.00	SS-4	13	78	3.5	SAME AS SS-3								22	A-6a (VISUAL)	

SUMMARY OF SOIL TEST DATA
BROOKS MALOTT ROAD

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-032-0-20	00.00 - 01.50	SS-1	13	78	3	SAME AS SS-2								18	A-6b (VISUAL)	660
STA 14+02, 29' LT.	01.50 - 03.00	SS-2	9	78	1.5	0	2	13	48	37	38	17	21	20	A-6b (12)	
LATITUDE = 39.047922	03.00 - 04.50	SS-3	9	78	1.5	2	4	20	30	44	51	19	32	25	A-7-6 (18)	
LONGITUDE = -83.938896	04.50 - 06.00	SS-4	16	78	2	SAME AS SS-3								22	A-7-6 (VISUAL)	
B-035-0-20	00.00 - 01.50	SS-1	10	78	4	17	5	14	38	26	37	24	13	11	A-6a (7)	
STA. 20+75, 41' LT.	01.50 - 03.00	SS-2	13	78	2	SAME AS SS-1								21	A-6a (VISUAL)	<100
LATITUDE = 39.046135	03.00 - 04.50	SS-3	14	78	1.5	17	3	11	45	24	38	25	13	22	A-6a (8)	
LONGITUDE = -83.939492	04.50 - 06.00	SS-4	6	78	1	SAME AS SS-3								26	A-6a (VISUAL)	

SUMMARY OF SOIL TEST DATA
HOMAN WAY

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-037-0-20	01.00 - 02.50	SS-1	6	78	-	9	4	13	41	33	29	17	12	18	A-6a (9)	
STA. 303+68, CL	03.50 - 05.00	SS-2	7	67	1	SAME AS SS-1								28	A-6a (VISUAL)	
LATITUDE = 39.048084	06.00 - 07.50	SS-3	12	78	2.5	SAME AS SS-1								23	A-6a (VISUAL)	
LONGITUDE = -83.964131	08.50 - 10.00	SS-4	54	78	4.5	8	12	19	35	26	25	15	10	9	A-4a (5)	
B-039-0-20	01.00 - 02.50	SS-1	7	56	2.5	SAME AS SS-2								23	A-6a (VISUAL)	380
STA. 311+25, CL	03.50 - 05.00	SS-2	30	100	2.5	8	12	19	36	25	29	16	13	17	A-6a (6)	
LATITUDE = 39.047539	06.00 - 07.50	SS-3	84	100	4.5	SAME AS SS-4								8	A-4a (VISUAL)	
LONGITUDE = -83.961524	08.50 - 10.00	SS-4	93	100	4.5	12	10	18	37	23	27	17	10	9	A-4a (5)	
B-040-0-20	01.00 - 02.50	SS-1	9	89	2	SAME AS SS-2								23	A-7-6 (VISUAL)	240
STA. 315+15, 10' LT.	03.50 - 05.00	SS-2	16	100	2	6	3	14	37	40	45	20	25	22	A-7-6 (15)	
LATITUDE = 39.047326	06.00 - 07.50	SS-3	41	100	4	12	11	18	34	25	27	15	12	11	A-6a (5)	
LONGITUDE = -83.960214	08.50 - 10.00	SS-4	69	100	4.5	SAME AS SS-3								12	A-6a (VISUAL)	

SUMMARY OF SOIL TEST DATA
HOMAN WAY (CONTINUED)

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-041-0-20	01.00 - 02.50	SS-1	9	89	1.5	SAME AS SS-1								21	A-7-6 (VISUAL)	210
STA. 318+95, 20' LT.	03.50 - 05.00	SS-2	9	100	2	5	2	12	35	46	47	18	29	25	A-7-6 (17)	
LATITUDE = 39.04718	06.00 - 07.50	SS-3	16	100	3	4	4	18	30	44	48	25	23	19	A-7-6 (15)	
LONGITUDE = -83.958889	08.50 - 10.00	SS-4	20/20/50/3"		4.5	SAME AS B-039-0-20 SS-4								11	A-4a (VISUAL)	
B-042-0-20	01.00 - 02.50	SS-1	6	89	0.5	SAME AS SS-2								26	A-7-6 (VISUAL)	<100
STA. 322.75, 10' LT.	03.50 - 05.00	SS-2	9	89	2.5	5	3	15	31	46	50	20	30	20	A-7-6 (18)	
LATITUDE = 39.047102	06.00 - 07.50	SS-3	23	100	3.5	SAME AS SS-2								21	A-7-6 (VISUAL)	
LONGITUDE = -83.957555	08.50 - 10.00	SS-4	75	100	4.5	15	11	19	30	25	25	14	11	9	A-6a (4)	
B-043-0-20	01.00 - 02.50	SS-1	7	78	2.5	SAME AS SS-2								23	A-7-6 (VISUAL)	200
STA. 326+55, 10' LT.	03.50 - 05.00	SS-2	23	89	1.25	4	2	13	29	52	60	21	39	29	A-7-6 (20)	
LATITUDE = 39.047008	06.00 - 07.50	SS-3	13	100	1.75	6	7	22	30	35	38	24	14	18	A-6a (8)	
LONGITUDE = -83.956223	08.50 - 10.00	SS-4	61	100	4.5	SAME AS B-039-0-20 SS-4								10	A-4a (VISUAL)	
B-044-0-20	01.00 - 02.50	SS-1	6	89	1.5	SAME AS SS-2								25	A-7-6 (VISUAL)	370
STA. 330+34, 15' LT.	03.50 - 05.00	SS-2	12	100	1.5	9	4	13	28	46	55	20	35	22	A-7-6 (19)	
LATITUDE = 39.046845	06.00 - 07.50	SS-3	12	100	1.25	SAME AS SS-4								24	A-6a (VISUAL)	
LONGITUDE = -83.954902	08.50 - 10.00	SS-4	62	67	4	33	10	16	23	18	26	15	11	8	A-6a (1)	
B-045-0-20	01.00 - 02.50	SS-1	9	100	1	SAME AS SS-2								22	A-7-5 (VISUAL)	170
STA. 334+15, 15' LT.	03.50 - 05.00	SS-2	10	89	0.75	7	3	13	28	49	53	31	22	31	A-7-5 (15)	
LATITUDE = 39.046613	06.00 - 07.50	SS-3	6	89	-	SAME AS SS-4								22	A-6b (VISUAL)	
LONGITUDE = -83.953597	08.50 - 10.00	SS-4	13	100	1.25	4	5	25	26	40	38	20	18	23	A-6b (9)	
B-046-0-20	01.00 - 02.50	SS-1	7	89	2.25	SAME AS SS-3								26	A-7-6 (VISUAL)	240
STA. 337+96, 20' LT.	03.50 - 05.00	SS-2	10	83	1	SAME AS SS-3								24	A-7-6 (VISUAL)	
LATITUDE = 39.046325	06.00 - 07.50	SS-3	12	100	2.25	5	3	14	31	47	51	17	34	23	A-7-6 (18)	
LONGITUDE = -83.952312	08.50 - 10.00	SS-4	27	100	4.5	13	9	19	34	25	29	16	13	15	A-6a (6)	
B-047-0-20	01.00 - 02.50	SS-1	6	67	1.25	SAME AS SS-2								24	A-7-6 (VISUAL)	130
STA. 341+75, 20' LT.	03.50 - 05.00	SS-2	12	83	1	4	4	26	24	42	51	19	32	25	A-7-6 (16)	
LATITUDE = 39.046028	06.00 - 07.50	SS-3	12	89	2	SAME AS SS-4								20	A-7-6 (VISUAL)	
LONGITUDE = -83.951029	08.50 - 10.00	SS-4	9	100	-	13	7	18	30	32	41	22	19	24	A-7-6 (9)	
B-048-0-20	01.00 - 02.50	SS-1	4	100	1.5	SAME AS SS-2								10	A-7-6 (VISUAL)	100
STA. 345+55, CL	03.50 - 05.00	SS-2	10	100	4	0	2	12	34	52	57	24	33	23	A-7-6 (19)	
LATITUDE = 39.045634	06.00 - 07.50	SS-3	13	100	3.5	3	3	17	32	45	44	20	24	21	A-7-6 (14)	
LONGITUDE = -83.95022	08.50 - 10.00	SS-4	14	100	3.5	SAME AS SS-3								20	A-7-6 (VISUAL)	
B-049-0-20	01.00 - 02.50	SS-1	6	100	2.5	0	3	13	54	30	28	17	11	20	A-7-6 (VISUAL)	
STA. 349+35, CL	03.50 - 05.00	SS-2	12	100	3.5	SAME AS SS-4								21	A-7-6 (VISUAL)	290
LATITUDE = 39.045338	06.00 - 07.50	SS-3	14	100	3	SAME AS SS-4								23	A-7-6 (VISUAL)	
LONGITUDE = -83.948937	08.50 - 10.00	SS-4	19	100	3.5	6	5	20	31	38	42	19	23	19	A-7-6 (12)	
B-050-0-20	01.00 - 02.50	SS-1	6	67	2.5	SAME AS SS-2								24	A-7-6 (VISUAL)	100
STA. 353+15, CL	03.50 - 05.00	SS-2	12	83	3.5	1	2	12	40	45	49	22	27	25	A-7-6 (17)	
LATITUDE = 39.04497	06.00 - 07.50	SS-3	12	89	4	SAME AS SS-2								22	A-7-6 (VISUAL)	
LONGITUDE = -83.947694	08.50 - 10.00	SS-4	9	100	1.5	4	5	15	40	36	36	19	17	28	A-6b (11)	

DRAWN MSJ
CHECKED EMK

SOIL PROFILE
SUMMARY OF SOIL TEST DATA

BRO-32-4.16

SUMMARY OF SOIL TEST DATA
HOMAN WAY (CONTINUED)

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-054-0-20	01.00 - 02.50	SS-1	4	67	1.5				SAME AS SS-2					22	A-7-6 (VISUAL)	100
STA. 356+95, CL	03.50 - 05.00	SS-2	12	100	3	3	3	14	40	40	46	17	29	24	A-7-6 (17)	
LATITUDE = 39.044163	06.00 - 07.50	SS-3	16	100	4.5	4	5	19	32	40	43	20	23	17	A-7-6 (13)	
LONGITUDE = -83.946858	08.50 - 10.00	SS-4	55	100	4.5				SAME AS SS-3					11	A-7-6 (VISUAL)	
B-055-0-20	01.00 - 02.50	SS-1	3	67	2	1	2	11	48	38	38	18	20	28	A-6b (12)	
STA. 360+75, CL	03.50 - 05.00	SS-2	7	11	3				SAME AS SS-4					23	A-7-6 (VISUAL)	830
LATITUDE = 39.043309	06.00 - 07.50	SS-3	12	78	3.5				SAME AS SS-4					24	A-7-6 (VISUAL)	
LONGITUDE = -83.946089	08.50 - 10.00	SS-4	13	100	4.5	4	4	17	30	45	46	17	29	24	A-7-6 (17)	
B-056-0-20	01.00 - 02.50	SS-1	7	67	3				SAME AS SS-2					27	A-7-6 (VISUAL)	100
STA. 364+25, CL	03.50 - 05.00	SS-2	12	94	3	3	2	9	40	46	51	24	27	28	A-7-6 (17)	
LATITUDE = 39.042604	06.00 - 07.50	SS-3	7	100	3.5	1	2	14	31	52	53	24	29	24	A-7-6 (18)	
LONGITUDE = -83.945271	08.50 - 10.00	SS-4	14	100	3				SAME AS SS-3					23	A-7-6 (VISUAL)	

SUMMARY OF SOIL TEST DATA
SHAW DRIVE

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-052-0-20	01.00 - 02.50	SS-1	9	67	1.5				SAME AS SS-3					16	A-6a (VISUAL)	518
STA. 22+02, 18' LT.	03.50 - 05.00	SS-2	12	78	2				SAME AS SS-3					17	A-6a (VISUAL)	
LATITUDE = 39.045732	06.00 - 07.50	SS-3	16	78	3.5	8	5	18	31	38	39	24	15	22	A-6a (9)	
LONGITUDE = -83.94442	08.50 - 10.00	SS-4	52	78	4.5	18	9	18	35	20	21	15	6	12	A-4a (4)	

SUMMARY OF SOIL TEST DATA
MERCY BLVD.

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-051-0-20	01.00 - 02.50	SS-1	3	56	1	0	3	9	45	43	50	21	29	25	A-7-6 (18)	
STA. 53+00, CL	03.50 - 05.00	SS-2	14	100	4.5				SAME AS SS-3					22	A-6b (VISUAL)	100
LATITUDE = 39.04497	06.00 - 07.50	SS-3	13	100	3	9	4	14	35	38	40	18	22	21	A-6b (12)	
LONGITUDE = -83.94769	08.50 - 10.00	SS-4	27	100	4.5				SAME AS SS-3					19	A-6b (VISUAL)	
B-053-0-20	01.00 - 02.50	SS-1	9	78	1				SAME AS SS-2					24	A-7-6 (VISUAL)	424
STA. 58+01, 10' RT.	03.50 - 05.00	SS-2	12	78	1.5	6	2	12	40	40	41	24	17	22	A-7-6 (11)	
LATITUDE = 39.0451	06.00 - 07.50	SS-3	14	78	1				SAME AS SS-2					19	A-7-6 (VISUAL)	
LONGITUDE = -83.94409	08.50 - 10.00	SS-4	16	78	1	11	9	21	39	20	25	17	8	14	A-4a (5)	

SUMMARY OF SOIL TEST DATA
BRUCE LUNSFORD WAY

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-057-0-20	01.00 - 02.50	SS-1	4	89	0.5	0	2	11	46	41	38	22	16	25	A-6b (10)	
STA. 407+00, CL	03.50 - 05.00	SS-2	7	33	0.5				SAME AS SS-1					28	A-6b (VISUAL)	
LATITUDE = 39.046972	06.00 - 07.50	SS-3	12	89	1.5				SAME AS SS-4					24	A-7-6 (VISUAL)	
LONGITUDE = -83.94985	08.50 - 10.00	SS-4	12	100	1.25	5	3	15	33	44	44	17	27	23	A-7-6 (16)	
	11.00 - 12.50	SS-5	51	100	4.5				SAME AS SS-6					11	A-4a (VISUAL)	
	13.50 - 15.00	SS-6	49	100	4.5	17	10	18	28	27	23	13	10	12	A-4a (4)	
	16.00 - 17.42	SS-7	10/14/50/5"	100	4.5				SAME AS SS-6					11	A-4a (VISUAL)	
	18.50 - 20.00	SS-8	69	100	4.5				SAME AS SS-6					11	A-4a (VISUAL)	
B-058-0-20	01.00 - 02.50	SS-1	6	89	0.75				SAME AS SS-2					30	A-7-6 (VISUAL)	
STA. 411+75, 108' LT.	03.50 - 05.00	SS-2	12	83	2	7	1	9	42	41	64	22	42	28	A-7-6 (20)	
LATITUDE = 39.048294	05.50 - 07.50	ST-1	ST	67	2				SAME AS SS-2					22	A-7-6 (VISUAL)	
LONGITUDE = -83.949592	08.50 - 10.00	SS-3	42	100	4.5				SAME AS SS-6					-	A-4a (VISUAL)	
	11.00 - 12.50	SS-4	82	100	4.5				SAME AS SS-6					9	A-4a (VISUAL)	
	13.50 - 15.00	SS-5	114	100	4.5	16	11	18	29	26	24	14	10	8	A-4a (4)	
	16.00 - 17.50	SS-6	78	100	4.5				SAME AS SS-6					8	A-4a (VISUAL)	
	18.50 - 20.00	SS-7	68	100	4.5	4	3	13	62	18	NP	NP	NP	19	A-4b (8)	
	23.50 - 23.67	SS-8	50/2"	100	4.5				SAME AS SS-7					12	A-4b (VISUAL)	
	28.50 - 30.00	SS-9	116	100	4.5	12	10	18	31	29	24	13	11	10	A-6a (5)	

SUMMARY OF SOIL TEST DATA
BRUCE LUNSFORD WAY (CONTINUED)

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-058-1-20	01.00 - 02.50	SS-1	6	83	1.25				SAME AS SS-2					28	A-7-6 (VISUAL)	
STA. 411+75, CL	03.50 - 05.00	SS-2	13	100	1.25	5	2	15	37	41	52	28	24	27	A-7-6 (16)	
LATITUDE = 39.048185	06.00 - 07.50	SS-3	13	100	1.5	2	3	18	37	40	52	18	34	20	A-7-6 (18)	
LONGITUDE = -83.949238	08.50 - 10.00	ST-1	ST	100	1.5				SAME AS SS-6					21	A-6a (VISUAL)	
	11.00 - 12.50	SS-4	77	100	4.5				SAME AS SS-6					9	A-6a (VISUAL)	
	13.50 - 15.00	SS-5	82	100	4.5				SAME AS SS-6					10	A-6a (VISUAL)	
	16.00 - 17.50	SS-6	113	100	4.5	16	10	16	37	21	24	13	11	8	A-6a (5)	
	18.50 - 20.00	SS-7	104	100	4.5				SAME AS SS-8					14	A-4a (VISUAL)	
	23.50 - 25.00	SS-8	98	100	4.5	14	8	17	40	21	23	14	9	8	A-4a (5)	
	28.50 - 30.00	SS-9	113	100	4.5				SAME AS SS-8					9	A-4a (VISUAL)	
B-058-2-20	01.00 - 02.50	SS-1	9	78	1	2	2	8	45	43	50	28	22	42	A-7-6 (15)	
STA. 411+75, 104' RT.	04.00 - 06.00	ST-1	ST	100	-				SAME AS SS-1					26	A-7-6 (VISUAL)	
LATITUDE = 39.048081	06.00 - 07.50	SS-2	10	78	1.5	10	2	11	29	48	60	24	36	24	A-7-6 (20)	
LONGITUDE = -83.948898	08.50 - 10.00	SS-3	13	78	2				SAME AS SS-2					23	A-7-6 (VISUAL)	
	11.50 - 12.00	ST-2	ST	100	-				SAME AS SS-2					20	A-7-6 (VISUAL)	
	12.00 - 12.75	SS-4	18/50/3"	56	4.5				SAME AS SS-5					12	A-6a (VISUAL)	
	13.50 - 14.92	SS-5	32/40/50/5"	100	4.5	23	11	17	30	19	26	15	11	10	A-6a (3)	
	16.00 -17.50	SS-6	81	100	4.5				SAME AS SS-5					13	A-6a (VISUAL)	
	18.50 - 20.00	SS-7	98	100	4.5				SAME AS SS-5					10	A-6a (VISUAL)	
	23.50 - 23.92	SS-8	50/5"	100	4.5				SAME AS SS-9					12	A-6a (VISUAL)	
	28.50 - 30.00	SS-9	95	100	4.5	17	8	17	35	23	25	14	11	9	A-6a (5)	
B-059-0-20	01.00 - 02.50	SS-1	7	78	1.5	5	3	13	46	33	33	16	17	22	A-6b (11)	
STA. 414+59, 101' LT.	03.50 - 05.00	SS-2	14	78	2.5	5	3	13	46	33	33	16	17	20	A-6b (11)	
LATITUDE = 39.049013	06.50 - 08.50	ST-1	ST	100	-				SAME AS SS-2					21	A-6b (VISUAL)	
LONGITUDE = -83.9492	08.50 - 10.00	SS-3	36	78	2.25	6	4	23	52	15	20	13	7	15	A-4b (6)	
	11.00 - 12.33	SS-4	23/40/50/4"	88	4.5	14	11	19	34	22	23	14	9	7	A-4a (4)	
	13.50 - 15.00	SS-5	114	78	4.5	14	11	19	34	22	23	14	9	8	A-4a (4)	
	16.00 - 17.08	SS-6	18/19/50/1"	92	4.5				SAME AS SS-5					8	A-4a (VISUAL)	
	18.50 - 18.92	SS-7	50/5"	100	4.5				SAME AS SS-5					8	A-4a (VISUAL)	
	23.50 - 25.00	SS-8	145	78	4.5				SAME AS SS-5					9	A-4a (VISUAL)	
	28.50 - 29.92	SS-9	27/40/50/5"	82	4.5				SAME AS SS-5					8	A-4a (VISUAL)	
B-059-1-20	01.00 - 02.50	SS-1	4	67	1.5	2	3	13	38	44	47	25	22	23	A-7-6 (14)	
STA. 414+59, CL	04.00 - 06.00	ST-1	ST	77	-				SAME AS SS-1					22	A-7-6 (VISUAL)	
LATITUDE = 39.048912	06.00 - 07.50	SS-2	13	78	2	2	3	13	38	44	47	25	22	20	A-7-6 (14)	
LONGITUDE = -83.948871	08.50 - 10.00	SS-3	25	78	4.5				SAME AS SS-2					16	A-7-6 (VISUAL)	
	11.00 - 12.50	SS-4	65	78	4.5				SAME AS SS-5					13	A-4a (VISUAL)	
	13.50 - 15.00	SS-5	80	78	4.5	30	11	14	25	20	25	15	10	8	A-4a (2)	
	16.00 - 17.50	SS-6	123	78	4.5	30	11	14	25	20	25	15	10	9	A-4a (2)	
	18.50 - 20.00	SS-7	132	78	4.5				SAME AS SS-6					8	A-4a (VISUAL)	
	23.50 - 25.00	SS-8	77	78	4.5				SAME AS SS-6					8	A-4a (VISUAL)	
	28.50 - 30.00	SS-9	87	78	4.5				SAME AS SS-6					11	A-4a (VISUAL)	
B-059-2-20	01.00 - 02.50	SS-1	4	67	1				SAME AS SS-2					25	A-7-6 (VISUAL)	
STA. 414+46, 103' RT.	03.50 - 05.00	SS-2	9	67	0.5	4	3	17	34	42	49	19	30	26	A-7-6 (18)	
LATITUDE = 39.048808	06.00 - 07.50	SS-3	13	78	2	4	3	17	34	42	49	19	30	19	A-7-6 (18)	
LONGITUDE = -83.948534	08.50 - 10.00	SS-4	17	78	1.5				SAME AS SS-3					19	A-7-6 (VISUAL)	
	11.00 - 12.50	SS-5	52	67	4.5	14	11	19	31	25	24	16	8	9	A-4a (4)	
	13.50 - 14.92	SS-6	11/19/50/5"	71	4.5	14	11	19	31	25	24	16	8	9	A-4a (4)	
	16.00 - 17.50	SS-7	65	78	4.5				SAME AS SS-6					9	A-4a (VISUAL)	
	18.50 - 20.00	SS-8	90	78	4.5				SAME AS SS-6					8	A-4a (VISUAL)	
	23.50 - 25.00	SS-9	116	78	4.5				SAME AS SS-6					8	A-4a (VISUAL)	
	28.50 - 30.00	SS-10	98	78	4.5				SAME AS SS-6					8	A-4a (VISUAL)	

DRAWN MSJ
CHECKED EMK

SOIL PROFILE
SUMMARY OF SOIL TEST DATA

BRO-32-4.16

SUMMARY OF SOIL TEST DATA
BRUCE LUNSFORD WAY (CONTINUED)

EXPLORATION ID., STATION & OFFSET	SAMPLE FROM - TO	ID	N60	% REC	tsf HP	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO4
B-060-0-20	01.00 - 02.50	SS-1	6	67	1.25	SAME AS SS-2								26	A-7-6 (VISUAL)	
STA. 420+50, CL	03.50 - 05.00	SS-2	14	78	2.25	5	2	12	34	47	58	23	35	30	A-7-6 (20)	
LATITUDE = 39.050378	06.00 - 07.50	SS-3	16	78	2	5	2	12	34	47	58	23	35	21	A-7-6 (20)	
LONGITUDE = -83.947995	08.50 - 10.00	SS-4	22	78	4.5	15	11	18	34	22	25	15	10	13	A-4a (4)	
	11.00 - 12.50	SS-5	74	78	4.5	15	11	18	34	22	25	15	10	9	A-4a (4)	
	13.50 - 15.00	SS-6	93	78	4.5	SAME AS SS-5								9	A-4a (VISUAL)	
	16.00 - 17.50	SS-7	85	78	4.5	SAME AS SS-5								8	A-4a (VISUAL)	
	18.50 - 20.00	SS-8	135	78	4.5	SAME AS SS-5								8	A-4a (VISUAL)	
B-061-0-20	01.00 - 02.50	SS-1	7	67	1.5	SAME AS SS-2								23	A-7-6 (VISUAL)	<100
STA. 423+50, 1' RT.	03.50 - 05.00	SS-2	10	78	1.75	3	3	13	31	50	66	21	45	27	A-7-6 (20)	
LATITUDE = 39.051138	06.00 - 07.50	SS-3	14	78	2	2	2	15	33	48	56	18	38	19	A-7-6 (19)	
LONGITUDE = -83.947585	08.50 - 10.00	SS-4	12	78	-	SAME AS SS-3								19	A-7-6 (VISUAL)	
B-062-0-20	01.00 - 02.50	SS-1	4	67	1.25	4	1	6	39	50	55	22	33	28	A-7-6 (19)	
STA. 427+00, 2' RT.	03.50 - 05.00	SS-2	12	78	2.25	SAME AS SS-1								24	A-7-6 (VISUAL)	
LATITUDE = 39.052027	06.00 - 07.50	SS-3	13	67	1.5	SAME AS SS-4								22	A-7-6 (VISUAL)	
LONGITUDE = -83.947117	08.50 - 10.00	SS-4	13	78	1.5	5	3	17	34	41	45	19	26	21	A-7-6 (15)	
B-063-0-20	01.00 - 02.50	SS-1	4	67	1	SAME AS SS-2								26	A-7-6 (VISUAL)	<100
STA. 430+07, 2' RT.	03.50 - 05.00	SS-2	13	78	2	12	2	11	30	45	54	23	31	24	A-7-6 (19)	
LATITUDE = 39.052807	06.00 - 07.50	SS-3	13	78	2	7	2	16	34	41	55	26	29	21	A-7-6 (18)	
LONGITUDE = -83.946706	08.50 - 10.00	SS-4	17	78	2.25	SAME AS SS-3								21	A-7-6 (VISUAL)	

SOIL PROFILE
SUMMARY OF SOIL TEST DATA

BRO-32-4.16

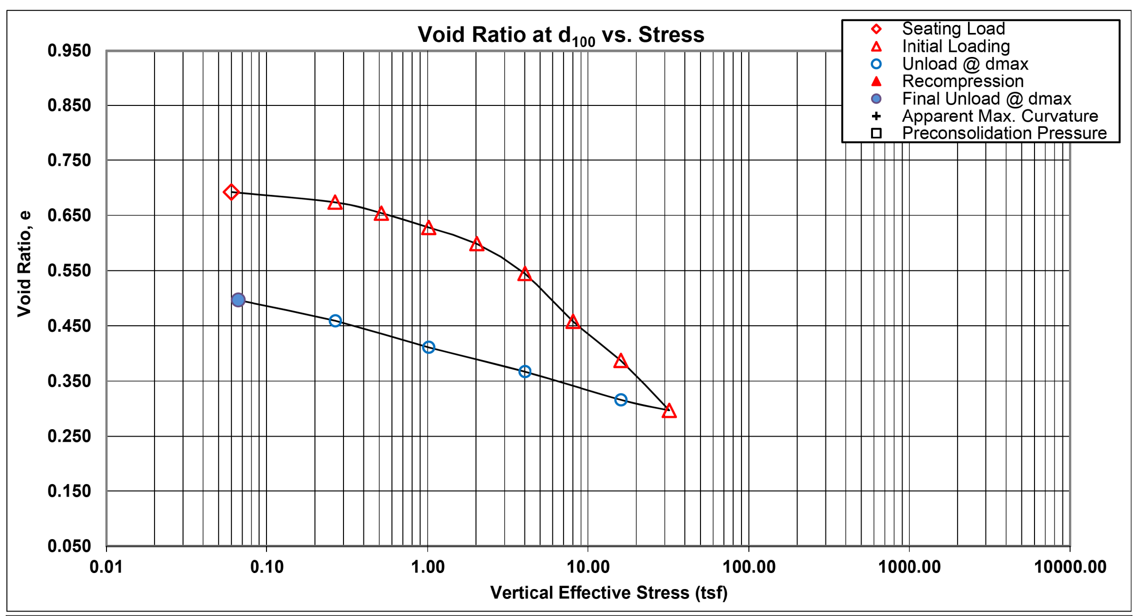
DRAWN MSJ
CHECKED EMK

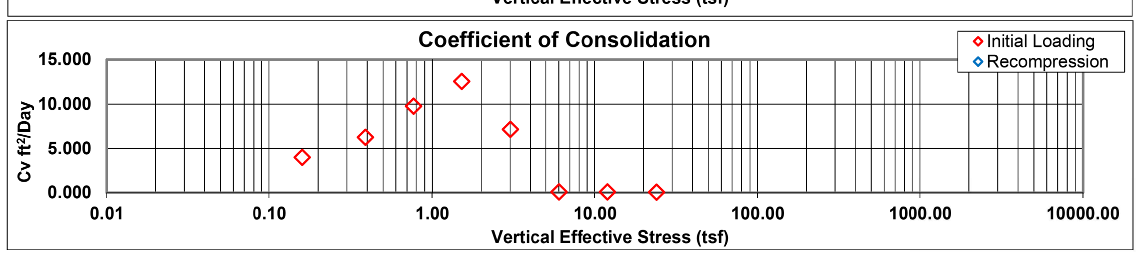
One Dimensional Consolidation of Soils Using Incremental Loading
ASTM D 2435

Project Name	BRO-32-4.16	Project No.	173620122
Source	B-058-1-20, 8.8'-9.0'	Lab ID	202A
Description	Silt and Clay (A-6a), brown, stiff, damp	Date Received	07/17/2020
Specimen Type	Undisturbed		

LL	N/A	Specific Gravity	2.7 ASTM D 854, Dry	Prepared	Using Cutting Ring
PL	N/A			Test Method	B - for 60 min.
PI	N/A			Test Condition	Inundated at 0.05 tsf

Initial Specimen Conditions		Final Specimen Conditions	
Moisture Content (%)	21.8	Moisture Content (%)	20.9
Dry Unit Weight (pcf)	99.4	Dry Unit Weight (pcf)	112.4
Void Ratio	0.692	Void Ratio	0.497
Degree of Saturation (%)	85.0	Degree of Saturation (%)	113.4
Initial Specimen Height (in)	0.9989	Final Specimen Height (in)	0.8835
Equivalent Height of Solids (in)	0.590	Preconsolidation Pressure* (tsf)	
		Void Ratio @ Preconsolidation Pressure	





Comments Classification from SS-6 (16.0' - 17.5'):
LL = 24, PL = 13, PI = 11
%GR - 16, %CS - 10, %FS - 16, %SI - 37, %CL - 21

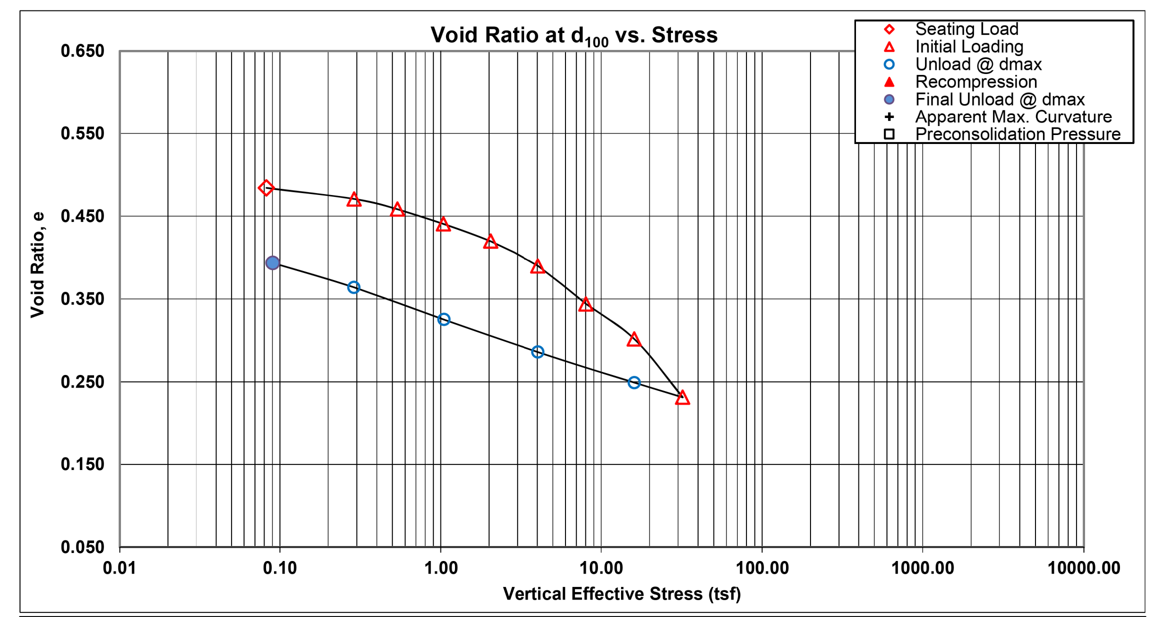
Reviewed By KG

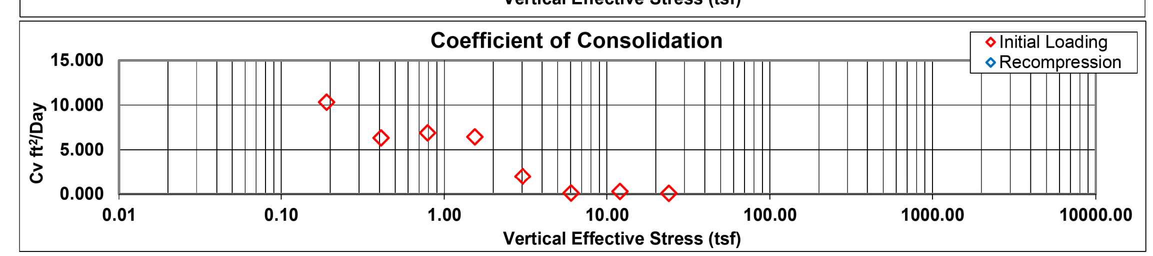
One Dimensional Consolidation of Soils Using Incremental Loading
ASTM D 2435

Project Name	BRO-32-4.16	Project No.	173620122
Source	B-059-0-20, 8.1'-8.2'	Lab ID	199
Description	Silt (A-4b), brown, hard, moist	Date Received	07/01/2020
Specimen Type	Undisturbed		

LL	N/A	Specific Gravity	2.64 ASTM D 854, Dry	Prepared	Using Cutting Ring
PL	N/A			Test Method	B - for 45 min.
PI	N/A			Test Condition	Inundated at 0.05 tsf

Initial Specimen Conditions		Final Specimen Conditions	
Moisture Content (%)	17.4	Moisture Content (%)	17.1
Dry Unit Weight (pcf)	110.8	Dry Unit Weight (pcf)	118.0
Void Ratio	0.484	Void Ratio	0.394
Degree of Saturation (%)	95.1	Degree of Saturation (%)	114.5
Initial Specimen Height (in)	0.9997	Final Specimen Height (in)	0.9386
Equivalent Height of Solids (in)	0.673	Preconsolidation Pressure* (tsf)	
		Void Ratio @ Preconsolidation Pressure	





Comments Classification from SS-3 (8.5' - 10.0'):
LL = 20, PL = 13, PI = 7
%GR - 6, %CS - 4, %FS - 23, %SI - 52, %CL - 15

Reviewed By KG

SUBSURFACE EXPLORATION
CONSOLIDATION TEST DATA RESULTS

BRO-32-4.16

DRAWN MSJ CHECKED EMK

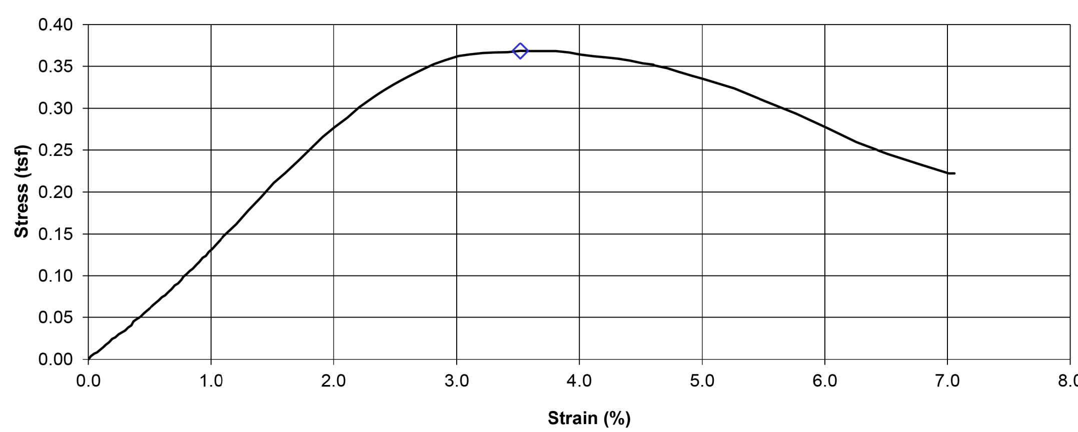
Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project Name BRO-32-4.16 | Project Number 173620122
Source B-001-0-20, 11.0'-13.0' | Lab ID 198A
Visual Description Silt and Clay (A-6a), brownish gray, medium stiff, moist
Recovered 1.8'
Test Interval 11.0' - 11.5'

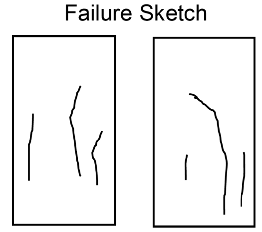
Specimen Type: Undisturbed | LL N/A | PL N/A | PI N/A
Date Extruded 07/15/2020
Date Tested 07/21/2020

Initial Wet Density (pcf)	129.4		
Initial Moisture Content (%)	23.0	Initial MC Taken	Before Test, From Trimmings
Initial Dry Density (pcf)	105.3		
At Test Moisture Content (%)	N/A	At Test MC Taken	N/A
At Test Dry Density (pcf)	N/A		
Specific Gravity	N/A		
Degree of Saturation (%)	N/A	Unconfined Compressive Strength (tsf)	0.37
Average Height (in)	6.003	Undrained Shear Strength (tsf)	0.18
Average Diameter (in)	2.832	Strain at Maximum Stress (%)	3.5
Height to Diameter Ratio	2.1	Strain rate to failure (% / min.)	1.00

Stress vs. Strain



Failure Sketch



Pocket Penetrometer Reading (tsf) N/A
Torvane Reading (kg/cm^2) N/A

Comments
198A - 11.0'-11.6' - UW
198B - 11.6'-12.2' - rough cut
198C - 12.2'-12.8' - rough cut
Classification from SS-2 (3.5' - 5.0'):
LL = 36, PL = 22, PI = 14
%GR - 4, %CS - 2, %FS - 11, %SI - 45, %CL - 38

Reviewed By RJ

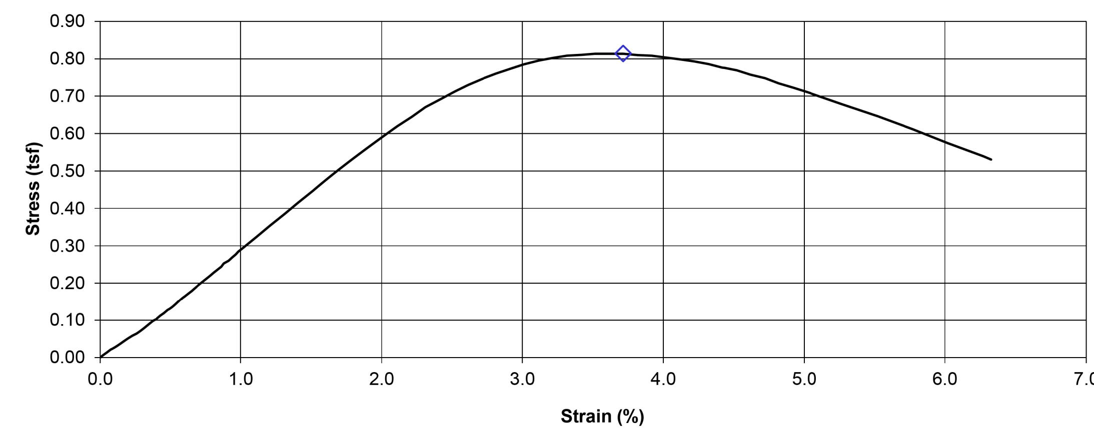
Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project Name BRO-32-4.16 | Project Number 173620122
Source B-003-0-20, 4.0'-6.0' | Lab ID 195A
Visual Description Silty Clay (A-6a), brown, stiff, moist
Recovered 1.8'
Test Interval 4.0' - 4.5'

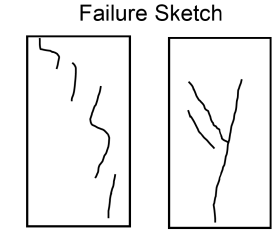
Specimen Type: Undisturbed | LL N/A | PL N/A | PI N/A
Date Extruded 07/14/2020
Date Tested 07/21/2020

Initial Wet Density (pcf)	126.0		
Initial Moisture Content (%)	20.7	Initial MC Taken	Before Test, From Trimmings
Initial Dry Density (pcf)	104.4		
At Test Moisture Content (%)	N/A	At Test MC Taken	N/A
At Test Dry Density (pcf)	N/A		
Specific Gravity	N/A		
Degree of Saturation (%)	N/A	Unconfined Compressive Strength (tsf)	0.81
Average Height (in)	6.067	Undrained Shear Strength (tsf)	0.41
Average Diameter (in)	2.866	Strain at Maximum Stress (%)	3.7
Height to Diameter Ratio	2.1	Strain rate to failure (% / min.)	1.00

Stress vs. Strain



Failure Sketch



Pocket Penetrometer Reading (tsf) N/A
Torvane Reading (kg/cm^2) N/A

Comments
195A - 4.0'-4.6' - UW
195B - 4.6'-5.2' - rough cut
195C - 5.2'-5.8' - rough cut
Classification from SS-2 (6.0' - 7.5'):
LL = 39, PL = 21, PI = 18
%GR - 5, %CS - 4, %FS - 12, %SI - 37, %CL - 42

Reviewed By RJ

DRAWN MSJ
CHECKED EMK

SUBSURFACE EXPLORATION COMPRESSIVE STRENGTH TEST DATA RESULTS

BRO-32-4.16

Unconfined Compressive Strength of Cohesive Soil

ASTM D 2166

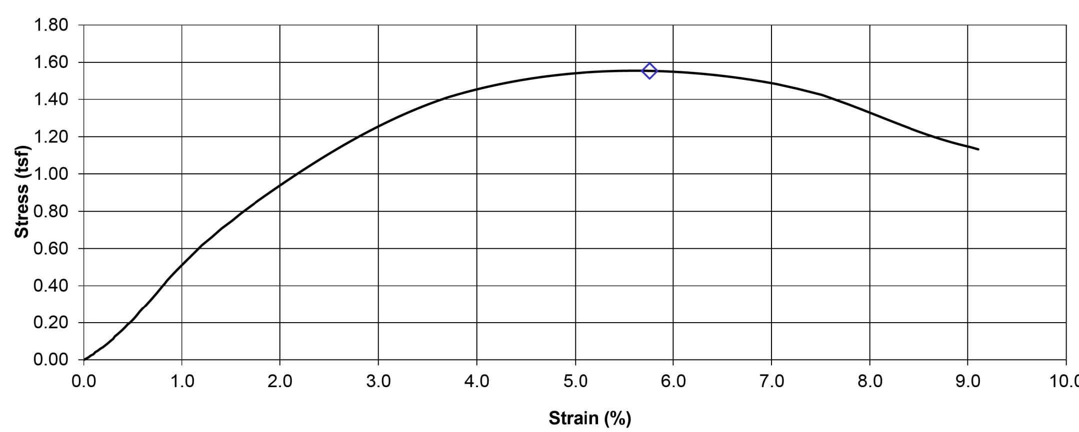
Project Name	BRO-32-4.16	Project Number	173620122
Source	B-003-0-20, 9.0'-11.0'	Lab ID	196A
Visual Description	Silty Clay (A-6b), brown, stiff, moist		
		Recovered	1.2'
		Test Interval	9.1' - 9.6'

Specimen Type: Undisturbed LL N/A PL N/A PI N/A

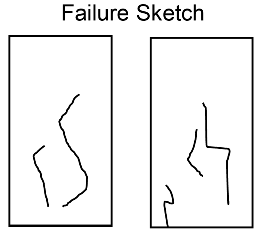
Date Extruded 07/14/2020
Date Tested 07/21/2020

Initial Wet Density (pcf)	131.6		
Initial Moisture Content (%)	19.2	Initial MC Taken	Before Test, From Trimmings
Initial Dry Density (pcf)	110.3		
At Test Moisture Content (%)	N/A	At Test MC Taken	N/A
At Test Dry Density (pcf)	N/A		
Specific Gravity	N/A		
Degree of Saturation (%)	N/A	Unconfined Compressive Strength (tsf)	1.55
Average Height (in)	6.013	Undrained Shear Strength (tsf)	0.78
Average Diameter (in)	2.862	Strain at Maximum Stress (%)	5.8
Height to Diameter Ratio	2.1	Strain rate to failure (% / min.)	1.00

Stress vs. Strain



Failure Sketch

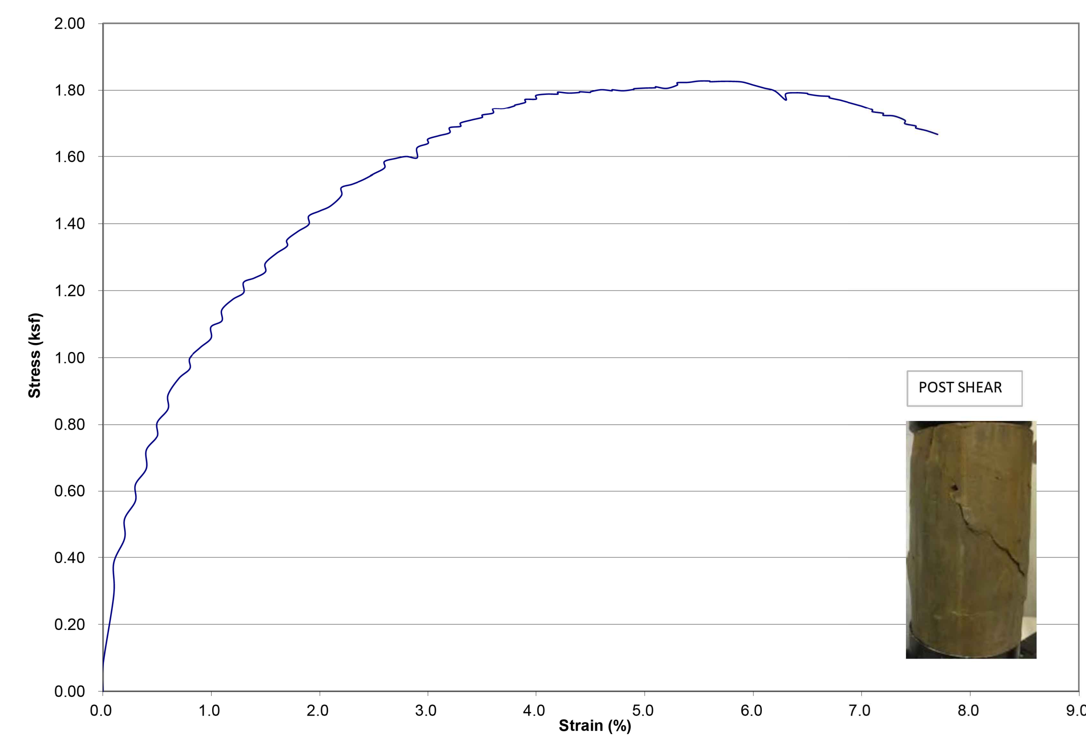


Pocket Penetrometer Reading (tsf) N/A
Torvane Reading (kg/cm^2) N/A

Comments
196A - 9.0'-9.6' - UW
196B - 9.6'-10.2' - rough cut
Classification from SS-3 (11.0' - 12.5'):
LL = 39, PL = 21, PI = 18
%GR - 5, %CS - 4, %FS - 12, %SI - 37, %CL - 42

Reviewed By RJ

Unconfined Compression Test Results ASTM D 2166, D 5102	CTL ENGINEERING, INC. 2860 Fisher Road Columbus, Ohio 43204
Avg. Sample Height (in.): 5.7827 Avg. Sample Diameter (in.): 2.8700 Height-to-diameter ratio: 2.01 Ultimate Strength (ksf): 1.8 Ultimate Strain (%): 5.5 Wet Density (pcf): 126.6 Moisture Content (%): 23.3 (obtained post-shear from specimen) % Agg: 4 % C.S: 2 LL: 42 % F.S. 17 PL: 21 % Silt: 39 PI: 21 % Clay: 38	Client: McCormick Taylor, Inc. Project: BRO-32-3.75 Location: Brown Co., OH Project No. 15050023COL Lab Code No. 15050023COL Date Tested: 3/27/2015 Reviewed by: JG Specimen ID: B-004-0-15, ST-3 5.5'-7.5' Specimen Type: Shelby Tube Visual Description: Brown Clay, moist Group Symbol: A-7-6 (13)



CTL ENGINEERING INC.

DRAWN MSJ
CHECKED EMK

SUBSURFACE EXPLORATION
COMPRESSIVE STRENGTH TEST DATA RESULTS

BRO-32-4.16

Unconsolidated Undrained Triaxial Compression
ASTM D 2850

Project Name	BRO-32-4.16	Project No.	173620122
Source	B-002-0-20, 6.0'-6.5'	Lab ID	197A
Description	Silt and Clay (A-6a), brown, stiff, moist	Test ID	197A-A
Specimen Type	Intact		
		Date Received	07/01/2020
		Date Tested	07/21/2020

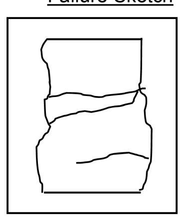
Specific Gravity 2.64
ASTM D 854, Dry

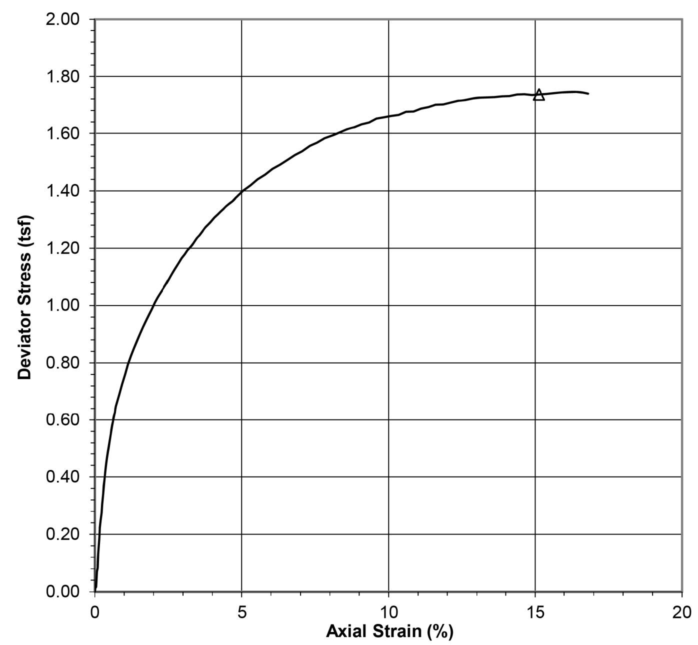
Liquid Limit
Plastic Limit
Plasticity Index

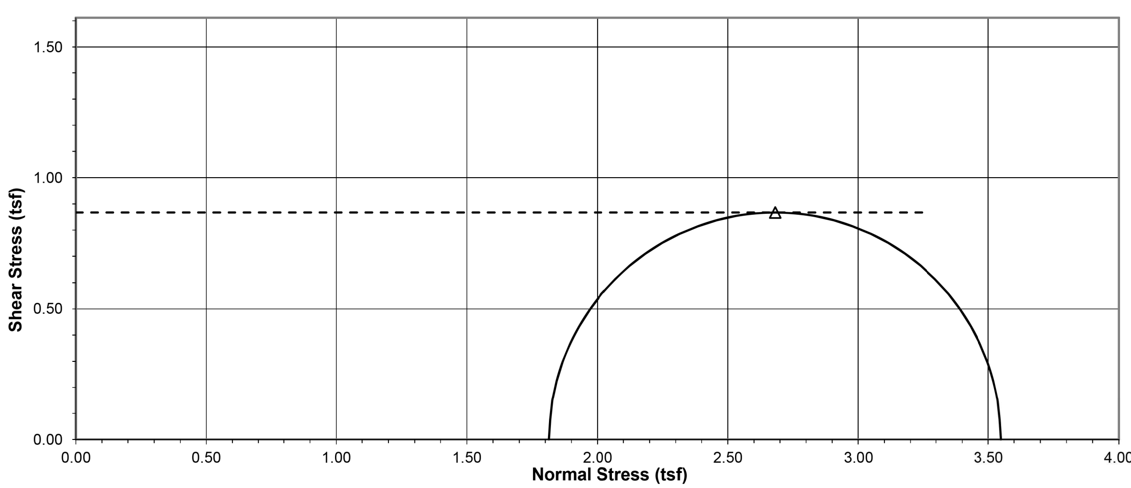
Target Test Parameters
Nominal Chamber Pressure (psi) 25
Actual Axial Strain Rate of Test (%/min) 1.006

At Unconsolidated Undrained Failure
Failure Criterion: 15% Axial Strain
Axial Strain (%) 15.14
Deviator Stress (tsf) 1.735
Minor Principal Stress, σ_3 (tsf) 1.813
Major Principal Stress, σ_1 (tsf) 3.549
Undrained Shear Strength, S_u (tsf) 0.868

Failure Sketch







Comments Classification from SS-2 (3.5' - 5.0'):
LL = 31, PL = 17, PI = 14
%GR - 8, %CS - 3, %FS - 13, %SI - 46, %CL - 30

Reviewed KG

Unconsolidated Undrained Triaxial Compression
ASTM D 2850

Project Name	BRO-32-4.16	Project No.	173620122
Source	B-058-2-20, 4.0'-4.5'	Lab ID	203A
Description	Clay (A-7-6), brownish gray, medium stiff, moist	Test ID	203A-A
Specimen Type	Intact		
		Date Received	07/17/2020
		Date Tested	07/23/2020

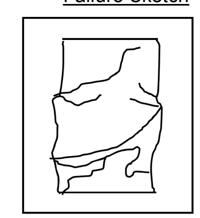
Specific Gravity 2.65
ASTM D 854, Dry

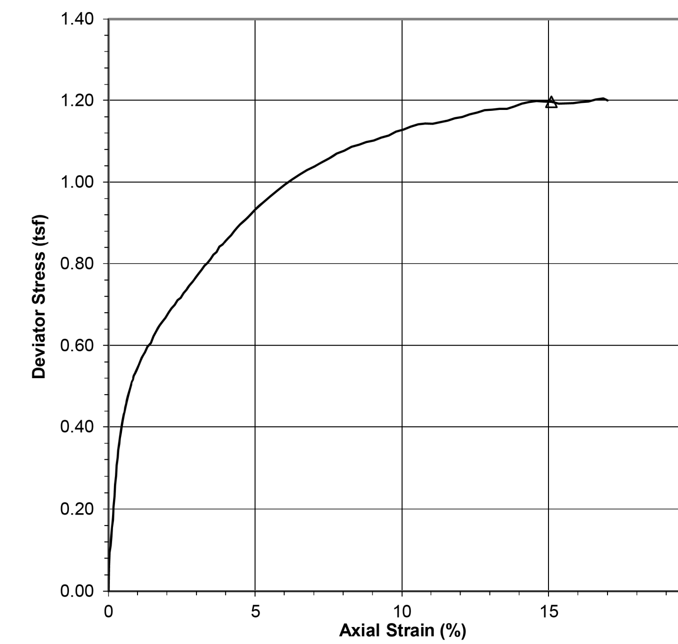
Liquid Limit
Plastic Limit
Plasticity Index

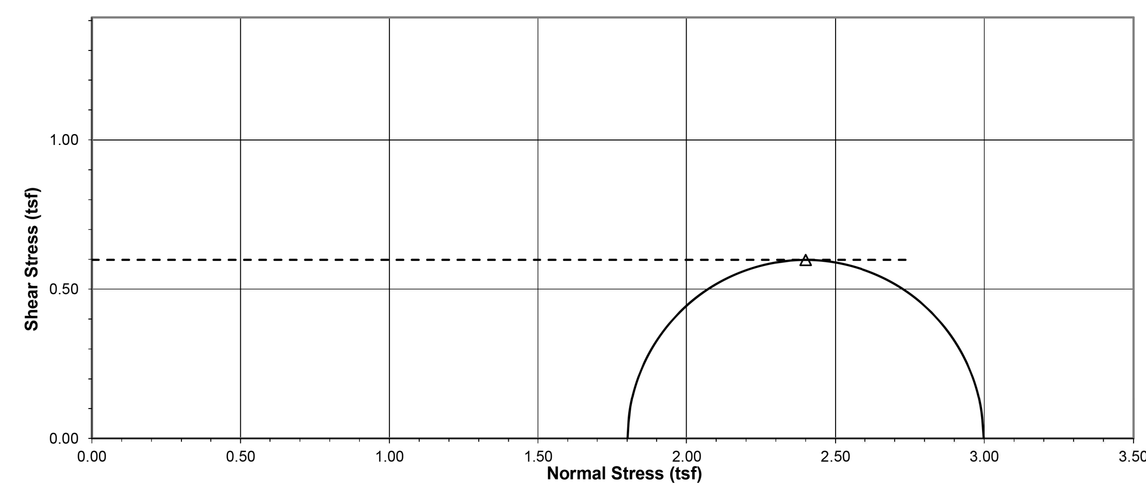
Target Test Parameters
Nominal Chamber Pressure (psi) 25
Actual Axial Strain Rate of Test (%/min) 1.006

At Unconsolidated Undrained Failure
Failure Criterion: 15% Axial Strain
Axial Strain (%) 15.10
Deviator Stress (tsf) 1.196
Minor Principal Stress, σ_3 (tsf) 1.801
Major Principal Stress, σ_1 (tsf) 2.998
Undrained Shear Strength, S_u (tsf) 0.598

Failure Sketch







Comments Classification from SS-2 (6.0' - 7.5'):
LL = 60, PL = 24, PI = 36
%GR - 10, %CS - 2, %FS - 11, %SI - 29, %CL - 48

Reviewed KG

DRAWN MSJ CHECKED EMK

SUBSURFACE EXPLORATION
UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST DATA RESULTS

BRO-32-4.16

Unconsolidated Undrained Triaxial Compression
ASTM D 2850

Project Name	BRO-32-4.16	Project No.	173620122
Source	B-059-1-20, 4.1'-4.6'	Lab ID	200A
Description	Clay (A-7-6), brownish gray, medium stiff, moist	Test ID	200A-A
Specimen Type	Intact	Date Received	07/01/2020
		Date Tested	07/21/2020

Specific Gravity 2.65
ASTM D 854, Dry

Liquid Limit
Plastic Limit
Plasticity Index

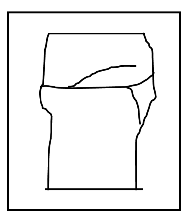
Target Test Parameters

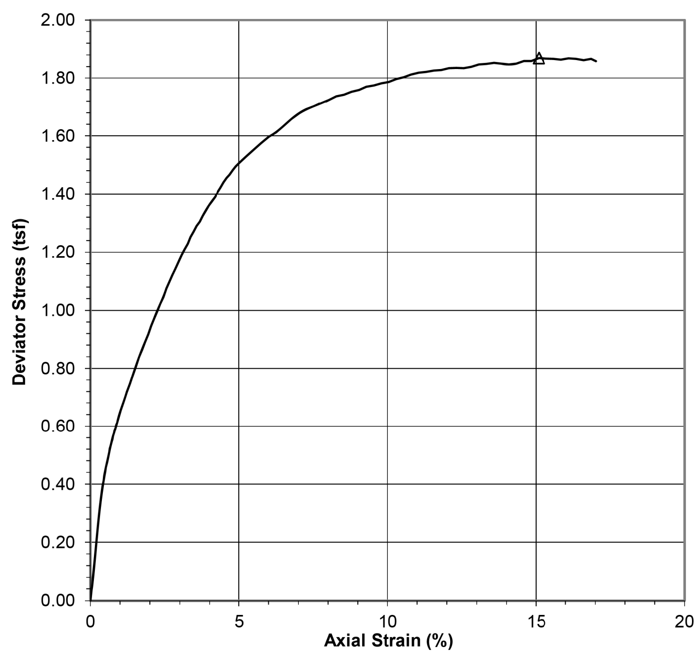
Nominal Chamber Pressure (psi) 25
Actual Axial Strain Rate of Test (%/min) 1.008

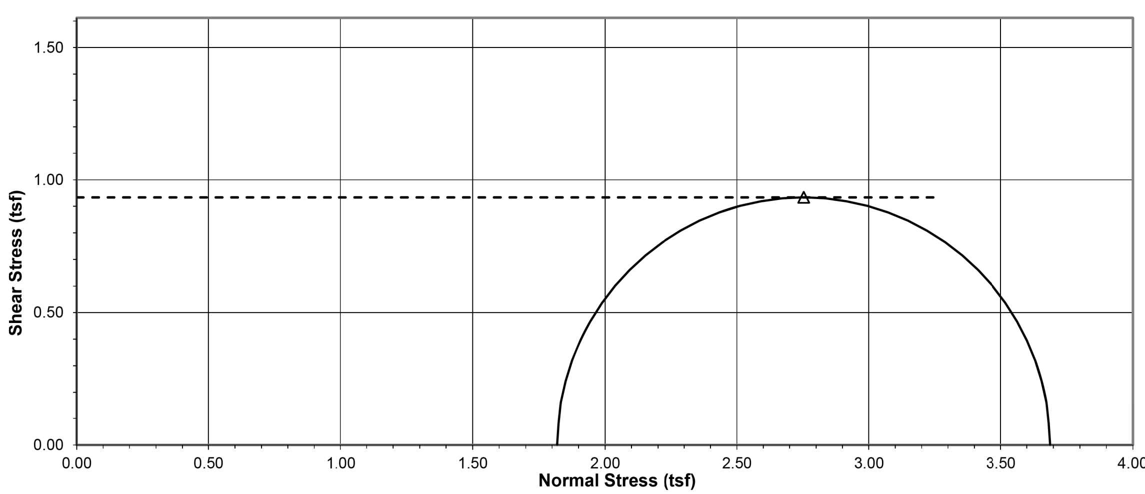
At Unconsolidated Undrained Failure

Failure Criterion: 15% Axial Strain
Axial Strain (%) 15.09
Deviator Stress (tsf) 1.869
Minor Principal Stress, σ_3 (tsf) 1.818
Major Principal Stress, σ_1 (tsf) 3.687
Undrained Shear Strength, S_u (tsf) 0.934

Failure Sketch







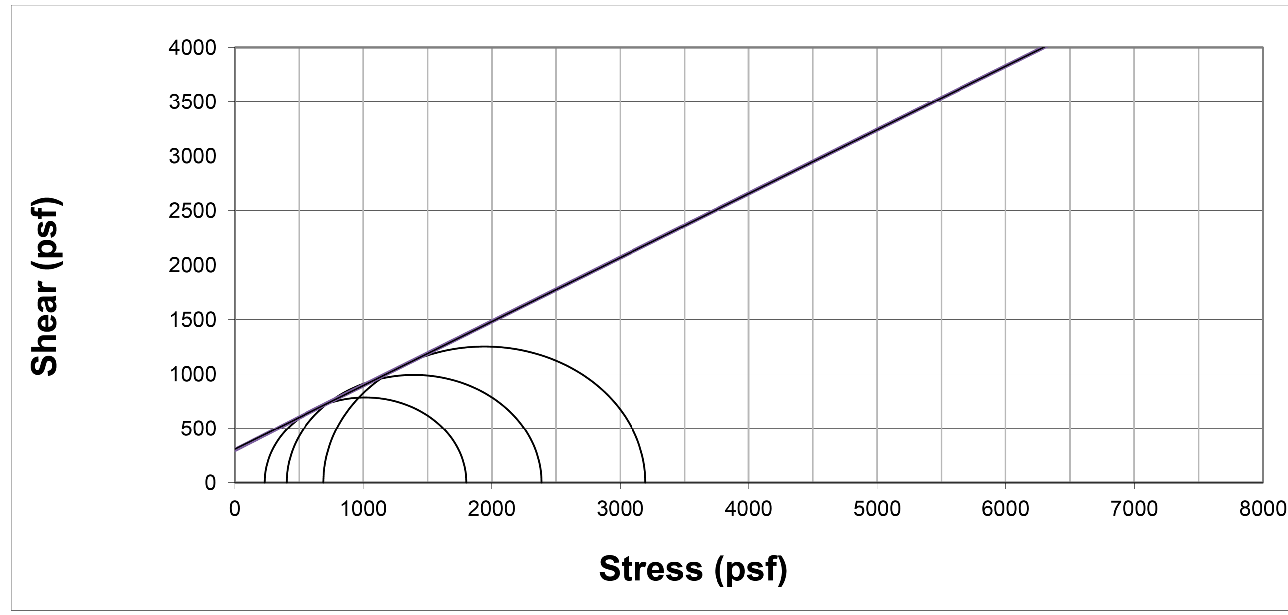
Comments Classification from SS-2 (6.0' - 7.5'):
LL = 47, PL = 25, PI = 22
%GR - 2, %CS - 3, %FS - 13, %SI - 38, %CL - 44

Reviewed KG

CTL - CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST

Mohr Circle Effective Stress

CLIENT:	McCormick Taylor, Inc.	Sample ID:	B-001-0-15, ST-3 6.5'-8.5'		
PROJECT:	BRO-32-3.75	Confining Pressure (psf):	720	1440	2160
LOCATION:	Brown Co., OH	Cohesion(psf):	305		
PROJECT #:	15050023COL	Angle of Friction(°):	30		



DRAWN MSJ
CHECKED EMK

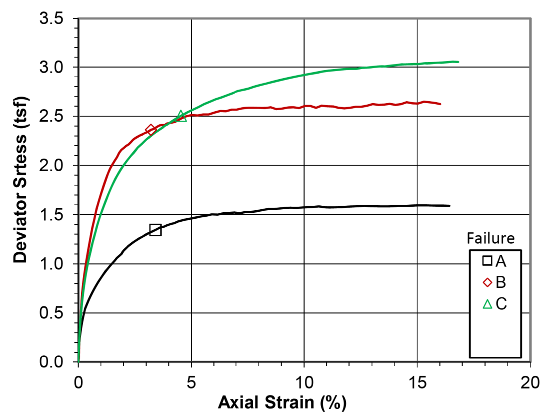
SUBSURFACE EXPLORATION
UNDRAINED TRIAXIAL COMPRESSION TEST DATA RESULTS

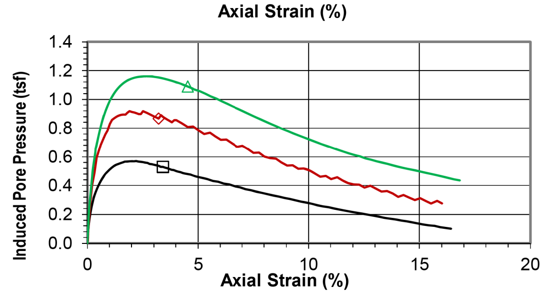
BRO-32-4.16

Consolidated Undrained Triaxial Compression
ASTM D 4767

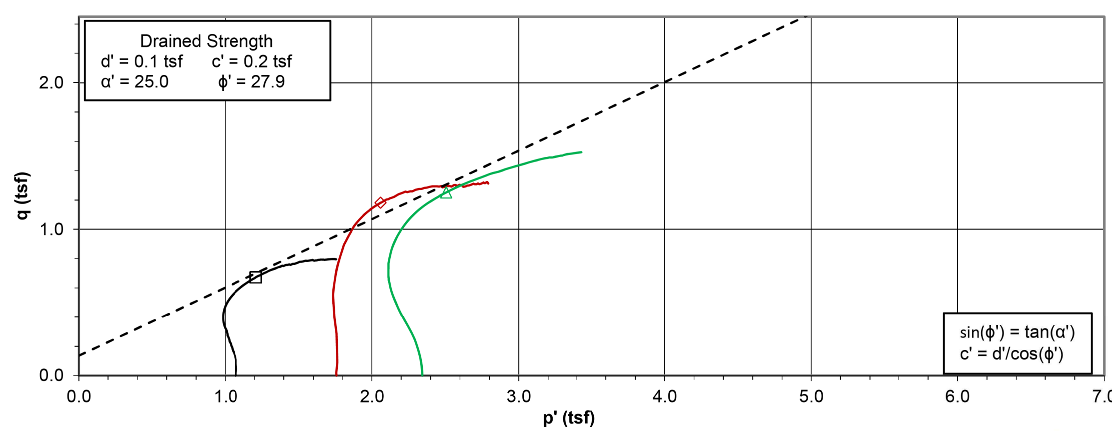
Project Name BRO-32-4.16 — Project 173620122 — Set ID 199

Test	Lab ID	Source	Description	Gs	LL	PL	PI
A	199A	B-059-0-20, 6.5'-7.0'	Silty Clay (A-6b), brown, stiff, moist	2.74			
B	199B	B-059-0-20, 7.0'-7.5'	Silty Clay (A-6b), brown, stiff, moist	2.68			
C	199C	B-059-0-20, 7.5'-8.1'	Silty Clay (A-6b), brown, stiff, moist	2.68			





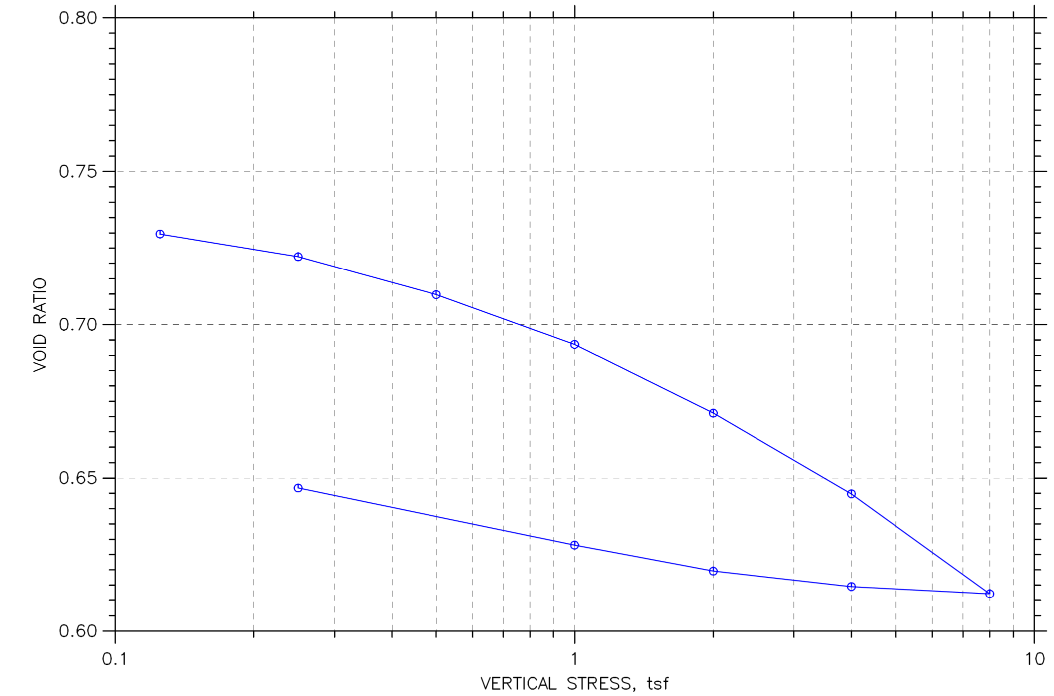
Specimen	A	B	C		
	Initial Specimen Conditions				
Average Height (in)	6.021	6.021	6.044		
Average Diameter (in)	2.875	2.892	2.893		
Moist Unit Weight (pcf)	129.7	129.0	130.9		
Moisture Content (%)	20.1	19.1	18.0		
Dry Unit Weight (pcf)	108.0	108.3	111.0		
Void Ratio	0.580	0.542	0.505		
Degree of Saturation (%)	94.7	94.6	95.4		
	Consolidated Specimen Conditions				
Moist Unit Weight (pcf)	132.3	131.8	134.3		
Moisture Content (%)	20.1	18.9	17.0		
Dry Unit Weight (pcf)	110.1	110.9	114.8		
Void Ratio	0.550	0.506	0.454		
Degree of Saturation (%)	100.0	100.0	100.0		
Eff. Con. Stress, σ_3' (tsf)	1.072	1.760	2.344		
	At Drained Failure				
Failure Criterion	Max. Eff. Prin. Stress Ratio				
Axial Strain (%)	3.414	3.216	4.531		
Deviator Stress (tsf)	1.345	2.363	2.504		
Induced Pore Press. (tsf)	0.529	0.867	1.090		
Minor Eff. Stress, σ_3' (tsf)	0.537	0.878	1.254		
Major Eff. Stress, σ_1' (tsf)	1.882	3.240	3.757		
Eff. Stress Ratio, σ_1'/σ_3'	3.502	3.692	2.997		
p' (tsf)	1.210	2.059	2.506		
q (tsf)	0.672	1.181	1.252		

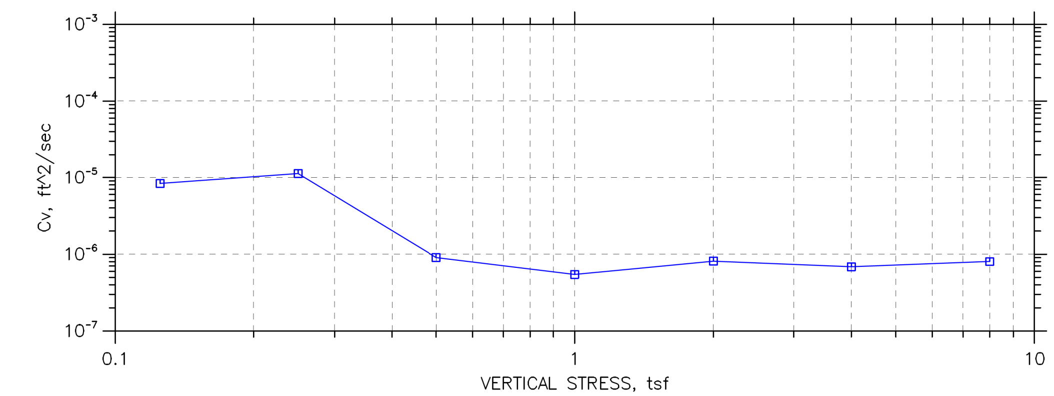


Comments Classification from SS-2 (3.5' - 5.0'):
LL = 33, PL = 16, PI = 17
%GR - 5, %CS - 3, %FS - 13, %SI - 46, %CL - 33

Reviewed By KG

CONSOLIDATION TEST DATA
SUMMARY REPORT





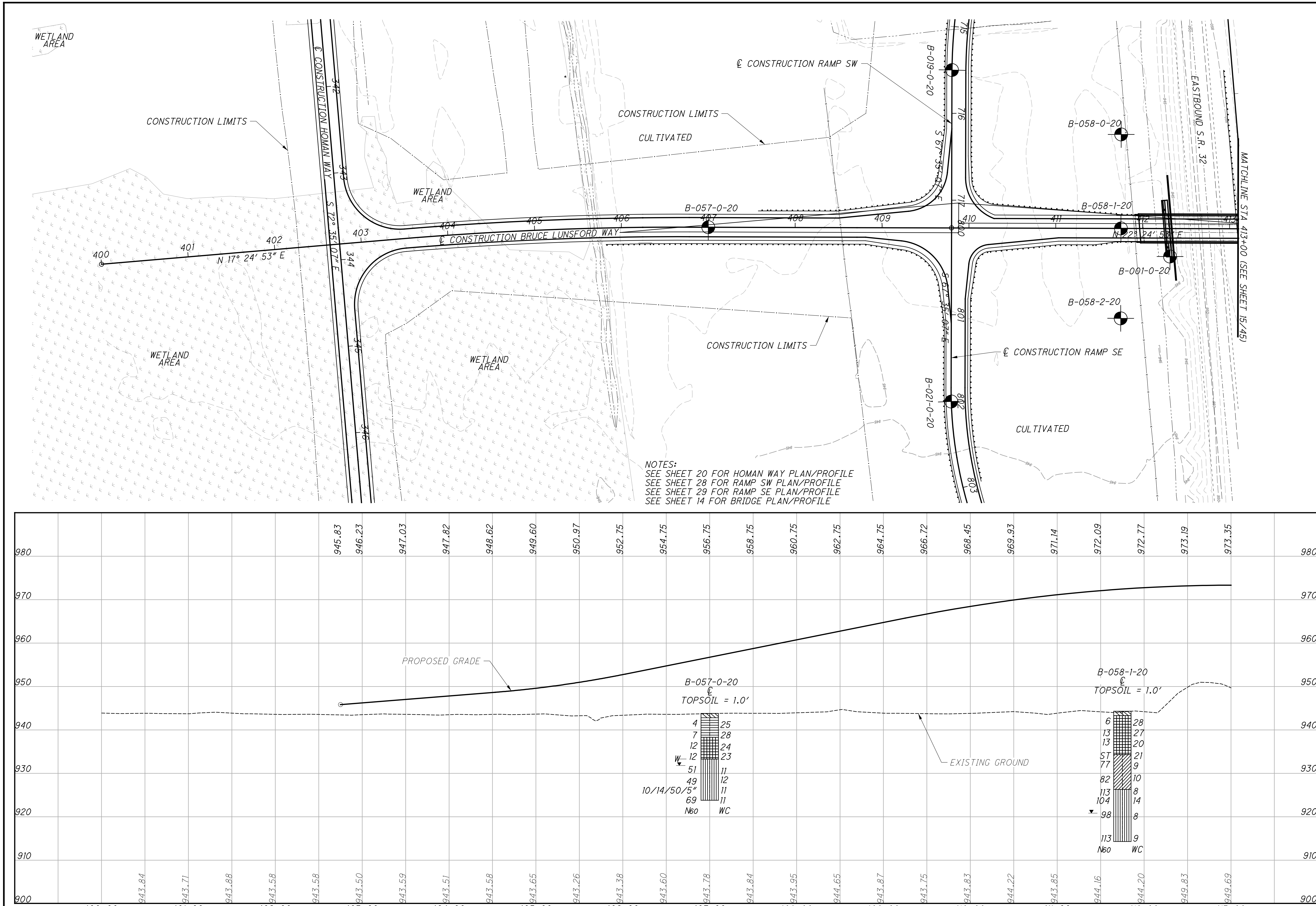
Project: BRO-32-3.75	Location: BROWN COUNTY	Project No.: 15050023COL
Boring No.: B-001-0-15	Tested By: MW	Checked By: SM
Sample No.: 3	Test Date: 03/27/15	Depth: 6.5'-8.5'
Test No.: 1	Sample Type: ST	Elevation:
Description: BROWN AND GRAY LEAN CLAY W/ GRAVEL		
Remarks:		

ue, 31-MAR-2015 13:02:30

DRAWN MSJ CHECKED EMK

SUBSURFACE EXPLORATION
CONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION TEST DATA RESULTS
CTL CONSOLIDATION TEST DATA

BRO-32-4.16

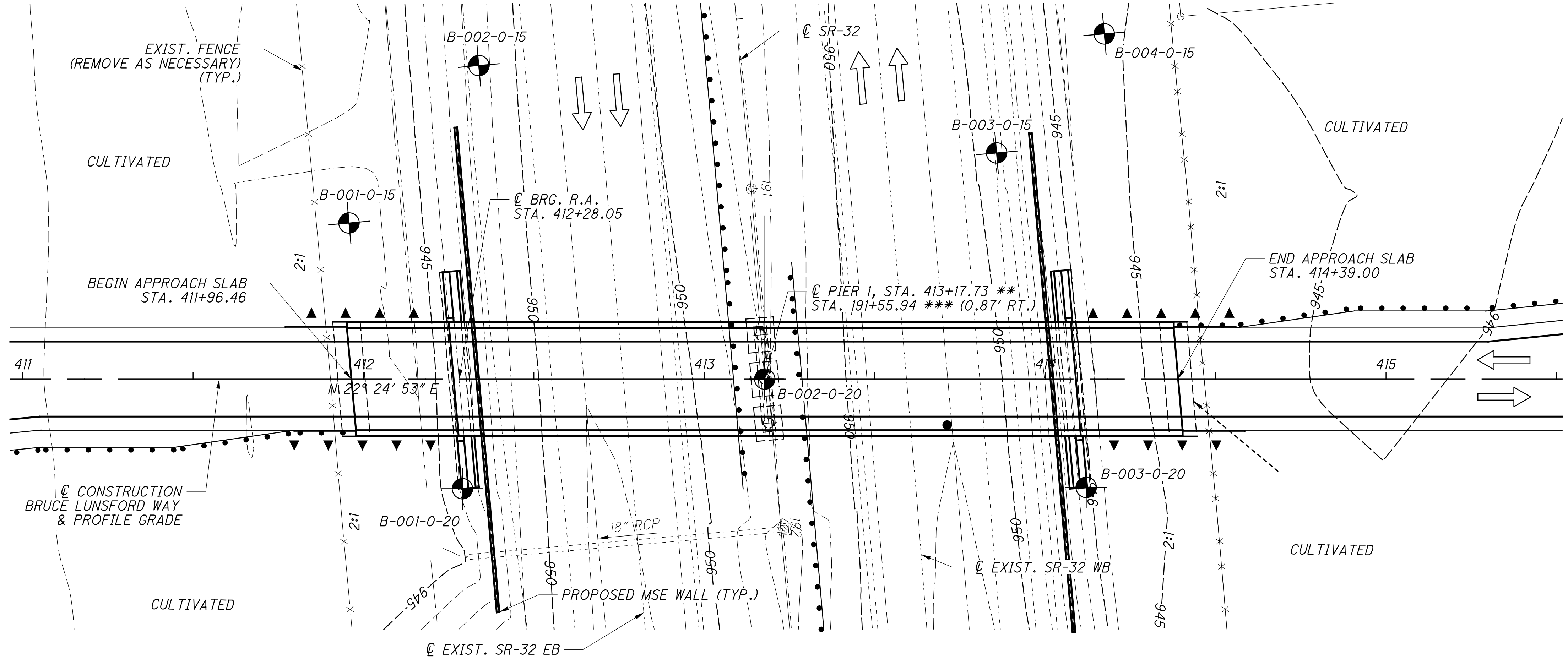


SOIL PROFILE - BRUCE LUNSFORD WAY
STA. 400+00.00 TO 413+00.00

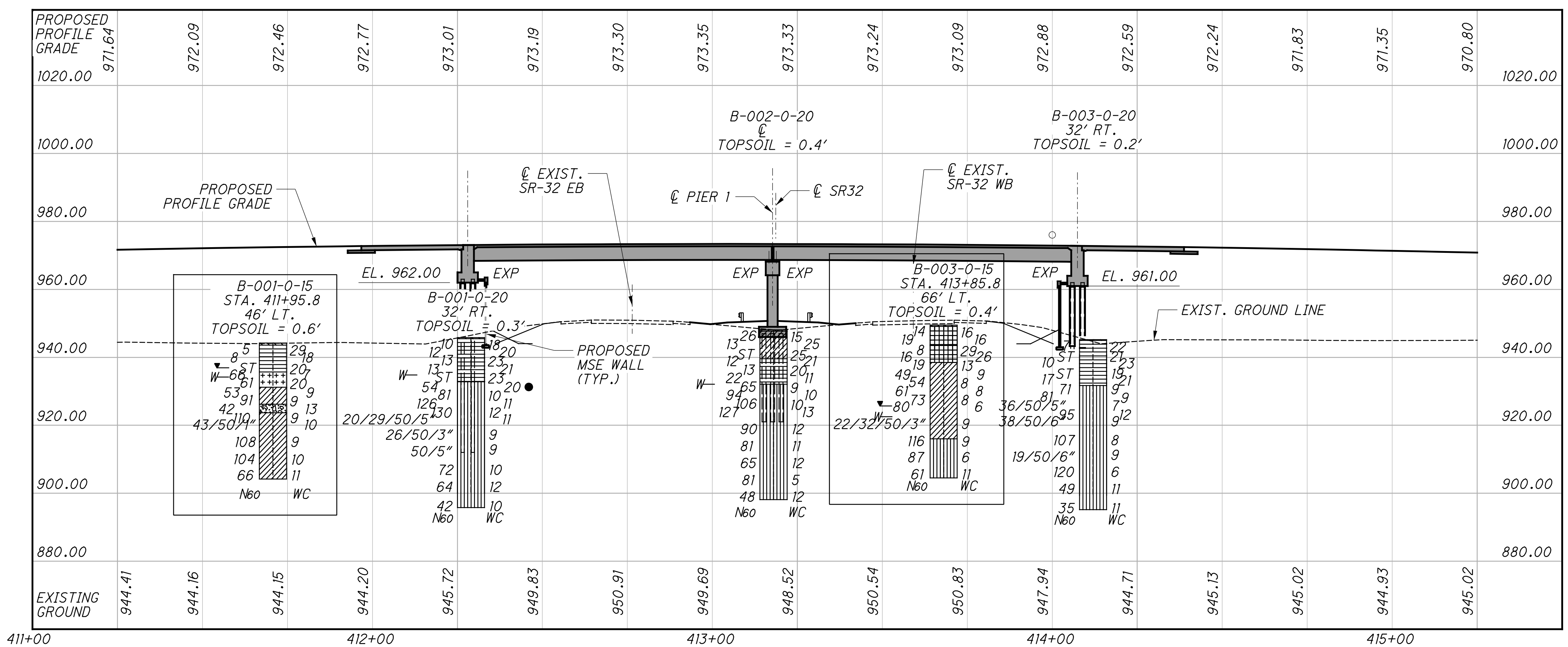
HORIZONTAL SCALE IN FEET

DRAWN MSJ
CHECKED EMK

BRO-32-4.16



NOTE:
SEE SHEETS 41 AND 43 FOR BORING LOGS B-002-0-15 & B-004-0-15 INFORMATION.

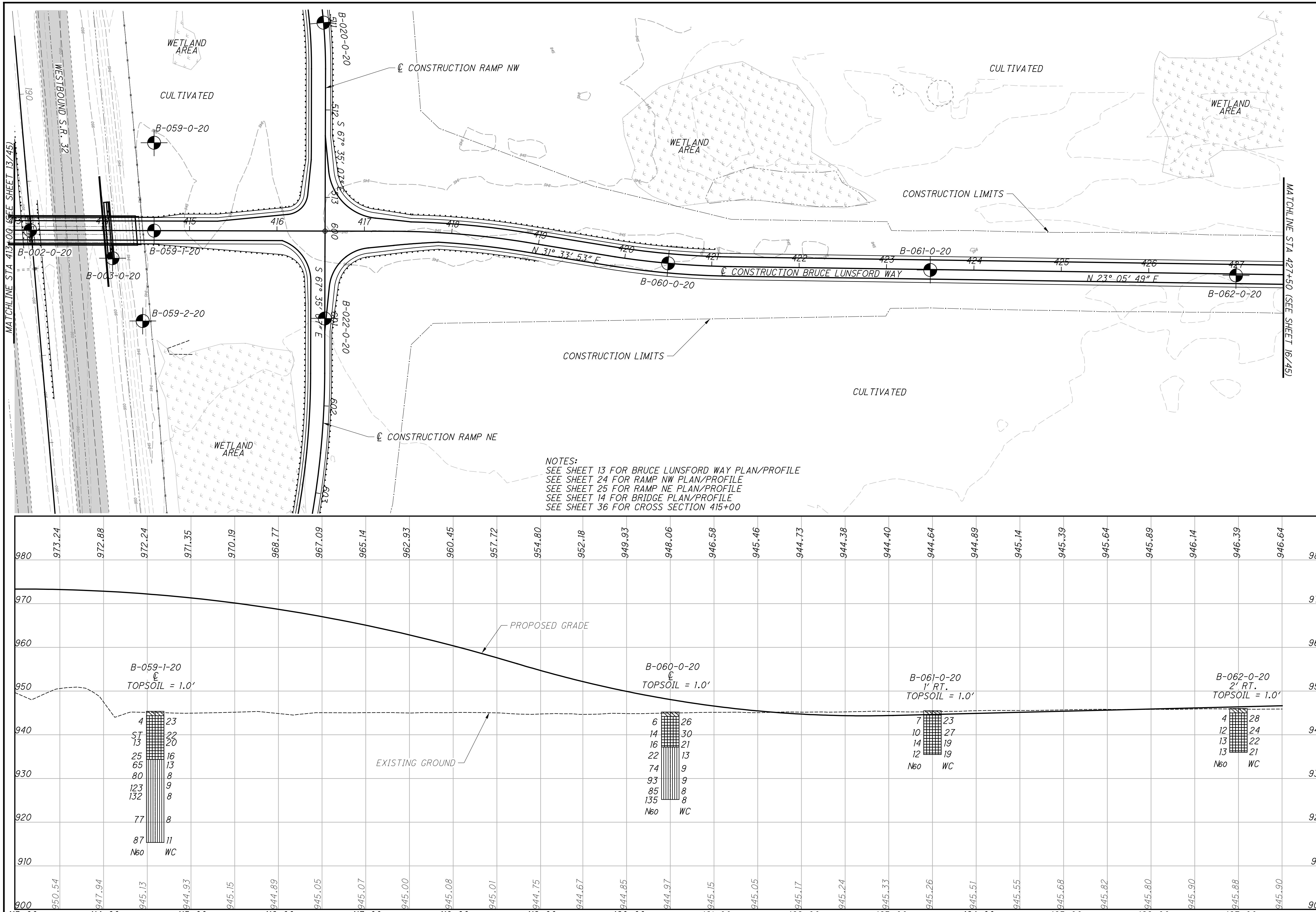


DRAWN MSJ
CHECKED EMK

HORIZONTAL SCALE IN FEET

STRUCTURE FOUNDATION EXPLORATION
BRUCE LUNSFORD WAY OVER S.R. 32

BRO-32-4.16



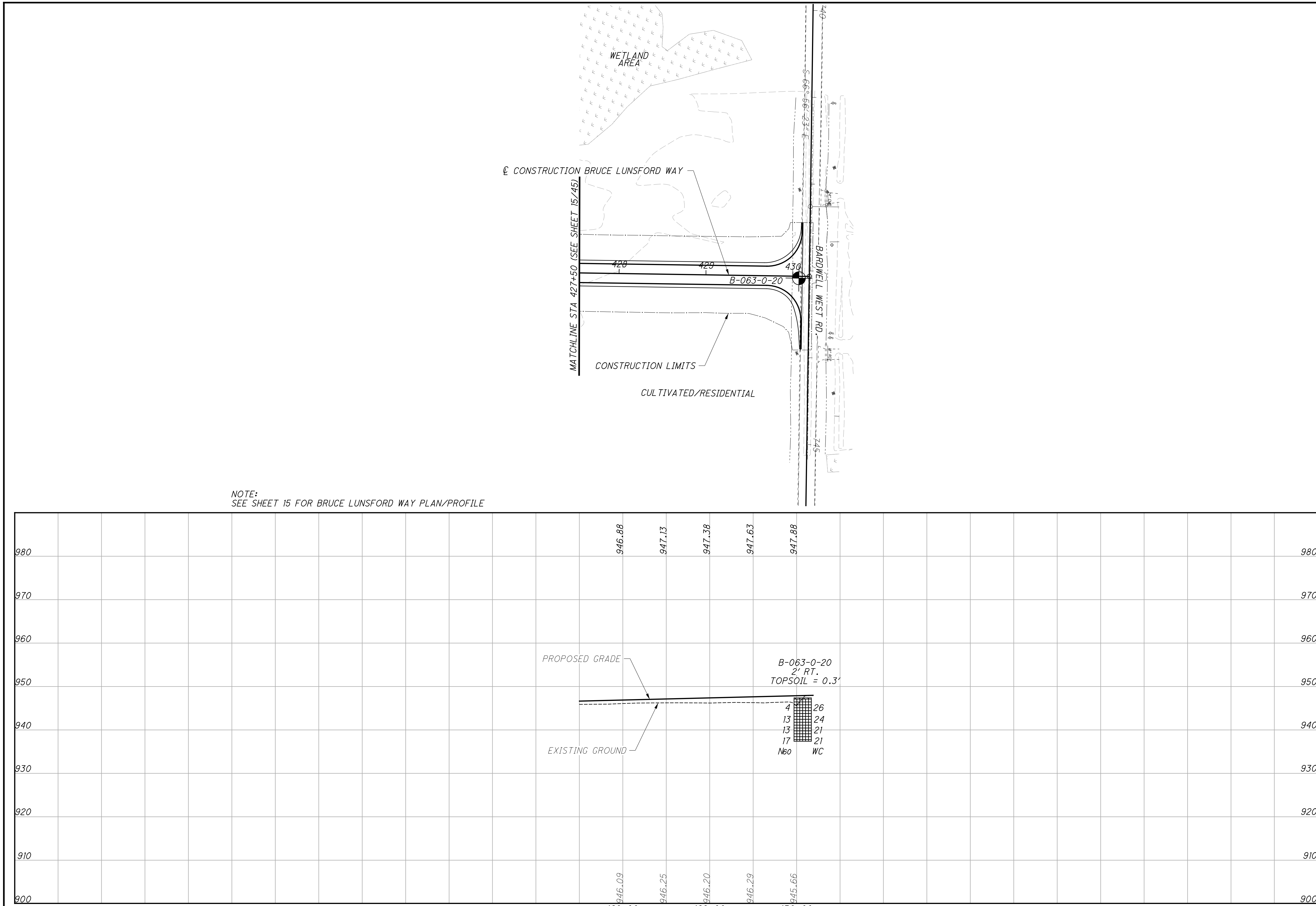
N

0 25 50 100
HORIZONTAL SCALE IN FEET

DRAWN MSJ
CHECKED EMK

SOIL PROFILE - BRUCE LUNSFORD WAY
STA. 413+00.00 TO 427+50.00

BRO-32-4.16

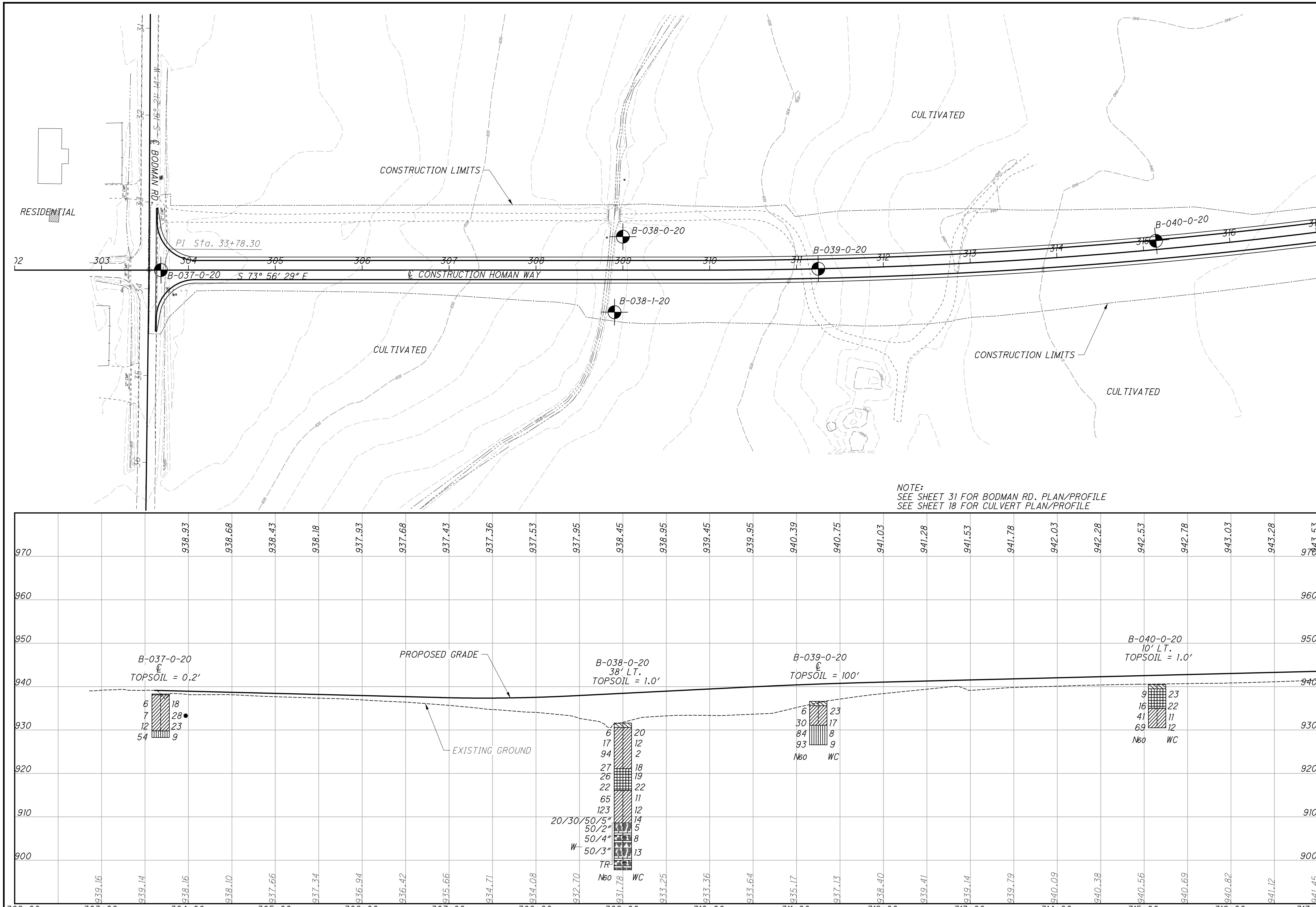


HORIZONTAL SCALE IN FEET
0 25 50 100

DRAWN MSJ
CHECKED EMK

SOIL PROFILE - BRUCE LUNSFORD WAY
STA. 427+50.00 TO 430+19.00

BRO-32-4.16



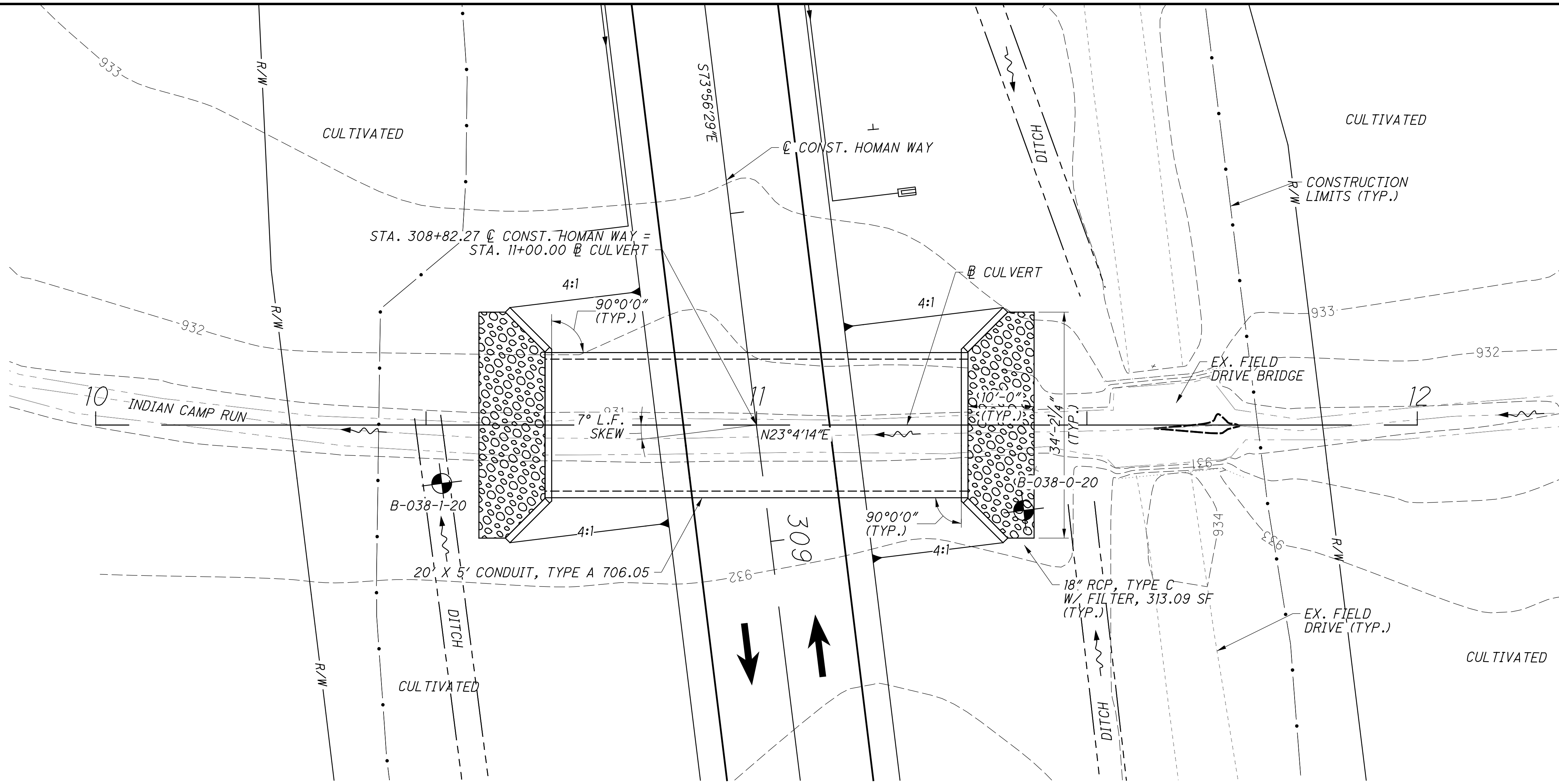
HORIZONTAL SCALE IN FEET

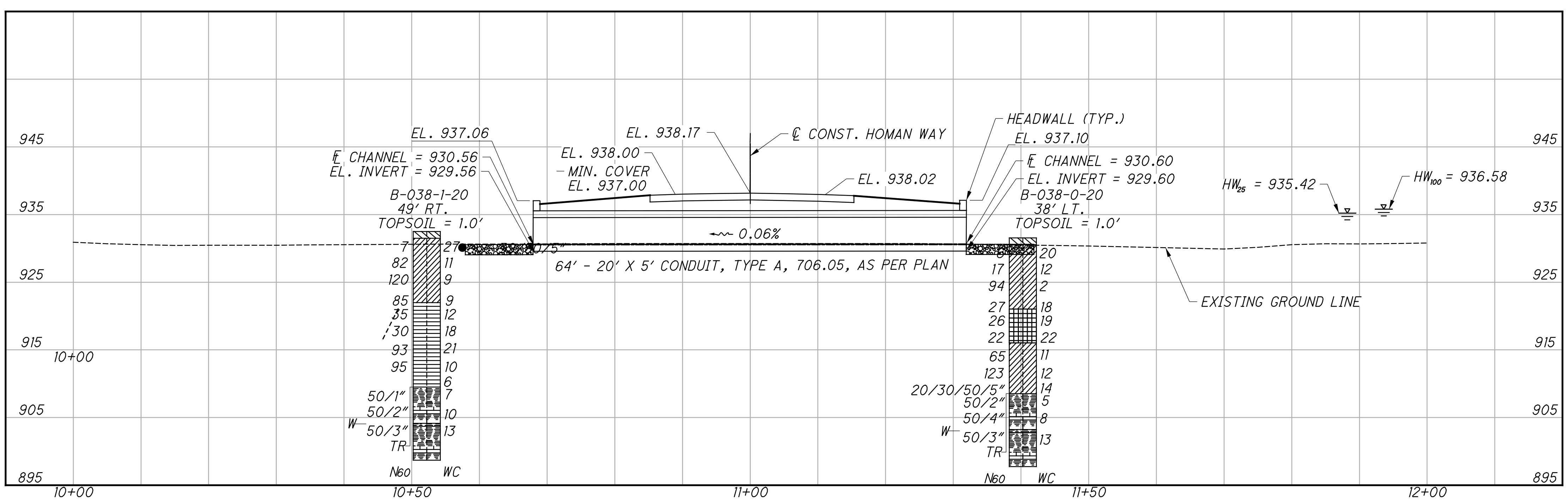
DRAWN MSJ

CHECKED EMK

SOIL PROFILE - HOMAN WAY
STA. 302+00.00 TO 317+00.00

BRO-32-4.16

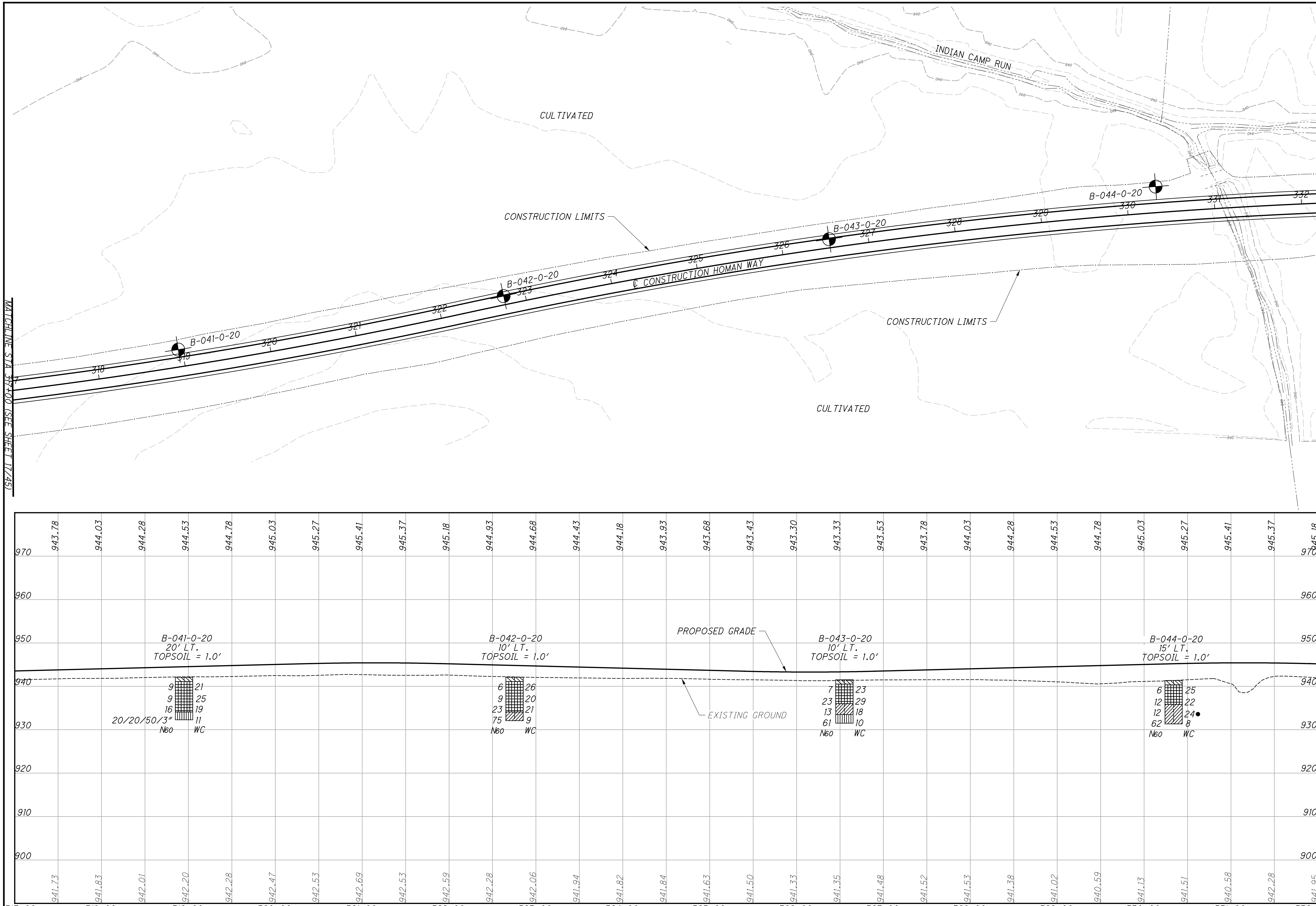




DRAWN MSJ
CHECKED EMK

STRUCTURE FOUNDATION EXPLORATION
CULVERT UNDER HOMAN WAY

BRO-32-4.16



HORIZONTAL SCALE IN FEET

0 25 50 100

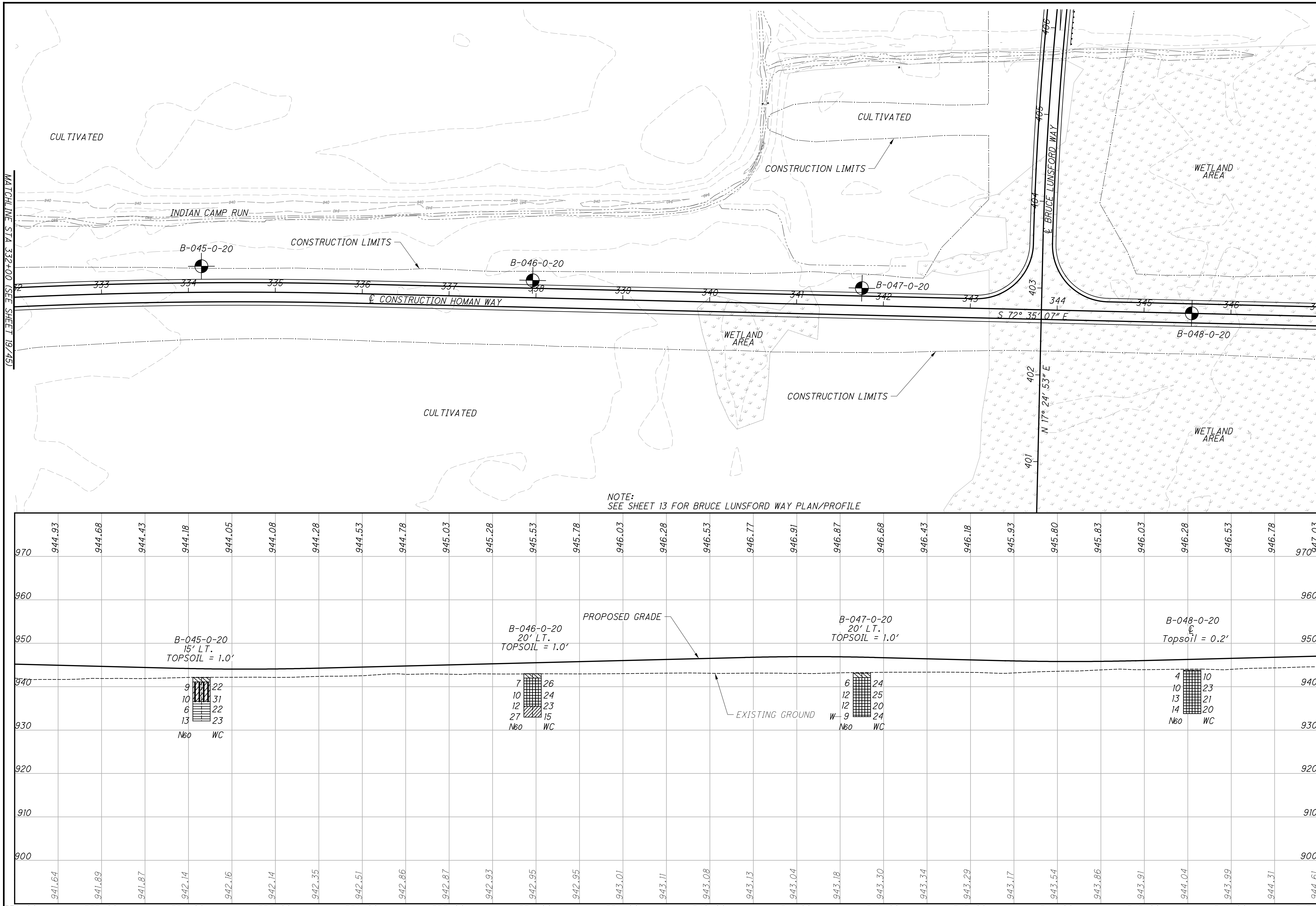
DRAWN MSJ

CHECKED EMK

SOIL PROFILE - HOMAN WAY

STA. 317+00.00 TO 332+00.00

BRO-32-4.16



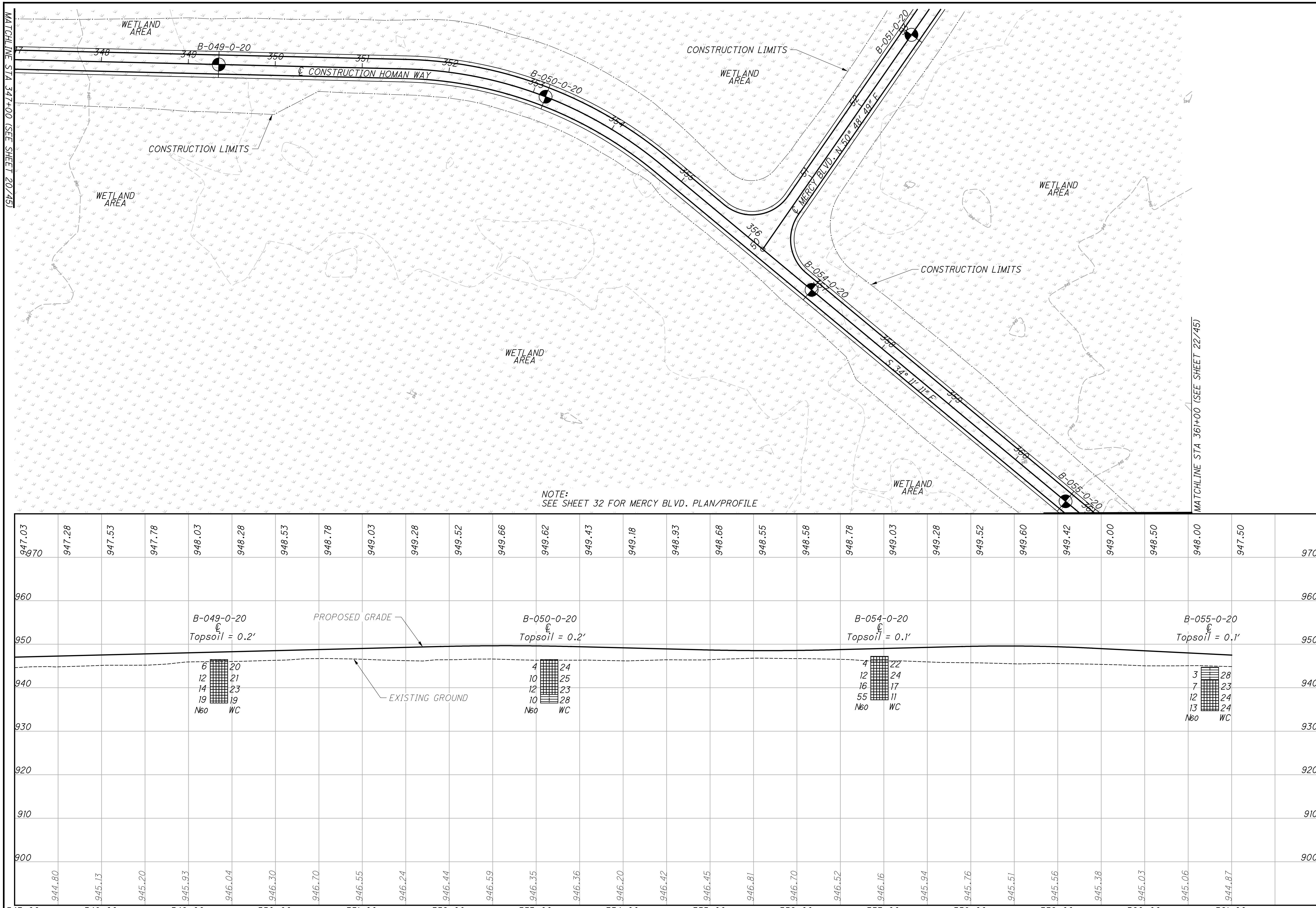
HORIZONTAL SCALE IN FEET

DRAWN MSJ
CHECKED EMK

SOIL PROFILE - HOMAN WAY
STA. 332+00.00 TO 342+00.00

BRO-32-4.16

20/45



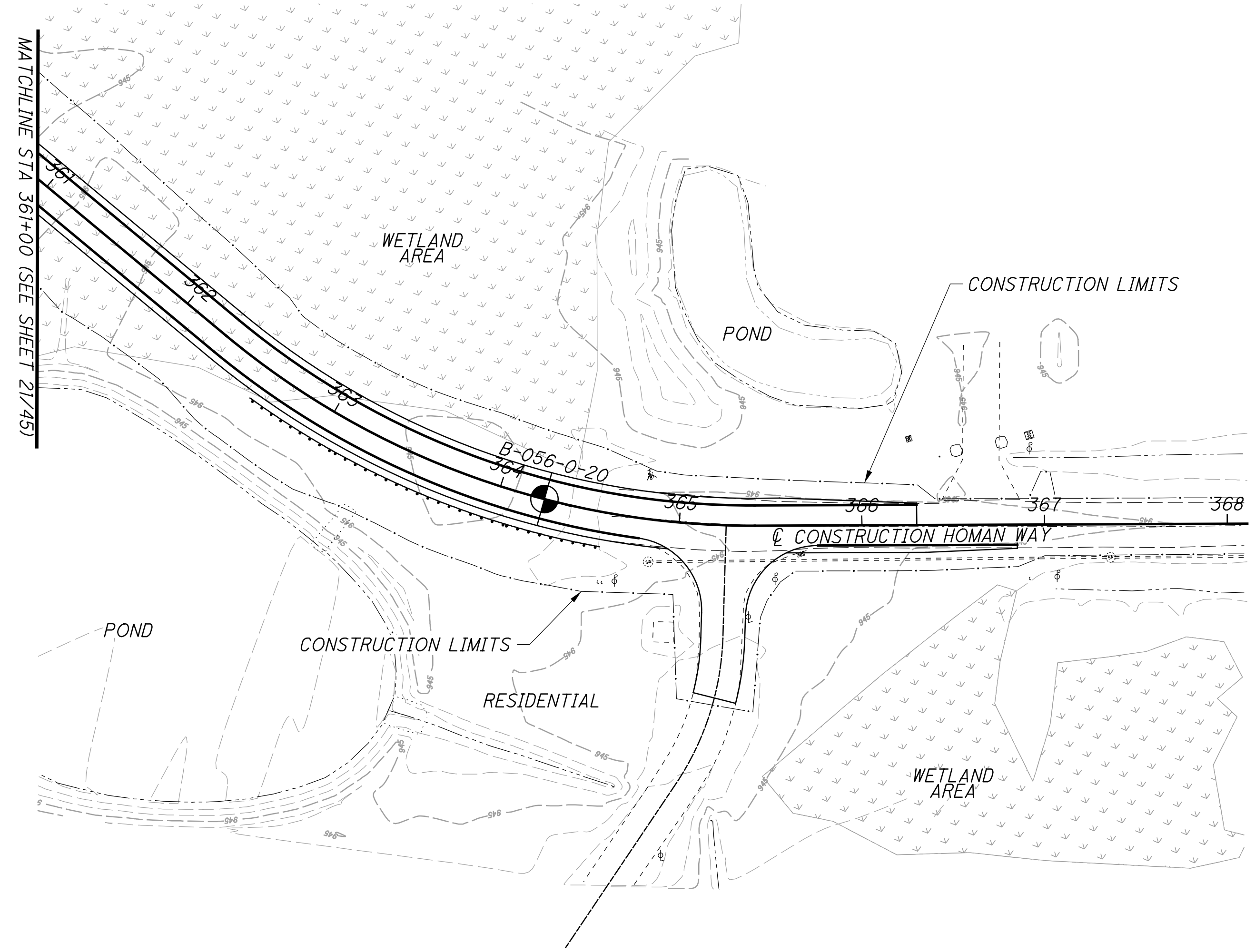
HORIZONTAL SCALE IN FEET

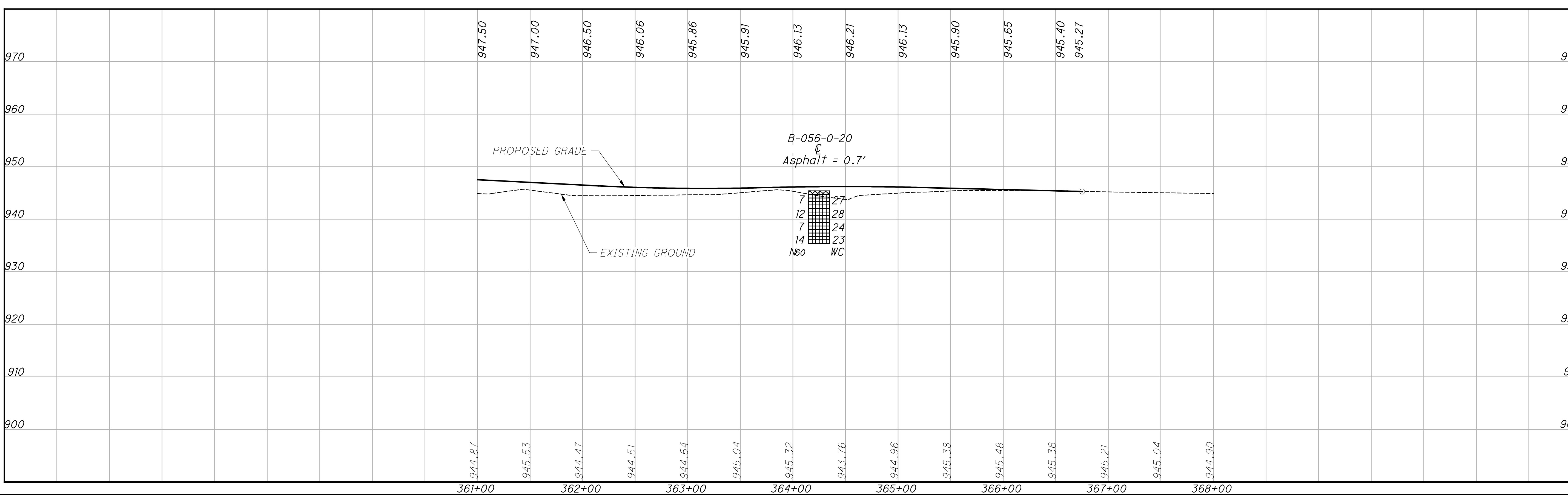
DRAWN MSJ

CHECKED EMK

SOIL PROFILE - HOMAN WAY
STA. 347+00.00 TO 361+00.00

BRO-32-4.16





HORIZONTAL SCALE IN FEET: 0 25 50 100

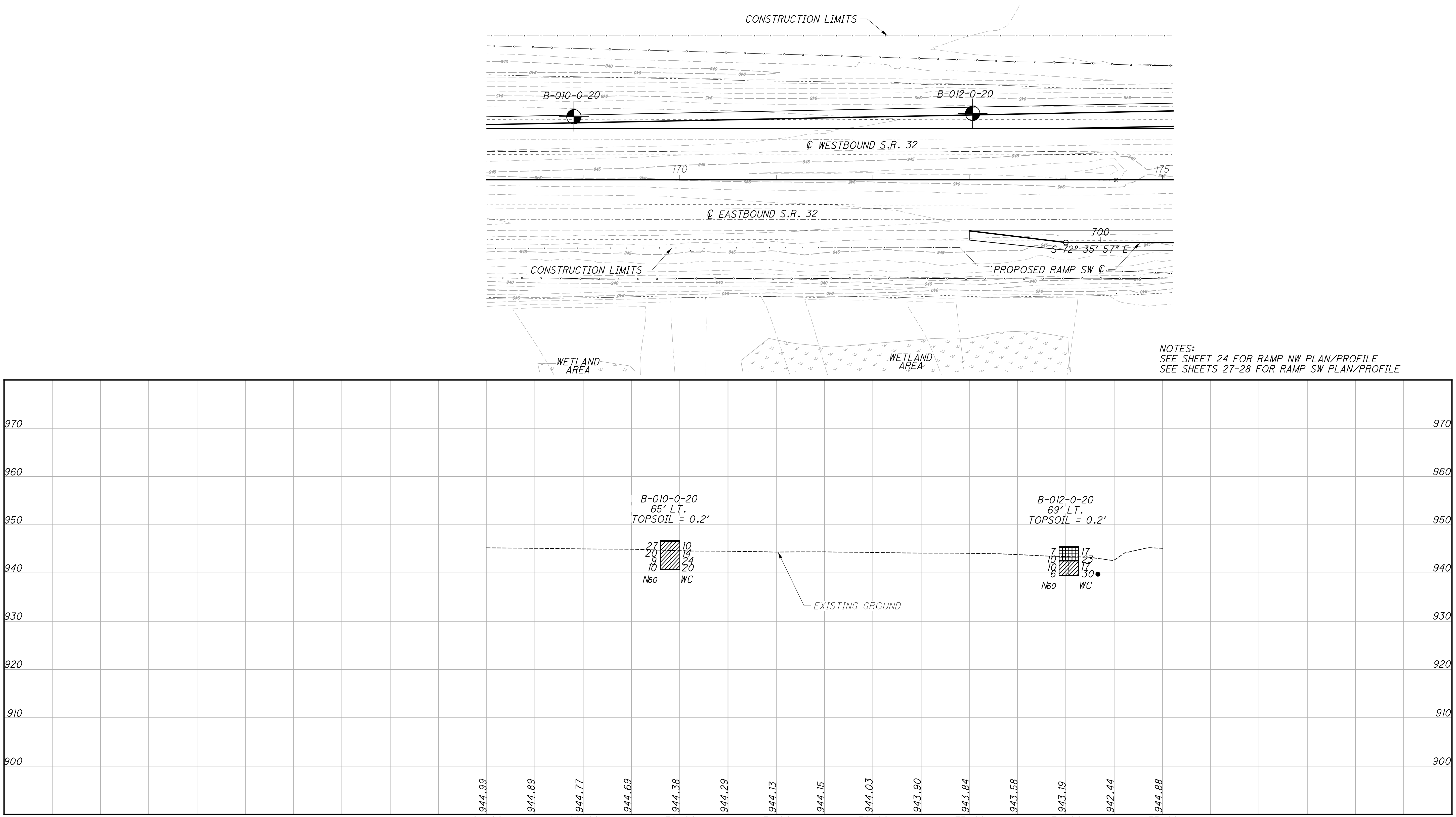
DRAWN MSJ

CHECKED EMK

SOIL PROFILE - HOMAN WAY
STA. 361+00.00 TO 368+00.00

BRO-32-4.16

22/45



HORIZONTAL SCALE IN FEET

0 25 50 100

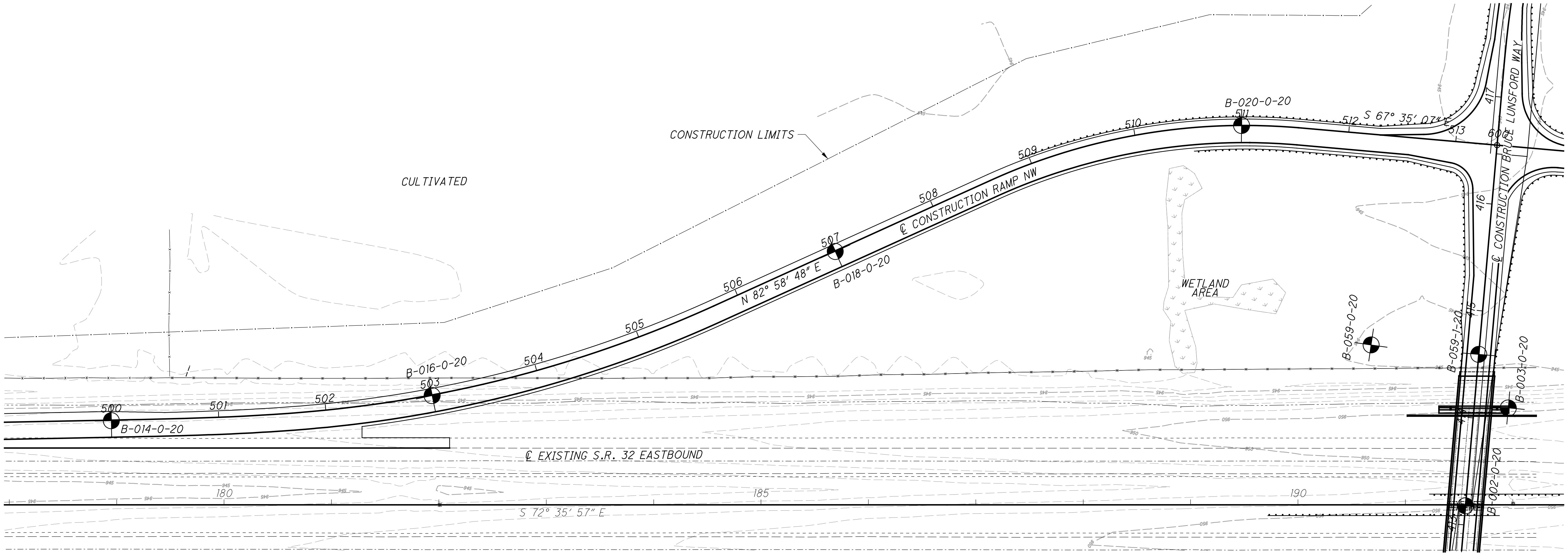
DRAWN MSJ

CHECKED EMK

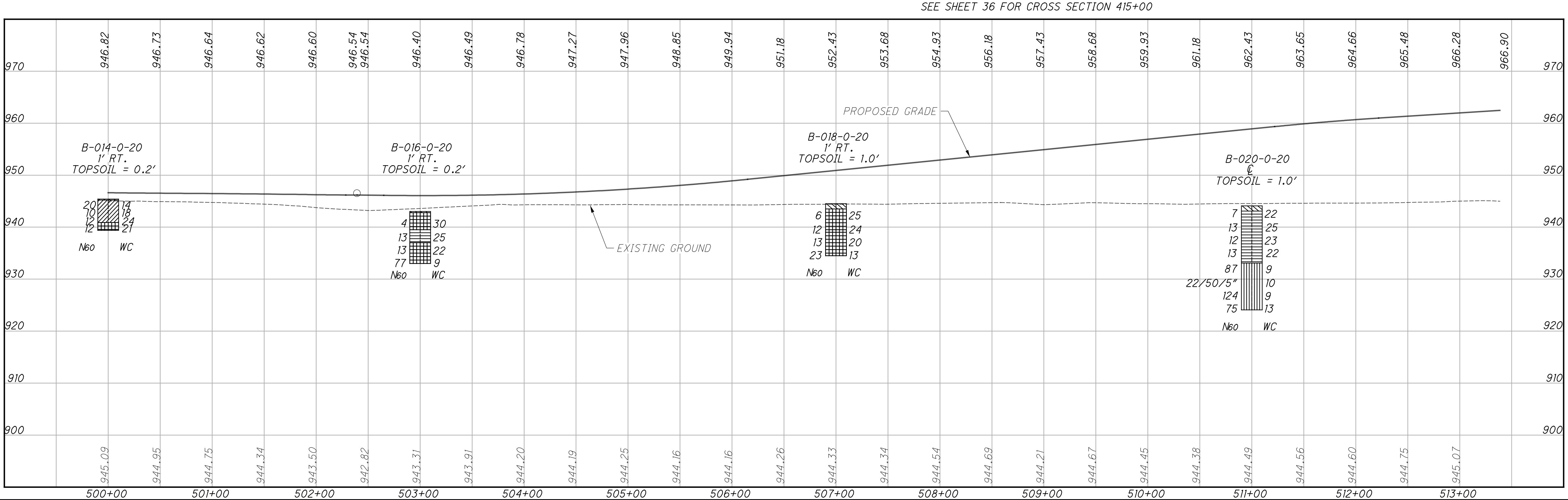
SOIL PROFILE - S.R. 32

STA. 168+00.00 TO 175+00.00

BRO-32-4.16



NOTES:
SEE SHEET 23 FOR S.R. 32 PLAN/PROFILE
SEE SHEET 15 BRUCE LUNSFORD WAY PLAN/PROFILE
SEE SHEET 14 FOR BRIDGE PLAN/PROFILE
SEE SHEET 36 FOR CROSS SECTION 415+00

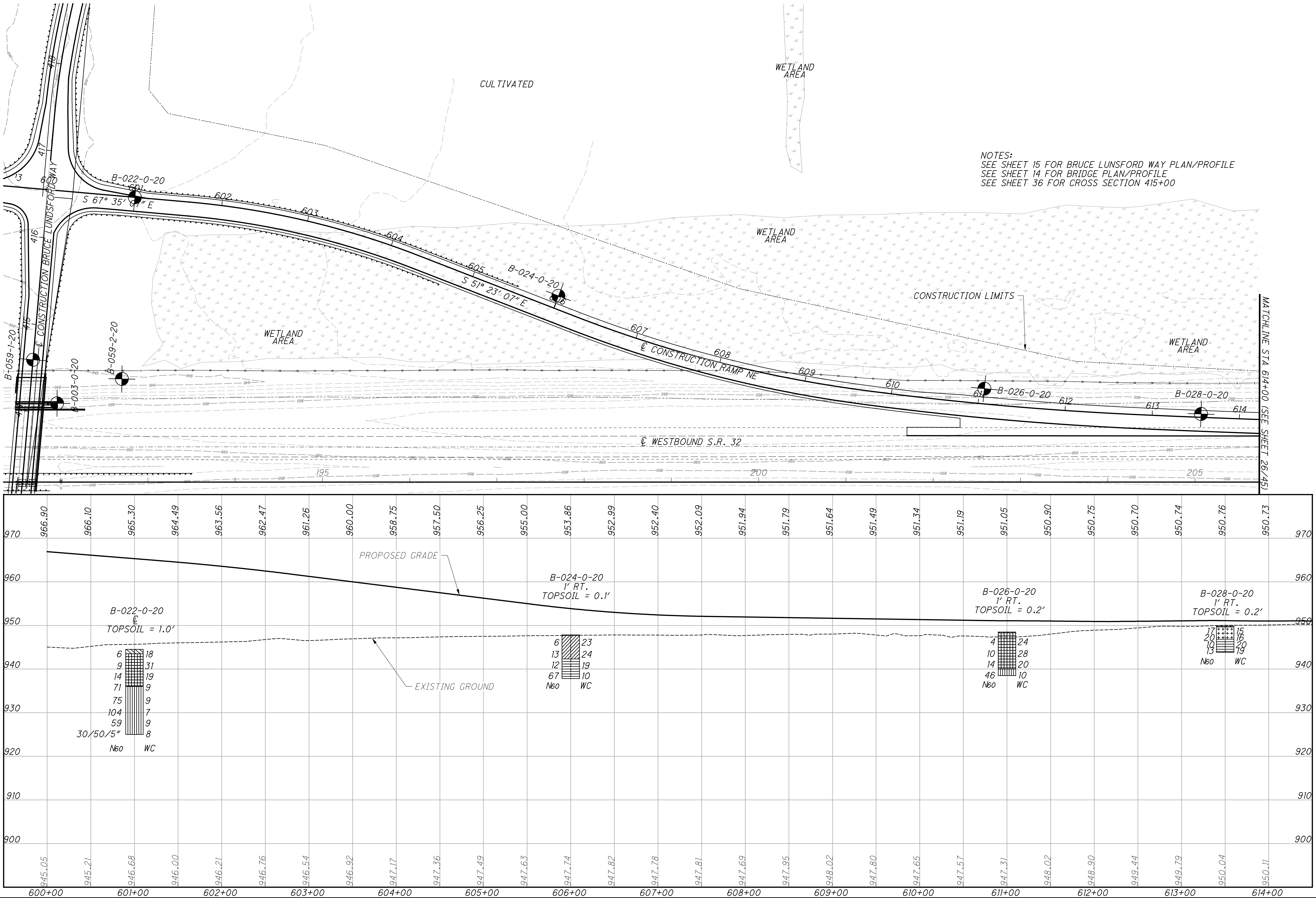


HORIZONTAL SCALE IN FEET
0 25 50 100

DRAWN MSJ
CHECKED EMK

SOIL PROFILE - RAMP NW
STA. 500+00.00 TO 513+38.58

BRO-32-4.16



HORIZONTAL SCALE IN FEET

0 25 50 100

DRAWN MSJ

CHECKED EMK

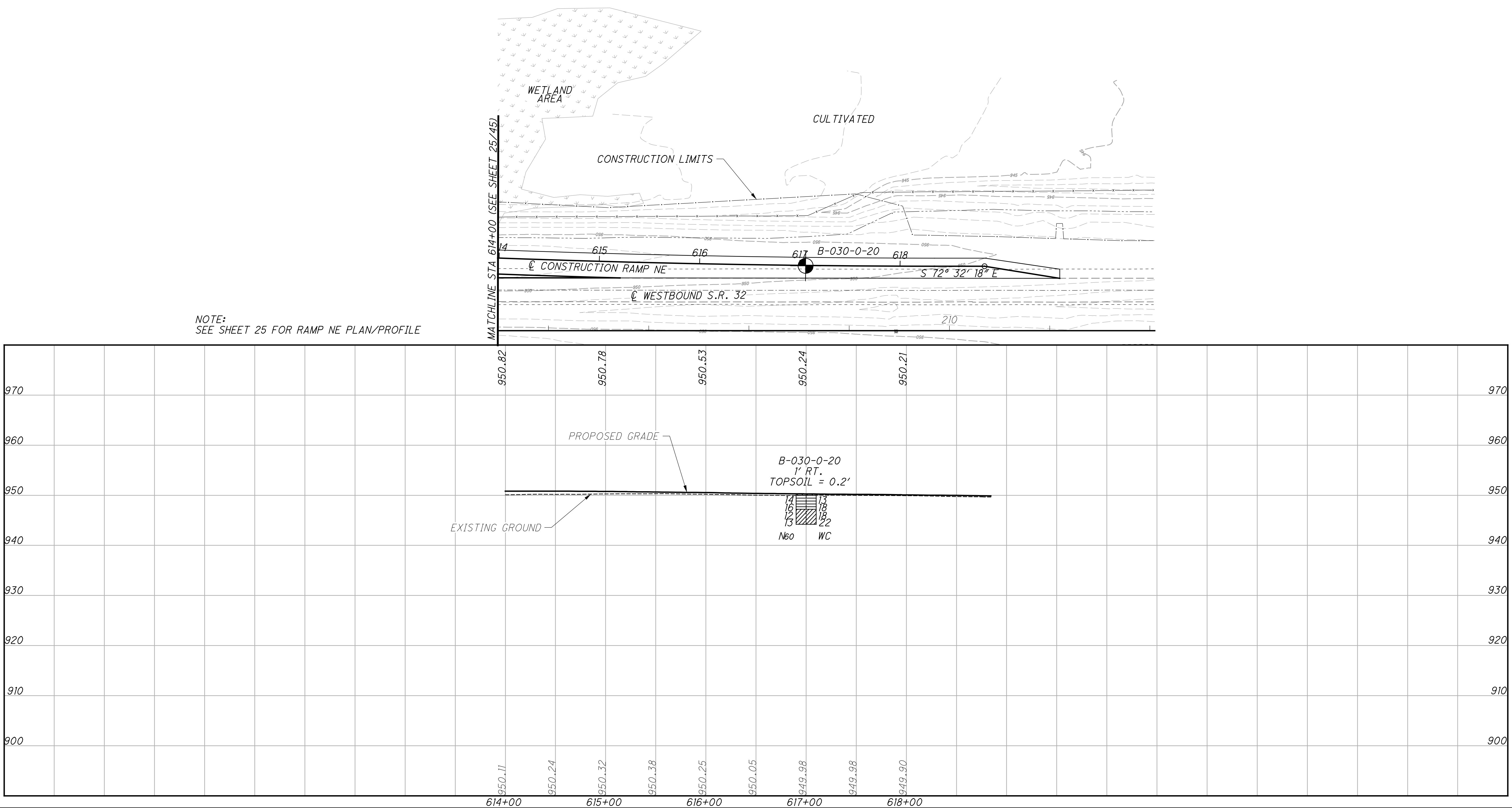
SOIL PROFILE - RAMP NE

STA. 600+00.00 TO 614+00.00

BRO-32-4.16

25/45

NOTE:
SEE SHEET 25 FOR RAMP NE PLAN/PROFILE



HORIZONTAL SCALE IN FEET

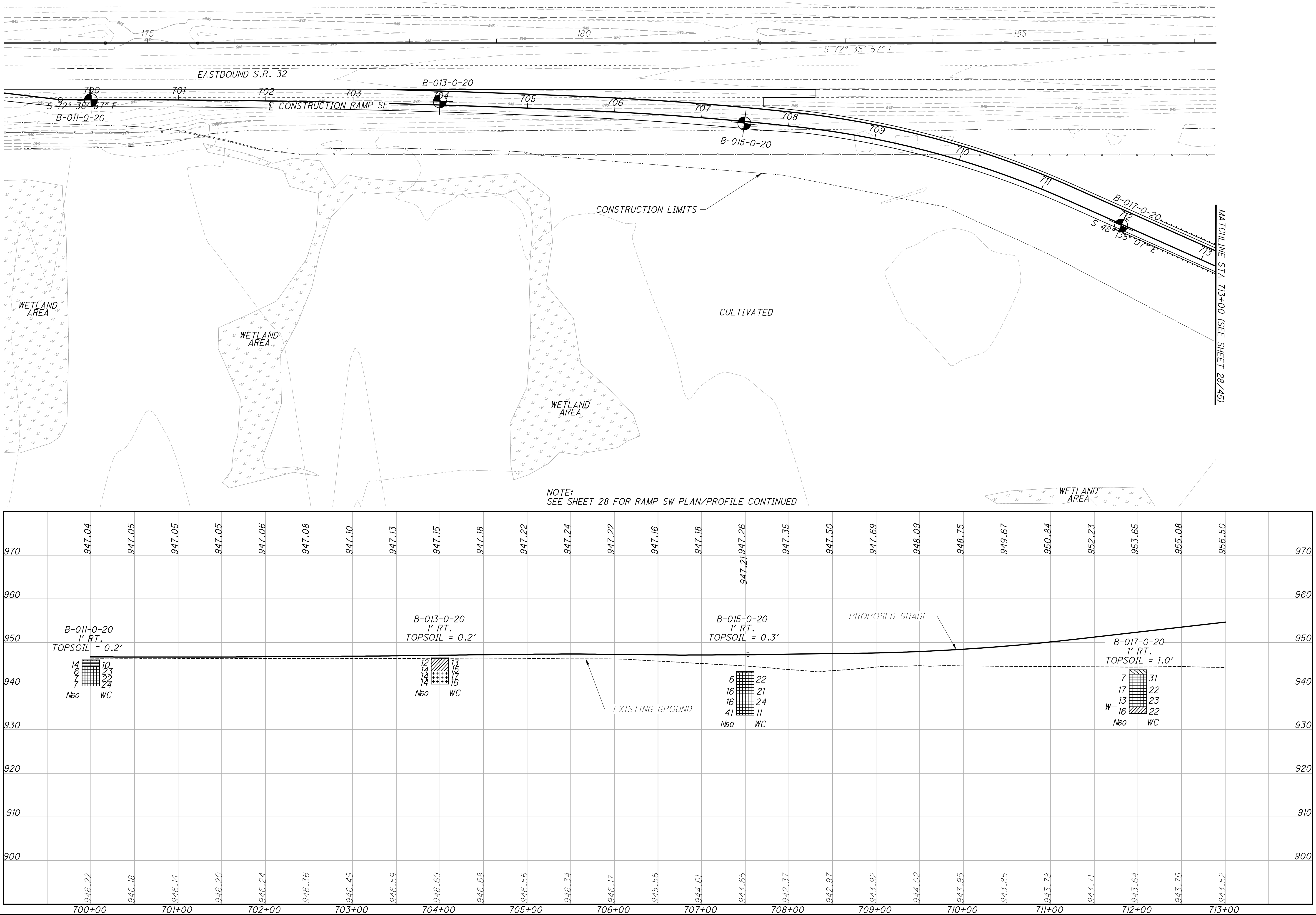
DRAWN MSJ

CHECKED EMK

SOIL PROFILE - RAMP NE (CONTINUED)
STA. 614+00.00 TO 618+84.21

BRO-32-4.16

26/45

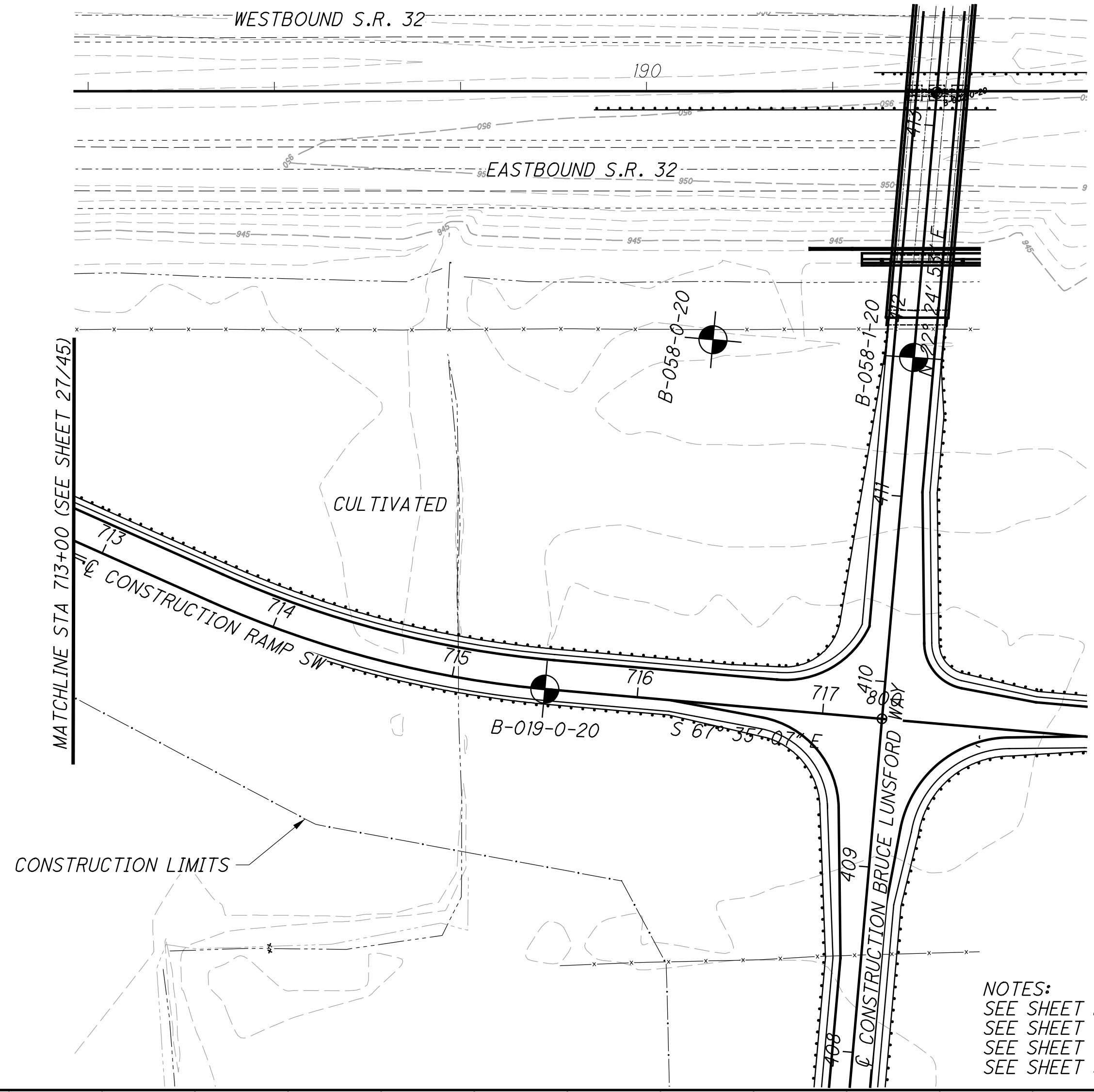


HORIZONTAL SCALE IN FEET
0 25 50 100

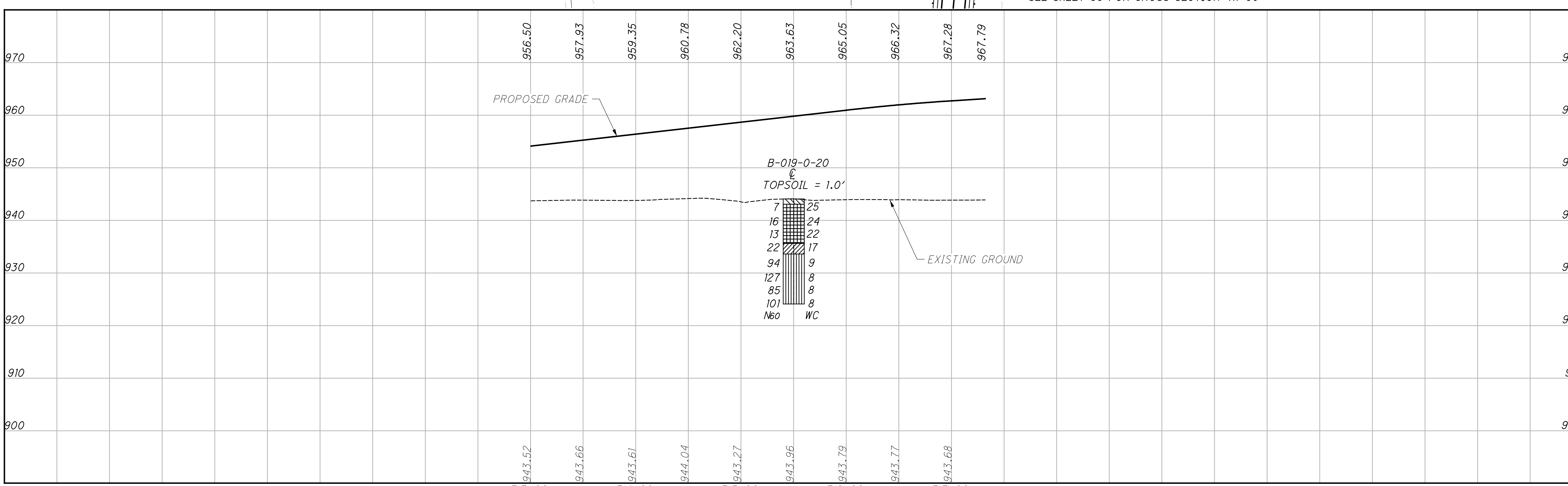
DRAWN MSJ
CHECKED EMK

SOIL PROFILE - RAMP SW
STA. 700+00.00 TO 713+00.00

BRO-32-4.16



NOTES:
SEE SHEET 27 FOR RAMP SW PLAN/PROFILE
SEE SHEET 13 FOR BRUCE LUNSFORD WAY PLAN/PROFILE
SEE SHEET 14 FOR BRIDGE PLAN/PROFILE
SEE SHEET 35 FOR CROSS SECTION 411+50

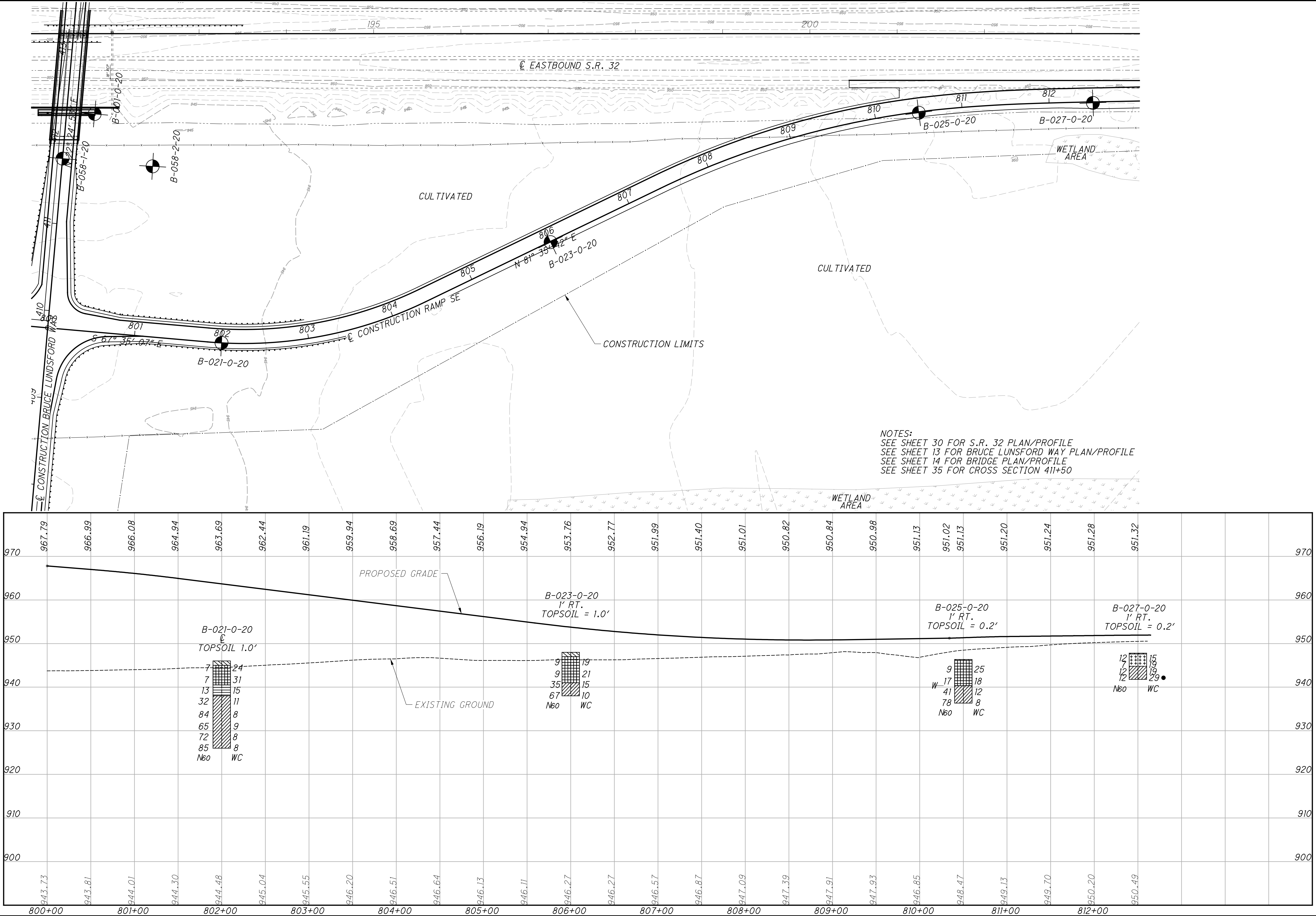


HORIZONTAL SCALE IN FEET
0 25 50 100

DRAWN MSJ
CHECKED EMK

SOIL PROFILE - RAMP SW (CONTINUED)
STA. 713+00.00 TO 717+31.97

BRO-32-4.16



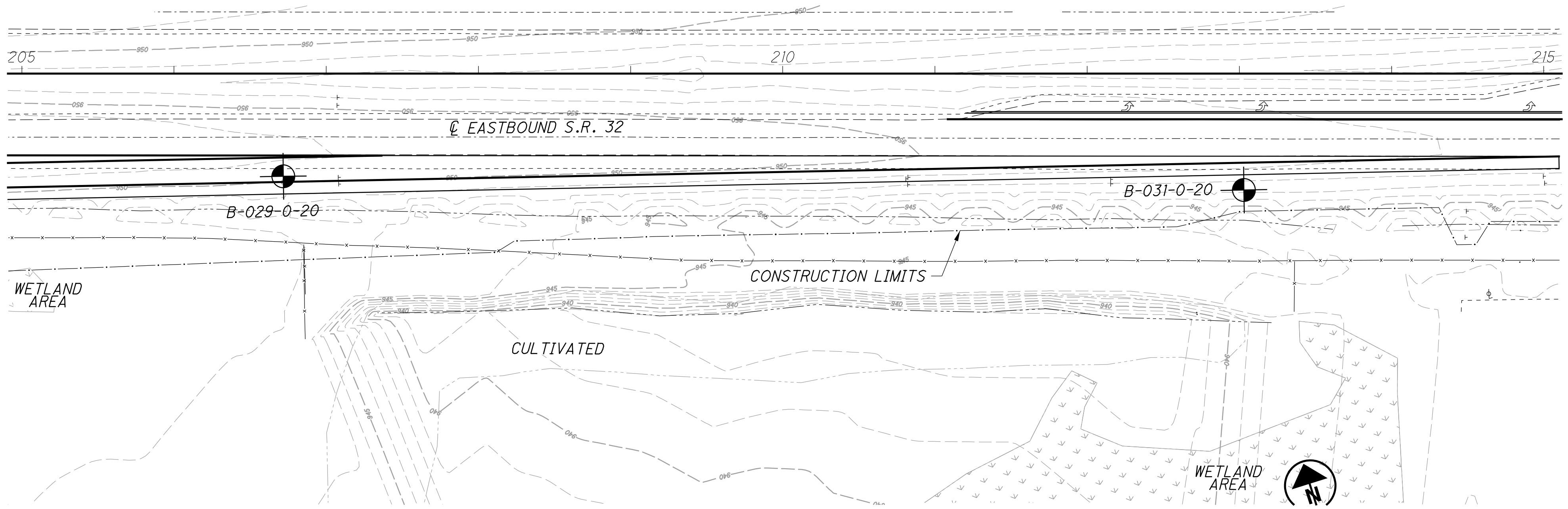
NOTES:
SEE SHEET 30 FOR S.R. 32 PLAN/PROFILE
SEE SHEET 13 FOR BRUCE LUNSFORD WAY PLAN/PROFILE
SEE SHEET 14 FOR BRIDGE PLAN/PROFILE
SEE SHEET 35 FOR CROSS SECTION 411+50

HORIZONTAL SCALE IN FEET

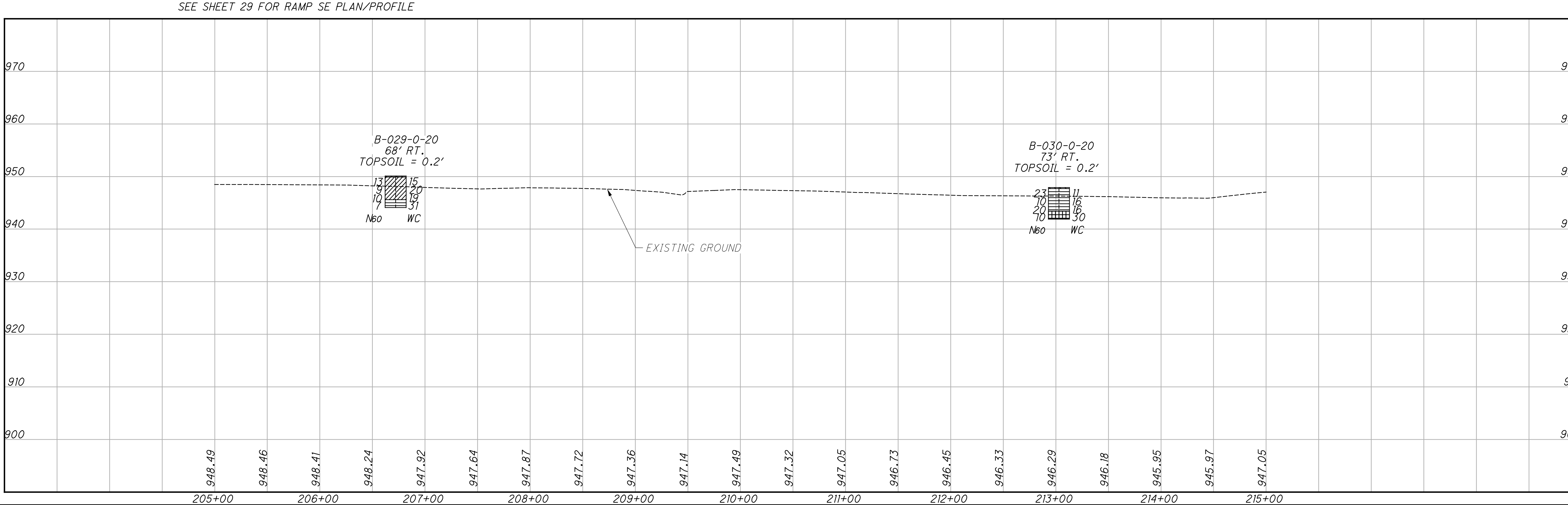
DRAWN MSJ
CHECKED EMK

SOIL PROFILE - RAMP SE
STA. 800+00.00 TO 812+60.87

BRO-32-4.16



NOTES:
SEE SHEET 29 FOR RAMP SE PLAN/PROFILE

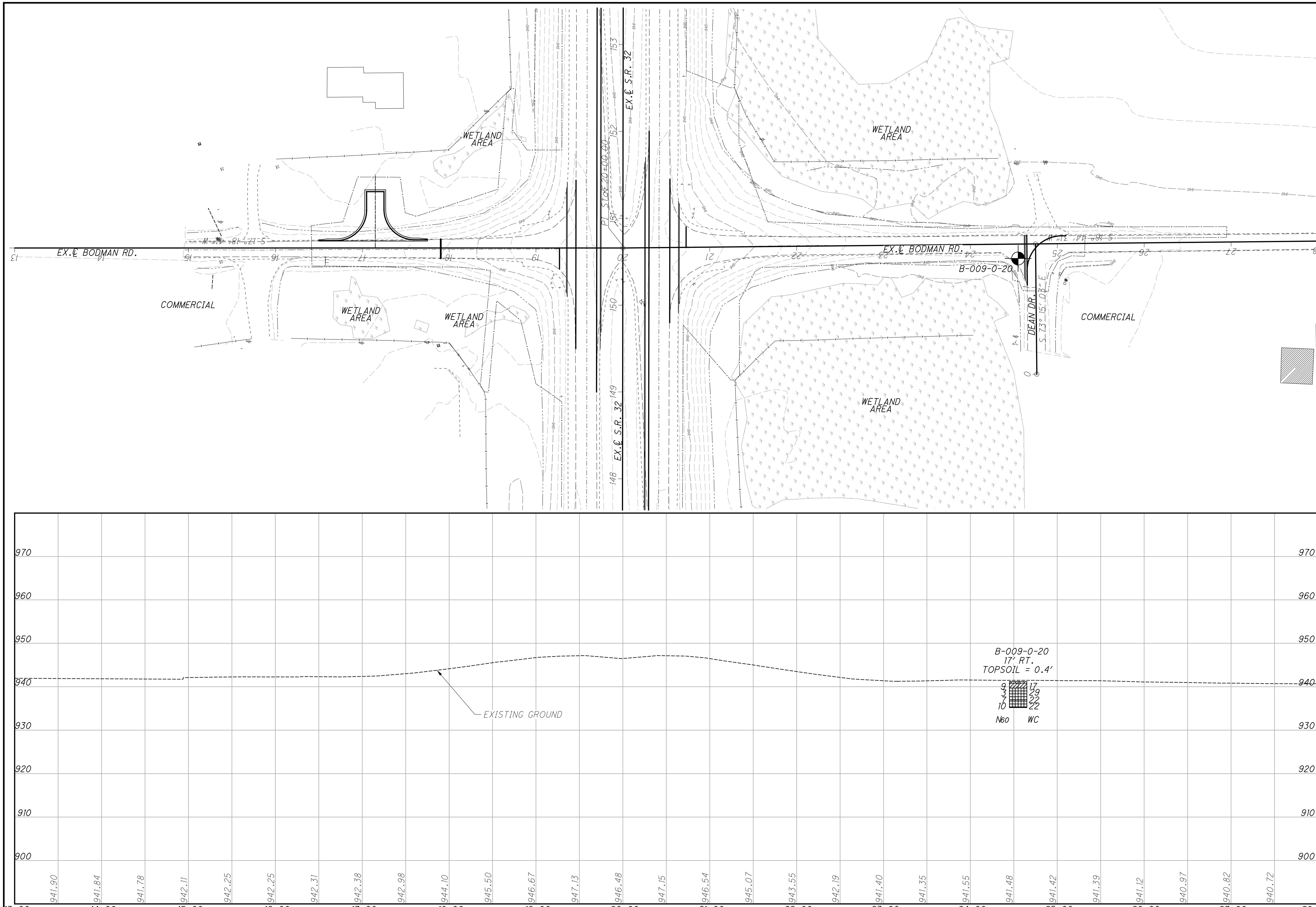


HORIZONTAL SCALE IN FEET
0 25 50 100

DRAWN MSJ
CHECKED EMK

SOIL PROFILE - S.R. 32
STA. 205+00.00 TO 215+00.00

BRO-32-4.16



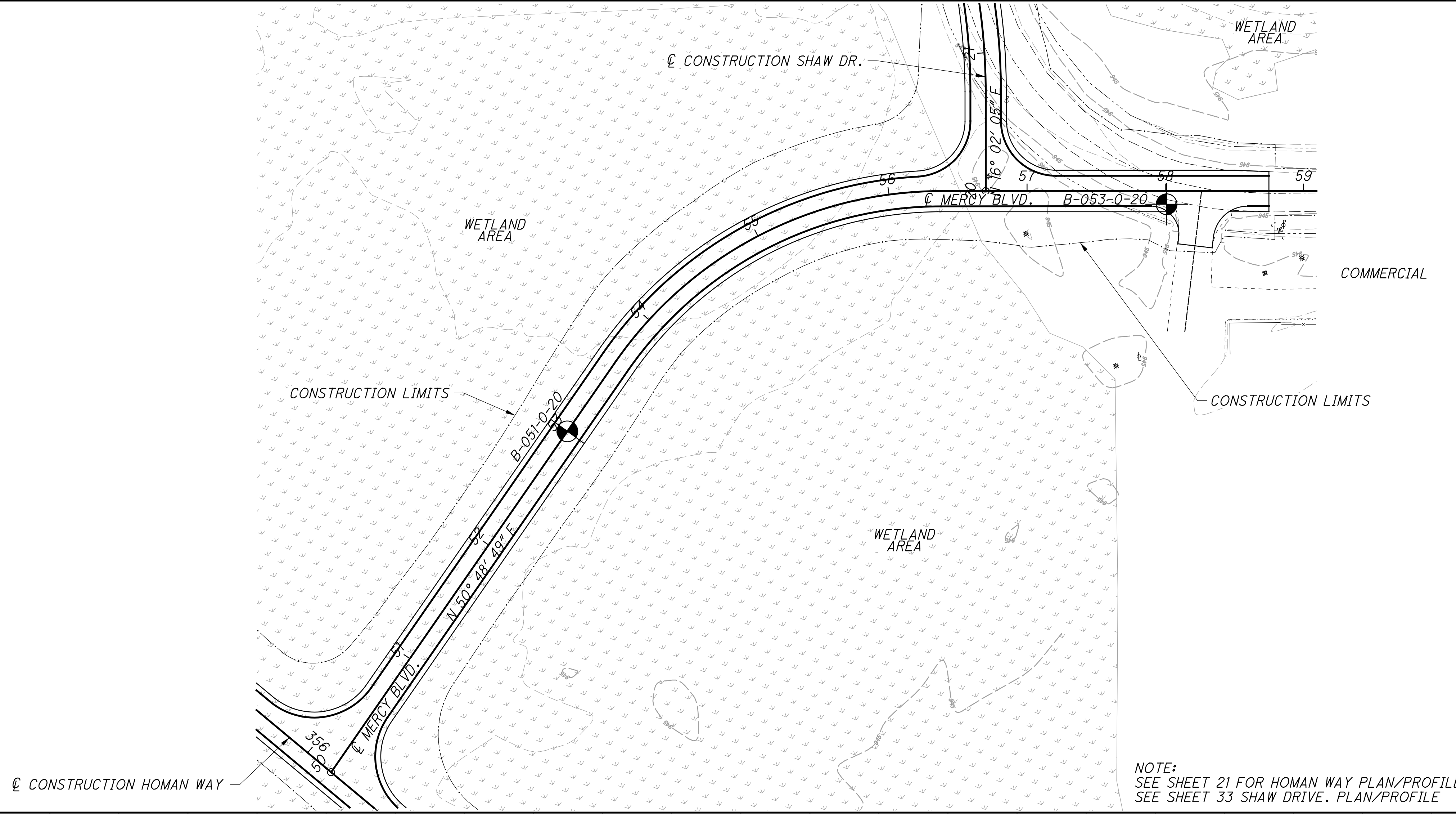
0 25 50 100
HORIZONTAL SCALE IN FEET

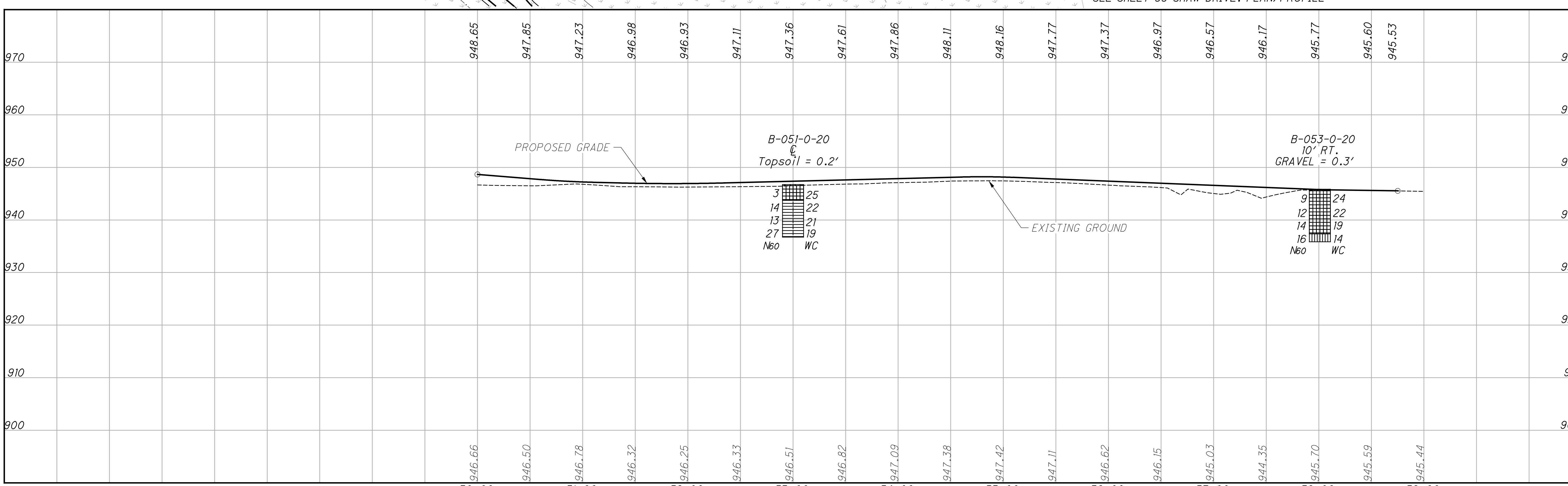
DRAWN MSJ
CHECKED EMK

SOIL PROFILE - BODMAN ROAD
STA. 13+00.00 TO 28+00.00

BRO-32-4.16

31/45



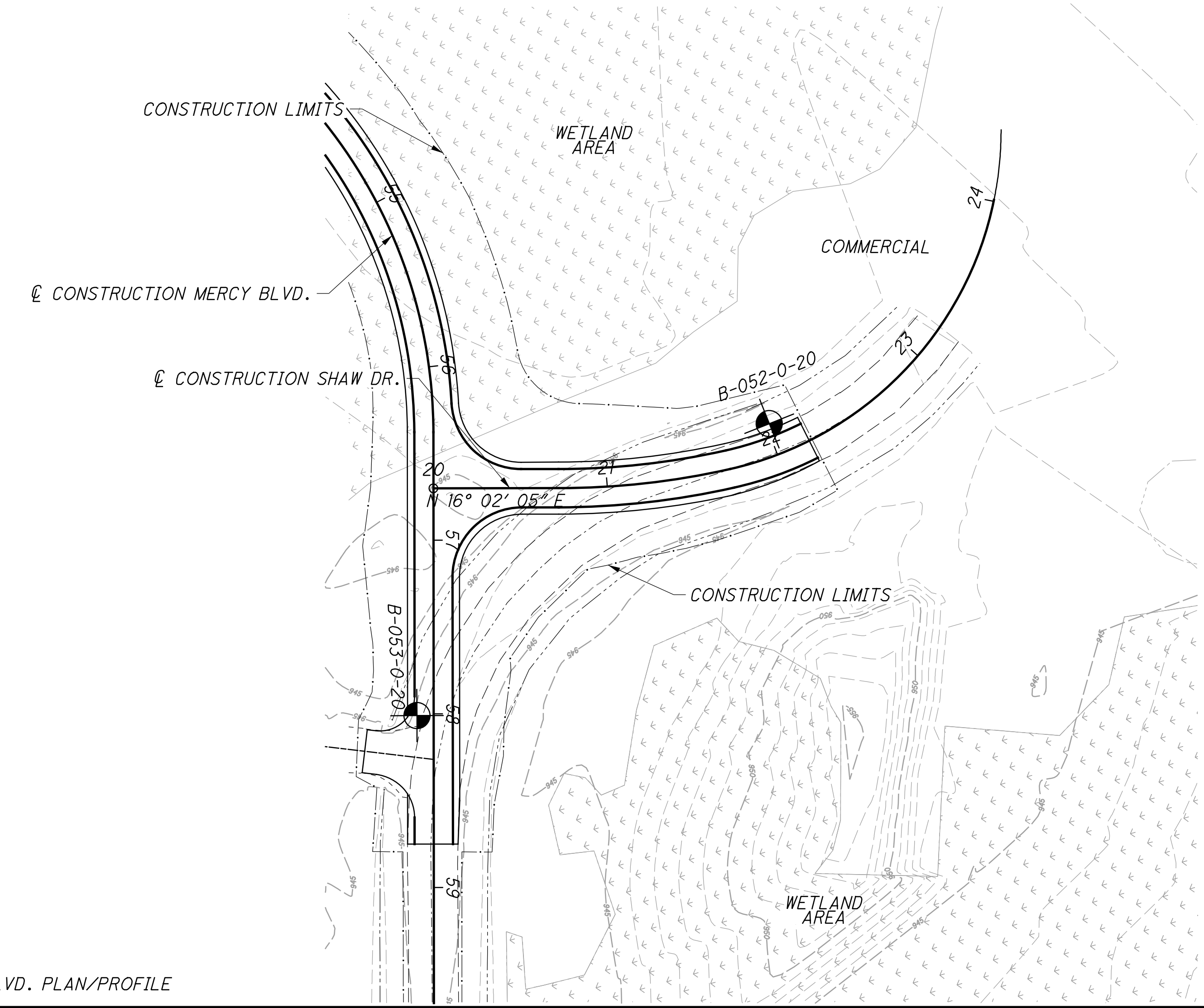


HORIZONTAL SCALE IN FEET
0 25 50 100

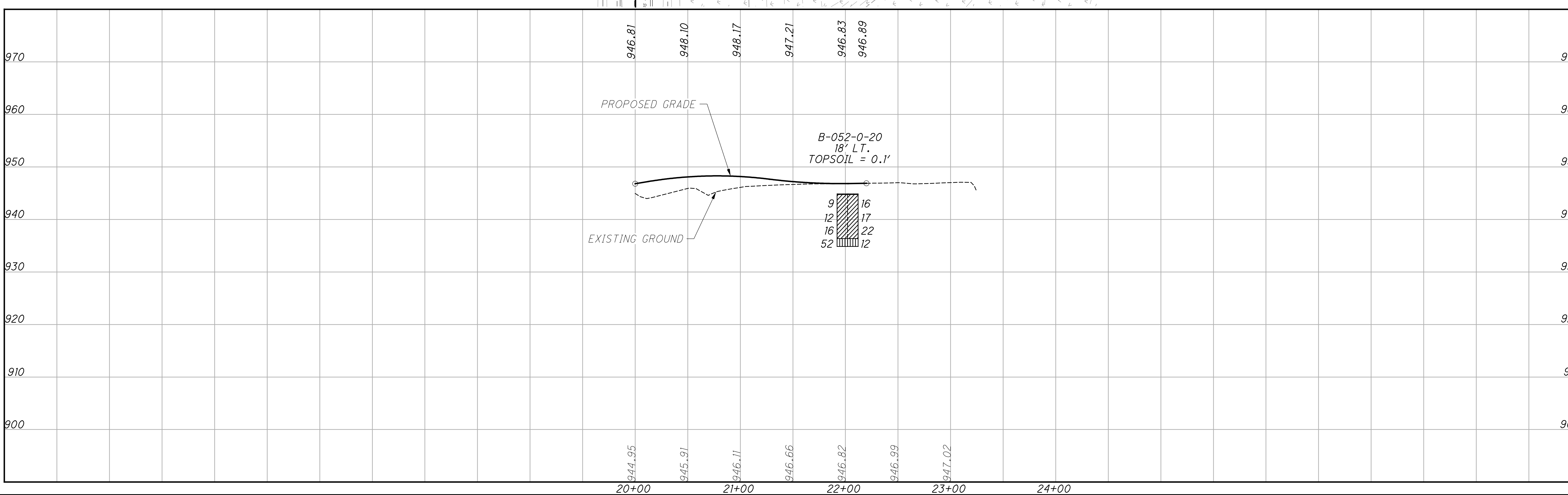
DRAWN MSJ
CHECKED EMK

SOIL PROFILE - MERCY BLVD.
STA. 50+00.00 TO 59+00.00

BRO-32-4.16



NOTE:
SEE SHEET 32 MERCY BLVD. PLAN/PROFILE

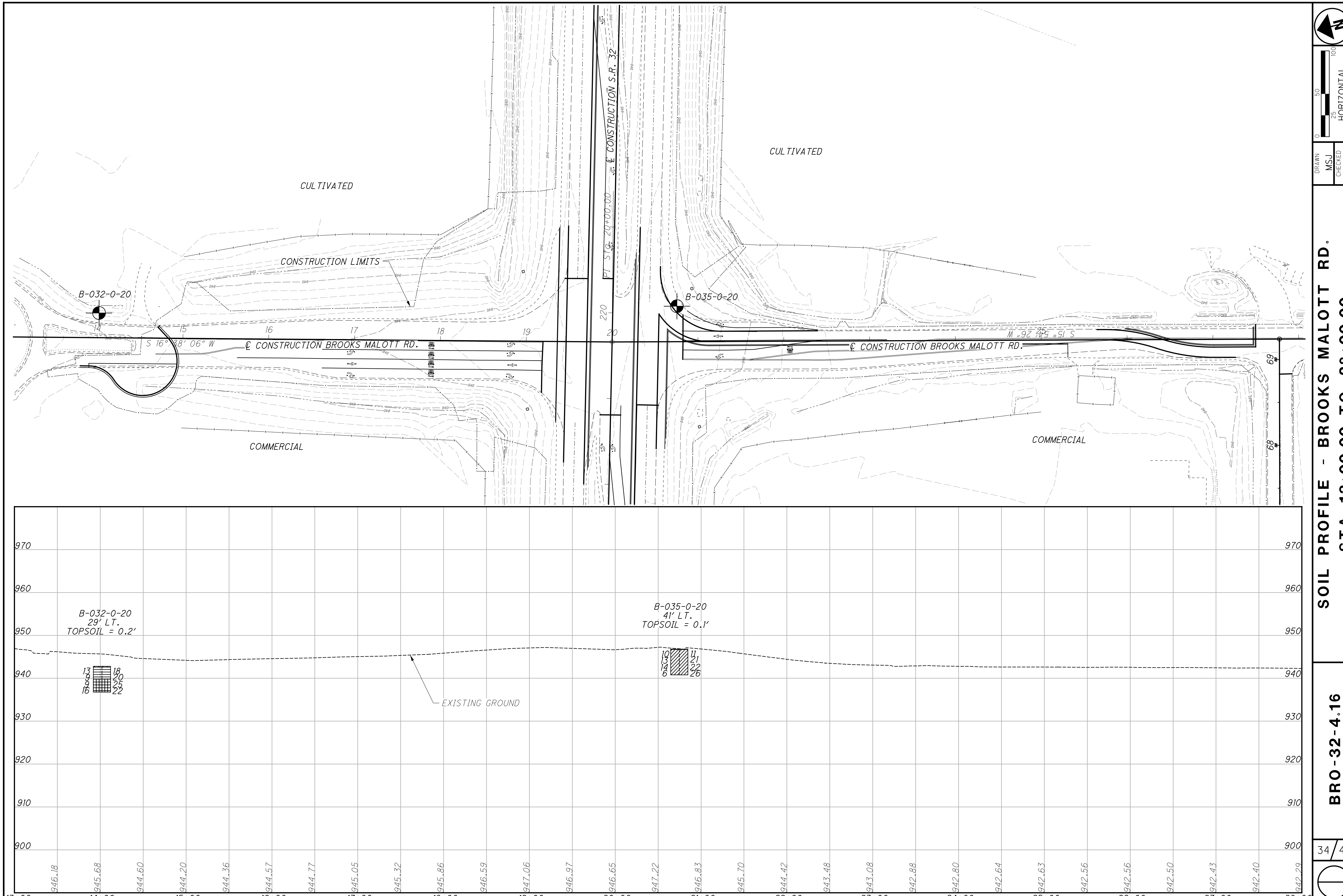


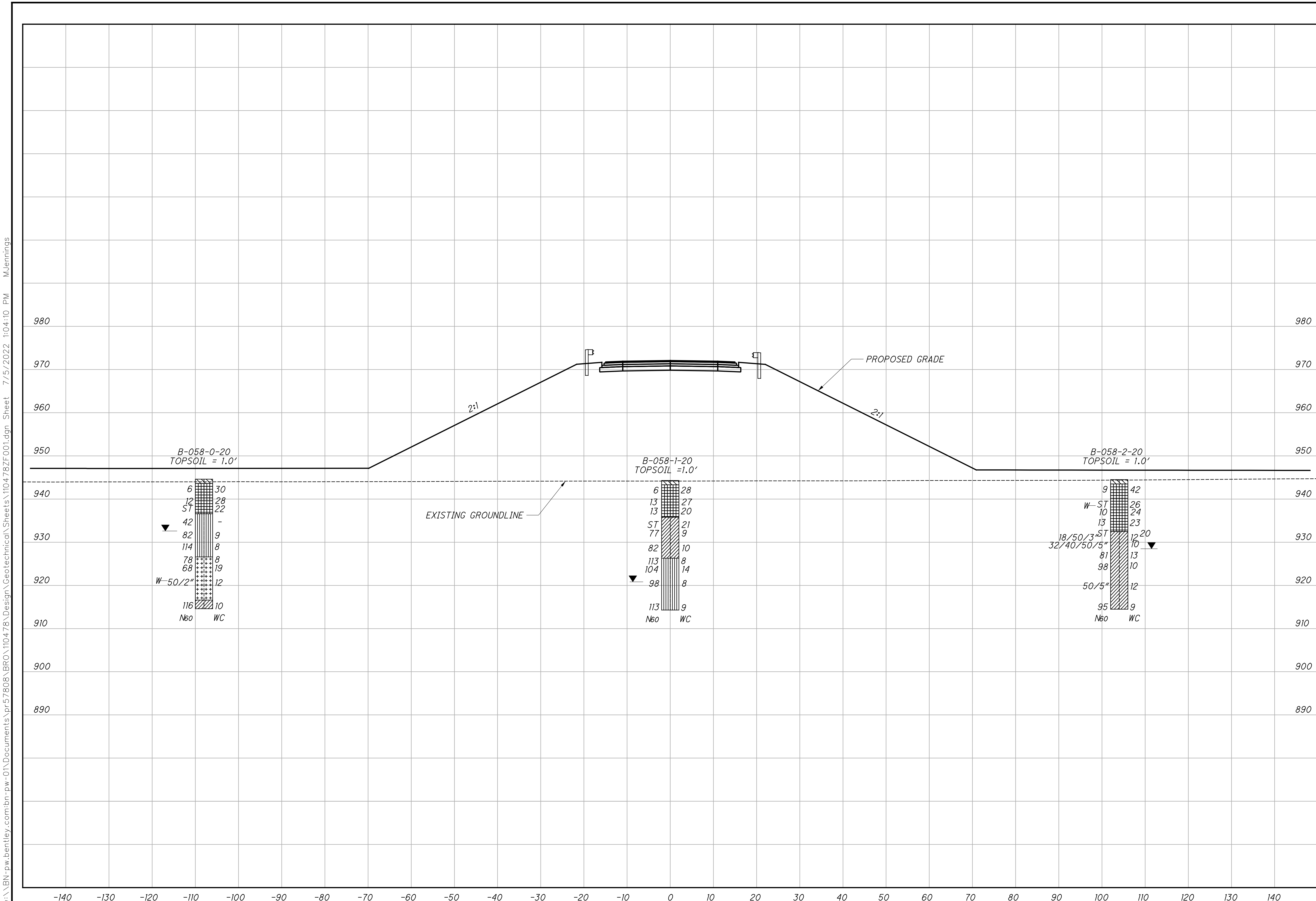
0 25 50 100
HORIZONTAL SCALE IN FEET

DRAWN MSJ
CHECKED EMK

SOIL PROFILE - SHAW DRIVE
STA. 20+00.00 TO 24+41.40

BRO-32-4.16


CULTIVATED
CULTIVATED
CONSTRUCTION LIMITS
B-032-0-20
B-035-0-20
℄ CONSTRUCTION S.R. 32
℄ CONSTRUCTION BROOKS MALOTT RD.
℄ CONSTRUCTION BROOKS MALOTT RD.
S 16° 38' 06" W
S 15° 54' 26" W
COMMERCIAL
COMMERCIAL
B-032-0-20
29' LT.
TOPSOIL = 0.2'
B-035-0-20
41' LT.
TOPSOIL = 0.1'
EXISTING GROUND
970
960
950
940
930
920
910
900
946.18
945.68
944.60
944.20
944.36
944.57
944.77
945.05
945.32
945.86
946.59
947.06
946.97
946.65
947.22
946.83
945.70
944.42
943.48
943.08
942.88
942.80
942.64
942.63
942.56
942.56
942.50
942.43
942.40
942.29
13+00
14+00
15+00
16+00
17+00
18+00
19+00
20+00
21+00
22+00
23+00
24+00
25+00
26+00
27+00
28+00
HORIZONTAL SCALE IN FEET
DRAWN MSJ
CHECKED EMK
SOIL PROFILE - BROOKS MALOTT RD.
STA. 13+00.00 TO 28+00.00
BRO-32-4.16
34/45

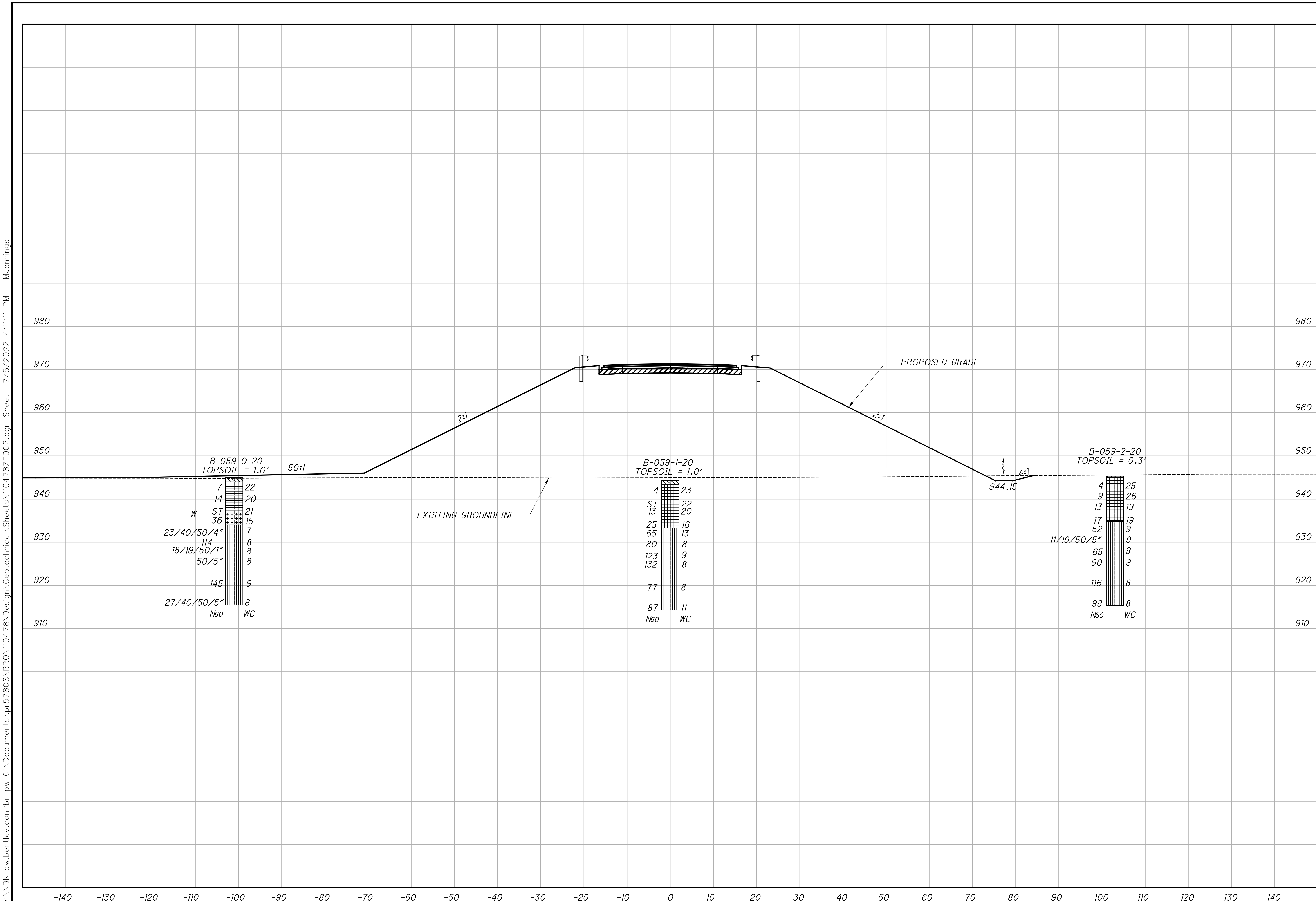


HORIZONTAL SCALE IN FEET

DRAWN MSJ
CHECKED EMK

CROSS SECTION
BRUCE LUNSFORD WAY - STATION 411+50.00

BRO-32-4.16



HORIZONTAL SCALE IN FEET
0 5 10 20

DRAWN MSJ
CHECKED EMK

CROSS SECTION
BRUCE LUNSFORD WAY - STATION 415+00.00

BRO-32-4.16

36/45

pw:\\BN-pw.bentley.com:bn-pw-01\Documents\pr57808\BRO\110478\Design\Geotechnical\Sheets\110478ZF002.dgn Sheet 7/5/2022 4:11:11 PM MJennings

PROJECT: BRO-32-04.16 TYPE: STRUCTURE FOUNDATION PID: 110478 SFN: 0800084 START: 6/18/20 END: 6/18/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT / ST	DRILL RIG: DIEDRICK D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 412+29, 32' RT. ALIGNMENT: BRUCE LUNSFORD WAY ELEVATION: 945.8 (MSL) EOB: 50.0 ft. LAT / LONG: 39.048291, -83.949062	EXPLORATION ID B-001-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 945.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
DARK BROWN, **TOPSOIL**	945.5																	
STIFF, BROWN TO BROWNISH GRAY, **SILT AND CLAY**, TRACE GRAVEL, LITTLE SAND, DAMP TO MOIST		1–2	4 4 3	10	78	SS-1	4.50	4	2	11	45	38	36	22	14	18	A-6a (10)	
		4–5	5 4 4	12	78	SS-2	2.50	4	2	11	45	38	36	22	14	20	A-6a (10)	
		6–7	3 3 6	13	78	SS-3	2.00	-	-	-	-	-	-	-	-	23	A-6a (V)	
		9–10	3 4 5	13	78	SS-4	4.50	-	-	-	-	-	-	-	-	21	A-6a (V)	
FROM 11.0 FT. TO 11.5 FT.: UCS = 0.37 TSF		W 934.8 11–13			100	ST-1	-	-	-	-	-	-	-	-	-	23	A-6a (V)	
HARD, BROWNISH GRAY TO GRAY, **SANDY SILT**, TRACE TO LITTLE GRAVEL, SOME CLAY, DAMP TO MOIST	932.8	14–15	10 20 17	54	78	SS-5	4.00	6	8	13	49	24	22	16	6	20	A-4a (8)	
		16–17	22 24 32	81	78	SS-6	4.50	6	8	13	49	24	22	16	6	10	A-4a (8)	
		19–20	25 37 50	126	78	SS-7	4.50	12	12	16	33	27	25	16	9	11	A-4a (5)	
		21–22	47 40 50	130	78	SS-8	4.50	12	12	16	33	27	25	16	9	12	A-4a (5)	
		24–25	20 29 50/5"	-	82	SS-9	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	
		29	26 50/3"	-	100	SS-10	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
		34	50/5"	-	100	SS-11	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
		39–40	13 15 35	72	78	SS-12	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
		44–45	9 15 29	64	78	SS-13	4.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
	895.8	49–50 EOB	9 12 17	42	78	SS-14	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT

BRO-32-4.16

STRUCTURE FOUNDATION EXPLORATION
BORING LOG B-001-0-20

DRAWN MSJ
CHECKED EMK

PROJECT: BRO-32-04.16 TYPE: STRUCTURE FOUNDATION PID: 110478 SFN: 0800084 START: 6/17/20 END: 6/17/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT / ST	DRILL RIG: DIEDRICK D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 413+18, CL ALIGNMENT: BRUCE LUNSFORD WAY ELEVATION: 948.1 (MSL) EOB: 50.0 ft. LAT / LONG: 39.048550, -83.949054	EXPLORATION ID B-002-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
	948.1																	
DARK BROWN, **TOPSOIL**	947.7																	
STIFF TO VERY STIFF, BROWN TO BROWNISH GRAY, **SILT AND CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST		1–2	5 8 10	26	67	SS-1	4.50	8	3	13	46	30	31	17	14	15	A-6a (10)	
		4–5	5 3 6	13	100	SS-2	3.00	8	3	13	46	30	31	17	14	25	A-6a (10)	
		6–8			100	ST-1	-	-	-	-	-	-	-	-	-	25	A-6a (V)	
	939.6																	
STIFF TO VERY STIFF, BROWNISH GRAY, **SILTY CLAY**, LITTLE GRAVEL, SOME SAND, DAMP TO MOIST		8.5–10	3 3 5	12	100	SS-3	3.00	-	-	-	-	-	-	-	-	21	A-6b (V)	
		11–12.5	2 4 5	13	100	SS-4	4.00	14	8	17	30	31	36	17	19	20	A-6b (9)	
		13.5–15	2 7 8	22	100	SS-5	4.50	14	8	17	30	31	36	17	19	11	A-6b (9)	
	932.1	W 932.1																
HARD, BROWNISH GRAY TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP TO MOIST		16–17.5	7 17 28	65	100	SS-6	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
		18.5–20	18 27 38	94	100	SS-7	4.50	19	11	16	30	24	23	13	10	10	A-4a (4)	
		21–22.5	22 28 45	106	100	SS-8	4.50	19	11	16	30	24	23	13	10	10	A-4a (4)	
		23.5–25	38 40 48	127	100	SS-9	4.50	-	-	-	-	-	-	-	-	13	A-4a (V)	
		28.5–30	17 22 40	90	100	SS-10	4.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
		33.5–35	34 28 28	81	100	SS-11	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	
		38.5–40	11 17 28	65	100	SS-12	4.00	-	-	-	-	-	-	-	-	12	A-4a (V)	
		43.5–45	34 26 30	81	56	SS-13	4.50	-	-	-	-	-	-	-	-	5	A-4a (V)	
		48.5–50	9 12 21	48	100	SS-14	4.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
	898.1	EOB 50																

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICK D-50	STATION / OFFSET: 414+12, 32' RT.
TYPE: STRUCTURE FOUNDATION	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BRUCE LUNSFORD WAY
PID: 110478 SFN: 0800084	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 945.2 (MSL) EOB: 50.0 ft.
START: 6/17/20 END: 6/17/20	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 86.8	LAT / LONG: 39.048759, -83.948828

EXPLORATION ID: B-003-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 945.2	DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
DARK BROWN, **TOPSOIL**	945.0																	
MEDIUM STIFF TO STIFF, BROWN, **SILTY CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST		1–2	4 2 3	7	78	SS-1	1.50	-	-	-	-	-	-	-	-	22	A-6b (V)	
FROM 4.0 FT. TO 4.5 FT.: UCS = 0.81 TSF		4–5			100	ST-1	-	-	-	-	-	-	-	-	-	21	A-6b (V)	
		6–7	2 3 4	10	78	SS-2	1.50	5	4	12	37	42	39	21	18	23	A-6b (11)	
FROM 9.1 FT. TO 9.6 FT.: UCS = 1.55 TSF		9–10			79	ST-2	-	-	-	-	-	-	-	-	-	19	A-6b (V)	
		11–12	2 4 8	17	67	SS-3	2.00	5	4	12	37	42	39	21	18	21	A-6b (11)	
	931.7	13																
VERY STIFF TO HARD, GRAY BROWN TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP		14–15	16 18 31	71	78	SS-4	4.50	22	12	16	29	21	22	13	9	9	A-4a (3)	
		16–17	27 23 33	81	78	SS-5	4.50	22	12	16	29	21	22	13	9	9	A-4a (3)	
		19	36 50/5"	-	82	SS-6	4.50	-	-	-	-	-	-	-	-	7	A-4a (V)	
		21–22	21 24 42	95	78	SS-7	4.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
		24	38 50/6"	-	100	SS-8	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
		29–30	29 31 43	107	78	SS-9	4.50	15	12	16	31	26	24	15	9	8	A-4a (4)	
		34	19 50/6"	-	100	SS-10	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
		39–40	12 33 50	120	78	SS-11	4.50	-	-	-	-	-	-	-	-	6	A-4a (V)	
		44–45	11 16 18	49	78	SS-12	4.50	15	12	16	31	26	24	15	9	11	A-4a (4)	
	895.2	49–50 EOB	8 9 15	35	78	SS-13	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT

39/45	BRO-32-4.16	STRUCTURE FOUNDATION EXPLORATION BORING LOG B-003-0-20	DRAWN MSJ CHECKED EMK

PROJECT: BRO-32-3.75	DRILLING FIRM / OPERATOR: CTL / LH	DRILL RIG: CME 550/# 349	STATION / OFFSET: 411+95.8, 46' LT.
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: CTL / LH	HAMMER: CME AUTOMATIC	ALIGNMENT: BRUCE LUNDFORD WAY
PID: 98608 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 10/29/13	ELEVATION: 944.2 (MSL) EOB: 40.0 ft.
START: 3/19/15 END: 3/19/15	SAMPLING METHOD: SPT	ENERGY RATIO (%): 81.2	LAT/LONG: 39.048284, 83.949360

EXPLORATION ID B-001-0-15 — PAGE 1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 944.2	DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	ABANDONED
Topsoil (6")	943.7																	
MEDIUM STIFF, BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		1–2	2 2 2	5	67	SS-1	1.00	1	2	13	56	28	35	17	18	29	A-6b (11)	
@3.5'; STIFF		4	3 3 3	8	22	SS-2	2.00	-	-	-	-	-	-	-	-	18	A-6b (V)	
		7			-	ST-3	-	10	6	19	31	34	36	18	18	20	A-6b (9)	
HARD, GRAY, **SILT**, SOME CLAY, LITTLE SAND, TRACE GRAVEL WITH COBBLES, DAMP	935.7	9 (W)	17 22 27	66	17	SS-4	-	-	-	-	-	-	-	-	-	7	A-4b (V)	
@11.0'; STIFF		12	14 22 23	61	33	SS-5	1.50	-	-	-	-	-	-	-	-	20	A-4b (V)	
HARD, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP	931.2	14	14 18 21	53	67	SS-6	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	
		17	21 29 38	91	78	SS-7	4.50	8	11	19	39	23	26	13	13	9	A-6a (7)	
DENSE, GRAY, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, TRACE SILT, TRACE CLAY, DAMP	926.2	19	14 12 19	42	33	SS-8	-	19	40	29	10	2	NP	NP	NP	13	A-1-b (0)	
HARD, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP	923.7	22	23 47 34	110	67	SS-9	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	
@23.5'; STIFF		24	43 50/1"	-	57	SS-10	1.50	-	-	-	-	-	-	-	-	10	A-6a (V)	
@28.5'; HARD		29	32 39 41	108	72	SS-11	4.50	7	10	20	43	20	24	13	11	9	A-6a (6)	

PID: 98608	SFN:	PROJECT: BRO-32-3.75	STATION / OFFSET: 411+95.8, 46' LT.	START: 3/19/15 END: 3/19/15	PG 2 OF 2 B-001-0-15

MATERIAL DESCRIPTION AND NOTES	ELEV. 914.2	DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	ABANDONED
HARD, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP *(continued)*		34	21 36 41	104	67	SS-12	4.50	-	-	-	-	-	-	-	-	10	A-6a (V)	
	904.2	39 — EOB 40	14 24 25	66	89	SS-13	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	

NOTES: CAVED AT 22.1'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; BACKFILLED WITH SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/14/15 11:45 - J:\DEPTS\15 PROJECTS\15050023COL-MCCORMICK TAYLOR-BRO-32-3.75\REPORTS\LOGS\15050023COL.GPJ

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/14/15 11:45 - J:\DEPTS\15 PROJECTS\15050023COL-MCCORMICK TAYLOR-BRO-32-3.75\REPORTS\LOGS\15050023COL.GPJ

BRO-32-4.16

STRUCTURE FOUNDATION EXPLORATION BORING LOG B-001-0-15

DRAWN MSJ CHECKED EMK

PROJECT: BRO-32-3.75 TYPE: STRUCTURE PID: 98608 SFN: START: 3/19/15 END: 3/19/15	DRILLING FIRM / OPERATOR: CTL / LH SAMPLING FIRM / LOGGER: CTL / LH DRILLING METHOD: 3.25" HSA SAMPLING METHOD: SPT	DRILL RIG: CME 550/# 349 HAMMER: CME AUTOMATIC CALIBRATION DATE: 10/29/13 ENERGY RATIO (%): 81.2	STATION / OFFSET: 412+33.1, 92' LT. ALIGNMENT: BRUCE LUNDFORD WAY ELEVATION: 948.7 (MSL) EOB: 50.0 ft. LAT/LONG: 39.048428, 83.949462

EXPLORATION ID B-002-0-15 — PAGE 1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 948.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	ABANDONED
Topsoil (3")	948.5																	
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, FILL, DAMP		1–2	3 4 5	12	67	SS-1	2.00	2	1	10	54	33	38	17	21	18	A-6b (12)	
@3.5'; VERY STIFF	943.2	4–5	3 5 6	15	94	SS-2	2.50	1	5	15	48	31	35	17	18	20	A-6b (11)	
STIFF, GRAY, **CLAY**, AND SILT, LITTLE SAND, TRACE GRAVEL, MOIST		6–7	3 3 3	8	67	SS-3	1.50	1	3	8	65	23	45	19	26	26	A-7-6 (15)	
@8.5'; NO RECOVERY		9–10	3 5 5	14	0	SS-4	-	-	-	-	-	-	-	-	-	-	A-7-6 (V)	
		11–12	4 5 6	15	72	SS-5	2.00	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
@13.5'; NO GRAVEL	933.2	14–15 W	6 6 9	20	44	SS-6	2.50	0	2	15	46	37	56	18	38	20	A-7-6 (19)	
HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP		16–17	11 19 39	78	67	SS-7	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	
		19–20	21 20 39	80	89	SS-8	4.50	8	11	20	38	23	26	13	13	7	A-6a (6)	
@20.5'; ENCOUNTERED COBBLES @21.0'; VERY STIFF		21–22	21 21 49	95	50	SS-9	3.00	-	-	-	-	-	-	-	-	9	A-6a (V)	
		24–25	11 19 23	57	72	SS-10	4.00	-	-	-	-	-	-	-	-	10	A-6a (V)	
@28.5'; HARD		29	29 36 49	115	56	SS-11	-	-	-	-	-	-	-	-	-	9	A-6a (V)	

PID: 98608	SFN:	PROJECT: BRO-32-3.75	STATION / OFFSET: 412+33.1, 92' LT.	START: 3/19/15 END: 3/19/15	PG 2 OF 2 B-002-0-15

MATERIAL DESCRIPTION AND NOTES	ELEV. 918.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	ABANDONED
HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP *(continued)*		34–35	31 29 47	103	89	SS-12	4.50	9	10	19	41	21	24	13	11	9	A-6a (6)	
@38.5'; VERY STIFF		39–40	18 26 34	81	78	SS-13	4.00	-	-	-	-	-	-	-	-	11	A-6a (V)	
		44–45	14 19 26	61	67	SS-14	4.00	-	-	-	-	-	-	-	-	11	A-6a (V)	
	898.7	49–50 EOB	31 38 42	108	67	SS-15	3.50	-	-	-	-	-	-	-	-	10	A-6a (V)	

NOTES: CAVED AT 16.4'
ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; BACKFILLED WITH SOIL CUTTINGS

BRO-32-4.16

STRUCTURE FOUNDATION EXPLORATION
BORING LOG B-002-0-15

DRAWN MSJ
CHECKED EMK

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/14/15 11:45 - J:\DEPT5\15 PROJECTS\15050023COL-MCCORMICK TAYLOR-BRO-32-3.75\REPORTS\LOGS\15050023COL.GPJ

PROJECT: BRO-32-3.75
TYPE: STRUCTURE
PID: 98608 SFN:
START: 3/23/15 END: 3/23/15

DRILLING FIRM / OPERATOR: CTL / LH
SAMPLING FIRM / LOGGER: CTL / LH
DRILLING METHOD: 3.25" HSA
SAMPLING METHOD: SPT

DRILL RIG: CME 550/# 349
HAMMER: CME AUTOMATIC
CALIBRATION DATE: 10/29/13
ENERGY RATIO (%): 81.2

STATION / OFFSET: 413+85.8, 66' LT.
ALIGNMENT: BRUCE LUNDFORD WAY
ELEVATION: 949.5 (MSL) EOB: 45.0 ft.
LAT/LONG: 39.048790, 83.949183

EXPLORATION ID B-003-0-15
PAGE 1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 949.5	DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
Topsoil (4")	949.2																	
VERY STIFF, BROWN, **CLAY**, AND SILT, SOME SAND, TRACE GRAVEL, FILL, DAMP		1–2	3 5 5	14	72	SS-1	4.00	4	5	20	36	35	42	19	23	16	A-7-6 (13)	
		4–5	4 6 8	19	83	SS-2	4.00	-	-	-	-	-	-	-	-	16	A-7-6 (V)	
VERY STIFF, BROWN AND GRAY, **CLAY**, AND SILT, LITTLE SAND, TRACE GRAVEL, MOIST	943.5	6–7	4 3 3	8	44	SS-3	3.50	2	2	11	52	33	45	17	28	29	A-7-6 (16)	
		9–10	4 6 6	16	78	SS-4	3.00	-	-	-	-	-	-	-	-	26	A-7-6 (V)	
HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP	938.5	11–12	5 6 8	19	56	SS-5	4.50	8	10	20	36	26	26	15	11	13	A-6a (6)	
		14–15	12 17 19	49	78	SS-6	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	
@16.0'; LITTLE GRAVEL		16–17	11 16 24	54	89	SS-7	4.50	13	11	19	33	24	25	13	12	8	A-6a (5)	
@18.5'; GRAY		19–20	19 21 24	61	89	SS-8	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	
		21–22	19 20 34	73	83	SS-9	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	
		24–25 (▼ 24; W 27)	20 29 30	80	67	SS-10	4.50	-	-	-	-	-	-	-	-	6	A-6a (V)	
		28.5–29	22 32 50/3"	-	80	SS-11	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/14/15 11:45 - J:\DEPT5\15 PROJECTS\15050023COL-MCCORMICK TAYLOR-BRO-32-3.75\REPORTS\LOGS\15050023COL.GPJ

PID: 98608 SFN: PROJECT: BRO-32-3.75 STATION / OFFSET: 413+85.8, 66' LT. START: 3/23/15 END: 3/23/15 PG 2 OF 2 B-003-0-15

MATERIAL DESCRIPTION AND NOTES	ELEV. 919.5	DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP *(continued)*		31–33																
HARD, GRAY, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, TILL, DAMP	916.0	34–35	37 37 49	116	72	SS-12	4.50	9	10	19	36	26	23	13	10	9	A-4a (5)	
		39–40	27 28 36	87	44	SS-13	-	-	-	-	-	-	-	-	-	6	A-4a (V)	
@43.5'; VERY STIFF	904.5	44–45 (EOB)	18 19 26	61	50	SS-14	3.00	-	-	-	-	-	-	-	-	11	A-4a (V)	

NOTES: CAVED AT 34.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; BACKFILLED WITH SOIL CUTTINGS

BRO-32-4.16

STRUCTURE FOUNDATION EXPLORATION
BORING LOG B-003-0-15

DRAWN MSJ
CHECKED EMK

PROJECT: BRO-32-3.75	DRILLING FIRM / OPERATOR: CTL / LH	DRILL RIG: CME 550/# 349	STATION / OFFSET: 414+17.4, 101' LT.	EXPLORATION ID B-004-0-15
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: CTL / LH	HAMMER: CME AUTOMATIC	ALIGNMENT: BRUCE LUNDFORD WAY	
PID: 98608 SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 10/29/13	ELEVATION: 944.7 (MSL) EOB: 40.0 ft.	PAGE 1 OF 2
START: 3/23/15 END: 3/24/15	SAMPLING METHOD: SPT	ENERGY RATIO (%): 81.2	LAT/LONG: 39.048906, 83.949256	

MATERIAL DESCRIPTION AND NOTES	ELEV. 944.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
Topsoil (4")	944.4																	
STIFF, BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		1–2	2, 2, 2	5	67	SS-1	2.00	1	3	15	54	27	34	18	16	27	A-6b (10)	
@3.5'; VERY STIFF	939.7	4–5	2, 3, 3	8	50	SS-2	2.50	-	-	-	-	-	-	-	-	29	A-6b (V)	
STIFF, BROWN, **CLAY**, AND SILT, LITTLE SAND, TRACE GRAVEL, MOIST	936.7	6–7			-	ST-3	-	4	2	17	39	38	42	21	21	23	A-7-6 (13)	
HARD, BROWN, **SILT**, SOME CLAY, LITTLE SAND, TRACE GRAVEL WITH COBBLES, TILL, DAMP		9–10	8, 14, 16	41	67	SS-4	4.50	2	2	14	56	26	25	16	9	14	A-4b (8)	
	931.7	11–12	15, 19, 29	65	50	SS-5	-	-	-	-	-	-	-	-	-	9	A-4b (V)	
HARD, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP		14–15	14, 22, 38	81	78	SS-6	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	
		16–17	19, 21, 34	74	94	SS-7	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	
	924.2	19–20	29, 36, 50/4"	-	75	SS-8	4.50	8	10	19	34	29	26	13	13	7	A-6a (7)	
VERY DENSE, GRAY, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND AND SILT**, TRACE CLAY, DAMP	921.7	21–22	21, 36, 48	114	56	SS-9	-	19	34	22	15	10	21	12	9	8	A-2-4 (0)	
HARD, GRAY, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, TILL, DAMP		24–25	24, 39, 46	115	78	SS-10	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	
		29	40, 39, 46	115	94	SS-11	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	

PID: 98608	SFN:	PROJECT: BRO-32-3.75	STATION / OFFSET: 414+17.4, 101' LT.	START: 3/23/15	END: 3/24/15	PG 2 OF 2	B-004-0-15

MATERIAL DESCRIPTION AND NOTES	ELEV. 914.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
HARD, GRAY, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, TILL, DAMP *(continued)*		34–35	20, 28, 30	78	94	SS-12	4.50	12	9	18	34	27	24	13	11	9	A-6a (6)	
	904.7	39–40 EOB	23, 27, 35	84	67	SS-13	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	

NOTES: CAVED AT 22.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; BACKFILLED WITH SOIL CUTTINGS

43/45	BRO-32-4.16	STRUCTURE FOUNDATION EXPLORATION BORING LOG B-004-0-15	DRAWN MSJ CHECKED EMK

PROJECT: BRO-32-04.16 TYPE: CULVERT PID: 110478 SFN: N/A START: 6/19/20 END: 6/19/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT / NQ2	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 309+00, 38' LT. ALIGNMENT: HOMAN WAY ELEVATION: 931.6 (MSL) EOB: 33.8 ft. LAT / LONG: 39.047596, -83.962469

EXPLORATION ID: B-038-0-20 — PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 931.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
DARK BROWN, **SILTY CLAY**, ORGANIC MEDIUM STIFF AT SS-1	930.6																	
VERY STIFF TO HARD, BROWNISH GRAY, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, DAMP		1–3	2 2 2	6	78	SS-1	0.50	-	-	-	-	-	-	-	-	20	A-6a (V)	
		3–5	4 5 7	17	78	SS-2	4.50	12	10	13	30	35	34	22	12	12	A-6a (7)	
		6–7.5	50 29 36	94	28	SS-3	4.50	-	-	-	-	-	-	-	-	2	A-6a (V)	
	921.1	8.5–10	8 9 10	27	100	SS-4	4.50	12	10	13	30	35	34	22	12	18	A-6a (7)	
VERY STIFF, BROWNISH GRAY, **CLAY**, LITTLE GRAVEL, LITTLE SAND, SOME SILT, DAMP		11–12.5	6 7 11	26	78	SS-5	4.50	11	8	8	26	47	51	23	28	19	A-7-6 (17)	
	916.1	13.5–15	6 7 8	22	100	SS-6	2.50	11	8	8	26	47	51	23	28	22	A-7-6 (17)	
HARD, BROWNISH GRAY, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, DAMP TO MOIST		16–17.5	16 20 25	65	89	SS-7	4.50	17	10	9	21	43	36	23	13	11	A-6a (7)	
		18.5–20	30 35 50	123	78	SS-8	4.50	17	10	9	21	43	36	23	13	12	A-6a (7)	
	908.6	21–22.5	20 30 50/5"	-	82	SS-9	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
INTERBEDDED LIMESTONE (80%) AND SHALE (20%); **LIMESTONE**, GRAY, SEVERELY TO HIGHLY WEATHERED, WEAK, THIN BEDDED, FRIABLE, CALCAREOUS; **SHALE**, DARK GRAY, SEVERELY TO HIGHLY WEATHERED, VERY WEAK, LAMINATED.		TR 23	50/2"	-	100	SS-10	4.50	-	-	-	-	-	-	-	-	5	Rock (V)	
		26	50/4"	-	100	SS-11	4.50	-	-	-	-	-	-	-	-	8	Rock (V)	
	902.8	W 903.1 28.5	50/3"	-	100	SS-12	4.50	-	-	-	-	-	-	-	-	13	Rock (V)	
INTERBEDDED LIMESTONE (80%) AND SHALE (20%), MODERATELY FRACTURED, RQD 18%, REC. 57%; **LIMESTONE**, GRAY, MODERATELY WEATHERED, MODERATELY STRONG TO STRONG, THIN TO MEDIUM BEDDED, SLIGHTLY FOSSILIFEROUS, CALCAREOUS; **SHALE**, DARK GRAY, HIGHLY WEATHERED, WEAK, LAMINATED.	897.8	28.8–33.8 EOB	30		95	NQ2-1											CORE	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT

Rock core from boring B-038-0-20, 28.8 to 33.8 ft.

RUN #:	DEPTH		RECOVERY		RQD	
NQ2-1	28.8'	33.8'	57/60	95%	18/60	30%
BRO-32-4.16 PID 110478						

PROJECT: BRO-32-04.16 TYPE: CULVERT PID: 110478 SFN: N/A START: 6/19/20 END: 6/19/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT / NQ2	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 308+70, 49' RT. ALIGNMENT: HOMAN WAY ELEVATION: 932.5 (MSL) EOB: 33.8 ft. LAT / LONG: 39.047825, -83.962290

EXPLORATION ID B-038-1-20 — PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 932.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
DARK BROWN, **SILTY CLAY**, ORGANIC MEDIUM STIFF AT SS-1	931.5																	
HARD, BROWNISH GRAY, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, DAMP TO MOIST		1–3	2 2 3	7	78	SS-1	0.50	-	-	-	-	-	-	-	-	27	A-6a (V)	
		4–5	5 26 31	82	78	SS-2	-	-	-	-	-	-	-	-	-	11	A-6a (V)	
		6–7	20 38 45	120	78	SS-3	-	13	11	16	31	29	26	15	11	9	A-6a (5)	
	922.0	9–10	19 28 31	85	78	SS-4	4.50	13	11	16	31	29	26	15	11	9	A-6a (5)	
HARD, BROWNISH GRAY, **SILTY CLAY**, SOME TO "AND" GRAVEL, LITTLE SAND, DAMP TO MOIST		11–12	9 11 13	35	78	SS-5	4.00	20	8	6	28	38	39	18	21	12	A-6b (11)	
		14–15	9 10 11	30	78	SS-6	4.50	20	8	6	28	38	39	18	21	18	A-6b (11)	
		16–17	5 14 50	93	78	SS-7	4.50	38	9	7	17	29	38	22	16	21	A-6b (4)	
		19–20	23 25 41	95	78	SS-8	4.50	38	9	7	17	29	38	22	16	10	A-6b (4)	
	909.5	21–22	39 50/5"	-	100	SS-9	4.50	-	-	-	-	-	-	-	-	6	A-6b (V)	
INTERBEDDED LIMESTONE (80%) AND SHALE (20%); **LIMESTONE**, GRAY, SEVERELY TO HIGHLY WEATHERED, WEAK, THIN BEDDED, FRIABLE, CALCAREOUS; **SHALE**, DARK GRAY, SEVERELY TO HIGHLY WEATHERED, VERY WEAK, LAMINATED.		TR W 909.0 23–24	50/1"	-	400	SS-10	4.50	-	-	-	-	-	-	-	-	7	Rock (V)	
		26	50/2"	-	250	SS-11	4.50	-	-	-	-	-	-	-	-	10	Rock (V)	
	903.7	28–29	50/3"	-	100	SS-12	4.50	-	-	-	-	-	-	-	-	13	Rock (V)	
INTERBEDDED LIMESTONE (80%) AND SHALE (20%), MODERATELY FRACTURED, RQD 12%, REC. 58%; **LIMESTONE**, GRAY, MODERATELY WEATHERED, MODERATELY STRONG TO STRONG, THIN TO MEDIUM BEDDED, SLIGHTLY FOSSILIFEROUS, CALCAREOUS; **SHALE**, DARK GRAY, HIGHLY WEATHERED, WEAK, LAMINATED.	898.7	29–33 EOB	20		97	NQ2-1											CORE	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT

Rock core from B-038-1-20, 28.8 to 33.8 ft.

RUN #:	DEPTH		RECOVERY		RQD	
NQ2-1	28.8'	33.8'	58/60	97%	12/60	20%
BRO-32-4.16 PID 110478						

45/45 — BRO-32-4.16

STRUCTURE FOUNDATION EXPLORATION
BORING LOG B-038-1-20

DRAWN MSJ CHECKED EMK

APPENDIX B

Boring Logs

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/14/15 11:45 - J:\DEPT5\15 PROJECTS\15050023COL-MCCORMICK TAYLOR-BRO-32-3.75\REPORTS\LOGS\15050023COL.GPJ

PROJECT: BRO-32-3.75	DRILLING FIRM / OPERATOR: CTL / LH	DRILL RIG: CME 550/# 349	STATION / OFFSET: 411+95.8, 46' LT.
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: CTL / LH	HAMMER: CME AUTOMATIC	ALIGNMENT: BRO-32
PID: 98608 SFN: N/A	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 10/29/13	ELEVATION: 944.2 (MSL) EOB: 40.0 ft.
START: 3/19/15 END: 3/19/15	SAMPLING METHOD: SPT	ENERGY RATIO (%): 81.2	LAT/LONG: 39.048284, -83.949360

EXPLORATION ID B-001-0-15

MATERIAL DESCRIPTION AND NOTES	ELEV. 944.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
Topsoil (6")	943.7																	
MEDIUM STIFF, BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		1–2	2 2 2	5	67	SS-1	1.00	1	2	13	56	28	35	17	18	29	A-6b (11)	
@3.5'; STIFF		4–5	3 3 3	8	22	SS-2	2.00	-	-	-	-	-	-	-	-	18	A-6b (V)	
	935.7	7–8 ▼			-	ST-3	-	10	6	19	31	34	36	18	18	20	A-6b (9)	
HARD, GRAY, **SILT**, SOME CLAY, LITTLE SAND, TRACE GRAVEL WITH COBBLES, DAMP		9–10 W	17 22 27	66	17	SS-4	-	-	-	-	-	-	-	-	-	7	A-4b (V)	
@11.0'; STIFF	931.2	11–12	14 22 23	61	33	SS-5	1.50	-	-	-	-	-	-	-	-	20	A-4b (V)	
HARD, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP		14–15	14 18 21	53	67	SS-6	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	
	926.2	16–17	21 29 38	91	78	SS-7	4.50	8	11	19	39	23	26	13	13	9	A-6a (7)	
DENSE, GRAY, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, TRACE SILT, TRACE CLAY, DAMP	923.7	19–20	14 12 19	42	33	SS-8	-	19	40	29	10	2	NP	NP	NP	13	A-1-b (0)	
HARD, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP		21–22	23 47 34	110	67	SS-9	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	
@23.5'; STIFF		24	43 50/1"	-	57	SS-10	1.50	-	-	-	-	-	-	-	-	10	A-6a (V)	
@28.5'; HARD		29	32 39 41	108	72	SS-11	4.50	7	10	20	43	20	24	13	11	9	A-6a (6)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 4/14/15 11:45 - J:\DEPT5\15 PROJECTS\15050023COL-MCCORMICK TAYLOR-BRO-32-3.75\REPORTS\LOGS\15050023COL.GPJ

PID: 98608	SFN: N/A	PROJECT: BRO-32-3.75	STATION / OFFSET: 411+95.8, 46' LT.	START: 3/19/15	END: 3/19/15	PG 2 OF 2	B-001-0-15

MATERIAL DESCRIPTION AND NOTES	ELEV. 914.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
HARD, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP *(continued)*		31 32 33																
		34 35	21 36 41	104	67	SS-12	4.50	-	-	-	-	-	-	-	-	10	A-6a (V)	
		36 37 38																
	904.2	39 EOB 40	14 24 25	66	89	SS-13	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	

NOTES: CAVED AT 22.1'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; BACKFILLED WITH SOIL CUTTINGS

PROJECT: BRO-32-3.75	DRILLING FIRM / OPERATOR: CTL / LH	DRILL RIG: CME 550/# 349	STATION / OFFSET: 412+33.1, 92' LT.	EXPLORATION ID B-002-0-15
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: CTL / LH	HAMMER: CME AUTOMATIC	ALIGNMENT: BRO-32	
PID: 98608 SFN: N/A	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 10/29/13	ELEVATION: 948.7 (MSL) EOB: 50.0 ft.	PAGE 1 OF 2
START: 3/19/15 END: 3/19/15	SAMPLING METHOD: SPT	ENERGY RATIO (%): 81.2	LAT/LONG: 39.048428, -83.949462	

MATERIAL DESCRIPTION AND NOTES	ELEV. 948.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN- DONED
Topsoil (3")	948.5																	
STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, FILL, DAMP		1–2	3 4 5	12	67	SS-1	2.00	2	1	10	54	33	38	17	21	18	A-6b (12)	
@3.5'; VERY STIFF		4–5	3 5 6	15	94	SS-2	2.50	1	5	15	48	31	35	17	18	20	A-6b (11)	
STIFF, GRAY, **CLAY**, AND SILT, LITTLE SAND, TRACE GRAVEL, MOIST	943.2	6–7	3 3 3	8	67	SS-3	1.50	1	3	8	65	23	45	19	26	26	A-7-6 (15)	
@8.5'; NO RECOVERY		9–10	3 5 5	14	0	SS-4	-	-	-	-	-	-	-	-	-	-	A-7-6 (V)	
		11–12 ▼	4 5 6	15	72	SS-5	2.00	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
@13.5'; NO GRAVEL		14–15	6 6 9	20	44	SS-6	2.50	0	2	15	46	37	56	18	38	20	A-7-6 (19)	
HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP	933.2	W 16–17	11 19 39	78	67	SS-7	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	
		19–20	21 20 39	80	89	SS-8	4.50	8	11	20	38	23	26	13	13	7	A-6a (6)	
@20.5'; ENCOUNTERED COBBLES @21.0'; VERY STIFF		21–22	21 21 49	95	50	SS-9	3.00	-	-	-	-	-	-	-	-	9	A-6a (V)	
		24–25	11 19 23	57	72	SS-10	4.00	-	-	-	-	-	-	-	-	10	A-6a (V)	
		26–28																
@28.5'; HARD		29	29 36 49	115	56	SS-11	-	-	-	-	-	-	-	-	-	9	A-6a (V)	

PID: 98608	SFN: N/A	PROJECT: BRO-32-3.75	STATION / OFFSET: 412+33.1, 92' LT.	START: 3/19/15	END: 3/19/15	PG 2 OF 2	B-002-0-15

MATERIAL DESCRIPTION AND NOTES	ELEV. 918.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP *(continued)*		31–33																
		34–35	31 29 47	103	89	SS-12	4.50	9	10	19	41	21	24	13	11	9	A-6a (6)	
@38.5'; VERY STIFF		39–40	18 26 34	81	78	SS-13	4.00	-	-	-	-	-	-	-	-	11	A-6a (V)	
		44–45	14 19 26	61	67	SS-14	4.00	-	-	-	-	-	-	-	-	11	A-6a (V)	
	898.7	EOB 50	31 38 42	108	67	SS-15	3.50	-	-	-	-	-	-	-	-	10	A-6a (V)	

NOTES: CAVED AT 16.4'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; BACKFILLED WITH SOIL CUTTINGS

PROJECT: BRO-32-3.75	DRILLING FIRM / OPERATOR: CTL / LH	DRILL RIG: CME 550/# 349	STATION / OFFSET: 413+85.8, 66' LT.	EXPLORATION ID B-003-0-15
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: CTL / LH	HAMMER: CME AUTOMATIC	ALIGNMENT: BRO-32	
PID: 98608 SFN: N/A	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 10/29/13	ELEVATION: 949.5 (MSL) EOB: 45.0 ft.	PAGE 1 OF 2
START: 3/23/15 END: 3/23/15	SAMPLING METHOD: SPT	ENERGY RATIO (%): 81.2	LAT/LONG: 39.048790, -83.949183	

MATERIAL DESCRIPTION AND NOTES	ELEV. 949.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
Topsoil (4")	949.2																	
VERY STIFF, BROWN, **CLAY**, AND SILT, SOME SAND, TRACE GRAVEL, FILL, DAMP		1–2	3 5 5	14	72	SS-1	4.00	4	5	20	36	35	42	19	23	16	A-7-6 (13)	
		4–5	4 6 8	19	83	SS-2	4.00	-	-	-	-	-	-	-	-	16	A-7-6 (V)	
VERY STIFF, BROWN AND GRAY, **CLAY**, AND SILT, LITTLE SAND, TRACE GRAVEL, MOIST	943.5	6–7	4 3 3	8	44	SS-3	3.50	2	2	11	52	33	45	17	28	29	A-7-6 (16)	
		9–10	4 6 6	16	78	SS-4	3.00	-	-	-	-	-	-	-	-	26	A-7-6 (V)	
HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP	938.5	11–12	5 6 8	19	56	SS-5	4.50	8	10	20	36	26	26	15	11	13	A-6a (6)	
		14–15	12 17 19	49	78	SS-6	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	
@16.0'; LITTLE GRAVEL		16–17	11 16 24	54	89	SS-7	4.50	13	11	19	33	24	25	13	12	8	A-6a (5)	
@18.5'; GRAY		19–20	19 21 24	61	89	SS-8	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	
		21–22	19 20 34	73	83	SS-9	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	
		▼ 24–25	20 29 30	80	67	SS-10	4.50	-	-	-	-	-	-	-	-	6	A-6a (V)	
		W 27																
		29	22 32 50/3"	-	80	SS-11	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	

PID: 98608	SFN: N/A	PROJECT: BRO-32-3.75	STATION / OFFSET: 413+85.8, 66' LT.	START: 3/23/15	END: 3/23/15	PG 2 OF 2	B-003-0-15

MATERIAL DESCRIPTION AND NOTES	ELEV. 919.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
HARD, BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP *(continued)*	916.0	31–33																
HARD, GRAY, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, TILL, DAMP		34–35	37 37 49	116	72	SS-12	4.50	9	10	19	36	26	23	13	10	9	A-4a (5)	
		39–40	27 28 36	87	44	SS-13	-	-	-	-	-	-	-	-	-	6	A-4a (V)	
@43.5'; VERY STIFF	904.5	44–45 (EOB)	18 19 26	61	50	SS-14	3.00	-	-	-	-	-	-	-	-	11	A-4a (V)	

NOTES: CAVED AT 34.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; BACKFILLED WITH SOIL CUTTINGS

PROJECT: BRO-32-3.75	DRILLING FIRM / OPERATOR: CTL / LH	DRILL RIG: CME 550/# 349	STATION / OFFSET: 414+17.4, 101' LT.	EXPLORATION ID B-004-0-15
TYPE: STRUCTURE	SAMPLING FIRM / LOGGER: CTL / LH	HAMMER: CME AUTOMATIC	ALIGNMENT: BRO-32	
PID: 98608 SFN: N/A	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 10/29/13	ELEVATION: 944.7 (MSL) EOB: 40.0 ft.	PAGE 1 OF 2
START: 3/23/15 END: 3/24/15	SAMPLING METHOD: SPT	ENERGY RATIO (%): 81.2	LAT/LONG: 39.048906, -83.949256	

MATERIAL DESCRIPTION AND NOTES	ELEV. 944.7	DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
Topsoil (4")	944.4																	
STIFF, BROWN AND GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST		1–2	2 2 2	5	67	SS-1	2.00	1	3	15	54	27	34	18	16	27	A-6b (10)	
@3.5'; VERY STIFF	939.7	4–5	2 3 3	8	50	SS-2	2.50	-	-	-	-	-	-	-	-	29	A-6b (V)	
STIFF, BROWN, **CLAY**, AND SILT, LITTLE SAND, TRACE GRAVEL, MOIST	936.7	6–7			-	ST-3	-	4	2	17	39	38	42	21	21	23	A-7-6 (13)	
HARD, BROWN, **SILT**, SOME CLAY, LITTLE SAND, TRACE GRAVEL WITH COBBLES, TILL, DAMP		9–10	8 14 16	41	67	SS-4	4.50	2	2	14	56	26	25	16	9	14	A-4b (8)	
	931.7	11–12	15 19 29	65	50	SS-5	-	-	-	-	-	-	-	-	-	9	A-4b (V)	
HARD, GRAY, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, TILL, DAMP		14–15	14 22 38	81	78	SS-6	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	
		16–17	19 21 34	74	94	SS-7	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	
	924.2	19–20	29 36 50/4"	-	75	SS-8	4.50	8	10	19	34	29	26	13	13	7	A-6a (7)	
VERY DENSE, GRAY, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND AND SILT**, TRACE CLAY, DAMP	921.7	21–22	21 36 48	114	56	SS-9	-	19	34	22	15	10	21	12	9	8	A-2-4 (0)	
HARD, GRAY, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, TILL, DAMP		24–25	24 39 46	115	78	SS-10	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	
		26–28																
		29	40 39 46	115	94	SS-11	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	

PID: 98608	SFN: N/A	PROJECT: BRO-32-3.75	STATION / OFFSET: 414+17.4, 101' LT.	START: 3/23/15	END: 3/24/15	PG 2 OF 2	B-004-0-15

MATERIAL DESCRIPTION AND NOTES	ELEV. 914.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	ABAN-DONED
HARD, GRAY, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, TILL, DAMP *(continued)*		31 – 33																
		34 – 35	20 28 30	78	94	SS-12	4.50	12	9	18	34	27	24	13	11	9	A-6a (6)	
		36 – 38																
	904.7	39 – 40 EOB	23 27 35	84	67	SS-13	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	

NOTES: CAVED AT 22.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE CHIPS; BACKFILLED WITH SOIL CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 412+29, 32' RT.	EXPLORATION ID B-001-0-20
TYPE: STRUCTURE FOUNDATION	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BRUCE LUNSFORD'S WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 945.2 (MSL) EOB: 50.0 ft.	PAGE 1 OF 2
START: 6/18/20 END: 6/18/20	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 86.8	LAT / LONG: 39.048193, -83.949537	

MATERIAL DESCRIPTION AND NOTES	ELEV. 945.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
DARK BROWN, **TOPSOIL**	944.9																	
VERY STIFF TO HARD, BROWN TO BROWNISH GRAY, **SILT AND CLAY**, TRACE GRAVEL, LITTLE SAND, DAMP TO MOIST		1–2	4 4 3	10	78	SS-1	4.50	4	2	11	45	38	36	22	14	18	A-6a (10)	
		3–4	5 4 4	12	78	SS-2	2.50	4	2	11	45	38	36	22	14	20	A-6a (10)	
		6–7	3 3 6	13	78	SS-3	2.00	-	-	-	-	-	-	-	-	23	A-6a (V)	
		8–9	3 4 5	13	78	SS-4	4.50	-	-	-	-	-	-	-	-	21	A-6a (V)	
FROM 11.0 FT. TO 11.5 FT.: UCS = 0.37 TSF		W 934.2																
		11–13			100	ST-1	-	-	-	-	-	-	-	-	-	23	A-6a (V)	
	932.2	13																
VERY STIFF TO HARD, BROWNISH GRAY TO GRAY, **SANDY SILT**, TRACE TO LITTLE GRAVEL, SOME CLAY, DAMP TO MOIST		13.5–15	10 20 17	54	78	SS-5	4.00	6	8	13	49	24	22	16	6	20	A-4a (8)	
		16–17.5	22 24 32	81	78	SS-6	4.50	6	8	13	49	24	22	16	6	10	A-4a (8)	
		18.5–20	25 37 50	126	78	SS-7	4.50	12	12	16	33	27	25	16	9	11	A-4a (5)	
		21–22.5	47 40 50	130	78	SS-8	4.50	12	12	16	33	27	25	16	9	12	A-4a (5)	
		23.5–25	20 29 50/5"	-	82	SS-9	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 7/5/22 10:13 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_STRUCTURE_LOGS.GPJ

PID: 110478	SFN: N/A	PROJECT: BRO-32-04.16	STATION / OFFSET: 412+29, 32' RT.	START: 6/18/20	END: 6/18/20	PG 2 OF 2	B-001-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 920.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
VERY STIFF TO HARD, BROWNISH GRAY TO GRAY, **SANDY SILT**, TRACE TO LITTLE GRAVEL, SOME CLAY, DAMP TO MOIST *(continued)*		26 – 28																
		29	26 50/3"	-	100	SS-10	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
		30 – 33																
		34	50/5"	-	100	SS-11	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
		35 – 38																
		39 – 40	13 15 35	72	78	SS-12	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
		41 – 43																
		44 – 45	9 15 29	64	78	SS-13	4.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
		46 – 48																
	895.2	49 – EOB 50	9 12 17	42	78	SS-14	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 413+18, CL	EXPLORATION ID B-002-0-20
TYPE: STRUCTURE FOUNDATION	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BRUCE LUNSFORD'S WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 948.1 (MSL) EOB: 50.0 ft.	PAGE 1 OF 2
START: 6/17/20 END: 6/17/20	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 86.8	LAT / LONG: 39.048452, -83.949528	

MATERIAL DESCRIPTION AND NOTES	ELEV. 948.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
DARK BROWN, **TOPSOIL**	947.7																	
VERY STIFF TO HARD, BROWN TO BROWNISH GRAY, **SILT AND CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST		1–2	5 8 10	26	67	SS-1	4.50	8	3	13	46	30	31	17	14	15	A-6a (10)	
		4–5	5 3 6	13	100	SS-2	3.00	8	3	13	46	30	31	17	14	25	A-6a (10)	
		6–8			100	ST-1	-	-	-	-	-	-	-	-	-	25	A-6a (V)	
	939.6																	
VERY STIFF TO HARD, BROWNISH GRAY, **SILTY CLAY**, LITTLE GRAVEL, SOME SAND, DAMP TO MOIST		8.5–10	3 3 5	12	100	SS-3	3.00	-	-	-	-	-	-	-	-	21	A-6b (V)	
		11–12.5	2 4 5	13	100	SS-4	4.00	14	8	17	30	31	36	17	19	20	A-6b (9)	
		13.5–15	2 7 8	22	100	SS-5	4.50	14	8	17	30	31	36	17	19	11	A-6b (9)	
	932.1	W 932.1																
HARD, BROWNISH GRAY TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP TO MOIST		16–17.5	7 17 28	65	100	SS-6	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
		18.5–20	18 27 38	94	100	SS-7	4.50	19	11	16	30	24	23	13	10	10	A-4a (4)	
		21–22.5	22 28 45	106	100	SS-8	4.50	19	11	16	30	24	23	13	10	10	A-4a (4)	
		23.5–25	38 40 48	127	100	SS-9	4.50	-	-	-	-	-	-	-	-	13	A-4a (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 7/5/22 10:13 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_STRUCTURE_LOGS.GPJ

PID: 110478	SFN: N/A	PROJECT: BRO-32-04.16	STATION / OFFSET: 413+18, CL	START: 6/17/20	END: 6/17/20	PG 2 OF 2	B-002-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 923.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
HARD, BROWNISH GRAY TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP TO MOIST *(continued)*		26–28																
		29–30	17 22 40	90	100	SS-10	4.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
		31–33																
		34–35	34 28 28	81	100	SS-11	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	
		36–38																
		39–40	11 17 28	65	100	SS-12	4.00	-	-	-	-	-	-	-	-	12	A-4a (V)	
		41–43																
		44–45	34 26 30	81	56	SS-13	4.50	-	-	-	-	-	-	-	-	5	A-4a (V)	
		46–48																
	898.1	49–50 EOB	9 12 21	48	100	SS-14	4.50	-	-	-	-	-	-	-	-	12	A-4a (V)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 414+12, 32' RT.	EXPLORATION ID B-003-0-20
TYPE: STRUCTURE FOUNDATION	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BRUCE LUNSFORD'S WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 945.8 (MSL) EOB: 50.0 ft.	PAGE 1 OF 2
START: 6/17/20 END: 6/17/20	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 86.8	LAT / LONG: 39.048661, -83.949302	

MATERIAL DESCRIPTION AND NOTES	ELEV. 945.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
DARK BROWN, **TOPSOIL**	945.6																	
STIFF, BROWN, **SILTY CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST		1–2	4 2 3	7	78	SS-1	1.50	-	-	-	-	-	-	-	-	22	A-6b (V)	
FROM 4.0 FT. TO 4.5 FT.: UCS = 0.81 TSF		4–6			100	ST-1	-	-	-	-	-	-	-	-	-	21	A-6b (V)	
		6–7.5	2 3 4	10	78	SS-2	1.50	5	4	12	37	42	39	21	18	23	A-6b (11)	
FROM 9.1 FT. TO 9.6 FT.: UCS = 1.55 TSF		9–11			79	ST-2	-	-	-	-	-	-	-	-	-	19	A-6b (V)	
		11–12.5	2 4 8	17	67	SS-3	2.00	5	4	12	37	42	39	21	18	21	A-6b (11)	
	932.3	13.5																
HARD, GRAY BROWN TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP		13.5–15	16 18 31	71	78	SS-4	4.50	22	12	16	29	21	22	13	9	9	A-4a (3)	
		16–17.5	27 23 33	81	78	SS-5	4.50	22	12	16	29	21	22	13	9	9	A-4a (3)	
		18.5–19.4	36 50/5"	-	82	SS-6	4.50	-	-	-	-	-	-	-	-	7	A-4a (V)	
		21–22.5	21 24 42	95	78	SS-7	4.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
		23.5–24.5	38 50/6"	-	100	SS-8	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 7/5/22 10:13 - U:\1736201221\GEOTECH\BORINGS\BRO-32-4.16_STRUCTURE_LOGS.GPJ

PID: 110478 | SFN: N/A | PROJECT: BRO-32-04.16 | STATION / OFFSET: 414+12, 32' RT. | START: 6/17/20 | END: 6/17/20 | PG 2 OF 2 | B-003-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 920.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	HOLE SEALED
HARD, GRAY BROWN TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP *(continued)*		26–28																
		29–30	29 31 43	107	78	SS-9	4.50	15	12	16	31	26	24	15	9	8	A-4a (4)	
		34	19 50/6"	-	100	SS-10	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
		39–40	12 33 50	120	78	SS-11	4.50	-	-	-	-	-	-	-	-	6	A-4a (V)	
		44–45	11 16 18	49	78	SS-12	4.50	15	12	16	31	26	24	15	9	11	A-4a (4)	
	895.8	EOB 50	8 9 15	35	78	SS-13	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 24+56, 17' RT.	EXPLORATION ID B-009-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BODMAN RD	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 941.2 (MSL) EOB: 6.0 ft.	PAGE 1 OF 1
START: 6/19/20 END: 6/19/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.050548, -83.963356	

MATERIAL DESCRIPTION AND NOTES	ELEV. 941.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**, TRACE GRAVEL	940.8																		
STIFF, BROWN, **SILT AND CLAY**, SOME GRAVEL, SOME SAND, DAMP	939.7	1	5 3 3	9	50	SS-1	-	32	10	14	30	14	40	25	15	17	A-6a (3)	-	
SOFT TO MEDIUM STIFF, BROWNISH GRAY, **CLAY**, TRACE GRAVEL, LITTLE SAND, "AND" SILT, MOIST		2	1 1 1	3	78	SS-2	0.50	-	-	-	-	-	-	-	-	29	A-7-6 (V)	450	
	936.7	3, 4	1 2 3	7	78	SS-3	0.50	3	3	13	36	45	47	18	29	22	A-7-6 (17)	-	
STIFF TO VERY STIFF, BROWN, **CLAY**, TRACE GRAVEL, LITTLE SAND, "AND" SILT, MOIST	935.2	5, EOB 6	3 3 4	10	78	SS-4	3.00	-	-	-	-	-	-	-	-	22	A-7-6 (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:51 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 169+90, 65' LT.	EXPLORATION ID B-010-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BRO-32	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 946.7 (MSL) EOB: 6.0 ft.	PAGE 1 OF 1
START: 6/18/20 END: 6/18/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.050411, -83.956299	

MATERIAL DESCRIPTION AND NOTES	ELEV. 946.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	946.5																		
STIFF TO VERY STIFF, BROWN TO GRAY, **SILT AND CLAY**, TRACE GRAVEL, TRACE TO LITTLE SAND, DAMP TO MOIST		1	6 8 11	27	67	SS-1	-	-	-	-	-	-	-	-	-	10	A-6a (V)	840	
		2	7 8 6	20	78	SS-2	-	5	3	9	56	27	29	18	11	14	A-6a (8)	-	
		3 – 4	3 3 3	9	78	SS-3	1.50	4	2	6	47	41	39	24	15	24	A-6a (10)	-	
	940.7	5 – EOB 6	2 3 4	10	78	SS-4	2.00	-	-	-	-	-	-	-	-	20	A-6a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 6/19/20 END: 6/19/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 700+00, 1' RT. ALIGNMENT: RAMP SW ELEVATION: 946.0 (MSL) EOB: 6.0 ft. LAT / LONG: 39.049720, -83.954929	EXPLORATION ID B-011-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 946.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	945.8																		
STIFF, BROWN, **SILTY CLAY**, TRACE GRAVEL, LITTLE SAND, DAMP	944.5	1	6 8 2	14	78	SS-1	-	10	7	13	37	33	33	16	17	10	A-6b (10)	-	
MEDIUM STIFF TO STIFF, GRAY TO DARK GRAY, **CLAY**, TRACE SAND, "AND" SILT, DAMP		2	5 2 2	6	78	SS-2	1.00	-	-	-	-	-	-	-	-	23	A-7-6 (V)	1000	
		3 / 4	2 2 3	7	78	SS-3	2.00	-	-	-	-	-	-	-	-	22	A-7-6 (V)	-	
	940.0	5 / EOB 6	2 2 3	7	78	SS-4	0.50	0	1	7	39	53	48	28	20	24	A-7-6 (14)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:51 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 174+03, 69' LT.	EXPLORATION ID B-012-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BRO-32	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 945.4 (MSL) EOB: 6.0 ft.	PAGE 1 OF 1
START: 6/17/20 END: 6/17/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.050098, -83.954901	

MATERIAL DESCRIPTION AND NOTES	ELEV. 945.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	945.2																		
STIFF TO VERY STIFF, BROWNISH GRAY, **CLAY**, TRACE GRAVEL, TRACE SAND, "AND" SILT, DAMP		1	3 3 2	7	78	SS-1	1.00	3	2	8	46	41	46	23	23	17	A-7-6 (14)	-	
	942.4	2	4 3 4	10	78	SS-2	3.00	-	-	-	-	-	-	-	-	23	A-7-6 (V)	100	
MEDIUM STIFF TO STIFF, GRAY, **SILT AND CLAY**, LITTLE SAND, DAMP TO MOIST		3 / 4	3 3 4	10	78	SS-3	2.00	0	2	12	53	33	29	18	11	17	A-6a (8)	-	
	939.4	5 / EOB 6	2 2 2	6	78	SS-4	1.00	-	-	-	-	-	-	-	-	30	A-6a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:51 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 704+00, 1' RT.	EXPLORATION ID B-013-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: RAMP SW	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 946.4 (MSL) EOB: 6.0 ft.	PAGE 1 OF 1
START: 6/19/20 END: 6/19/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.049405, -83.953579	

MATERIAL DESCRIPTION AND NOTES	ELEV. 946.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	946.2																		
STIFF TO VERY STIFF, BROWN TO GRAY, **SILT AND CLAY**, TRACE GRAVEL, LITTLE SAND, DAMP		1	3 4 4	12	78	SS-1	3.00	-	-	-	-	-	-	-	-	13	A-6a (V)	100	
	943.4	2	4 4 6	14	78	SS-2	2.00	7	5	16	41	31	31	19	12	15	A-6a (8)	-	
STIFF, GRAY, **SILT**, LITTLE SAND, SOME CLAY, DAMP		3–4	5 4 6	14	78	SS-3	-	0	3	12	55	30	27	20	7	17	A-4b (8)	-	
	940.4	5 – EOB 6	4 4 6	14	78	SS-4	1.50	-	-	-	-	-	-	-	-	16	A-4b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 500+00, 1' RT.	EXPLORATION ID B-014-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: RAMP NW	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 945.4 (MSL) EOB: 6.0 ft.	PAGE 1 OF 1
START: 6/18/20 END: 6/18/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.049741, -83.953232	

MATERIAL DESCRIPTION AND NOTES	ELEV. 945.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	945.2																		
STIFF TO VERY STIFF, BROWN TO BROWNISH GRAY, **SILT AND CLAY**, TRACE GRAVEL, LITTLE SAND, DAMP TO MOIST		1	15 7 7	20	78	SS-1	-	3	5	14	47	31	29	17	12	14	A-6a (9)	-	
		2	4 3 4	10	78	SS-2	1.50	-	-	-	-	-	-	-	-	18	A-6a (V)	100	
	940.9	3, 4	3 3 5	12	67	SS-3	1.00	-	-	-	-	-	-	-	-	24	A-6a (V)	-	
STIFF, BROWN, **CLAY**, TRACE GRAVEL, LITTLE SAND, SOME SILT, MOIST	939.4	5, EOB 6	3 3 5	12	78	SS-4	1.50	2	3	14	38	43	52	20	32	21	A-7-6 (18)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 707+50, 1' RT.	EXPLORATION ID B-015-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: RAMP SW	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 943.2 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 6/19/20 END: 6/19/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.049067, -83.952426	

MATERIAL DESCRIPTION AND NOTES	ELEV. 943.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	942.9																		
VERY STIFF TO HARD, BROWN TO BROWNISH GRAY, **CLAY**, LITTLE GRAVEL, LITTLE SAND, SOME TO "AND" SILT, DAMP TO MOIST		1–2.5	3 2 2	6	78	SS-1	4.50	-	-	-	-	-	-	-	-	22	A-7-6 (V)	300	
		3.5–5	3 5 6	16	78	SS-2	4.50	0	2	16	36	46	46	23	23	21	A-7-6 (14)	-	
		6–7.5	4 5 6	16	78	SS-3	3.00	13	2	12	25	48	54	21	33	24	A-7-6 (18)	-	
	933.2	8.5–10 EOB	9 11 17	41	78	SS-4	4.50	-	-	-	-	-	-	-	-	11	A-7-6 (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:51 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 503+00, 1' RT.	EXPLORATION ID B-016-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: RAMP NW	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 943.0 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 6/18/20 END: 6/18/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.049570, -83.952200	

MATERIAL DESCRIPTION AND NOTES	ELEV. 943.0	DEPTHS	SPT/RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	942.8																		
SOFT, BROWN, **CLAY**, TRACE GRAVEL, LITTLE SAND, SOME SILT, MOIST		1–2	2 1 2	4	78	SS-1	0.50	-	-	-	-	-	-	-	-	30	A-7-6 (V)	3300	
	939.5	3																	
STIFF, BROWNISH GRAY, **SILTY CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST		4–5	3 4 5	13	67	SS-2	1.50	3	1	10	46	40	38	20	18	25	A-6b (11)	-	
	937.0	6																	
STIFF TO HARD, BROWN, **CLAY**, TRACE GRAVEL, LITTLE SAND, SOME SILT, DAMP		6–7	5 4 5	13	78	SS-3	2.00	2	2	14	31	51	49	25	24	22	A-7-6 (15)	-	
		8																	
	933.0	9–10 (EOB)	12 20 33	77	78	SS-4	4.50	-	-	-	-	-	-	-	-	9	A-7-6 (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 7/14/20 END: 7/14/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 712+00, 2' RT. ALIGNMENT: RAMP SW ELEVATION: 943.7 (MSL) EOB: 10.0 ft. LAT / LONG: 39.048422, -83.951085	EXPLORATION ID B-017-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 943.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	942.7																		
STIFF TO VERY STIFF, BROWN WITH GRAY MOTTLING, **CLAY**, LITTLE GRAVEL, LITTLE SAND, SOME SILT, DAMP TO MOIST		1 – 2	2 2 3	7	56	SS-1	1.25	-	-	-	-	-	-	-	-	31	A-7-6 (V)	220	
		3 – 5	5 6 6	17	94	SS-2	2.25	12	3	14	29	42	56	29	27	22	A-7-6 (17)	-	
		6 – 7	3 4 5	13	100	SS-3	1.00	-	-	-	-	-	-	-	-	23	A-7-6 (V)	-	
	935.2	W 935.2 — 8																	
VERY STIFF, BROWN WITH GRAY MOTTLING, **SILT AND CLAY**, LITTLE GRAVEL, LITTLE SAND, MOIST	933.7	9 – EOB 10	3 3 8	16	100	SS-4	-	11	6	17	39	27	33	19	14	22	A-6a (8)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 6/17/20 END: 6/17/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 507+00, 1' RT. ALIGNMENT: RAMP NW ELEVATION: 944.5 (MSL) EOB: 10.0 ft. LAT / LONG: 39.049631, -83.950798	EXPLORATION ID B-018-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 944.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	943.5	1																	
MEDIUM STIFF TO STIFF, BROWN TO GRAY, **CLAY**, TRACE GRAVEL, LITTLE SAND, "AND" SILT, MOIST		2	2 1 3	6	78	SS-1	0.50	2	2	10	41	45	46	20	26	25	A-7-6 (16)	-	
		3																	
		4	3 3 5	12	78	SS-2	1.50	-	-	-	-	-	-	-	-	24	A-7-6 (V)	-	
	939.0	5																	
VERY STIFF, BROWN, **CLAY**, TRACE GRAVEL, LITTLE SAND, SOME SILT, DAMP		6																	
		7	4 4 5	13	67	SS-3	4.00	6	2	15	33	44	46	17	29	20	A-7-6 (17)	-	
		8																	
		9	4 5 11	23	78	SS-4	4.00	-	-	-	-	-	-	-	-	13	A-7-6 (V)	-	
	934.5	EOB 10																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 715+50, CL	EXPLORATION ID B-019-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: RAMP SW	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 944.1 (MSL) EOB: 20.0 ft.	PAGE 1 OF 1
START: 7/14/20 END: 7/14/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.047870, -83.950085	

MATERIAL DESCRIPTION AND NOTES	ELEV. 944.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	943.1	1																	
STIFF TO VERY STIFF, BROWN, **CLAY**, LITTLE GRAVEL, LITTLE SAND, SOME SILT, DAMP		2	2 2 3	7	83	SS-1	1.25	-	-	-	-	-	-	-	-	25	A-7-6 (V)	-	
		4	5 5 6	16	94	SS-2	2.25	-	-	-	-	-	-	-	-	24	A-7-6 (V)	-	
	935.6	7	3 3 5	12	94	SS-3	1.75	10	3	16	30	41	49	26	23	22	A-7-6 (14)	-	
STIFF TO VERY STIFF, RED BROWN, **SILT AND CLAY**, LITTE GRAVEL, SOME SAND, DAMP	933.6	9	5 6 9	22	100	SS-4	1.75	11	12	21	36	20	30	17	13	17	A-6a (5)	-	
HARD, BROWN TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP		12	17 28 37	94	100	SS-5	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	-	
		14	28 38 50	127	100	SS-6	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	
		17	22 27 32	85	100	SS-7	4.50	14	13	18	31	24	25	15	10	8	A-4a (4)	-	
	924.1	19	15 26 44	101	100	SS-8	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	
		EOB 20																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:51 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 511+00, CL	EXPLORATION ID B-020-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: RAMP NW	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 944.6 (MSL) EOB: 20.0 ft.	PAGE 1 OF 1
START: 6/17/20 END: 6/17/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.049645, -83.949403	

MATERIAL DESCRIPTION AND NOTES	ELEV. 944.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	943.6	1																	
MEDIUM STIFF TO STIFF, BROWN TO GRAY, **SILTY CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST		2	2 2 3	7	78	SS-1	1.00	-	-	-	-	-	-	-	-	22	A-6b (V)	-	
		4	4 4 5	13	78	SS-2	1.50	-	-	-	-	-	-	-	-	25	A-6b (V)	-	
		7	3 3 5	12	78	SS-3	2.00	5	3	12	39	41	40	19	21	23	A-6b (12)	-	
		9	4 3 6	13	78	SS-4	1.00	5	3	12	39	41	40	19	21	22	A-6b (12)	-	
	933.6	11																	
VERY STIFF TO HARD, BROWN TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP		12	8 25 35	87	78	SS-5	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	-	
		14	22 50/5"	-	82	SS-6	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	-	
		17	44 38 48	124	78	SS-7	4.50	13	5	8	48	26	24	16	8	9	A-4a (8)	-	
		19	14 18 34	75	78	SS-8	4.00	13	5	8	48	26	24	16	8	13	A-4a (8)	-	
	924.6	EOB 20																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 7/13/20 END: 7/13/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 802+00, CL ALIGNMENT: RAMP SE ELEVATION: 946.0 (MSL) EOB: 20.0 ft. LAT / LONG: 39.049311, -83.948290	EXPLORATION ID B-021-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 946.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	945.0																		
MEDIUM STIFF TO STIFF, BROWN, **CLAY**, TRACE GRAVEL, LITTLE SAND, "AND" SILT, MOIST		1–2	2 2 3	7	89	SS-1	1.25	-	-	-	-	-	-	-	-	24	A-7-6 (V)	-	
	940.5	4–5	2 3 2	7	89	SS-2	1.00	4	2	11	44	39	47	20	27	31	A-7-6 (16)	-	
VERY STIFF, RED BROWN, **SILTY CLAY**, TRACE GRAVEL, SOME SAND, DAMP	938.0	6–7	4 5 4	13	83	SS-3	3.00	6	5	19	31	39	39	18	21	15	A-6b (11)	-	
VERY STIFF TO HARD, BROWN TO GRAY, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, DAMP		9–10	14 13 9	32	83	SS-4	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	-	
		11–12	14 21 37	84	100	SS-5	4.00	17	11	18	31	23	25	14	11	8	A-6a (4)	-	
		14–15	17 19 26	65	100	SS-6	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	-	
		16–17	15 20 30	72	100	SS-7	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	-	
	926.0	19–20 EOB	17 29 30	85	100	SS-8	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 601+00, CL	EXPLORATION ID B-022-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: RAMP NE	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 944.6 (MSL) EOB: 19.5 ft.	PAGE 1 OF 1
START: 6/16/20 END: 6/16/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.047487, -83.948834	

MATERIAL DESCRIPTION AND NOTES	ELEV. 944.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	943.6																		
STIFF TO VERY STIFF, LIGHT GRAY TO BROWN, **CLAY**, TRACE GRAVEL, LITTLE SAND, "AND" SILT, DAMP TO MOIST		1–2	3 2 2	6	78	SS-1	1.75	1	3	11	42	43	44	26	18	18	A-7-6 (12)	-	
		4	2 2 4	9	67	SS-2	1.00	1	3	11	42	43	44	26	18	31	A-7-6 (12)	-	
	936.1	7	4 5 5	14	78	SS-3	2.25	-	-	-	-	-	-	-	-	19	A-7-6 (V)	-	
HARD, BROWNISH GRAY TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP		9	14 22 27	71	100	SS-4	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	-	
		12	16 22 30	75	78	SS-5	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	-	
		14	30 30 42	104	100	SS-6	4.50	12	12	19	35	22	24	14	10	7	A-4a (4)	-	
		17	20 23 18	59	100	SS-7	4.50	12	12	19	35	22	24	14	10	9	A-4a (4)	-	
	925.1	19 EOB	30 50/5"	-	82	SS-8	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:52 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 7/14/20 END: 7/14/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 806+00, 1' RT. ALIGNMENT: RAMP SE ELEVATION: 948.0 (MSL) EOB: 10.0 ft. LAT / LONG: 39.048636, -83.946764	EXPLORATION ID B-023-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 948.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	947.0																		
STIFF TO VERY STIFF, LIGHT BROWN WITH DARK BROWN STREAKS, **CLAY**, TRACE GRAVEL, LITTLE SAND, "AND" SILT, DAMP		1–2	3 3 3	9	83	SS-1	1.50	-	-	-	-	-	-	-	-	19	A-7-6 (V)	390	
		4–5	3 2 4	9	67	SS-2	3.00	3	3	13	37	44	50	21	29	21	A-7-6 (18)	-	
	941.0	6–7	5 7 17	35	100	SS-3	4.50	-	-	-	-	-	-	-	-	15	A-7-6 (V)	-	
HARD, LIGHT BROWN, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, DAMP	938.0	9–10 EOB	15 18 28	67	100	SS-4	4.50	14	12	18	36	20	26	14	12	10	A-6a (5)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 10/26/20 END: 10/26/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JP DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 606+00, 15' LT. ALIGNMENT: RAMP NE ELEVATION: 948.0 (MSL) EOB: 10.0 ft. LAT / LONG: 39.047335, -83.945662	EXPLORATION ID B-024-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 948.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	947.9																		
VERY STIFF, DARK BROWN TO BROWN, **SILT AND CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST		1 – 2	2 2 2	6	100	SS-1	3.00	1	3	12	58	26	32	19	13	23	A-6a (9)	-	
		3 – 5	3 4 5	13	100	SS-2	3.00	-	-	-	-	-	-	-	-	24	A-6a (V)	250	
	942.5																		
VERY STIFF TO HARD, BROWN, **SILTY CLAY**, TRACE GRAVEL, LITTLE SAND, DAMP		6 – 7	3 3 5	12	100	SS-3	4.00	3	4	19	36	38	37	20	17	19	A-6b (11)	-	
		8 – 9	10 19 27	67	100	SS-4	4.50	-	-	-	-	-	-	-	-	10	A-6b (V)	-	
	938.0	EOB 10																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:52 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 810+50, 1' RT.	EXPLORATION ID B-025-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: RAMP SE	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 946.3 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 6/18/20 END: 6/18/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.047497, -83.947445	

MATERIAL DESCRIPTION AND NOTES	ELEV. 946.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	946.1																		
STIFF TO VERY STIFF, BROWN AND GRAY, **CLAY**, TRACE GRAVEL, SOME SAND, SOME SILT, DAMP		1–2	3 3 3	9	78	SS-1	1.50	-	-	-	-	-	-	-	-	25	A-7-6 (V)	130	
		4–5	4 5 7	17	78	SS-2	2.00	3	5	16	27	49	51	28	23	18	A-7-6 (15)	-	
	940.3	W 940.3																	
HARD, BROWN, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, DAMP		6–7	7 11 17	41	78	SS-3	4.50	11	9	21	32	27	28	17	11	12	A-6a (5)	-	
		8.5–10	21 24 30	78	78	SS-4	4.50	-	-	-	-	-	-	-	-	8	A-6a (V)	-	
	936.3	EOB 10																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 611+06, 17' LT.	EXPLORATION ID B-026-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: RAMP NE	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 948.5 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 6/17/20 END: 6/17/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.047975, -83.945222	

MATERIAL DESCRIPTION AND NOTES	ELEV. 948.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	948.3																		
STIFF TO VERY STIFF, BROWNISH GRAY, **CLAY**, TRACE GRAVEL, LITTLE SAND, SOME SILT, DAMP TO MOIST		1 – 2.5	2 2 1	4	78	SS-1	3.50	-	-	-	-	-	-	-	-	24	A-7-6 (V)	-	
		3.5 – 5	3 3 4	10	78	SS-2	1.50	2	3	13	28	54	58	23	35	28	A-7-6 (20)	-	
		6 – 7.5	3 4 6	14	78	SS-3	1.50	2	3	14	32	49	55	26	29	20	A-7-6 (19)	-	
	940.0																		
HARD, BROWN, **SANDY SILT**, DAMP		8.5 – 10	13 16 16	46	78	SS-4	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	-	
	938.5	EOB 10																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 6/18/20 END: 6/18/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 812+50, 1' RT. ALIGNMENT: RAMP SE ELEVATION: 947.9 (MSL) EOB: 6.0 ft. LAT / LONG: 39.047559, -83.945872

EXPLORATION ID B-027-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 947.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	947.7																		
MEDIUM STIFF TO STIFF, BROWN TO BROWNISH GRAY, **SILT**, TRACE GRAVEL, LITTLE SAND, SOME CLAY, DAMP TO MOIST		1	6 5 3	12	78	SS-1	-	-	-	-	-	-	-	-	-	15	A-4b (V)	100	
	944.9	2	2 2 3	7	78	SS-2	1.00	1	3	15	54	27	25	17	8	19	A-4b (8)	-	
STIFF TO VERY STIFF, BROWN TO GRAY, **SILT AND CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST		3 4	4 4 4	12	78	SS-3	2.00	1	3	12	51	33	31	19	12	19	A-6a (9)	-	
	941.9	5 EOB 6	2 3 5	12	78	SS-4	2.50	-	-	-	-	-	-	-	-	29	A-6a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:52 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 6/17/20 END: 6/17/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 613+56, 4' LT. ALIGNMENT: RAMP NE ELEVATION: 949.8 (MSL) EOB: 6.0 ft. LAT / LONG: 39.047705, -83.944413

EXPLORATION ID B-028-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 949.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	949.6																		
VERY STIFF TO HARD, BROWNISH GRAY TO GRAY, **SILT**, TRACE GRAVEL, LITTLE SAND, SOME CLAY, DAMP TO MOIST		1	6 5 7	17	67	SS-1	4.00	-	-	-	-	-	-	-	-	15	A-4b (V)	100	
	946.8	2	8 7 7	20	78	SS-2	4.50	1	3	17	53	26	26	16	10	16	A-4b (8)	-	
STIFF, BROWNISH GRAY TO GRAY, **SILTY CLAY**, LITTLE SAND, MOIST		3 4	3 3 4	10	78	SS-3	2.00	0	2	11	50	37	38	18	20	20	A-6b (12)	-	
	943.8	5 EOB 6	5 4 5	13	78	SS-4	1.00	-	-	-	-	-	-	-	-	19	A-6b (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 206+72, 68' RT.	EXPLORATION ID B-029-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BRO-32	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 950.1 (MSL) EOB: 6.0 ft.	PAGE 1 OF 1
START: 6/18/20 END: 6/18/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.047193, -83.944002	

MATERIAL DESCRIPTION AND NOTES	ELEV. 950.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	949.9																		
VERY STIFF TO HARD, BROWN TO GRAY, **SILT AND CLAY**, LITTLE SAND, DAMP TO MOIST		1	4 4 5	13	78	SS-1	4.00	-	-	-	-	-	-	-	-	15	A-6a (V)	100	
		2	3 3 3	9	78	SS-2	2.00	0	3	11	58	28	30	18	12	20	A-6a (9)	-	
	945.6	3 4	3 3 4	10	78	SS-3	2.25	-	-	-	-	-	-	-	-	19	A-6a (V)	-	
MEDIUM STIFF, BROWNISH GRAY, **SILTY CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST	944.1	5 EOB 6	3 2 3	7	78	SS-4	-	3	3	8	45	41	40	24	16	31	A-6b (10)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 617+06, 1' RT.	EXPLORATION ID B-030-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: RAMP NE	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 950.2 (MSL) EOB: 6.0 ft.	PAGE 1 OF 1
START: 6/17/20 END: 6/17/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.047398, -83.943246	

MATERIAL DESCRIPTION AND NOTES	ELEV. 950.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	950.0																		
VERY STIFF TO HARD, BROWN TO GRAY, **SILTY CLAY**, LITTLE GRAVEL, LITTLE SAND, DAMP TO MOIST		1	4 5 5	14	78	SS-1	4.50	13	6	13	34	34	35	16	19	13	A-6b (10)	-	
	947.2	2	5 5 6	16	78	SS-2	2.00	-	-	-	-	-	-	-	-	18	A-6b (V)	1300	
VERY STIFF, BROWNISH GRAY TO GRAY, **SILT AND CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST		3 4	5 4 4	12	67	SS-3	3.00	1	3	11	53	32	29	17	12	18	A-6a (9)	-	
	944.2	5 EOB 6	4 3 6	13	78	SS-4	3.50	-	-	-	-	-	-	-	-	22	A-6a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 213+03, 73' RT.	EXPLORATION ID B-031-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BRO-32	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 947.9 (MSL) EOB: 6.0 ft.	PAGE 1 OF 1
START: 6/18/20 END: 6/18/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.046688, -83.941876	

MATERIAL DESCRIPTION AND NOTES	ELEV. 947.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
								GR	CS	FS	SI	CL	LL	PL	PI				
DARK BROWN, **TOPSOIL**	947.7																		
STIFF TO HARD, BROWN, **SILTY CLAY**, TRACE GRAVEL, LITTLE SAND, DAMP		1	6 7 9	23	78	SS-1	4.50	-	-	-	-	-	-	-	-	11	A-6b (V)	100	
		2	5 4 3	10	78	SS-2	1.50	2	6	16	42	34	34	18	16	16	A-6b (10)	-	
	943.4	3 4	4 6 8	20	78	SS-3	2.00	-	-	-	-	-	-	-	-	16	A-6b (V)	-	
STIFF, GRAY, **CLAY**, TRACE SAND, "AND" SILT, MOIST	941.9	5 EOB 6	2 3 4	10	78	SS-4	1.00	0	1	7	55	37	48	19	29	30	A-7-6 (17)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 14+02, 29' LT.	EXPLORATION ID B-032-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BROOKS-MALOTT RD	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 942.8 (MSL) EOB: 6.0 ft.	PAGE 1 OF 1
START: 6/17/20 END: 6/17/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.047922, -83.938896	

MATERIAL DESCRIPTION AND NOTES	ELEV. 942.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	942.6																		
STIFF TO VERY STIFF, BROWNISH GRAY TO GRAY, **SILTY CLAY**, LITTLE SAND, MOIST		1	6 5 4	13	78	SS-1	3.00	-	-	-	-	-	-	-	-	18	A-6b (V)	660	
	939.8	2	2 3 3	9	78	SS-2	1.50	0	2	13	48	37	38	17	21	20	A-6b (12)	-	
STIFF TO VERY STIFF, BROWN TO BROWNISH GRAY, **CLAY**, TRACE GRAVEL, SOME SAND, SOME SILT, MOIST		3 – 4	3 2 4	9	78	SS-3	1.50	2	4	20	30	44	51	19	32	25	A-7-6 (18)	-	
	936.8	5 – EOB 6	5 4 7	16	78	SS-4	2.00	-	-	-	-	-	-	-	-	22	A-7-6 (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 20+75, 41' LT.	EXPLORATION ID B-035-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BROOKS-MALOTT RD	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 946.8 (MSL) EOB: 6.0 ft.	PAGE 1 OF 1
START: 6/15/20 END: 6/15/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.046135, -83.939492	

MATERIAL DESCRIPTION AND NOTES	ELEV. 946.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
								GR	CS	FS	SI	CL	LL	PL	PI				
DARK BROWN, **TOPSOIL**	946.7																		
STIFF TO VERY STIFF, BROWN TO LIGHT GRAY, **SILT AND CLAY**, LITTLE GRAVEL, LITTLE SAND, DAMP TO MOIST		1	5 3 4	10	78	SS-1	4.00	17	5	14	38	26	37	24	13	11	A-6a (7)	-	
		2	5 4 5	13	78	SS-2	2.00	-	-	-	-	-	-	-	-	21	A-6a (V)	100	
		3, 4	4 5 5	14	78	SS-3	1.50	17	3	11	45	24	38	25	13	22	A-6a (8)	-	
	940.8	5, EOB 6	2 2 2	6	78	SS-4	1.00	-	-	-	-	-	-	-	-	26	A-6a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 303+68, CL	EXPLORATION ID B-037-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: HOMAN WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 938.3 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 6/19/20 END: 6/19/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.048084, -83.964131	

MATERIAL DESCRIPTION AND NOTES	ELEV. 938.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**, WITH GRAVEL	938.1																		
STIFF TO VERY STIFF, DARK BROWN TO BROWN, **SILT AND CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST		1 – 2.5	2 2 2	6	78	SS-1	-	9	4	13	41	33	29	17	12	18	A-6a (9)	-	
		3.5 – 5	2 2 3	7	67	SS-2	1.00	-	-	-	-	-	-	-	-	28	A-6a (V)	-	
		6 – 7.5	3 3 5	12	78	SS-3	2.50	-	-	-	-	-	-	-	-	23	A-6a (V)	-	
	929.8																		
HARD, BROWN, **SANDY SILT**, TRACE GRAVEL, SOME CLAY, DAMP	928.3	8.5 – 10 EOB	5 11 26	54	78	SS-4	4.50	8	12	19	35	26	25	15	10	9	A-4a (5)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 309+00, 38' LT.	EXPLORATION ID B-038-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: HOMAN WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 931.6 (MSL) EOB: 33.8 ft.	PAGE 1 OF 2
START: 6/19/20 END: 6/19/20	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 86.8	LAT / LONG: 39.047596, -83.962469	

MATERIAL DESCRIPTION AND NOTES	ELEV. 931.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
DARK BROWN, **TOPSOIL**	930.6																		
VERY STIFF TO HARD, BROWNISH GRAY, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, DAMP MEDIUM STIFF AT SS-1		1–2	2 2 2	6	78	SS-1	0.50	-	-	-	-	-	-	-	-	20	A-6a (V)	-	
		4–5	4 5 7	17	78	SS-2	4.50	12	10	13	30	35	34	22	12	12	A-6a (7)	-	
		6–7	50 29 36	94	28	SS-3	4.50	-	-	-	-	-	-	-	-	2	A-6a (V)	-	
	921.1	8.5–10	8 9 10	27	100	SS-4	4.50	12	10	13	30	35	34	22	12	18	A-6a (7)	-	
VERY STIFF TO HARD, BROWNISH GRAY, **CLAY**, LITTLE GRAVEL, LITTLE SAND, SOME SILT, DAMP		11–12	6 7 11	26	78	SS-5	4.50	11	8	8	26	47	51	23	28	19	A-7-6 (17)	-	
	916.1	13.5–15	6 7 8	22	100	SS-6	2.50	11	8	8	26	47	51	23	28	22	A-7-6 (17)	-	
HARD, BROWNISH GRAY, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, DAMP TO MOIST		16–17	16 20 25	65	89	SS-7	4.50	17	10	9	21	43	36	23	13	11	A-6a (7)	-	
		18.5–20	30 35 50	123	78	SS-8	4.50	17	10	9	21	43	36	23	13	12	A-6a (7)	-	
	908.6	21–22.5	20 30 50/5"	-	82	SS-9	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	-	
		TR 23																	
		23.5	50/2"	-	100	SS-10	4.50	-	-	-	-	-	-	-	-	5	Rock (V)	-	
		24																	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:52 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PID: 110478	SFN: N/A	PROJECT: BRO-32-04.16	STATION / OFFSET: 309+00, 38' LT.	START: 6/19/20	END: 6/19/20	PG 2 OF 2	B-038-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 906.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
INTERBEDDED LIMESTONE (80%) AND SHALE (20%); **LIMESTONE**, GRAY, SEVERELY TO HIGHLY WEATHERED, WEAK, THIN BEDDED, FRIABLE, CALCAREOUS; **SHALE**, DARK GRAY, SEVERELY TO HIGHLY WEATHERED, VERY WEAK, LAMINATED. *(continued)*		26	50/4"	-	100	SS-11	4.50	-	-	-	-	-	-	-	-	8	Rock (V)	-	
	902.8	W 903.1 — 28	50/3"	-	100	SS-12	4.50	-	-	-	-	-	-	-	-	13	Rock (V)	-	
INTERBEDDED LIMESTONE (80%) AND SHALE (20%), MODERATELY FRACTURED, RQD 18%, REC. 57%; **LIMESTONE**, GRAY, MODERATELY WEATHERED, MODERATELY STRONG TO STRONG, THIN TO MEDIUM BEDDED, SLIGHTLY FOSSILIFEROUS, CALCAREOUS; **SHALE**, DARK GRAY, HIGHLY WEATHERED, WEAK, LAMINATED.	897.8	29 – 33, EOB	30		95	NQ2-1											CORE		

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 308+70, 49' RT.	EXPLORATION ID B-038-1-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: HOMAN WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 932.5 (MSL) EOB: 33.8 ft.	PAGE 1 OF 2
START: 6/19/20 END: 6/19/20	SAMPLING METHOD: SPT / NQ2	ENERGY RATIO (%): 86.8	LAT / LONG: 39.047825, -83.962290	

MATERIAL DESCRIPTION AND NOTES	ELEV. 932.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
DARK BROWN, **TOPSOIL**	931.5																		
HARD, BROWNISH GRAY, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, DAMP TO MOIST MEDIUM STIFF AT SS-1		1 – 2	2 2 3	7	78	SS-1	0.50	-	-	-	-	-	-	-	-	27	A-6a (V)	-	
		3 – 5	5 26 31	82	78	SS-2	-	-	-	-	-	-	-	-	-	11	A-6a (V)	-	
		6 – 7	20 38 45	120	78	SS-3	-	13	11	16	31	29	26	15	11	9	A-6a (5)	-	
	922.0	8 – 10	19 28 31	85	78	SS-4	4.50	13	11	16	31	29	26	15	11	9	A-6a (5)	-	
VERY STIFF TO HARD, BROWNISH GRAY, **SILTY CLAY**, SOME TO "AND" GRAVEL, LITTLE SAND, DAMP TO MOIST		11 – 12	9 11 13	35	78	SS-5	4.00	20	8	6	28	38	39	18	21	12	A-6b (11)	-	
		13 – 15	9 10 11	30	78	SS-6	4.50	20	8	6	28	38	39	18	21	18	A-6b (11)	-	
		16 – 17	5 14 50	93	78	SS-7	4.50	38	9	7	17	29	38	22	16	21	A-6b (4)	-	
		18 – 20	23 25 41	95	78	SS-8	4.50	38	9	7	17	29	38	22	16	10	A-6b (4)	-	
	909.5	21 – 22	39 50/5"	-	100	SS-9	4.50	-	-	-	-	-	-	-	-	6	A-6b (V)	-	
		W TR 909.0 23 – 24	50/1"	-	100	SS-10	4.50	-	-	-	-	-	-	-	-	7	Rock (V)	-	

PID: 110478	SFN: N/A	PROJECT: BRO-32-04.16	STATION / OFFSET: 308+70, 49' RT.	START: 6/19/20	END: 6/19/20	PG 2 OF 2	B-038-1-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 907.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	HOLE SEALED
INTERBEDDED LIMESTONE (80%) AND SHALE (20%); **LIMESTONE**, GRAY, SEVERELY TO HIGHLY WEATHERED, WEAK, THIN BEDDED, FRIABLE, CALCAREOUS; **SHALE**, DARK GRAY, SEVERELY TO HIGHLY WEATHERED, VERY WEAK, LAMINATED. *(continued)*	903.7	26	50/2"	-	250	SS-11	4.50	-	-	-	-	-	-	-	-	10	Rock (V)	-	
		27, 28																	
INTERBEDDED LIMESTONE (80%) AND SHALE (20%), MODERATELY FRACTURED, RQD 12%, REC. 58%; **LIMESTONE**, GRAY, MODERATELY WEATHERED, MODERATELY STRONG TO STRONG, THIN TO MEDIUM BEDDED, SLIGHTLY FOSSILIFEROUS, CALCAREOUS; **SHALE**, DARK GRAY, HIGHLY WEATHERED, WEAK, LAMINATED.		29	50/3"	-	100	SS-12	4.50	-	-	-	-	-	-	-	-	13	Rock (V)	-	
		30, 31, 32, 33	20		97	NQ2-1											CORE		
	898.7	EOB																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: BENTONITE GROUT

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:52 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 311+25, CL	EXPLORATION ID B-039-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: HOMAN WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 936.6 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 7/13/20 END: 7/13/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.047539, -83.961524	

MATERIAL DESCRIPTION AND NOTES	ELEV. 936.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	935.6	1																	
STIFF, BROWN, **SILT AND CLAY**, TRACE GRAVEL, SOME SAND, MOIST		2	2 2 3	7	56	SS-1	2.50	-	-	-	-	-	-	-	-	23	A-6a (V)	380	
		3																	
		4	6 8 13	30	100	SS-2	2.50	8	12	19	36	25	29	16	13	17	A-6a (6)	-	
	931.1	5																	
HARD, BROWN, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP		6																	
		7	19 23 35	84	100	SS-3	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	
		8																	
		9	16 27 37	93	100	SS-4	4.50	12	10	18	37	23	27	17	10	9	A-4a (5)	-	
	926.6	EOB 10																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 7/13/20 END: 7/13/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 315+15, 10' LT. ALIGNMENT: HOMAN WAY ELEVATION: 940.5 (MSL) EOB: 10.0 ft. LAT / LONG: 39.047326, -83.960214	EXPLORATION ID B-040-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 940.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	939.5																		
STIFF TO VERY STIFF, LIGHT BROWN, **CLAY**, TRACE GRAVEL, LITTLE SAND, "AND" SILT, MOIST		1–2	3 3 3	9	89	SS-1	2.00	-	-	-	-	-	-	-	-	23	A-7-6 (V)	240	
	935.0	4–5	4 4 7	16	100	SS-2	2.00	6	3	14	37	40	45	20	25	22	A-7-6 (15)	-	
VERY STIFF TO HARD, REDDISH BROWN, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, DAMP		6–7	8 12 16	41	100	SS-3	4.00	12	11	18	34	25	27	15	12	11	A-6a (5)	-	
	930.5	9–EOB 10	18 18 30	69	100	SS-4	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:53 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 7/13/20 END: 7/13/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 318+95, 20' LT. ALIGNMENT: HOMAN WAY ELEVATION: 942.1 (MSL) EOB: 9.8 ft. LAT / LONG: 39.047180, -83.958889	EXPLORATION ID B-041-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 942.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	941.1	1																	
STIFF TO VERY STIFF, BROWN TO LIGHT GRAY, **CLAY**, TRACE GRAVEL, LITTLE SAND, DAMP TO MOIST		2	4 3 3	9	89	SS-1	1.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	210	
		3																	
		4	4 3 3	9	100	SS-2	2.00	5	2	12	35	46	47	18	29	25	A-7-6 (17)	-	
		5																	
		6																	
		7	4 5 6	16	100	SS-3	3.00	4	4	18	30	44	48	25	23	19	A-7-6 (15)	-	
	934.1	8																	
HARD, LIGHT BROWN, **SANDY SILT**, DAMP		9	20 20 50/3"	-	100	SS-4	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	-	
	932.3	EOB																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:53 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:53 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 7/13/20 END: 7/13/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 322+75, 10' LT. ALIGNMENT: HOMAN WAY ELEVATION: 942.1 (MSL) EOB: 10.0 ft. LAT / LONG: 39.047102, -83.957555	EXPLORATION ID B-042-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 942.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	941.1																		
VERY STIFF, BROWN WITH GRAY MOTTLING, **CLAY**, TRACE GRAVEL, LITTLE SAND, SOME SILT, DAMP TO MOIST MEDIUM STIFF AT SS-1		1 – 2.5	2 2 2	6	89	SS-1	0.50	-	-	-	-	-	-	-	-	26	A-7-6 (V)	100	
		3.5 – 5	2 3 3	9	89	SS-2	2.50	5	3	15	31	46	50	20	30	20	A-7-6 (18)	-	
	934.1	6 – 7.5	3 5 11	23	100	SS-3	3.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	-	
HARD, BROWN, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, DAMP	932.1	8.5 – 10 EOB	10 21 31	75	100	SS-4	4.50	15	11	19	30	25	25	14	11	9	A-6a (4)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 326+55, 10' LT.	EXPLORATION ID B-043-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: HOMAN WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 941.5 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 7/13/20 END: 7/13/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.047008, -83.956223	

MATERIAL DESCRIPTION AND NOTES	ELEV. 941.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	940.5	1																	
STIFF TO VERY STIFF, BROWN WITH GRAY MOTTLING, **CLAY**, TRACE GRAVEL, LITTLE SAND, SOME SILT, MOIST		2	3 2 3	7	78	SS-1	2.50	-	-	-	-	-	-	-	-	23	A-7-6 (V)	200	
VERY STIFF AT SS-2		3–4	4 8 8	23	89	SS-2	1.25	4	2	13	29	52	60	21	39	29	A-7-6 (20)	-	
	936.0	5																	
STIFF, REDDISH BROWN, **SILT AND CLAY**, TRACE GRAVEL, SOME SAND, MOIST	933.5	6–7	3 4 5	13	100	SS-3	1.75	6	7	22	30	35	38	24	14	18	A-6a (8)	-	
HARD, BROWN, **SANDY SILT**, DAMP	931.5	8–9	14 21 21	61	100	SS-4	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	-	
		EOB 10																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 330+34, 15' LT.
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: HOMAN WAY
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 941.3 (MSL) EOB: 10.0 ft.
START: 7/13/20 END: 7/13/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.046845, -83.954902

EXPLORATION ID B-044-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 941.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	940.3																		
MEDIUM STIFF TO STIFF, BROWN, **CLAY**, TRACE GRAVEL, LITTLE SAND, SOME SILT, MOIST		1–2	3 2 2	6	89	SS-1	1.50	-	-	-	-	-	-	-	-	25	A-7-6 (V)	370	
	935.8	4–5	3 3 5	12	100	SS-2	1.50	9	4	13	28	46	55	20	35	22	A-7-6 (19)	-	
STIFF TO VERY STIFF, REDDISH BROWN, **SILT AND CLAY**, SOME GRAVEL, SOME SAND, DAMP TO MOIST		6–7	3 4 4	12	100	SS-3	1.25	-	-	-	-	-	-	-	-	24	A-6a (V)	-	
	931.3	9–10 EOB	11 19 24	62	67	SS-4	4.00	33	10	16	23	18	26	15	11	8	A-6a (1)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 7/14/20 END: 7/14/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 334+15, 15' LT. ALIGNMENT: HOMAN WAY ELEVATION: 942.1 (MSL) EOB: 10.0 ft. LAT / LONG: 39.046613, -83.953597	EXPLORATION ID B-045-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 942.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	941.1																		
MEDIUM STIFF TO STIFF, BROWN, **ELASTIC CLAY**, TRACE GRAVEL, LITTLE SAND, SOME SILT, DAMP		1 - 2.5	2 3 3	9	100	SS-1	1.00	-	-	-	-	-	-	-	-	22	A-7-5 (V)	170	
	936.6	3.5 - 5	3 3 4	10	89	SS-2	0.75	7	3	13	28	49	53	31	22	31	A-7-5 (15)	-	
MEDIUM STIFF TO STIFF, REDDISH BROWN TO GRAY, **SILTY CLAY**, TRACE GRAVEL, SOME SAND, MOIST		6 - 7.5	1 2 2	6	89	SS-3	-	-	-	-	-	-	-	-	-	22	A-6b (V)	-	
	932.1	8.5 - 10 (EOB 10)	4 4 5	13	100	SS-4	1.25	4	5	25	26	40	38	20	18	23	A-6b (9)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 337+96, 20' LT.	EXPLORATION ID B-046-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: HOMAN WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 943.0 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 7/13/20 END: 7/13/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.046325, -83.952312	

MATERIAL DESCRIPTION AND NOTES	ELEV. 943.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	942.0																		
STIFF TO VERY STIFF, BROWN, **CLAY**, TRACE GRAVEL, LITTLE SAND, SOME SILT, MOIST		1–2	3 2 3	7	89	SS-1	2.25	-	-	-	-	-	-	-	-	26	A-7-6 (V)	240	
		4	2 3 4	10	83	SS-2	1.00	-	-	-	-	-	-	-	-	24	A-7-6 (V)	-	
	935.5	7	3 3 5	12	100	SS-3	2.25	5	3	14	31	47	51	17	34	23	A-7-6 (18)	-	
HARD, REDDISH BROWN, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, DAMP	933.0	9 / EOB 10	7 7 12	27	100	SS-4	4.50	13	9	19	34	25	29	16	13	15	A-6a (6)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:53 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 7/13/20 END: 7/13/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 341+75, 20' LT. ALIGNMENT: HOMAN WAY ELEVATION: 943.1 (MSL) EOB: 10.0 ft. LAT / LONG: 39.046028, -83.951029	EXPLORATION ID B-047-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 943.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	942.1																		
MEDIUM STIFF TO STIFF, BROWN, **CLAY**, TRACE TO LITTLE GRAVEL, SOME SAND, SOME SILT, DAMP TO MOIST		1-2	3 2 2	6	67	SS-1	1.25	-	-	-	-	-	-	-	-	24	A-7-6 (V)	130	
		4-5	3 4 4	12	83	SS-2	1.00	4	4	26	24	42	51	19	32	25	A-7-6 (16)	-	
		6-7	3 3 5	12	89	SS-3	2.00	-	-	-	-	-	-	-	-	20	A-7-6 (V)	-	
	933.1	9-10	2 2 4	9	100	SS-4	-	13	7	18	30	32	41	22	19	24	A-7-6 (9)	-	
		W 933.1 EOB 10																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 10/26/20 END: 10/26/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JP DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 345+55, CL ALIGNMENT: HOMAN WAY ELEVATION: 943.9 (MSL) EOB: 10.0 ft. LAT / LONG: 39.045634, -83.950220	EXPLORATION ID B-048-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 943.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	943.7																		
STIFF TO VERY STIFF, BROWN TO GREY, **CLAY**, TRACE GRAVEL, LITTLE TO SOME SAND, SOME SILT, DAMP TO MOIST		1 – 2	1 1 2	4	100	SS-1	1.50	-	-	-	-	-	-	-	-	10	A-7-6 (V)	100	
		3 – 4 – 5	3 3 4	10	100	SS-2	4.00	0	2	12	34	52	57	24	33	23	A-7-6 (19)	-	
		6 – 7	4 4 5	13	100	SS-3	3.50	3	3	17	32	45	44	20	24	21	A-7-6 (14)	-	
	933.9	8 – 9 – EOB 10	4 4 6	14	100	SS-4	3.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 349+35, CL	EXPLORATION ID B-049-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JP	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: HOMAN WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 946.4 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 10/26/20 END: 10/26/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.045338, -83.948937	

MATERIAL DESCRIPTION AND NOTES	ELEV. 946.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	946.2																		
VERY STIFF, GREYISH BROWN, **SILT AND CLAY**, LITTLE SAND, MOIST		1–2	2 2 2	6	100	SS-1	2.50	0	3	13	54	30	28	17	11	20	A-6a (8)	-	
	943.4	3																	
VERY STIFF, BROWN TO GREY, **CLAY**, TRACE GRAVEL, SOME SAND, SOME SILT, MOIST		4–5	3 4 4	12	100	SS-2	3.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	290	
		6–7	4 4 6	14	100	SS-3	3.00	-	-	-	-	-	-	-	-	23	A-7-6 (V)	-	
		8																	
	936.4	9–10 EOB	5 6 7	19	100	SS-4	3.50	6	5	20	31	38	42	19	23	19	A-7-6 (12)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 353+15, CL	EXPLORATION ID B-050-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JP	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: HOMAN WAY	PAGE 1 OF 1
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 946.4 (MSL) EOB: 10.0 ft.	
START: 10/26/20 END: 10/26/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.044970, -83.947694	

MATERIAL DESCRIPTION AND NOTES	ELEV. 946.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	946.2																		
VERY STIFF, GREYISH BROWN, **CLAY**, TRACE GRAVEL, LITTLE SAND, "AND" SILT, DAMP TO MOIST		1–2	2 1 2	4	78	SS-1	2.50	-	-	-	-	-	-	-	-	24	A-7-6 (V)	100	
		4–5	2 3 4	10	100	SS-2	3.50	1	2	12	40	45	49	22	27	25	A-7-6 (17)	-	
		6–7	2 3 5	12	100	SS-3	4.00	-	-	-	-	-	-	-	-	22	A-7-6 (V)	-	
STIFF, BROWNISH GREY, **SILTY CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST	938.4	8																	
		9–10	3 3 4	10	100	SS-4	1.50	4	5	15	40	36	36	19	17	28	A-6b (11)	-	
	936.4	EOB 10																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:53 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 53+00, CL	EXPLORATION ID B-051-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JP	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: MERCY BLVD	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 946.7 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 10/26/20 END: 10/26/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.044857, -83.946198	

MATERIAL DESCRIPTION AND NOTES	ELEV. 946.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	946.5																		
MEDIUM STIFF, BROWN, **CLAY**, LITTLE SAND, "AND"SILT, MOIST		1–2	1 1 1	3	56	SS-1	1.00	0	3	9	45	43	50	21	29	25	A-7-6 (18)	-	
	943.7																		
VERY STIFF TO HARD, BROWN TO GREY, **SILTY CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST		3.5–5	4 4 6	14	100	SS-2	4.50	-	-	-	-	-	-	-	-	22	A-6b (V)	100	
		6–7.5	3 3 6	13	100	SS-3	3.00	9	4	14	35	38	40	18	22	21	A-6b (12)	-	
		8.5–10	12 9 10	27	100	SS-4	4.50	-	-	-	-	-	-	-	-	19	A-6b (V)	-	
	936.7	EOB 10																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:53 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 22+02, 18' LT.	EXPLORATION ID B-052-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: SHAW DR	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 946.9 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 6/15/02 END: 6/15/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.045732, -83.944420	

MATERIAL DESCRIPTION AND NOTES	ELEV. 946.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	946.8																		
STIFF TO VERY STIFF, BROWN, **SILT AND CLAY**, TRACE GRAVEL, SOME SAND, DAMP		1–2	4 3 3	9	67	SS-1	1.50	-	-	-	-	-	-	-	-	16	A-6a (V)	520	
		3–5	3 4 4	12	78	SS-2	2.00	-	-	-	-	-	-	-	-	17	A-6a (V)	-	
	938.4	6–8	3 4 7	16	78	SS-3	3.50	8	5	18	31	38	39	24	15	22	A-6a (9)	-	
HARD, BROWN, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP	936.9	9 – EOB 10	16 15 21	52	78	SS-4	4.50	18	9	18	35	20	21	15	6	12	A-4a (4)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:53 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 58+01, 10' RT.	EXPLORATION ID B-053-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: MERCY BLVD	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 945.8 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 6/15/20 END: 6/15/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.045100, -83.944090	

MATERIAL DESCRIPTION AND NOTES	ELEV. 945.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
GRAY, **GRAVEL**	945.3																		
STIFF, BROWNISH GRAY, **CLAY**, TRACE GRAVEL, LITTLE SAND, "AND" SILT, DAMP		1–2.5	3 3 3	9	78	SS-1	1.00	-	-	-	-	-	-	-	-	24	A-7-6 (V)	420	
		3.5–5	4 4 4	12	78	SS-2	1.50	6	2	12	40	40	41	24	17	22	A-7-6 (11)	-	
	937.3	6–7.5	4 5 5	14	78	SS-3	1.00	-	-	-	-	-	-	-	-	19	A-7-6 (V)	-	
STIFF TO VERY STIFF, BROWN, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP	935.8	8.5–10 EOB	4 5 6	16	78	SS-4	1.00	11	9	21	39	20	25	17	8	14	A-4a (5)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:53 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 10/26/20 END: 10/26/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JP DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 356+95, CL ALIGNMENT: HOMAN WAY ELEVATION: 947.2 (MSL) EOB: 10.0 ft. LAT / LONG: 39.044163, -83.946858	EXPLORATION ID B-054-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 947.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	947.1																		
STIFF TO VERY STIFF, BROWN TO GREY, **CLAY**, TRACE GRAVEL, LITTLE SAND, "AND" SILT, MOIST		1–2	2 1 2	4	67	SS-1	1.50	-	-	-	-	-	-	-	-	22	A-7-6 (V)	100	
		4–5	2 3 5	12	100	SS-2	3.00	3	3	14	40	40	46	17	29	24	A-7-6 (17)	-	
HARD, BROWNISH GREY, **CLAY**, TRACE GRAVEL, SOME SAND, SOME SILT, MOIST	941.7	6–7	3 5 6	16	100	SS-3	4.50	4	5	19	32	40	43	20	23	17	A-7-6 (13)	-	
	937.2	9–10 (EOB 10)	8 16 22	55	100	SS-4	4.50	-	-	-	-	-	-	-	-	11	A-7-6 (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 360+75, CL	EXPLORATION ID B-055-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JP	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: HOMAN WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 944.7 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 10/26/20 END: 10/26/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.043309, -83.946089	

MATERIAL DESCRIPTION AND NOTES	ELEV. 944.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	944.6																		
STIFF, GREYISH BROWN, **SILTY CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST		1–2	2 1 1	3	67	SS-1	2.00	1	2	11	48	38	38	18	20	28	A-6b (12)	-	
VERY STIFF TO HARD, GREYISH BROWN, **CLAY**, TRACE GRAVEL, SOME SAND, SOME SILT, MOIST	941.7	3.5–5	2 2 3	7	11	SS-2	3.00	-	-	-	-	-	-	-	-	23	A-7-6 (V)	830	
		6–7.5	3 3 5	12	78	SS-3	3.50	-	-	-	-	-	-	-	-	24	A-7-6 (V)	-	
		8.5–10	4 4 5	13	100	SS-4	4.50	4	4	17	30	45	46	17	29	24	A-7-6 (17)	-	
	934.7	EOB 10																	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 364+25, CL	EXPLORATION ID B-056-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JP	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: HOMAN WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 945.2 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 10/26/20 END: 10/26/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.042604, -83.945271	

MATERIAL DESCRIPTION AND NOTES	ELEV. 945.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
BLACK, **ASPHALT**, SOME GRAVEL	944.5																		
VERY STIFF, DARK BROWN TO BROWN, **CLAY**, TRACE GRAVEL, LITTLE SAND, SOME TO "AND" SILT, DAMP TO MOIST		1–2	2 2 3	7	67	SS-1	3.00	-	-	-	-	-	-	-	-	27	A-7-6 (V)	100	
		3.5–5	3 3 5	12	94	SS-2	3.00	3	2	9	40	46	51	24	27	28	A-7-6 (17)	-	
		6–7.5	2 2 3	7	100	SS-3	3.50	1	2	14	31	52	53	24	29	24	A-7-6 (18)	-	
	935.2	8.5–10 EOB	4 3 7	14	100	SS-4	3.00	-	-	-	-	-	-	-	-	23	A-7-6 (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 407+00, CL	EXPLORATION ID B-057-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BRUCE LUNSFORD WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 943.9 (MSL) EOB: 20.0 ft.	PAGE 1 OF 1
START: 7/13/20 END: 7/13/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.046972, -83.949850	

MATERIAL DESCRIPTION AND NOTES	ELEV. 943.9	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	942.9																		
SOFT TO MEDIUM STIFF, BROWN, **SILTY CLAY**, LITTLE SAND, MOIST		1–2.5	2 1 2	4	89	SS-1	0.50	0	2	11	46	41	38	22	16	25	A-6b (10)	-	
	938.4	3.5–5	3 2 3	7	33	SS-2	0.50	-	-	-	-	-	-	-	-	28	A-6b (V)	-	
STIFF, REDDISH BROWN, **CLAY**, TRACE GRAVEL, LITTLE SAND, SOME SILT, MOIST		6–7.5	2 3 5	12	89	SS-3	1.50	-	-	-	-	-	-	-	-	24	A-7-6 (V)	-	
	933.4	8.5–10; W 933.4	4 4 4	12	100	SS-4	1.25	5	3	15	33	44	44	17	27	23	A-7-6 (16)	-	
HARD, BROWN TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP		11–12.5	7 14 21	51	100	SS-5	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	-	
		13.5–15	12 16 18	49	100	SS-6	4.50	17	10	18	28	27	23	13	10	12	A-4a (4)	-	
		16–17.4	10 14 50/5"	-	100	SS-7	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	-	
	923.9	18.5–20; EOB 20	12 19 29	69	100	SS-8	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:53 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 7/14/20 END: 7/14/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT / ST	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 411+75, 108' LT. ALIGNMENT: BRUCE LUNSFORD WAY ELEVATION: 944.6 (MSL) EOB: 30.0 ft. LAT / LONG: 39.048294, -83.949592	EXPLORATION ID B-058-0-20 PAGE 1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 944.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	943.6																		
MEDIUM STIFF TO STIFF, BROWN WITH GRAY MOTTLING, **CLAY**, TRACE GRAVEL, TRACE SAND, "AND" SILT, MOIST		1–2	2 2 2	6	89	SS-1	0.75	-	-	-	-	-	-	-	-	30	A-7-6 (V)	-	
		3–5	3 3 5	12	83	SS-2	2.00	7	1	9	42	41	64	22	42	28	A-7-6 (20)	-	
	936.6	5.5–7.5			67	ST-1	2.00	-	-	-	-	-	-	-	-	22	A-7-6 (V)	-	
HARD, BROWN TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP		8.5–10	6 9 20	42	100	SS-3	4.50	-	-	-	-	-	-	-	-	-	A-4a (V)	-	
		11–12.5 (▼ at 12)	15 25 32	82	100	SS-4	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	-	
		13.5–15	30 35 44	114	100	SS-5	4.50	16	11	18	29	26	24	14	10	8	A-4a (4)	-	
	926.6	16–17.5	9 25 29	78	100	SS-6	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	
VERY DENSE, GRAY, **SILT**, TRACE GRAVEL, LITTLE SAND, LITTLE CLAY, MOIST		18.5–20	26 22 25	68	100	SS-7	-	4	3	13	62	18	NP	NP	NP	19	A-4b (8)	-	
		W 921.1 (23.5)	50/2"	-	100	SS-8	-	-	-	-	-	-	-	-	-	12	A-4b (V)	-	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:54 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PID: 110478	SFN: N/A	PROJECT: BRO-32-04.16	STATION / OFFSET: 411+75, 108' LT.	START: 7/14/20	END: 7/14/20	PG 2 OF 2	B-058-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 919.6	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
VERY DENSE, GRAY, **SILT**, TRACE GRAVEL, LITTLE SAND, LITTLE CLAY, MOIST *(continued)*	916.6	26, 27, 28																	
HARD, GRAY, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, DAMP	914.6	29, EOB 30	30 39 41	116	100	SS-9	4.50	12	10	18	31	29	24	13	11	10	A-6a (5)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 7/14/20 END: 7/14/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT / ST	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 411+75, CL ALIGNMENT: BRUCE LUNSFORD WAY ELEVATION: 944.3 (MSL) EOB: 30.0 ft. LAT / LONG: 39.048185, -83.949238

EXPLORATION ID B-058-1-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 944.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	943.3																		
MEDIUM STIFF TO STIFF, BROWN TO REDDISH BROWN, **CLAY**, TRACE GRAVEL, LITTLE TO SOME SAND, "AND" SILT, DAMP TO MOIST		1–2.5	2 2 2	6	83	SS-1	1.25	-	-	-	-	-	-	-	-	28	A-7-6 (V)	-	
		3.5–5	4 4 5	13	100	SS-2	1.25	5	2	15	37	41	52	28	24	27	A-7-6 (16)	-	
		6–7.5	3 5 4	13	100	SS-3	1.50	2	3	18	37	40	52	18	34	20	A-7-6 (18)	-	
	934.3	8.5–10			100	ST-1	1.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	-	
HARD, BROWN TO GRAY, **SILT AND CLAY**, LITTLE GRAVEL, SOME SAND, DAMP		11–12.5	20 22 31	77	100	SS-4	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	-	
		13.5–15	20 27 30	82	100	SS-5	4.50	-	-	-	-	-	-	-	-	10	A-6a (V)	-	
	926.3	16–17.5	25 33 45	113	100	SS-6	4.50	16	10	16	37	21	24	13	11	8	A-6a (5)	-	
HARD, GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP TO MOIST		18.5–20	29 31 41	104	100	SS-7	4.50	-	-	-	-	-	-	-	-	14	A-4a (V)	-	
		23.5–25	20 27 41	98	100	SS-8	4.50	14	8	17	40	21	23	14	9	8	A-4a (5)	-	

PID: 110478	SFN: N/A	PROJECT: BRO-32-04.16	STATION / OFFSET: 411+75, CL	START: 7/14/20	END: 7/14/20	PG 2 OF 2	B-058-1-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 919.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
HARD, GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP TO MOIST *(continued)*		26 27 28																	
	914.3	29 EOB 30	30 38 40	113	100	SS-9	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 411+75, 104' RT.	EXPLORATION ID B-058-2-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BRUCE LUNSFORD WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 944.5 (MSL) EOB: 30.0 ft.	PAGE 1 OF 2
START: 7/14/20 END: 7/14/20	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 86.8	LAT / LONG: 39.048081, -83.948898	

MATERIAL DESCRIPTION AND NOTES	ELEV. 944.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	943.5																		
MEDIUM STIFF TO STIFF, BROWNISH GRAY, **CLAY**, TRACE GRAVEL, TRACE TO LITTLE SAND, SOME TO "AND" SILT, DAMP TO MOIST		1, 2	3 3 3	9	78	SS-1	1.00	2	2	8	45	43	50	28	22	42	A-7-6 (15)	-	
		3																	
FROM 4.0 FT. TO 4.5 FT., Su = 0.6 TSF		4, 5			100	ST-1	-	-	-	-	-	-	-	-	-	26	A-7-6 (V)	-	
		W 938.5, 6, 7	2 3 4	10	78	SS-2	1.50	10	2	11	29	48	60	24	36	24	A-7-6 (20)	-	
		8																	
		9, 10	3 4 5	13	78	SS-3	2.00	-	-	-	-	-	-	-	-	23	A-7-6 (V)	-	
		11																	
	932.5				100	ST-2	-	-	-	-	-	-	-	-	-	20	A-7-6 (V)	-	
HARD, BROWN TO GRAY, **SILT AND CLAY**, LITTLE TO SOME GRAVEL, SOME SAND, DAMP TO MOIST		12	18 50/3"	-	56	SS-4	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	-	
		13																	
		14	32 40 50/5"	-	100	SS-5	4.50	23	11	17	30	19	26	15	11	10	A-6a (3)	-	
		15																	
		▼ 16, 17	16 23 33	81	100	SS-6	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	-	
		18																	
		19, 20	28 29 39	98	100	SS-7	4.50	-	-	-	-	-	-	-	-	10	A-6a (V)	-	
		21, 22, 23																	
		24	50/5"	-	100	SS-8	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	-	

PID: 110478	SFN: N/A	PROJECT: BRO-32-04.16	STATION / OFFSET: 411+75, 104' RT.	START: 7/14/20	END: 7/14/20	PG 2 OF 2	B-058-2-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 919.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
HARD, BROWN TO GRAY, **SILT AND CLAY**, LITTLE TO SOME GRAVEL, SOME SAND, DAMP TO MOIST *(continued)*		26 27 28																	
	914.5	29 EOB 30	21 30 36	95	100	SS-9	4.50	17	8	17	35	23	25	14	11	9	A-6a (5)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:54 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 414+59, 101' LT.	EXPLORATION ID B-059-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BRUCE LUNSFORD WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 945.0 (MSL) EOB: 29.9 ft.	PAGE 1 OF 2
START: 6/16/20 END: 6/16/20	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 86.8	LAT / LONG: 39.049013, -83.949200	

MATERIAL DESCRIPTION AND NOTES	ELEV. 945.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	944.0																		
STIFF TO VERY STIFF, LIGHT BROWN TO BROWN, **SILTY CLAY**, TRACE GRAVEL, LITTLE SAND, MOIST		1 – 2	2 2 3	7	78	SS-1	1.50	5	3	13	46	33	33	16	17	22	A-6b (11)	-	
		3.5 – 5	3 5 5	14	78	SS-2	2.50	5	3	13	46	33	33	16	17	20	A-6b (11)	-	
	936.5	6.5 – 8.5; W 936.5			100	ST-1	-	-	-	-	-	-	-	-	-	21	A-6b (V)	-	
VERY STIFF TO HARD, BROWN, **SILT**, TRACE GRAVEL, SOME SAND, LITTLE CLAY, MOIST	934.0	8.5 – 10	8 11 14	36	78	SS-3	2.25	6	4	23	52	15	20	13	7	15	A-4b (6)	-	
HARD, BROWN TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP		11 – 12.3	23 40 50/4"	-	88	SS-4	4.50	14	11	19	34	22	23	14	9	7	A-4a (4)	-	
		13.5 – 15	26 37 42	114	78	SS-5	4.50	14	11	19	34	22	23	14	9	8	A-4a (4)	-	
		16 – 17.1	18 19 50/1"	-	92	SS-6	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	
		18.5 – 18.9	50/5"	-	100	SS-7	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	
		23.5 – 25	28 50 50	145	78	SS-8	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	-	

MATERIAL DESCRIPTION AND NOTES	ELEV. 920.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
HARD, BROWN TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP *(continued)*		26 27 28																	
	915.1	29 EOB	27 40 50/5"	-	82	SS-9	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	

NOTES: WATER ADDED AT 20 FT

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 6/16/20 END: 6/16/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT / ST	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 414+59, CL ALIGNMENT: BRUCE LUNSFORD WAY ELEVATION: 945.0 (MSL) EOB: 30.0 ft. LAT / LONG: 39.048912, -83.948871	EXPLORATION ID B-059-1-20 PAGE 1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 945.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	944.0																		
STIFF TO VERY STIFF, BROWNISH GRAY, **CLAY**, TRACE GRAVEL, LITTLE SAND, "AND" SAND, DAMP		1–2.5	2 1 2	4	67	SS-1	1.50	2	3	13	38	44	47	25	22	23	A-7-6 (14)	-	
FROM 4.1 FT. TO 4.6 FT., Su = 0.9 TSF		4–6			77	ST-1	-	-	-	-	-	-	-	-	-	22	A-7-6 (V)	-	
		6–7.5	3 4 5	13	78	SS-2	2.00	2	3	13	38	44	47	25	22	20	A-7-6 (14)	-	
HARD, BROWN TO GRAY, **SANDY SILT**, SOME GRAVEL, SOME CLAY, DAMP		8.5–10	3 6 11	25	78	SS-3	4.50	-	-	-	-	-	-	-	-	16	A-4a (V)	-	
	934.0	11–12.5	8 15 30	65	78	SS-4	4.50	-	-	-	-	-	-	-	-	13	A-4a (V)	-	
		13.5–15	19 23 32	80	78	SS-5	4.50	30	11	14	25	20	25	15	10	8	A-4a (2)	-	
		16–17.5	20 40 45	123	78	SS-6	4.50	30	11	14	25	20	25	15	10	9	A-4a (2)	-	
		18.5–20	37 45 46	132	78	SS-7	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	
		23.5–25	22 24 29	77	78	SS-8	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:54 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PID: 110478	SFN: N/A	PROJECT: BRO-32-04.16	STATION / OFFSET: 414+59, CL	START: 6/16/20	END: 6/16/20	PG 2 OF 2	B-059-1-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 920.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
HARD, BROWN TO GRAY, **SANDY SILT**, SOME GRAVEL, SOME CLAY, DAMP *(continued)*		26																	
		27																	
		28																	
		29	19 25 35	87	78	SS-9	4.50	-	-	-	-	-	-	-	-	11	A-4a (V)	-	
	915.0	EOB 30																	

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:54 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 414+46, 103' RT.	EXPLORATION ID B-059-2-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BRUCE LUNSFORD WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 945.3 (MSL) EOB: 30.0 ft.	PAGE 1 OF 2
START: 6/17/20 END: 6/17/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.048808, -83.948534	

MATERIAL DESCRIPTION AND NOTES	ELEV. 945.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	945.0																		
STIFF TO VERY STIFF, BROWN TO BROWNISH GRAY, **CLAY**, TRACE GRAVEL, LITTLE SAND, SOME SAND, DAMP TO MOIST SOFT AT SS-1		1–2	1 1 2	4	67	SS-1	1.00	-	-	-	-	-	-	-	-	25	A-7-6 (V)	-	
		4–5	3 2 4	9	67	SS-2	0.50	4	3	17	34	42	49	19	30	26	A-7-6 (18)	-	
		6–7	4 4 5	13	78	SS-3	2.00	4	3	17	34	42	49	19	30	19	A-7-6 (18)	-	
		9–10	4 4 8	17	78	SS-4	1.50	-	-	-	-	-	-	-	-	19	A-7-6 (V)	-	
	934.8																		
HARD, BROWNISH GRAY TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP		11–12	11 14 22	52	67	SS-5	4.50	14	11	19	31	25	24	16	8	9	A-4a (4)	-	
		14–15	11 19 50/5"	-	71	SS-6	4.50	14	11	19	31	25	24	16	8	9	A-4a (4)	-	
		16–17	15 20 25	65	78	SS-7	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	-	
		19–20	20 29 33	90	78	SS-8	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	
		24	28 32 48	116	78	SS-9	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	

PID: 110478	SFN: N/A	PROJECT: BRO-32-04.16	STATION / OFFSET: 414+46, 103' RT.	START: 6/17/20	END: 6/17/20	PG 2 OF 2	B-059-2-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 920.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
HARD, BROWNISH GRAY TO GRAY, **SANDY SILT**, LITTLE GRAVEL, SOME CLAY, DAMP *(continued)*		26 27 28																	
	915.3	29 EOB 30	18 28 40	98	78	SS-10	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 420+50, CL	EXPLORATION ID B-060-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BRUCE LUNSFORD WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 945.1 (MSL) EOB: 20.0 ft.	PAGE 1 OF 1
START: 6/16/20 END: 6/16/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.050378, -83.947995	

MATERIAL DESCRIPTION AND NOTES	ELEV. 945.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	944.1																		
STIFF TO VERY STIFF, BROWN TO BROWNISH GRAY, **CLAY**, TRACE GRAVEL, LITTLE SAND, SOME SILT, DAMP TO MOIST		1 – 2	2 2 2	6	67	SS-1	1.25	-	-	-	-	-	-	-	-	26	A-7-6 (V)	-	
		3 – 5	3 4 6	14	78	SS-2	2.25	5	2	12	34	47	58	23	35	30	A-7-6 (20)	-	
	937.1	6 – 7	4 5 6	16	78	SS-3	2.00	5	2	12	34	47	58	23	35	21	A-7-6 (20)	-	
VERY STIFF TO HARD, BROWN TO GRAY, **SANDY SILT**, LITTLE GRAVEL, LITTLE CLAY, DAMP		8 – 10	3 5 10	22	78	SS-4	4.50	15	11	18	34	22	25	15	10	13	A-4a (4)	-	
		11 – 12	14 23 28	74	78	SS-5	4.50	15	11	18	34	22	25	15	10	9	A-4a (4)	-	
		13 – 15	20 27 37	93	78	SS-6	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	-	
		16 – 17	15 24 35	85	78	SS-7	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	
	925.1	18 – 19 – EOB 20	27 43 50	135	78	SS-8	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 6/16/20 END: 6/16/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 423+50, 1' RT. ALIGNMENT: BRUCE LUNSFORD WAY ELEVATION: 945.5 (MSL) EOB: 10.0 ft. LAT / LONG: 39.051138, -83.947585	EXPLORATION ID B-061-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 945.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	944.5	0 - 1																	
MEDIUM STIFF TO STIFF, BROWNISH GRAY, **CLAY**, TRACE GRAVEL, LITTLE SAND, SOME SILT, DAMP TO MOIST		1 - 2.5	1 2 3	7	67	SS-1	1.50	-	-	-	-	-	-	-	-	23	A-7-6 (V)	100	
		3.5 - 5	2 3 4	10	78	SS-2	1.75	3	3	13	31	50	66	21	45	27	A-7-6 (20)	-	
		6 - 7.5	3 5 5	14	78	SS-3	2.00	2	2	15	33	48	56	18	38	19	A-7-6 (19)	-	
	935.5	8.5 - 10 EOB	3 3 5	12	78	SS-4	-	-	-	-	-	-	-	-	-	19	A-7-6 (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

STANDARD ODOT LOG W/ SULFATES (8.5 X 11) - OH DOT.GDT - 7/5/22 09:54 - U:\173620122\GEOTECH\BORINGS\BRO-32-4.16_ROADWAY_LOGS.GPJ

PROJECT: BRO-32-04.16	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS	DRILL RIG: DIEDRICH D-50	STATION / OFFSET: 427+00, 2' RT.	EXPLORATION ID B-062-0-20
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: STANTEC / JS	HAMMER: DIEDRICH AUTOMATIC	ALIGNMENT: BRUCE LUNSFORD WAY	
PID: 110478 SFN: N/A	DRILLING METHOD: 2.25" HSA	CALIBRATION DATE: 11/26/19	ELEVATION: 946.0 (MSL) EOB: 10.0 ft.	PAGE 1 OF 1
START: 6/16/20 END: 6/16/20	SAMPLING METHOD: SPT	ENERGY RATIO (%): 86.8	LAT / LONG: 39.052027, -83.947117	

MATERIAL DESCRIPTION AND NOTES	ELEV. 946.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%)					ATTERBERG			WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
								GR	CS	FS	SI	CL	LL	PL	PI				
DARK BROWN, **TOPSOIL**	945.0																		
STIFF TO VERY STIFF, BROWN TO BROWNISH GRAY, **CLAY**, TRACE GRAVEL, TRACE TO LITTLE SAND, SOME TO "AND" SILT, DAMP TO MOIST		1–2	2 1 2	4	67	SS-1	1.25	4	1	6	39	50	55	22	33	28	A-7-6 (19)	-	
		4–5	3 4 4	12	78	SS-2	2.25	-	-	-	-	-	-	-	-	24	A-7-6 (V)	-	
		6–7	4 4 5	13	67	SS-3	1.50	-	-	-	-	-	-	-	-	22	A-7-6 (V)	-	
	936.0	9–10 EOB	3 4 5	13	78	SS-4	1.50	5	3	17	34	41	45	19	26	21	A-7-6 (15)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

PROJECT: BRO-32-04.16 TYPE: ROADWAY PID: 110478 SFN: N/A START: 6/16/20 END: 6/16/20	DRILLING FIRM / OPERATOR: CENTRAL STAR / TS SAMPLING FIRM / LOGGER: STANTEC / JS DRILLING METHOD: 2.25" HSA SAMPLING METHOD: SPT	DRILL RIG: DIEDRICH D-50 HAMMER: DIEDRICH AUTOMATIC CALIBRATION DATE: 11/26/19 ENERGY RATIO (%): 86.8	STATION / OFFSET: 430+07, 2' RT. ALIGNMENT: BRUCE LUNSFORD WAY ELEVATION: 947.4 (MSL) EOB: 10.0 ft. LAT / LONG: 39.052807, -83.946706	EXPLORATION ID B-063-0-20 PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 947.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
DARK BROWN, **TOPSOIL**	947.1																		
STIFF TO VERY STIFF, BROWN TO BROWNISH GRAY, **CLAY**, TRACE TO LITTLE GRAVEL, LITTLE SAND, SOME SILT, DAMP TO MOIST		1 – 2.5	2 1 2	4	67	SS-1	1.00	-	-	-	-	-	-	-	-	26	A-7-6 (V)	100	
		3.5 – 5	3 4 5	13	78	SS-2	2.00	12	2	11	30	45	54	23	31	24	A-7-6 (19)	-	
		6 – 7.5	4 4 5	13	78	SS-3	2.00	7	2	16	34	41	55	26	29	21	A-7-6 (18)	-	
	937.4	8.5 – 10 EOB	5 5 7	17	78	SS-4	2.25	-	-	-	-	-	-	-	-	21	A-7-6 (V)	-	

NOTES: NONE

ABANDONMENT METHODS, MATERIALS, QUANTITIES: AUGER CUTTINGS

APPENDIX C

Seismic Site Class Derivation

Seismic Site Class Evaluation

Project: BRO-32-4.16 **Structure:** Overpass Bridge

Performed by: J. Samples
Checked by: E. Kistner

SPT Hammer Efficiency	86.8%

Boring: B-001-0-20

SPT Blow Counts			N-value	N60	Range	Range/N
4	2	3	5	7	6	0.83
2	3	4	7	10	5	0.49
2	4	8	12	17	2.5	0.14
16	18	31	49	71	2.5	0.04
27	23	33	56	81	2.5	0.03
36	50		100	100	2.5	0.03
21	24	42	66	95	2.5	0.03
38	50		100	100	5	0.05
29	31	43	74	100	5	0.05
19	50		100	100	5	0.05
12	33	50	83	100	5	0.05
11	16	18	34	49	5	0.10
8	9	15	24	35	6.5	0.19
Assumed Bedrock			100	100	45	0.45

Σ Range/N 2.52
Ň = 39.6

Boring: B-002-0-20

SPT Blow Counts			N-value	N60	Range	Range/N
5	8	10	18	26	3.5	0.13
5	3	6	9	13	5	0.38
3	3	5	8	12	2.5	0.22
2	4	5	9	13	2.5	0.19
2	7	8	15	22	2.5	0.12
7	17	28	45	65	2.5	0.04
18	27	38	65	94	2.5	0.03
22	28	45	73	100	2.5	0.03
38	40	48	88	100	5	0.05
17	22	40	62	90	5	0.06
34	28	28	56	81	5	0.06
11	17	28	45	65	5	0.08
34	26	30	56	81	5	0.06
9	12	21	33	48	6.5	0.14
Assumed Bedrock			100	100	45	0.45

Σ Range/N 2.02
Ň = 49.4

Boring: B-003-0-20

SPT Blow Counts			N-value	N60	Range	Range/N
4	4	3	7	10	3.5	0.35
5	4	4	8	12	2.5	0.22
3	3	6	9	13	2.5	0.19
3	4	5	9	13	5	0.38
10	20	17	37	54	2.5	0.05
22	24	32	56	81	2.5	0.03
25	37	50	87	100	2.5	0.03
47	40	50	90	100	2.5	0.03
20	29	50	100	100	5	0.05
26	50		100	100	5	0.05
50			100	100	5	0.05
13	15	35	50	72	5	0.07
9	15	29	44	64	5	0.08
9	12	17	29	42	6.5	0.15
Assumed Bedrock			100	100	45	0.45

Σ Range/N 2.17
Ň = 46.1

Average Ň = 45.1

In accordance with ODOT's Seismic Design Policy (2016) and AASHTO LRFD Section 3.10.3.1 (8th Edition)
The average Ň for the three borings is 15 < Ň < 50.

Therefore, based on AASHTO Table 3.10.3.1-1, use Site Class D

Table 3.10.3.1-1—Site Class Definitions

Site Class	Soil Type and Profile
A	Hard rock with measured shear wave velocity, 5,000 ft/s
B	Rock with 2,500 ft/sec < < 5,000 ft/s
C	Very dense soil and soil rock with 1,200 ft/sec < < 2,500 ft/s, or with either > 50 blows/ft, or > 2.0 ksf
D	Stiff soil with 600 ft/s < vs < 1,200 ft/s, or with either 15 < Ň < 50 blows/ft, or 1.0 < < 2.0 ksf
E	Soil profile with < 600 ft/s or with either < 15 blows/ft or < 1.0 ksf, or any profile with more than 10.0 ft of soft clay defined as soil with PI > 20, w > 40 percent and < 0.5 ksf
F	Soils requiring site-specific evaluations, such as: Peats or highly organic clays (H > 10.0 ft of peat or highly organic clay where H = thickness of soil) Very high plasticity clays (H > 25.0 ft with PI > 75) Very thick soft/medium stiff clays (H >120 ft)

APPENDIX D

Pile Capacity Analyses

==

APILE for Windows, Version 2019.9.4

Serial Number : 160705594

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.

==

This program is licensed to :

Stantec Consulting Services Inc.
Cincinnati, OHIO / USA

Path to file locations : U:\1736\173620122 BRO-32-4.16\GEOTECH\Analysis\Piles\B-003_Rear Abutment\New Till Strengths\Ultimate\
Name of input data file : BRO-32 Rear Abutment_12000.ap9d
Name of output file : BRO-32 Rear Abutment_12000.ap9o
Name of plot output file : BRO-32 Rear Abutment_12000.ap9p

Time and Date of Analysis

Date: February 01, 2021 Time: 13:48:59

1

****
* INPUT INFORMATION *
****

New Pile

DESIGNER   :

JOB NUMBER :

METHOD FOR UNIT LOAD TRANSFERS :

- FHWA (Federal Highway Administration)
  Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

Steel pipe pile or non-tapered portion of monotube pile
- Close-Ended Pile

DATA FOR AXIAL STIFFNESS :

```
- MODULUS OF ELASTICITY     = 0.290E+08 PSI
- CROSS SECTION AREA        =     11.46 IN2
```

CIRCULAR PILE PROPERTIES :

```
- OUTSIDE DIAMETER, OD      =     12.00 IN.
- INTERNAL DIAMETER, ID     =     11.38 IN.
```

```
- TOTAL PILE LENGTH, TL     =     65.00 FT.
- BATTER ANGLE              =      0.00 DEG
- PILE STICKUP LENGTH, PSL  =     17.00 FT.
- ZERO FRICTION LENGTH, ZFL =      0.00 FT.
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION       =      1.00 FT.
- LENGTH OF ENHANCED
  END SECTION               =     65.00 FT.
- INTERNAL DIAMETER OF
  ENHANCED END SECTION      =     11.38 IN.
```

PLUGGED/UNPLUGGED CONDITIONS :
Internal Pile Plug Calculated by Program

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.80*	125.00	0.00	8.00**
11.83	CLAY	0.80*	125.00	0.00	8.00**
11.83	CLAY	0.80*	130.00	0.00	8.00**
50.00	CLAY	0.80*	130.00	0.00	8.00**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	1.60	0.00	0.00	0.00	0.00

```
0.10E+08* 0.10E+08*       1.60      0.00   0.00       0.00      0.00
0.10E+08* 0.10E+08*      12.00      0.00   0.00       0.00      0.00
0.10E+08* 0.10E+08*      12.00      0.00   0.00       0.00      0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
  WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT
  PLAN TO LIMIT THE COMPUTED DATA.



         LRFD FACTOR  LRFD FACTOR
          ON UNIT      ON UNIT
 DEPTH    FRICTION     BEARING
  FT.
   0.00    1.000       1.000
  11.83    1.000       1.000
  11.83    1.000       1.000
  50.00    1.000       1.000
```

1

```
**********************
* COMPUTATION RESULT *
**********************



                  **********************
                  *  FED. HWY. METHOD  *
                  **********************

   PILE       TOTAL SKIN      END       ULTIMATE
PENETRATION   FRICTION      BEARING     CAPACITY
    FT.          KIP          KIP          KIP
    0.00          0.0          5.7          5.7
    1.00          2.0          5.7          7.6
    2.00          4.0         11.3         15.3
    3.00          5.9         11.3         17.2
    4.00          7.9         11.3         19.2
```

5.00	9.9	11.3	21.2
6.00	11.9	11.3	23.2
7.00	13.8	11.3	25.1
8.00	15.8	11.3	27.1
9.00	17.8	11.3	29.1
10.00	19.8	11.3	31.1
11.00	22.5	23.6	46.1
12.00	26.0	48.1	74.0
13.00	33.3	72.6	105.9
14.00	44.6	84.8	129.4
15.00	55.9	84.8	140.7
16.00	67.1	84.8	152.0
17.00	78.4	84.8	163.2
18.00	89.7	84.8	174.5
19.00	101.0	84.8	185.8
20.00	112.2	84.8	197.1
21.00	123.5	84.8	208.3
22.00	134.8	84.8	219.6
23.00	146.1	84.8	230.9
24.00	157.3	84.8	242.1
25.00	168.6	84.8	253.4
26.00	179.9	84.8	264.7
27.00	191.1	84.8	276.0
28.00	202.4	84.8	287.2
29.00	213.7	84.8	298.5
30.00	225.0	84.8	309.8
31.00	236.2	84.8	321.1
32.00	247.5	84.8	332.3
33.00	258.8	84.8	343.6
34.00	270.0	84.8	354.9
35.00	281.3	84.8	366.1
36.00	292.6	84.8	377.4
37.00	303.9	84.8	388.7
38.00	315.1	84.8	400.0
39.00	326.4	84.8	411.2
40.00	337.7	84.8	422.5
41.00	348.9	84.8	433.8
42.00	360.2	84.8	445.0
43.00	371.5	84.8	456.3
44.00	382.8	84.8	467.6

```
 45.00          394.0          84.8         478.9
 46.00          405.3          84.8         490.1
 47.00          416.6          84.8         501.4
 48.00          427.9          84.8         512.7
```

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN
  IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
  OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

```
     *************************************************
     * COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
     * CURVES FOR AXIAL LOADING                      *
     *************************************************
```

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.0000E+00		
			0.0000E+00	0.0000E+00
			0.1311E+01	0.1920E-01
			0.2185E+01	0.3720E-01
			0.3278E+01	0.6840E-01
			0.3933E+01	0.9600E-01
			0.4370E+01	0.1200E+00
			0.3933E+01	0.2400E+00
			0.3933E+01	0.3600E+00
			0.3933E+01	0.6000E+00
			0.3933E+01	0.2400E+01
2	10	0.5940E+01		
			0.0000E+00	0.0000E+00
			0.1311E+01	0.1920E-01
			0.2185E+01	0.3720E-01
			0.3278E+01	0.6840E-01
			0.3933E+01	0.9600E-01
			0.4370E+01	0.1200E+00

			0.3933E+01	0.2400E+00
			0.3933E+01	0.3600E+00
			0.3933E+01	0.6000E+00
			0.3933E+01	0.2400E+01
3	10	0.1179E+02		
			0.0000E+00	0.0000E+00
			0.2301E+01	0.1920E-01
			0.3834E+01	0.3720E-01
			0.5752E+01	0.6840E-01
			0.6902E+01	0.9600E-01
			0.7669E+01	0.1200E+00
			0.6902E+01	0.2400E+00
			0.6902E+01	0.3600E+00
			0.6902E+01	0.6000E+00
			0.6902E+01	0.2400E+01
4	10	0.1183E+02		
			0.0000E+00	0.0000E+00
			0.2301E+01	0.1920E-01
			0.3834E+01	0.3720E-01
			0.5752E+01	0.6840E-01
			0.6902E+01	0.9600E-01
			0.7669E+01	0.1200E+00
			0.6902E+01	0.2400E+00
			0.6902E+01	0.3600E+00
			0.6902E+01	0.6000E+00
			0.6902E+01	0.2400E+01
5	10	0.3094E+02		
			0.0000E+00	0.0000E+00
			0.7475E+01	0.1920E-01
			0.1246E+02	0.3720E-01
			0.1869E+02	0.6840E-01
			0.2242E+02	0.9600E-01
			0.2492E+02	0.1200E+00
			0.2242E+02	0.2400E+00
			0.2242E+02	0.3600E+00
			0.2242E+02	0.6000E+00
			0.2242E+02	0.2400E+01
6	10	0.4996E+02		
			0.0000E+00	0.0000E+00
			0.7475E+01	0.1920E-01

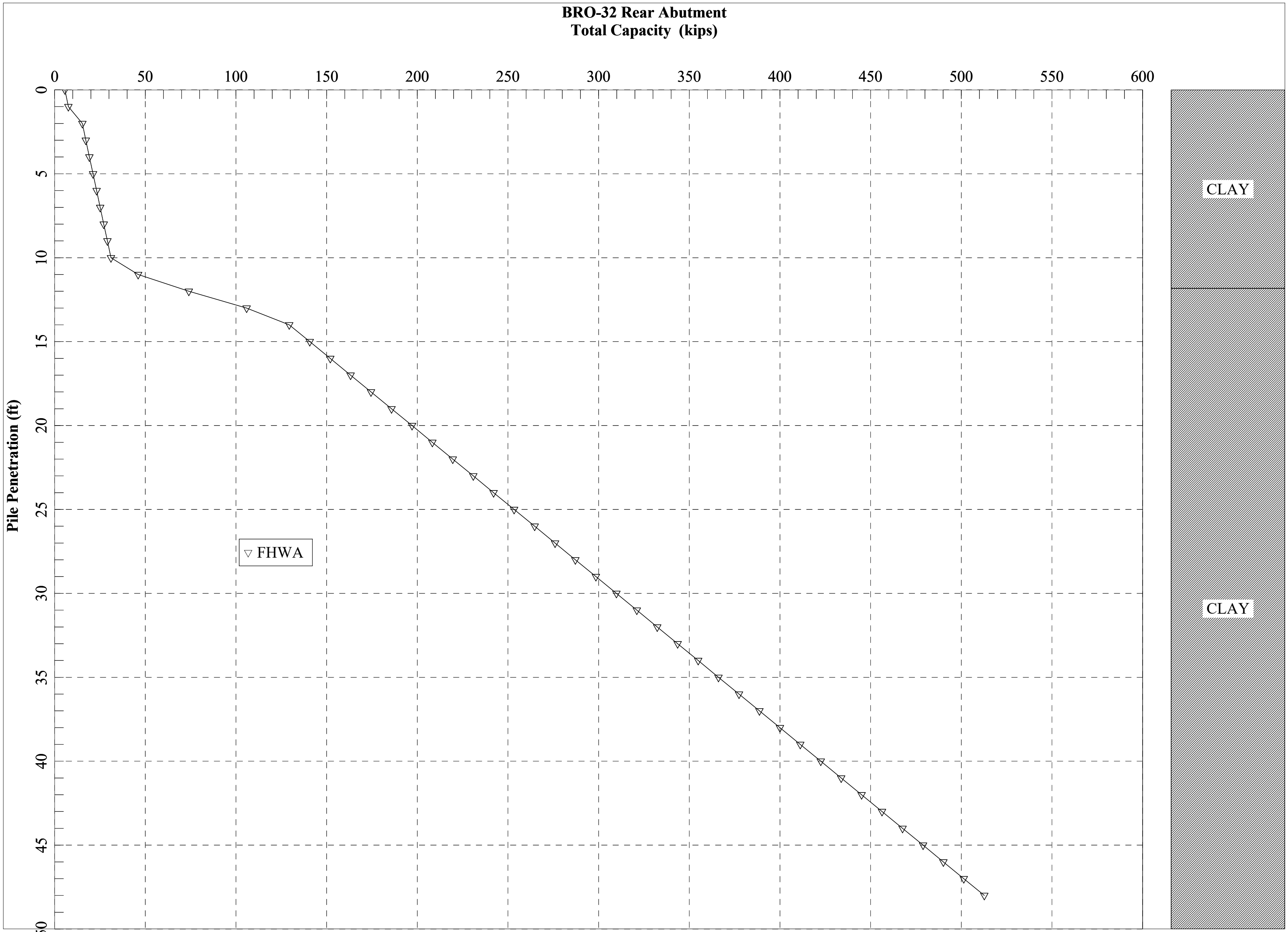
0.1246E+02	0.3720E-01
0.1869E+02	0.6840E-01
0.2242E+02	0.9600E-01
0.2492E+02	0.1200E+00
0.2242E+02	0.2400E+00
0.2242E+02	0.3600E+00
0.2242E+02	0.6000E+00
0.2242E+02	0.2400E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.5301E+01	0.6000E-02
0.1060E+02	0.1200E-01
0.2121E+02	0.2400E-01
0.4241E+02	0.1560E+00
0.6362E+02	0.5040E+00
0.7634E+02	0.8760E+00
0.8482E+02	0.1200E+01
0.8482E+02	0.1800E+01
0.8482E+02	0.2400E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.3114E+01	0.4289E-02	0.8836E-01	0.1000E-03
0.3303E+02	0.4519E-01	0.8836E+00	0.1000E-02
0.1392E+03	0.2010E+00	0.4418E+01	0.5000E-02
0.2213E+03	0.3359E+00	0.8836E+01	0.1000E-01
0.3100E+03	0.5037E+00	0.1767E+02	0.2000E-01
0.3911E+03	0.6977E+00	0.2538E+02	0.5000E-01

0.4233E+03	0.7992E+00	0.3020E+02	0.8000E-01
0.4337E+03	0.8441E+00	0.3342E+02	0.1000E+00
0.4329E+03	0.9478E+00	0.4509E+02	0.2000E+00
0.4488E+03	0.1285E+01	0.6337E+02	0.5000E+00
0.4592E+03	0.1610E+01	0.7374E+02	0.8000E+00
0.4650E+03	0.1823E+01	0.7959E+02	0.1000E+01
0.4702E+03	0.2836E+01	0.8482E+02	0.2000E+01


BRO-32 Rear Abutment
Total Capacity (kips)
0
50
100
150
200
250
300
350
400
450
500
550
600
Pile Penetration (ft)
0
5
10
15
20
25
30
35
40
45
50
FHWA
CLAY
CLAY

```
==========================================================================

                 APILE for Windows, Version 2019.9.4

                  Serial Number :  160705594

                  A Program for Analyzing the Axial Capacity
                  and Short-term Settlement of Driven Piles
                            under Axial Loading.
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==========================================================================


This program is licensed to :

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Cincinnati, OHIO / USA

Path to file locations      : U:\1736\173620122 BRO-32-4.16\GEOTECH\Analysis\Piles\B-003_Rear Abutment\New Till
Strengths\Sand sleeve\
Name of input data file     : BRO-32 Rear Abutment_sand sleeve_12000.ap9d
Name of output file         : BRO-32 Rear Abutment_sand sleeve_12000.ap9o
Name of plot output file    : BRO-32 Rear Abutment_sand sleeve_12000.ap9p

--------------------------------------------------------------------------
                     Time and Date of Analysis
--------------------------------------------------------------------------

          Date:  February 02, 2021     Time:  09:00:54


1
     *********************
     * INPUT INFORMATION *
     *********************
```

New Pile

DESIGNER :

JOB NUMBER :

METHOD FOR UNIT LOAD TRANSFERS :

- FHWA (Federal Highway Administration)
  Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

Steel pipe pile or non-tapered portion of monotube pile
- Close-Ended Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 11.46 IN2

CIRCULAR PILE PROPERTIES :

- OUTSIDE DIAMETER, OD = 12.00 IN.
- INTERNAL DIAMETER, ID = 11.38 IN.

- TOTAL PILE LENGTH, TL = 43.00 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 0.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- INCREMENT OF PILE LENGTH USED IN COMPUTATION = 2.05 FT.
- LENGTH OF ENHANCED END SECTION = 43.00 FT.
- INTERNAL DIAMETER OF ENHANCED END SECTION = 11.38 IN.

PLUGGED/UNPLUGGED CONDITIONS :
Internal Pile Plug Calculated by Program

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	SAND	0.80*	120.00	28.00	16.80**
17.00	SAND	0.80*	120.00	28.00	16.80**
17.00	CLAY	0.80*	125.00	0.00	8.00**
28.83	CLAY	0.80*	125.00	0.00	8.00**
28.83	CLAY	0.80*	130.00	0.00	8.00**
70.00	CLAY	0.80*	130.00	0.00	8.00**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION	MAXIMUM UNIT BEARING	UNDISTURB SHEAR STRENGTH	REMOLDED SHEAR STRENGTH	BLOW COUNT	UNIT SKIN FRICTION	UNIT END BEARING

```
  KSF       KSF        KSF       KSF                 KSF       KSF
0.10E+08* 0.10E+08*       0.00      0.00   0.00       0.00      0.00
0.10E+08* 0.10E+08*       0.00      0.00   0.00       0.00      0.00
0.10E+08* 0.10E+08*       1.60      0.00   0.00       0.00      0.00
0.10E+08* 0.10E+08*       1.60      0.00   0.00       0.00      0.00
0.10E+08* 0.10E+08*      12.00      0.00   0.00       0.00      0.00
0.10E+08* 0.10E+08*      12.00      0.00   0.00       0.00      0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
  WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT
  PLAN TO LIMIT THE COMPUTED DATA.



         LRFD FACTOR  LRFD FACTOR
          ON UNIT      ON UNIT
 DEPTH    FRICTION     BEARING
  FT.
   0.00    0.830       1.000
  17.00    0.830       1.000
  17.00    0.570       1.000
  28.83    0.570       1.000
  28.83    0.670       1.000
  70.00    0.670       1.000


1
 **********************
 * COMPUTATION RESULT *
 **********************


                  **********************
                  *  FED. HWY. METHOD  *
                  **********************

   PILE       TOTAL SKIN       END       ULTIMATE
PENETRATION   FRICTION       BEARING     CAPACITY
```

FT.	KIP	KIP	KIP
0.00	0.0	0.4	0.4
2.05	0.1	1.6	1.8
4.10	0.6	4.7	5.3
6.14	1.3	7.1	8.4
8.19	2.4	9.2	11.6
10.24	3.7	10.3	14.0
12.29	5.4	10.5	15.8
14.33	7.3	10.5	17.8
16.38	9.6	10.5	20.0
18.43	11.3	10.9	22.2
20.48	13.4	11.3	24.7
22.52	15.7	11.3	27.0
24.57	18.0	11.3	29.3
26.62	20.3	11.3	31.6
28.67	23.5	11.3	34.8
30.71	28.2	48.1	76.3
32.76	37.6	84.8	122.4
34.81	51.6	84.8	136.4
36.86	65.6	84.8	150.4
38.90	79.6	84.8	164.4
40.95	93.6	84.8	178.4
43.00	107.6	84.8	192.4

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN
  IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
  OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

```
*************************************************
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING                      *
*************************************************
```

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.

1	10	0.0000E+00		
			0.0000E+00	0.0000E+00
			0.0000E+00	0.1920E-01
			0.0000E+00	0.3720E-01
			0.0000E+00	0.6840E-01
			0.0000E+00	0.9600E-01
			0.0000E+00	0.1200E+00
			0.0000E+00	0.2400E+00
			0.0000E+00	0.3600E+00
			0.0000E+00	0.6000E+00
			0.0000E+00	0.2400E+01
2	10	0.8525E+01		
			0.0000E+00	0.0000E+00
			0.4857E+00	0.1920E-01
			0.8095E+00	0.3720E-01
			0.1214E+01	0.6840E-01
			0.1457E+01	0.9600E-01
			0.1619E+01	0.1200E+00
			0.1619E+01	0.2400E+00
			0.1619E+01	0.3600E+00
			0.1619E+01	0.6000E+00
			0.1619E+01	0.2400E+01
3	10	0.1696E+02		
			0.0000E+00	0.0000E+00
			0.9661E+00	0.1920E-01
			0.1610E+01	0.3720E-01
			0.2415E+01	0.6840E-01
			0.2898E+01	0.9600E-01
			0.3220E+01	0.1200E+00
			0.3220E+01	0.2400E+00
			0.3220E+01	0.3600E+00
			0.3220E+01	0.6000E+00
			0.3220E+01	0.2400E+01
4	10	0.1700E+02		
			0.0000E+00	0.0000E+00
			0.9685E+00	0.1920E-01
			0.1614E+01	0.3720E-01
			0.2421E+01	0.6840E-01
			0.2906E+01	0.9600E-01

			0.3228E+01	0.1200E+00
			0.2906E+01	0.2400E+00
			0.2906E+01	0.3600E+00
			0.2906E+01	0.6000E+00
			0.2906E+01	0.2400E+01
5	10	0.2294E+02		
			0.0000E+00	0.0000E+00
			0.1311E+01	0.1920E-01
			0.2185E+01	0.3720E-01
			0.3278E+01	0.6840E-01
			0.3933E+01	0.9600E-01
			0.4370E+01	0.1200E+00
			0.3933E+01	0.2400E+00
			0.3933E+01	0.3600E+00
			0.3933E+01	0.6000E+00
			0.3933E+01	0.2400E+01
6	10	0.2879E+02		
			0.0000E+00	0.0000E+00
			0.2301E+01	0.1920E-01
			0.3834E+01	0.3720E-01
			0.5752E+01	0.6840E-01
			0.6902E+01	0.9600E-01
			0.7669E+01	0.1200E+00
			0.6902E+01	0.2400E+00
			0.6902E+01	0.3600E+00
			0.6902E+01	0.6000E+00
			0.6902E+01	0.2400E+01
7	10	0.2883E+02		
			0.0000E+00	0.0000E+00
			0.2301E+01	0.1920E-01
			0.3834E+01	0.3720E-01
			0.5752E+01	0.6840E-01
			0.6902E+01	0.9600E-01
			0.7669E+01	0.1200E+00
			0.6902E+01	0.2400E+00
			0.6902E+01	0.3600E+00
			0.6902E+01	0.6000E+00
			0.6902E+01	0.2400E+01
8	10	0.4944E+02		
			0.0000E+00	0.0000E+00

			0.6763E+01	0.1920E-01
			0.1127E+02	0.3720E-01
			0.1691E+02	0.6840E-01
			0.2029E+02	0.9600E-01
			0.2254E+02	0.1200E+00
			0.2029E+02	0.2400E+00
			0.2029E+02	0.3600E+00
			0.2029E+02	0.6000E+00
			0.2029E+02	0.2400E+01
9	10	0.6996E+02		
			0.0000E+00	0.0000E+00
			0.6763E+01	0.1920E-01
			0.1127E+02	0.3720E-01
			0.1691E+02	0.6840E-01
			0.2029E+02	0.9600E-01
			0.2254E+02	0.1200E+00
			0.2029E+02	0.2400E+00
			0.2029E+02	0.3600E+00
			0.2029E+02	0.6000E+00
			0.2029E+02	0.2400E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.5301E+01	0.6000E-02
0.1060E+02	0.1200E-01
0.2121E+02	0.2400E-01
0.4241E+02	0.1560E+00
0.6362E+02	0.5040E+00
0.7634E+02	0.8760E+00
0.8482E+02	0.1200E+01
0.8482E+02	0.1800E+01
0.8482E+02	0.2400E+01

LOAD VERSUS SETTLEMENT CURVE

****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.5318E+00	0.6850E-03	0.8836E-01	0.1000E-03
0.5460E+01	0.6961E-02	0.8836E+00	0.1000E-02
0.2772E+02	0.3552E-01	0.4418E+01	0.5000E-02
0.5272E+02	0.6956E-01	0.8836E+01	0.1000E-01
0.9264E+02	0.1283E+00	0.1767E+02	0.2000E-01
0.1470E+03	0.2275E+00	0.2538E+02	0.5000E-01
0.1768E+03	0.2982E+00	0.3020E+02	0.8000E-01
0.1892E+03	0.3360E+00	0.3342E+02	0.1000E+00
0.1938E+03	0.4459E+00	0.4509E+02	0.2000E+00
0.2098E+03	0.7711E+00	0.6337E+02	0.5000E+00
0.2202E+03	0.1087E+01	0.7374E+02	0.8000E+00
0.2261E+03	0.1296E+01	0.7959E+02	0.1000E+01
0.2313E+03	0.2304E+01	0.8482E+02	0.2000E+01

```
==========================================================================

                 APILE for Windows, Version 2019.9.4

                  Serial Number :  160705594

                  A Program for Analyzing the Axial Capacity
                  and Short-term Settlement of Driven Piles
                            under Axial Loading.
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==========================================================================


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Path to file locations      : U:\1736\173620122 BRO-32-4.16\GEOTECH\Analysis\Piles\B-002_Center Pier\New Till Strengths\Ultimate\
Name of input data file     : Bro-32_Center Pier_12000.ap9d
Name of output file         : Bro-32_Center Pier_12000.ap9o
Name of plot output file    : Bro-32_Center Pier_12000.ap9p

--------------------------------------------------------------------------
                     Time and Date of Analysis
--------------------------------------------------------------------------

          Date:  February 01, 2021     Time:  12:12:02


1
     *********************
     * INPUT INFORMATION *
     *********************
```

BRO-32 Center Pier Pile

DESIGNER   : James Samples

JOB NUMBER : 173620122

METHOD FOR UNIT LOAD TRANSFERS :

- FHWA (Federal Highway Administration)
  Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

Steel pipe pile or non-tapered portion of monotube pile
- Close-Ended Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY   = 0.290E+08 PSI
- CROSS SECTION AREA   =   17.09 IN2

CIRCULAR PILE PROPERTIES :

- OUTSIDE DIAMETER, OD   =   14.00 IN.
- INTERNAL DIAMETER, ID   =   13.20 IN.

```
- TOTAL PILE LENGTH, TL     =     50.00 FT.
- BATTER ANGLE              =      0.00 DEG
- PILE STICKUP LENGTH, PSL  =      1.00 FT.
- ZERO FRICTION LENGTH, ZFL =      2.10 FT.
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION       =      1.00 FT.
- LENGTH OF ENHANCED
  END SECTION               =     50.00 FT.
- INTERNAL DIAMETER OF
  ENHANCED END SECTION      =     13.20 IN.
```

PLUGGED/UNPLUGGED CONDITIONS :
Internal Pile Plug Calculated by Program

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.80*	125.00	0.00	8.00**
16.00	CLAY	0.80*	125.00	0.00	8.00**
16.00	CLAY	0.80*	130.00	0.00	8.00**
53.00	CLAY	0.80*	130.00	0.00	8.00**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	1.60	0.00	0.00	0.00	0.00

0.10E+08*	0.10E+08*	1.60	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	12.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	12.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
  WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT
  PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
16.00	1.000	1.000
16.00	1.000	1.000
53.00	1.000	1.000

1

****
* COMPUTATION RESULT *
****

****
* FED. HWY. METHOD *
****

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	7.7	7.7
1.00	0.0	7.7	7.7
2.00	0.0	15.4	15.4
3.00	1.4	15.4	16.7
4.00	4.1	15.4	19.5

5.00	6.8	15.4	22.2
6.00	9.5	15.4	24.9
7.00	12.2	15.4	27.6
8.00	14.9	15.4	30.3
9.00	17.6	15.4	33.0
10.00	20.3	15.4	35.7
11.00	23.0	15.4	38.4
12.00	25.7	15.4	41.1
13.00	28.4	15.4	43.8
14.00	31.1	15.4	46.5
15.00	33.9	36.8	70.7
16.00	37.2	65.4	102.7
17.00	45.8	94.0	139.8
18.00	59.0	115.5	174.4
19.00	72.1	115.5	187.6
20.00	85.3	115.5	200.7
21.00	98.4	115.5	213.9
22.00	111.6	115.5	227.0
23.00	124.7	115.5	240.2
24.00	137.9	115.5	253.3
25.00	151.0	115.5	266.5
26.00	164.2	115.5	279.6
27.00	177.3	115.5	292.8
28.00	190.5	115.5	305.9
29.00	203.6	115.5	319.1
30.00	216.8	115.5	332.2
31.00	229.9	115.5	345.4
32.00	243.1	115.5	358.5
33.00	256.2	115.5	371.7
34.00	269.4	115.5	384.8
35.00	282.5	115.5	398.0
36.00	295.7	115.5	411.1
37.00	308.8	115.5	424.3
38.00	322.0	115.5	437.4
39.00	335.1	115.5	450.6
40.00	348.3	115.5	463.7
41.00	361.4	115.5	476.9
42.00	374.6	115.5	490.0
43.00	387.7	115.5	503.2
44.00	400.9	115.5	516.3

45.00	414.0	115.5	529.5
46.00	427.2	115.5	542.7
47.00	440.3	115.5	555.8
48.00	453.5	115.5	569.0
49.00	466.6	115.5	582.1

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN
  IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
  OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

```
**************************************************
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING                       *
**************************************************
```

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.0000E+00		
			0.0000E+00	0.0000E+00
			0.0000E+00	0.2240E-01
			0.0000E+00	0.4340E-01
			0.0000E+00	0.7980E-01
			0.0000E+00	0.1120E+00
			0.0000E+00	0.1400E+00
			0.0000E+00	0.2800E+00
			0.0000E+00	0.4200E+00
			0.0000E+00	0.7000E+00
			0.0000E+00	0.2800E+01
2	10	0.8025E+01		
			0.0000E+00	0.0000E+00
			0.1539E+01	0.2240E-01
			0.2565E+01	0.4340E-01
			0.3848E+01	0.7980E-01
			0.4618E+01	0.1120E+00

			0.5131E+01	0.1400E+00
			0.4618E+01	0.2800E+00
			0.4618E+01	0.4200E+00
			0.4618E+01	0.7000E+00
			0.4618E+01	0.2800E+01
3	10	0.1596E+02		
			0.0000E+00	0.0000E+00
			0.2269E+01	0.2240E-01
			0.3782E+01	0.4340E-01
			0.5672E+01	0.7980E-01
			0.6807E+01	0.1120E+00
			0.7563E+01	0.1400E+00
			0.6807E+01	0.2800E+00
			0.6807E+01	0.4200E+00
			0.6807E+01	0.7000E+00
			0.6807E+01	0.2800E+01
4	10	0.1600E+02		
			0.0000E+00	0.0000E+00
			0.2301E+01	0.2240E-01
			0.3834E+01	0.4340E-01
			0.5752E+01	0.7980E-01
			0.6902E+01	0.1120E+00
			0.7669E+01	0.1400E+00
			0.6902E+01	0.2800E+00
			0.6902E+01	0.4200E+00
			0.6902E+01	0.7000E+00
			0.6902E+01	0.2800E+01
5	10	0.3453E+02		
			0.0000E+00	0.0000E+00
			0.7475E+01	0.2240E-01
			0.1246E+02	0.4340E-01
			0.1869E+02	0.7980E-01
			0.2242E+02	0.1120E+00
			0.2492E+02	0.1400E+00
			0.2242E+02	0.2800E+00
			0.2242E+02	0.4200E+00
			0.2242E+02	0.7000E+00
			0.2242E+02	0.2800E+01
6	10	0.5296E+02		
			0.0000E+00	0.0000E+00

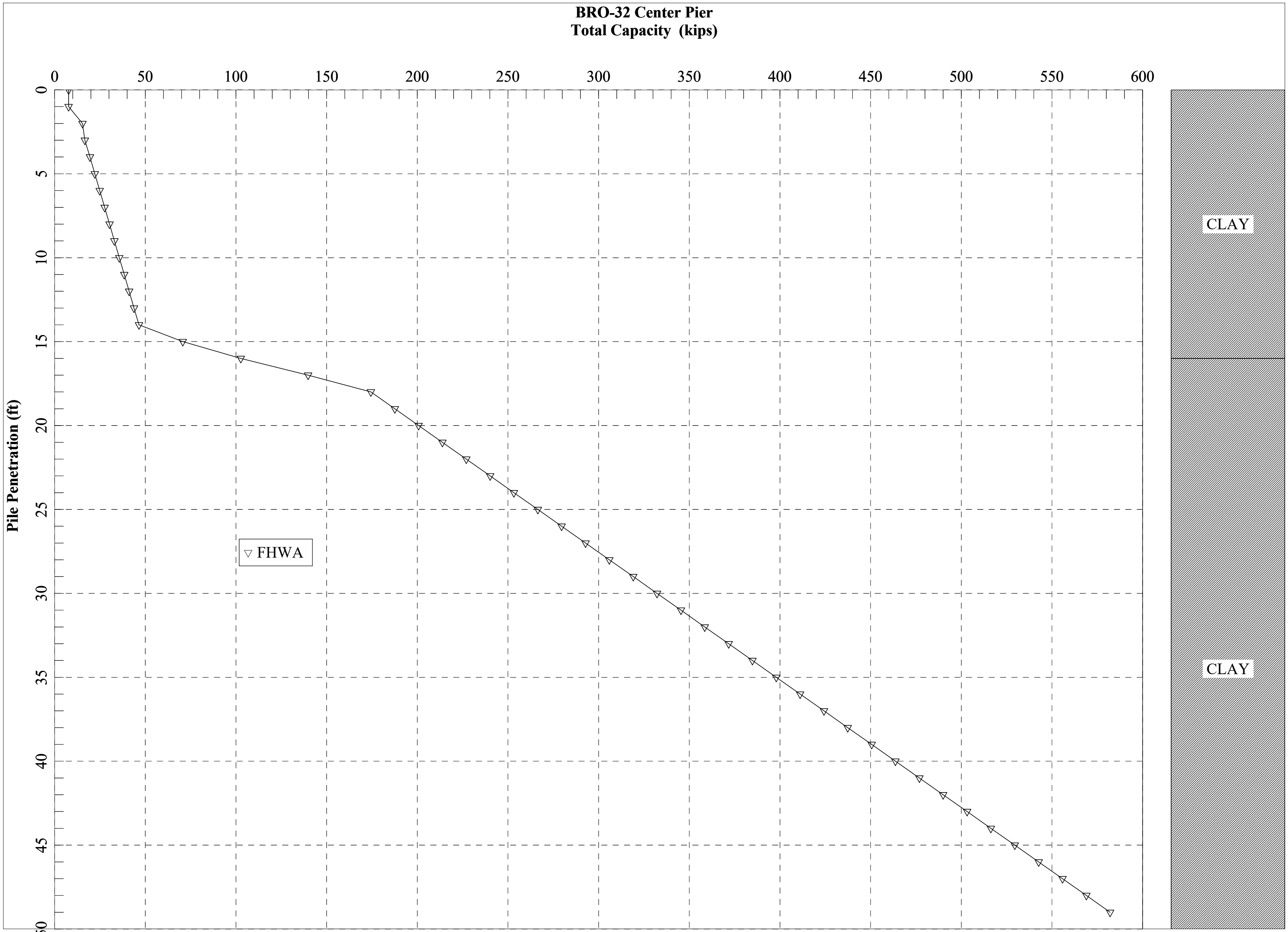
0.7475E+01	0.2240E-01
0.1246E+02	0.4340E-01
0.1869E+02	0.7980E-01
0.2242E+02	0.1120E+00
0.2492E+02	0.1400E+00
0.2242E+02	0.2800E+00
0.2242E+02	0.4200E+00
0.2242E+02	0.7000E+00
0.2242E+02	0.2800E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.7216E+01	0.7000E-02
0.1443E+02	0.1400E-01
0.2886E+02	0.2800E-01
0.5773E+02	0.1820E+00
0.8659E+02	0.5880E+00
0.1039E+03	0.1022E+01
0.1155E+03	0.1400E+01
0.1155E+03	0.2100E+01
0.1155E+03	0.2800E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.1917E+01	0.1301E-02	0.1031E+00	0.1000E-03
0.1952E+02	0.1315E-01	0.1031E+01	0.1000E-02
0.9545E+02	0.6599E-01	0.5154E+01	0.5000E-02
0.1709E+03	0.1240E+00	0.1031E+02	0.1000E-01
0.2763E+03	0.2155E+00	0.2062E+02	0.2000E-01

0.4057E+03	0.3592E+00	0.3299E+02	0.5000E-01
0.4587E+03	0.4438E+00	0.3861E+02	0.8000E-01
0.4773E+03	0.4854E+00	0.4236E+02	0.1000E+00
0.4876E+03	0.6039E+00	0.5901E+02	0.2000E+00
0.5003E+03	0.9207E+00	0.8033E+02	0.5000E+00
0.5151E+03	0.1239E+01	0.9505E+02	0.8000E+00
0.5230E+03	0.1448E+01	0.1030E+03	0.1000E+01
0.5355E+03	0.2463E+01	0.1155E+03	0.2000E+01



BRO-32 Center Pier
Total Capacity (kips)
0
50
100
150
200
250
300
350
400
450
500
550
600
Pile Penetration (ft)
0
5
10
15
20
25
30
35
40
45
50
FHWA
CLAY
CLAY

```
==========================================================================

                 APILE for Windows, Version 2019.9.4

                  Serial Number :  160705594

                  A Program for Analyzing the Axial Capacity
                  and Short-term Settlement of Driven Piles
                            under Axial Loading.
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==========================================================================


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 Cincinnati, OHIO / USA

 Path to file locations      : U:\1736\173620122 BRO-32-4.16\GEOTECH\Analysis\Piles\B-001_Forward Abutment\New
Till Strengths\Ultimate\
 Name of input data file     : BRO-32_Forward Abutment_12000.ap9d
 Name of output file         : BRO-32_Forward Abutment_12000.ap9o
 Name of plot output file    : BRO-32_Forward Abutment_12000.ap9p

 --------------------------------------------------------------------------
                     Time and Date of Analysis
 --------------------------------------------------------------------------

          Date:  February 01, 2021     Time:  13:36:31


1
      ********************
      * INPUT INFORMATION *
      ********************
```

BRO-32 Forward Abutment

DESIGNER   : James Samples

JOB NUMBER : 173620122

METHOD FOR UNIT LOAD TRANSFERS :

- FHWA (Federal Highway Administration)
  Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

Steel pipe pile or non-tapered portion of monotube pile
- Close-Ended Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY   = 0.290E+08 PSI
- CROSS SECTION AREA   =   11.46 IN2

CIRCULAR PILE PROPERTIES :

- OUTSIDE DIAMETER, OD   =   12.00 IN.
- INTERNAL DIAMETER, ID   =   11.38 IN.

```
- TOTAL PILE LENGTH, TL     =     65.00 FT.
- BATTER ANGLE              =      0.00 DEG
- PILE STICKUP LENGTH, PSL  =     17.40 FT.
- ZERO FRICTION LENGTH, ZFL =      0.00 FT.
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION       =      1.00 FT.
- LENGTH OF ENHANCED
  END SECTION               =     65.00 FT.
- INTERNAL DIAMETER OF
  ENHANCED END SECTION      =     11.38 IN.
```

PLUGGED/UNPLUGGED CONDITIONS :
Internal Pile Plug Calculated by Program

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.80*	125.00	0.00	8.00**
13.55	CLAY	0.80*	125.00	0.00	8.00**
13.55	CLAY	0.80*	130.00	0.00	8.00**
51.00	CLAY	0.80*	130.00	0.00	8.00**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	1.60	0.00	0.00	0.00	0.00

0.10E+08*	0.10E+08*	1.60	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	12.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	12.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT
PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
13.55	1.000	1.000
13.55	1.000	1.000
51.00	1.000	1.000

1

****
* COMPUTATION RESULT *
****

****
* FED. HWY. METHOD *
****

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	5.7	5.7
1.00	2.3	5.7	7.9
2.00	4.6	11.3	15.9
3.00	6.9	11.3	18.2
4.00	9.2	11.3	20.5

5.00	11.5	11.3	22.8
6.00	13.7	11.3	25.1
7.00	16.0	11.3	27.3
8.00	18.3	11.3	29.6
9.00	20.6	11.3	31.9
10.00	22.9	11.3	34.2
11.00	25.2	11.3	36.5
12.00	27.5	11.3	38.8
13.00	30.4	23.6	53.9
14.00	33.8	48.1	81.9
15.00	41.2	72.6	113.8
16.00	52.5	84.8	137.3
17.00	63.8	84.8	148.6
18.00	75.0	84.8	159.9
19.00	86.3	84.8	171.1
20.00	97.6	84.8	182.4
21.00	108.8	84.8	193.7
22.00	120.1	84.8	204.9
23.00	131.4	84.8	216.2
24.00	142.7	84.8	227.5
25.00	153.9	84.8	238.8
26.00	165.2	84.8	250.0
27.00	176.5	84.8	261.3
28.00	187.8	84.8	272.6
29.00	199.0	84.8	283.8
30.00	210.3	84.8	295.1
31.00	221.6	84.8	306.4
32.00	232.8	84.8	317.7
33.00	244.1	84.8	328.9
34.00	255.4	84.8	340.2
35.00	266.7	84.8	351.5
36.00	277.9	84.8	362.7
37.00	289.2	84.8	374.0
38.00	300.5	84.8	385.3
39.00	311.7	84.8	396.6
40.00	323.0	84.8	407.8
41.00	334.3	84.8	419.1
42.00	345.6	84.8	430.4
43.00	356.8	84.8	441.7
44.00	368.1	84.8	452.9

```
     45.00          379.4           84.8        464.2
     46.00          390.6           84.8        475.5
     47.00          401.9           84.8        486.7


    NOTES:
    - AN ASTERISK IS PLACED IN THE END-BEARING COLUMN
      IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
      OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.



        *************************************************
        * COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
        * CURVES FOR AXIAL LOADING                      *
        *************************************************


T-Z CURVE   NO. OF   DEPTH TO CURVE   LOAD TRANSFER   PILE MOVEMENT
   NO.      POINTS        FT.              PSI             IN.

    1         10      0.0000E+00
                                       0.0000E+00      0.0000E+00
                                       0.1519E+01      0.1920E-01
                                       0.2532E+01      0.3720E-01
                                       0.3798E+01      0.6840E-01
                                       0.4558E+01      0.9600E-01
                                       0.5065E+01      0.1200E+00
                                       0.4558E+01      0.2400E+00
                                       0.4558E+01      0.3600E+00
                                       0.4558E+01      0.6000E+00
                                       0.4558E+01      0.2400E+01
    2         10      0.6800E+01
                                       0.0000E+00      0.0000E+00
                                       0.1519E+01      0.1920E-01
                                       0.2532E+01      0.3720E-01
                                       0.3798E+01      0.6840E-01
                                       0.4558E+01      0.9600E-01
                                       0.5065E+01      0.1200E+00
                                       0.4558E+01      0.2400E+00
```

			0.4558E+01	0.3600E+00
			0.4558E+01	0.6000E+00
			0.4558E+01	0.2400E+01
3	10	0.1351E+02		
			0.0000E+00	0.0000E+00
			0.2301E+01	0.1920E-01
			0.3834E+01	0.3720E-01
			0.5752E+01	0.6840E-01
			0.6902E+01	0.9600E-01
			0.7669E+01	0.1200E+00
			0.6902E+01	0.2400E+00
			0.6902E+01	0.3600E+00
			0.6902E+01	0.6000E+00
			0.6902E+01	0.2400E+01
4	10	0.1355E+02		
			0.0000E+00	0.0000E+00
			0.2301E+01	0.1920E-01
			0.3834E+01	0.3720E-01
			0.5752E+01	0.6840E-01
			0.6902E+01	0.9600E-01
			0.7669E+01	0.1200E+00
			0.6902E+01	0.2400E+00
			0.6902E+01	0.3600E+00
			0.6902E+01	0.6000E+00
			0.6902E+01	0.2400E+01
5	10	0.3230E+02		
			0.0000E+00	0.0000E+00
			0.7475E+01	0.1920E-01
			0.1246E+02	0.3720E-01
			0.1869E+02	0.6840E-01
			0.2242E+02	0.9600E-01
			0.2492E+02	0.1200E+00
			0.2242E+02	0.2400E+00
			0.2242E+02	0.3600E+00
			0.2242E+02	0.6000E+00
			0.2242E+02	0.2400E+01
6	10	0.5096E+02		
			0.0000E+00	0.0000E+00
			0.7475E+01	0.1920E-01
			0.1246E+02	0.3720E-01

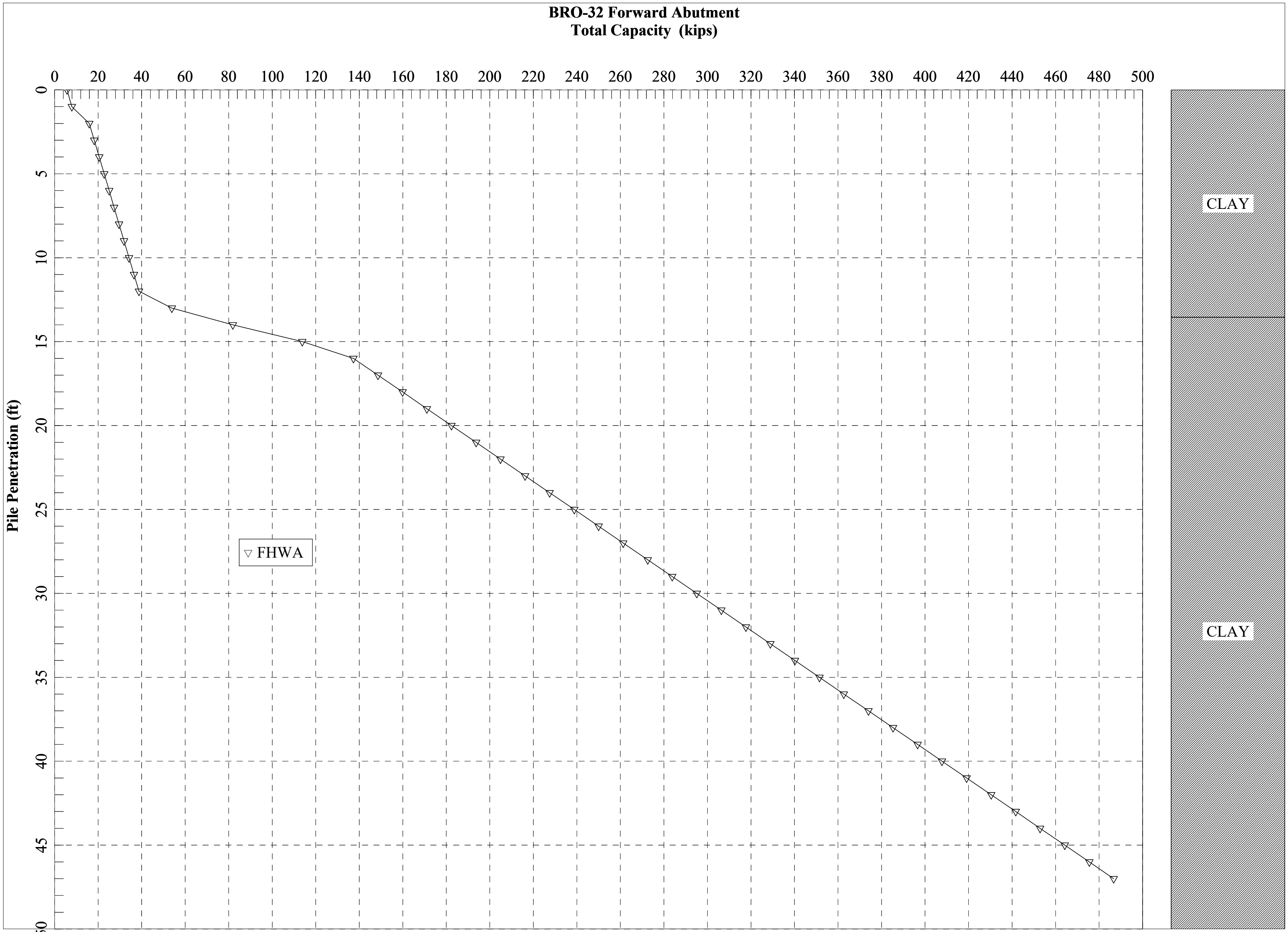
0.1869E+02	0.6840E-01
0.2242E+02	0.9600E-01
0.2492E+02	0.1200E+00
0.2242E+02	0.2400E+00
0.2242E+02	0.3600E+00
0.2242E+02	0.6000E+00
0.2242E+02	0.2400E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.5301E+01	0.6000E-02
0.1060E+02	0.1200E-01
0.2121E+02	0.2400E-01
0.4241E+02	0.1560E+00
0.6362E+02	0.5040E+00
0.7634E+02	0.8760E+00
0.8482E+02	0.1200E+01
0.8482E+02	0.1800E+01
0.8482E+02	0.2400E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.2783E+01	0.3922E-02	0.8836E-01	0.1000E-03
0.2948E+02	0.4123E-01	0.8836E+00	0.1000E-02
0.1264E+03	0.1866E+00	0.4418E+01	0.5000E-02
0.2031E+03	0.3154E+00	0.8836E+01	0.1000E-01
0.2906E+03	0.4819E+00	0.1767E+02	0.2000E-01
0.3729E+03	0.6771E+00	0.2538E+02	0.5000E-01
0.4051E+03	0.7787E+00	0.3020E+02	0.8000E-01

0.4155E+03	0.8236E+00	0.3342E+02	0.1000E+00
0.4148E+03	0.9273E+00	0.4509E+02	0.2000E+00
0.4306E+03	0.1265E+01	0.6337E+02	0.5000E+00
0.4410E+03	0.1589E+01	0.7374E+02	0.8000E+00
0.4468E+03	0.1803E+01	0.7959E+02	0.1000E+01
0.4521E+03	0.2815E+01	0.8482E+02	0.2000E+01



BRO-32 Forward Abutment
Total Capacity (kips)
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500
Pile Penetration (ft)
0 5 10 15 20 25 30 35 40 45 50
FHWA
CLAY
CLAY

```
================================================================================

                 APILE for Windows, Version 2019.9.4

                  Serial Number :  160705594

                  A Program for Analyzing the Axial Capacity
                  and Short-term Settlement of Driven Piles
                            under Axial Loading.
                (c) Copyright ENSOFT, Inc., 1987-2015
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================================================================================


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Path to file locations      : U:\1736\173620122 BRO-32-4.16\GEOTECH\Analysis\Piles\B-001_Forward Abutment\New
Till Strengths\Sand sleeve\
Name of input data file     : BRO-32_Forward Abutment_sand sleeve_12000.ap9d
Name of output file         : BRO-32_Forward Abutment_sand sleeve_12000.ap9o
Name of plot output file    : BRO-32_Forward Abutment_sand sleeve_12000.ap9p

--------------------------------------------------------------------------------
                     Time and Date of Analysis
--------------------------------------------------------------------------------

          Date:  February 01, 2021     Time:  13:47:19


1
     ********************
     * INPUT INFORMATION *
     ********************
```

BRO-32 Forward Abutment

DESIGNER   : James Samples

JOB NUMBER : 173620122

METHOD FOR UNIT LOAD TRANSFERS :

- FHWA (Federal Highway Administration)
  Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

Steel pipe pile or non-tapered portion of monotube pile
- Close-Ended Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY   = 0.290E+08 PSI
- CROSS SECTION AREA   =   11.46 IN2

CIRCULAR PILE PROPERTIES :

- OUTSIDE DIAMETER, OD   =   12.00 IN.
- INTERNAL DIAMETER, ID   =   11.38 IN.

- TOTAL PILE LENGTH, TL = 45.00 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 0.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- INCREMENT OF PILE LENGTH USED IN COMPUTATION = 2.14 FT.
- LENGTH OF ENHANCED END SECTION = 45.00 FT.
- INTERNAL DIAMETER OF ENHANCED END SECTION = 11.38 IN.

PLUGGED/UNPLUGGED CONDITIONS :
Internal Pile Plug Calculated by Program

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	SAND	0.80*	120.00	28.00	16.80**
17.40	SAND	0.80*	120.00	28.00	16.80**
17.40	CLAY	0.80*	125.00	0.00	8.00**
30.95	CLAY	0.80*	125.00	0.00	8.00**
30.95	CLAY	0.80*	130.00	0.00	8.00**
68.40	CLAY	0.80*	130.00	0.00	8.00**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION	MAXIMUM UNIT BEARING	UNDISTURB SHEAR STRENGTH	REMOLDED SHEAR STRENGTH	BLOW COUNT	UNIT SKIN FRICTION	UNIT END BEARING

KSF	KSF	KSF	KSF		KSF	KSF
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.60	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.60	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	12.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	12.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
  WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT
  PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	0.830	1.000
17.40	0.830	1.000
17.40	0.570	1.000
30.95	0.570	1.000
30.95	0.670	1.000
68.40	0.670	1.000

1

```
**********************
* COMPUTATION RESULT *
**********************
```

```
**********************
*  FED. HWY. METHOD  *
**********************
```

PILE PENETRATION	TOTAL SKIN FRICTION	END BEARING	ULTIMATE CAPACITY

FT.	KIP	KIP	KIP
0.00	0.0	0.4	0.4
2.14	0.2	1.7	1.8
4.29	0.7	4.9	5.6
6.43	1.5	7.4	8.9
8.57	2.6	9.5	12.2
10.71	4.1	10.4	14.5
12.86	5.9	10.5	16.4
15.00	8.0	10.5	18.5
17.14	10.5	10.5	20.9
19.29	12.4	10.9	23.3
21.43	14.8	11.3	26.1
23.57	17.6	11.3	28.9
25.71	20.4	11.3	31.7
27.86	23.2	11.3	34.5
30.00	26.0	11.3	37.3
32.14	29.3	48.1	77.4
34.29	37.7	84.8	122.5
36.43	51.1	84.8	135.9
38.57	64.4	84.8	149.2
40.71	77.7	84.8	162.5
42.86	91.0	84.8	175.9
45.00	104.4	84.8	189.2

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN
  IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
  OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

```
**************************************************
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING                       *
**************************************************
```

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.

1	10	0.0000E+00		
			0.0000E+00	0.0000E+00
			0.0000E+00	0.1920E-01
			0.0000E+00	0.3720E-01
			0.0000E+00	0.6840E-01
			0.0000E+00	0.9600E-01
			0.0000E+00	0.1200E+00
			0.0000E+00	0.2400E+00
			0.0000E+00	0.3600E+00
			0.0000E+00	0.6000E+00
			0.0000E+00	0.2400E+01
2	10	0.8725E+01		
			0.0000E+00	0.0000E+00
			0.4971E+00	0.1920E-01
			0.8285E+00	0.3720E-01
			0.1243E+01	0.6840E-01
			0.1491E+01	0.9600E-01
			0.1657E+01	0.1200E+00
			0.1657E+01	0.2400E+00
			0.1657E+01	0.3600E+00
			0.1657E+01	0.6000E+00
			0.1657E+01	0.2400E+01
3	10	0.1736E+02		
			0.0000E+00	0.0000E+00
			0.9889E+00	0.1920E-01
			0.1648E+01	0.3720E-01
			0.2472E+01	0.6840E-01
			0.2967E+01	0.9600E-01
			0.3296E+01	0.1200E+00
			0.3296E+01	0.2400E+00
			0.3296E+01	0.3600E+00
			0.3296E+01	0.6000E+00
			0.3296E+01	0.2400E+01
4	10	0.1740E+02		
			0.0000E+00	0.0000E+00
			0.9913E+00	0.1920E-01
			0.1652E+01	0.3720E-01
			0.2478E+01	0.6840E-01
			0.2974E+01	0.9600E-01

			0.3304E+01	0.1200E+00
			0.2974E+01	0.2400E+00
			0.2974E+01	0.3600E+00
			0.2974E+01	0.6000E+00
			0.2974E+01	0.2400E+01
5	10	0.2420E+02		
			0.0000E+00	0.0000E+00
			0.1519E+01	0.1920E-01
			0.2532E+01	0.3720E-01
			0.3798E+01	0.6840E-01
			0.4558E+01	0.9600E-01
			0.5065E+01	0.1200E+00
			0.4558E+01	0.2400E+00
			0.4558E+01	0.3600E+00
			0.4558E+01	0.6000E+00
			0.4558E+01	0.2400E+01
6	10	0.3091E+02		
			0.0000E+00	0.0000E+00
			0.1545E+01	0.1920E-01
			0.2575E+01	0.3720E-01
			0.3863E+01	0.6840E-01
			0.4635E+01	0.9600E-01
			0.5150E+01	0.1200E+00
			0.4635E+01	0.2400E+00
			0.4635E+01	0.3600E+00
			0.4635E+01	0.6000E+00
			0.4635E+01	0.2400E+01
7	10	0.3095E+02		
			0.0000E+00	0.0000E+00
			0.1546E+01	0.1920E-01
			0.2577E+01	0.3720E-01
			0.3866E+01	0.6840E-01
			0.4639E+01	0.9600E-01
			0.5154E+01	0.1200E+00
			0.4639E+01	0.2400E+00
			0.4639E+01	0.3600E+00
			0.4639E+01	0.6000E+00
			0.4639E+01	0.2400E+01
8	10	0.4970E+02		
			0.0000E+00	0.0000E+00

			0.6156E+01	0.1920E-01
			0.1026E+02	0.3720E-01
			0.1539E+02	0.6840E-01
			0.1847E+02	0.9600E-01
			0.2052E+02	0.1200E+00
			0.1847E+02	0.2400E+00
			0.1847E+02	0.3600E+00
			0.1847E+02	0.6000E+00
			0.1847E+02	0.2400E+01
9	10	0.6836E+02		
			0.0000E+00	0.0000E+00
			0.6156E+01	0.1920E-01
			0.1026E+02	0.3720E-01
			0.1539E+02	0.6840E-01
			0.1847E+02	0.9600E-01
			0.2052E+02	0.1200E+00
			0.1847E+02	0.2400E+00
			0.1847E+02	0.3600E+00
			0.1847E+02	0.6000E+00
			0.1847E+02	0.2400E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.5301E+01	0.6000E-02
0.1060E+02	0.1200E-01
0.2121E+02	0.2400E-01
0.4241E+02	0.1560E+00
0.6362E+02	0.5040E+00
0.7634E+02	0.8760E+00
0.8482E+02	0.1200E+01
0.8482E+02	0.1800E+01
0.8482E+02	0.2400E+01

LOAD VERSUS SETTLEMENT CURVE

****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.5373E+00	0.7040E-03	0.8836E-01	0.1000E-03
0.5523E+01	0.7158E-02	0.8836E+00	0.1000E-02
0.2798E+02	0.3651E-01	0.4418E+01	0.5000E-02
0.5287E+02	0.7124E-01	0.8836E+01	0.1000E-01
0.9231E+02	0.1310E+00	0.1767E+02	0.2000E-01
0.1449E+03	0.2306E+00	0.2538E+02	0.5000E-01
0.1730E+03	0.3009E+00	0.3020E+02	0.8000E-01
0.1847E+03	0.3388E+00	0.3342E+02	0.1000E+00
0.1896E+03	0.4495E+00	0.4509E+02	0.2000E+00
0.2058E+03	0.7761E+00	0.6337E+02	0.5000E+00
0.2162E+03	0.1093E+01	0.7374E+02	0.8000E+00
0.2220E+03	0.1302E+01	0.7959E+02	0.1000E+01
0.2273E+03	0.2311E+01	0.8482E+02	0.2000E+01

APPENDIX E

Pile Drivability Analyses

BRO-32 Center Pier

Hammer Information

Select from following list [8/3/2015-2003]: ID: 41

ID	Name	Type	Ram Wt	Energy/Power
40	DELMAG D 19-32	OED	4.0000	42.440
41	DELMAG D 19-42	OED	4.0000	43.240
42	DELMAG D200-42	OED	44.0900	492.044

Hammer parameters

Efficiency	0.8			
Pressure	1600	psi	Fixed	100 %
Stroke	10.81	ft	Variable	

Pile material

( ) Concrete (•) Steel ( ) Timber

Cushion Information

	Hammer	Pile	
Area	227.	0.	in^2
Elastic Modulus	530.	0.	ksi
Thickness	2.	0.	in
C.O.R.	0.8	0.	
Stiffness	0.	0.	kips/in
Helmet Weight	1.9		kips

Pile Information

Length	30.5	ft	Auto	Segments
Penetration	30.5	ft	Auto.	S-Length
Section Area	17.1	in^2	Auto.	S-St, Wt
Elast Modulus	29000.	ksi	0	Splices
Spec Weight	492.0	lb/ft^3		
Toe Area	153.94	in^2	Pile Type:	
Perimeter	3.67	ft	Unknown	
Pile Size	14.	in		

Resistance Gain/Loss Factors

	Shaft		Toe
1	0.57142	1	1.0
2	1.0	2	1.0
3	0.0	3	0.0
4	0.0	4	0.0
5	0.0	5	0.0

Incr. 0 Action >>

Soil Parameters

Quake

Shaft	0.1	in	Const
Toe	0.1	in	

Damping

Shaft	0.15	s/ft	Const
Toe	0.15	s/ft	Smith

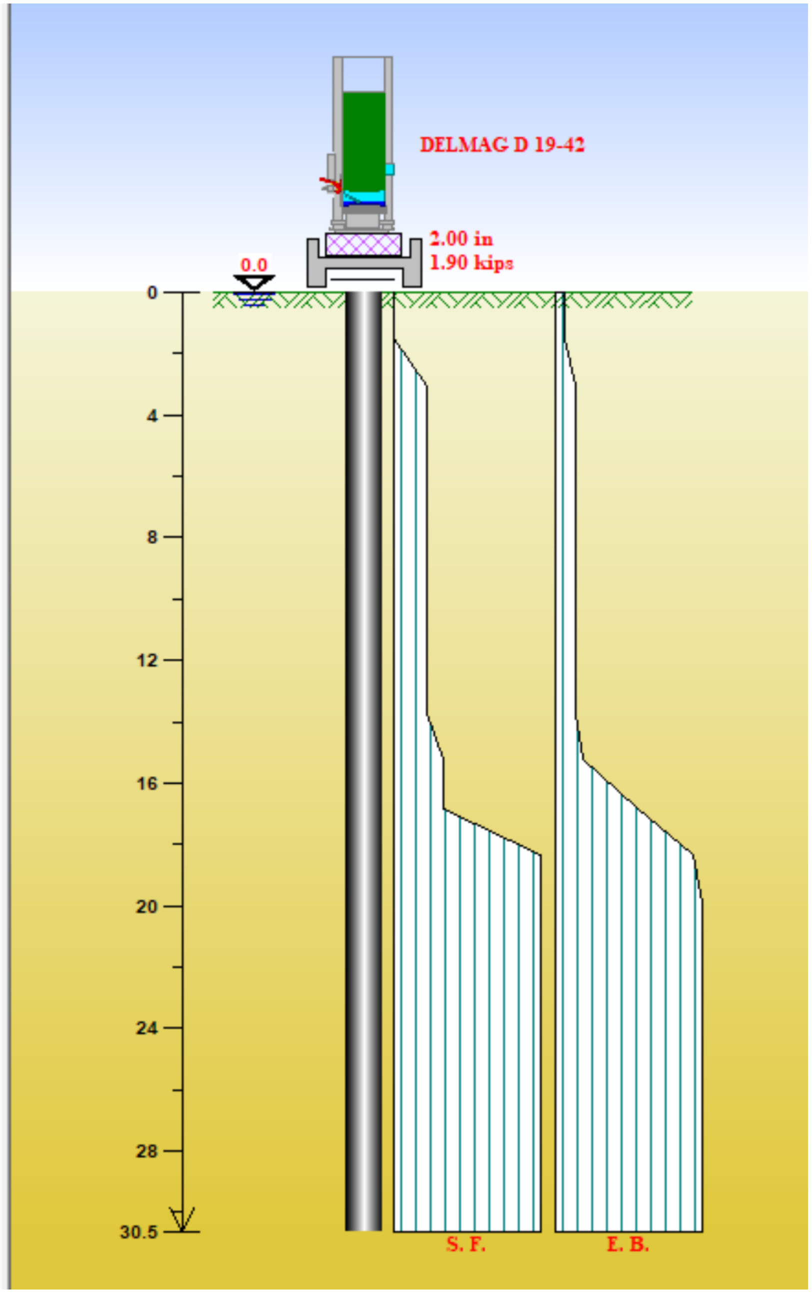
Shaft Resistance

Percentage 0 %

100%

Dist. Shape Num 0.0

Residual Stress Analysis: No



BRO-32 Center Pier

Resistance Distribution Input for Pile 1

General Information

Pile Length: 30.5 ft

Depths below ground surface and in pile penetration direction

Add Row Insert Row Delete Row

Depth	Unit Shaft Resist	Unit Toe Resist	Skin Quake	Toe Quake	Skin Damping	Toe Damping	Setup Factor	Limit Distance	Setup Time	Toe Area
ft	ksf	ksf	in	in	s/ft	s/ft		ft	hours	in^2
0.000	0.000	7.203	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
1.520	0.000	7.203	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
3.050	0.739	14.406	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
4.570	0.739	14.406	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
6.100	0.739	14.406	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
7.620	0.739	14.406	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
9.140	0.739	14.406	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
10.700	0.739	14.406	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
12.200	0.739	14.406	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
13.700	0.739	14.406	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
15.200	1.100	20.486	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
16.800	1.100	61.177	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
18.300	3.260	101.962	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
19.800	3.260	108.510	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
21.300	3.260	108.510	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
22.900	3.260	108.510	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
24.400	3.260	108.510	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
25.900	3.260	108.510	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
27.400	3.260	108.510	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
29.000	3.260	108.510	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
30.500	3.260	108.510	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00

Stantec Consulting Services
BRO-32 Center Pier

Feb 01 2021
GRLWEAP Version 2010

Gain/Loss 1 at Shaft and Toe 0.571 / 1.000

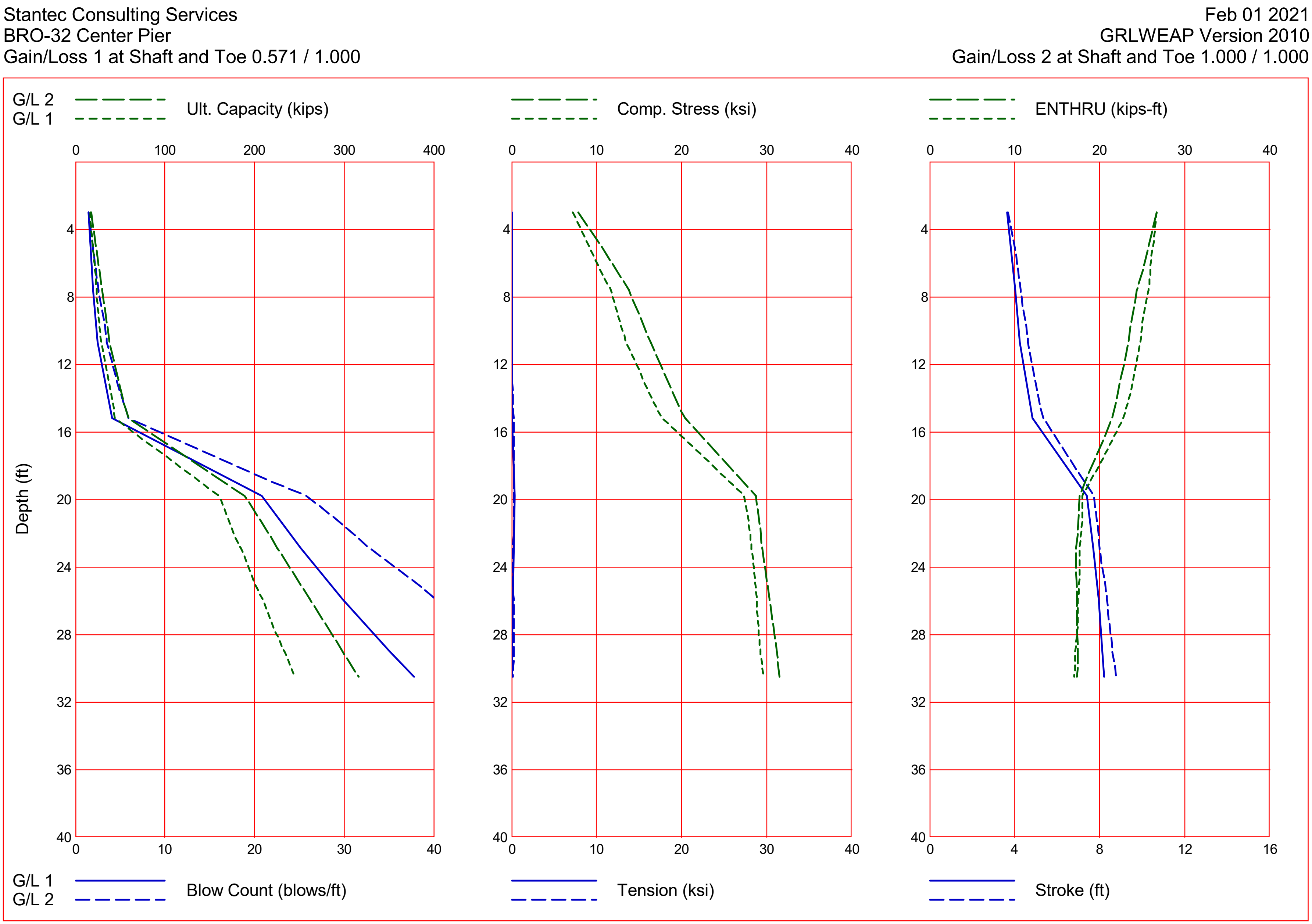
Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
3.0	16.6	1.2	15.4	1.5	7.239	0.000	3.66	26.7
7.6	23.7	8.3	15.4	2.0	11.694	0.000	4.03	25.8
10.7	28.4	13.0	15.4	2.5	13.503	0.000	4.26	24.8
15.2	43.6	20.7	23.0	4.1	17.678	0.000	4.86	22.8
19.8	160.6	44.6	116.0	20.8	27.372	-0.379	7.40	18.0
22.9	184.9	68.9	116.0	25.2	28.182	-0.278	7.70	17.7
25.9	209.1	93.1	116.0	29.8	28.820	-0.128	7.94	17.4
29.0	233.5	117.5	116.0	35.1	29.288	-0.043	8.11	17.1
30.5	245.8	129.8	116.0	37.8	29.573	0.000	8.21	17.0

Total Continuous Driving Time 9.00 minutes; Total Number of Blows 396

Gain/Loss 2 at Shaft and Toe 1.000 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
3.0	17.5	2.1	15.4	1.5	7.893	0.000	3.71	26.7
7.6	29.9	14.5	15.4	2.6	13.800	0.000	4.28	24.4
10.7	38.1	22.7	15.4	3.5	16.395	0.000	4.65	23.4
15.2	59.2	36.2	23.0	5.9	20.426	-0.290	5.35	21.5
19.8	188.5	72.5	116.0	25.8	28.789	-0.305	7.75	17.7
22.9	225.0	109.0	116.0	32.9	29.528	-0.157	8.01	17.2
25.9	261.4	145.4	116.0	40.3	30.395	-0.282	8.34	17.3
29.0	297.9	181.9	116.0	49.0	31.178	-0.265	8.61	17.4
30.5	316.4	200.4	116.0	54.1	31.509	-0.132	8.75	17.3

Total Continuous Driving Time 13.00 minutes; Total Number of Blows 527


Stantec Consulting Services
BRO-32 Center Pier
Gain/Loss 1 at Shaft and Toe 0.571 / 1.000
Feb 01 2021
GRLWEAP Version 2010
Gain/Loss 2 at Shaft and Toe 1.000 / 1.000
G/L 2
G/L 1
Ult. Capacity (kips)
Comp. Stress (ksi)
ENTHRU (kips-ft)
Depth (ft)
G/L 1
G/L 2
Blow Count (blows/ft)
Tension (ksi)
Stroke (ft)

BRO-32 Forward Abutment

Hammer Information

Select from following list [8/3/2015-2003]: ID: 41

ID	Name	Type	Ram Wt	Energy/Power
40	DELMAG D 19-32	OED	4.0000	42.440
41	DELMAG D 19-42	OED	4.0000	43.240
42	DELMAG D200-42	OED	44.0900	492.044

Hammer parameters

Efficiency	0.8			
Pressure	1600	psi	Fixed	100 %
Stroke	10.81	ft	Variable	

Pile material

Concrete / (•) Steel / Timber

Cushion Information

	Hammer	Pile	
Area	227.	0.	in^2
Elastic Modulus	530.	0.	ksi
Thickness	2.	0.	in
C.O.R.	0.8	0.	
Stiffness	0.	0.	kips/in
Helmet Weight	1.9		kips

Pile Information

Length	27.4	ft	Auto	Segments
Penetration	27.4	ft	Auto.	S-Length
Section Area	11.46	in^2	Auto.	S-St, Wt
Elast Modulus	29000.	ksi	0	Splices
Spec Weight	492.0	lb/ft^3		
Toe Area	113.1	in^2	Pile Type:	
Perimeter	3.14	ft	Unknown	
Pile Size	12.	in		

Resistance Gain/Loss Factors

	Shaft		Toe
1	0.57142	1	1.0
2	1.0	2	1.0
3	0.0	3	0.0
4	0.0	4	0.0
5	0.0	5	0.0

Incr. 0 Action >>

Soil Parameters

Quake

Shaft	0.1	in	Const
Toe	0.1	in	

Damping

Shaft	0.15	s/ft	Const
Toe	0.15	s/ft	Smith

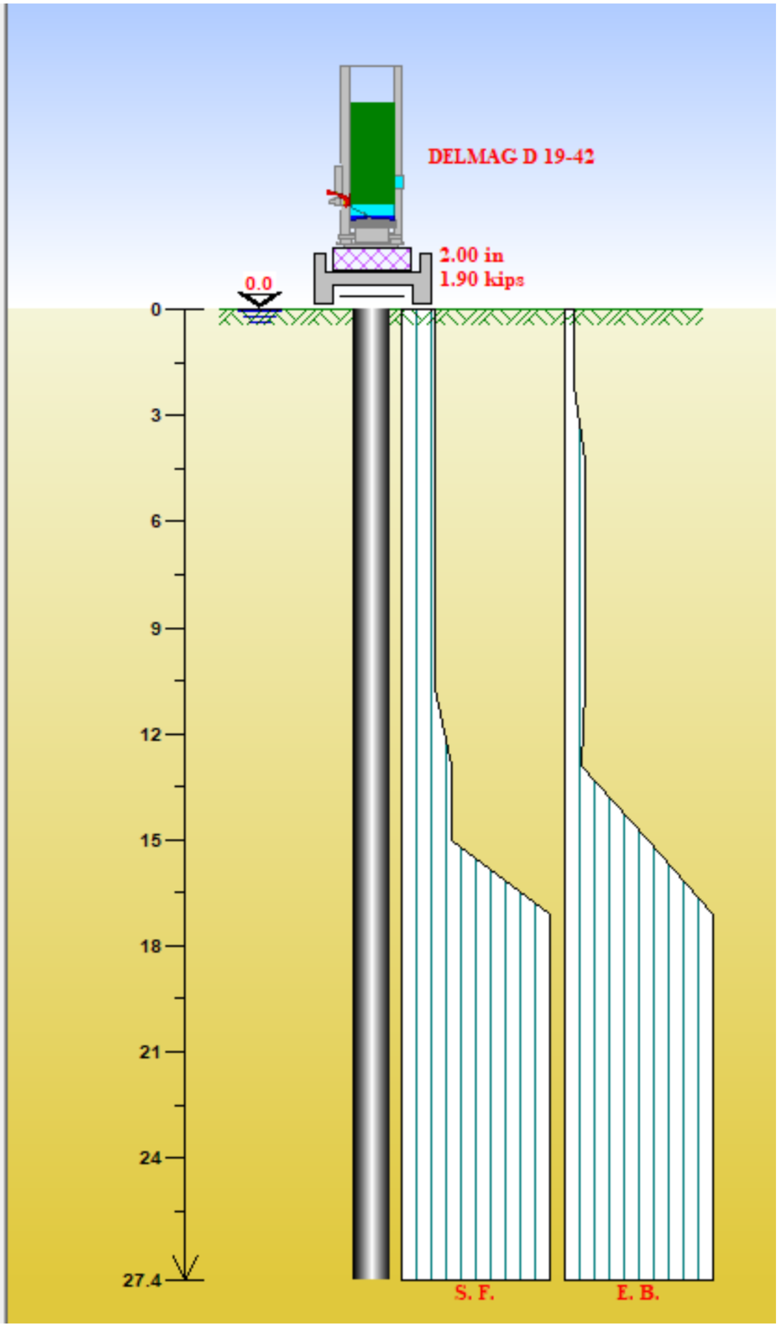
Shaft Resistance

Percentage 0 %

100%

Dist. Shape Num 0.0

Residual Stress Analysis: No



BRO-32 Forward Abutment

Resistance Distribution Input for Pile 1

General Information

Pile Length: 27.4 ft

Depths below ground surface and in pile penetration direction

Add Row | Insert Row | Delete Row

Depth ft	Unit Shaft Resist ksf	Unit Toe Resist ksf	Skin Quake in	Toe Quake in	Skin Damping s/ft	Toe Damping s/ft	Setup Factor	Limit Distance ft	Setup Time hours	Toe Area in^2
0.000	0.729	7.257	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
2.140	0.729	7.257	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
4.290	0.729	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
6.430	0.729	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
8.570	0.729	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
10.700	0.729	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
12.900	1.100	11.300	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
15.000	1.100	61.241	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
17.100	3.290	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
19.300	3.290	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
21.400	3.290	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
23.600	3.290	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
25.700	3.290	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
27.400	3.290	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00

Stantec Consulting Services
BRO-32 Forward Abutment

Feb 04 2021
GRLWEAP Version 2010

Gain/Loss 1 at Shaft and Toe 0.571 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
2.1	8.5	2.8	5.7	-1.0	0.000	0.000	0.00	0.0
6.4	19.7	8.4	11.3	1.7	9.014	0.000	3.62	26.7
10.7	25.3	14.0	11.3	2.3	12.496	-0.084	3.90	25.4
12.9	26.5	17.6	8.9	2.4	13.161	-0.012	3.97	25.2
15.0	70.2	22.1	48.1	7.3	23.864	-0.157	5.55	20.7
19.3	131.7	46.9	84.8	16.1	28.980	0.000	6.96	18.5
21.4	146.3	61.5	84.8	18.6	29.793	-0.109	7.20	18.2
25.7	175.7	90.9	84.8	23.8	31.759	0.000	7.59	17.5
27.4	187.4	102.6	84.8	26.1	32.924	0.000	7.71	17.2

Total Continuous Driving Time 5.00 minutes; Total Number of Blows 244

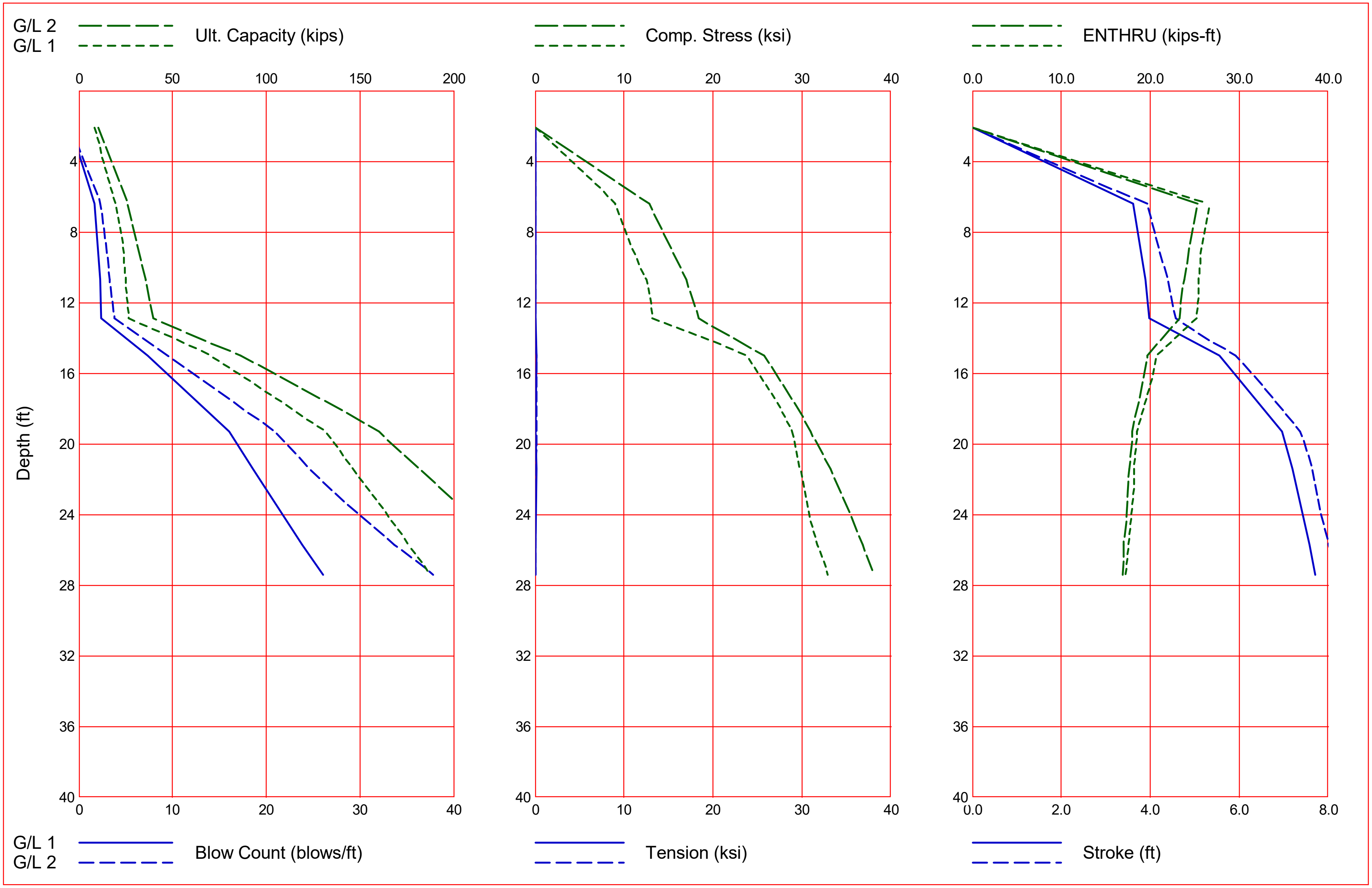
Gain/Loss 2 at Shaft and Toe 1.000 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
2.1	10.6	4.9	5.7	-1.0	0.000	0.000	0.00	0.0
6.4	26.0	14.7	11.3	2.3	12.860	-0.056	3.94	25.3
10.7	35.8	24.5	11.3	3.3	16.971	0.000	4.41	23.8
12.9	39.7	30.8	8.9	3.8	18.407	0.000	4.57	23.3
15.0	86.2	38.1	48.1	9.5	25.776	-0.131	5.92	19.7
19.3	160.1	75.3	84.8	20.9	30.942	-0.143	7.38	18.0
21.4	182.1	97.3	84.8	24.7	33.221	-0.012	7.65	17.7
25.7	226.2	141.4	84.8	33.7	36.873	0.000	8.02	17.0
27.4	243.7	158.9	84.8	37.8	38.133	0.000	8.20	16.9

Total Continuous Driving Time 8.00 minutes; Total Number of Blows 337

Stantec Consulting Services
BRO-32 Forward Abutment
Gain/Loss 1 at Shaft and Toe 0.571 / 1.000

Feb 04 2021
GRLWEAP Version 2010
Gain/Loss 2 at Shaft and Toe 1.000 / 1.000



BRO-32 Rear Abutment

Hammer Information

Select from following list [8/3/2015-2003]: ID: 41

ID	Name	Type	Ram Wt	Energy/Power
40	DELMAG D 19-32	OED	4.0000	42.440
41	DELMAG D 19-42	OED	4.0000	43.240
42	DELMAG D200-42	OED	44.0900	492.044

Hammer parameters

Efficiency	0.8			
Pressure	1600	psi	Fixed	100 %
Stroke	10.81	ft	Variable	

Pile material

○ Concrete ◉ Steel ○ Timber

Cushion Information

	Hammer	Pile	
Area	227.	0.	in^2
Elastic Modulus	530.	0.	ksi
Thickness	2.	0.	in
C.O.R.	0.8	0.	
Stiffness	0.	0.	kips/in
Helmet Weight	1.9		kips

Pile Information

Length	26.1	ft	Auto	Segments
Penetration	26.1	ft	Auto.	S-Length
Section Area	11.46	in^2	Auto.	S-St, Wt
Elast Modulus	29000.	ksi	0	Splices
Spec Weight	492.0	lb/ft^3		
Toe Area	113.1	in^2	Pile Type:	
Perimeter	3.14	ft	Unknown	
Pile Size	12.	in		

Resistance Gain/Loss Factors

	Shaft		Toe
1	0.57142	1	1.0
2	1.0	2	1.0
3	0.0	3	0.0
4	0.0	4	0.0
5	0.0	5	0.0

Incr. 0 Action >>

Soil Parameters

Quake

Shaft	0.1	in	Const
Toe	0.1	in	

Damping

Shaft	0.15	s/ft	Const
Toe	0.15	s/ft	Smith

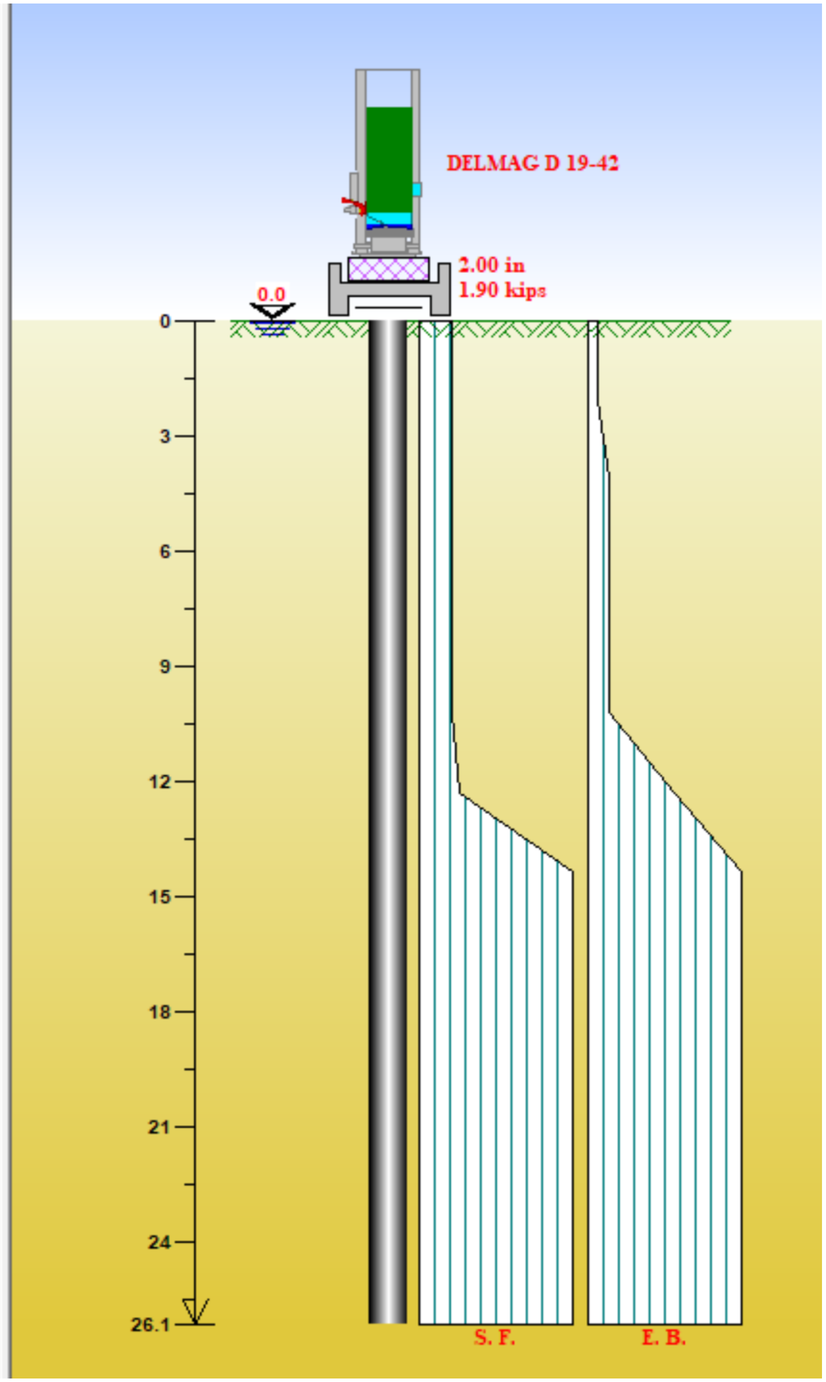
Shaft Resistance

Percentage 0 %

100%

Dist. Shape Num 0.0

Residual Stress Analysis: No



BRO-32 Rear Abutment

Resistance Distribution Input for Pile 1

General Information

Pile Length: 26.1 ft

Depths below ground surface and in pile penetration direction

Add Row | Insert Row | Delete Row

Depth ft	Unit Shaft Resist ksf	Unit Toe Resist ksf	Skin Quake in	Toe Quake in	Skin Damping s/ft	Toe Damping s/ft	Setup Factor	Limit Distance ft	Setup Time hours	Toe Area in^2
0.000	0.629	7.257	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
2.050	0.629	7.257	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
4.100	0.629	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
6.140	0.629	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
8.190	0.629	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
10.200	0.629	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
12.300	0.765	61.241	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
14.300	2.960	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
16.400	2.960	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
18.400	2.960	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
20.500	2.960	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
22.500	2.960	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
24.600	2.960	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
26.100	2.960	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00

Stantec Consulting Services Feb 04 2021
BRO-32 Rear Abutment GRLWEAP Version 2010

Gain/Loss 1 at Shaft and Toe 0.571 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
2.0	8.0	2.3	5.7	-1.0	0.000	0.000	0.00	0.0
6.1	18.2	6.9	11.3	-1.0	0.000	0.000	0.00	0.0
10.2	23.5	11.5	12.0	2.1	11.508	-0.111	3.84	25.9
12.3	62.4	14.3	48.1	6.4	22.885	-0.179	5.33	21.3
14.3	107.1	22.3	84.8	12.4	27.086	0.000	6.43	19.0
18.4	132.3	47.5	84.8	16.3	28.989	-0.126	6.98	18.4
20.5	145.2	60.4	84.8	18.4	29.737	-0.111	7.19	18.2
24.6	170.7	85.9	84.8	23.0	31.795	0.000	7.55	17.6
26.1	180.0	95.2	84.8	24.9	32.573	0.000	7.65	17.3

Total Continuous Driving Time 5.00 minutes; Total Number of Blows 246

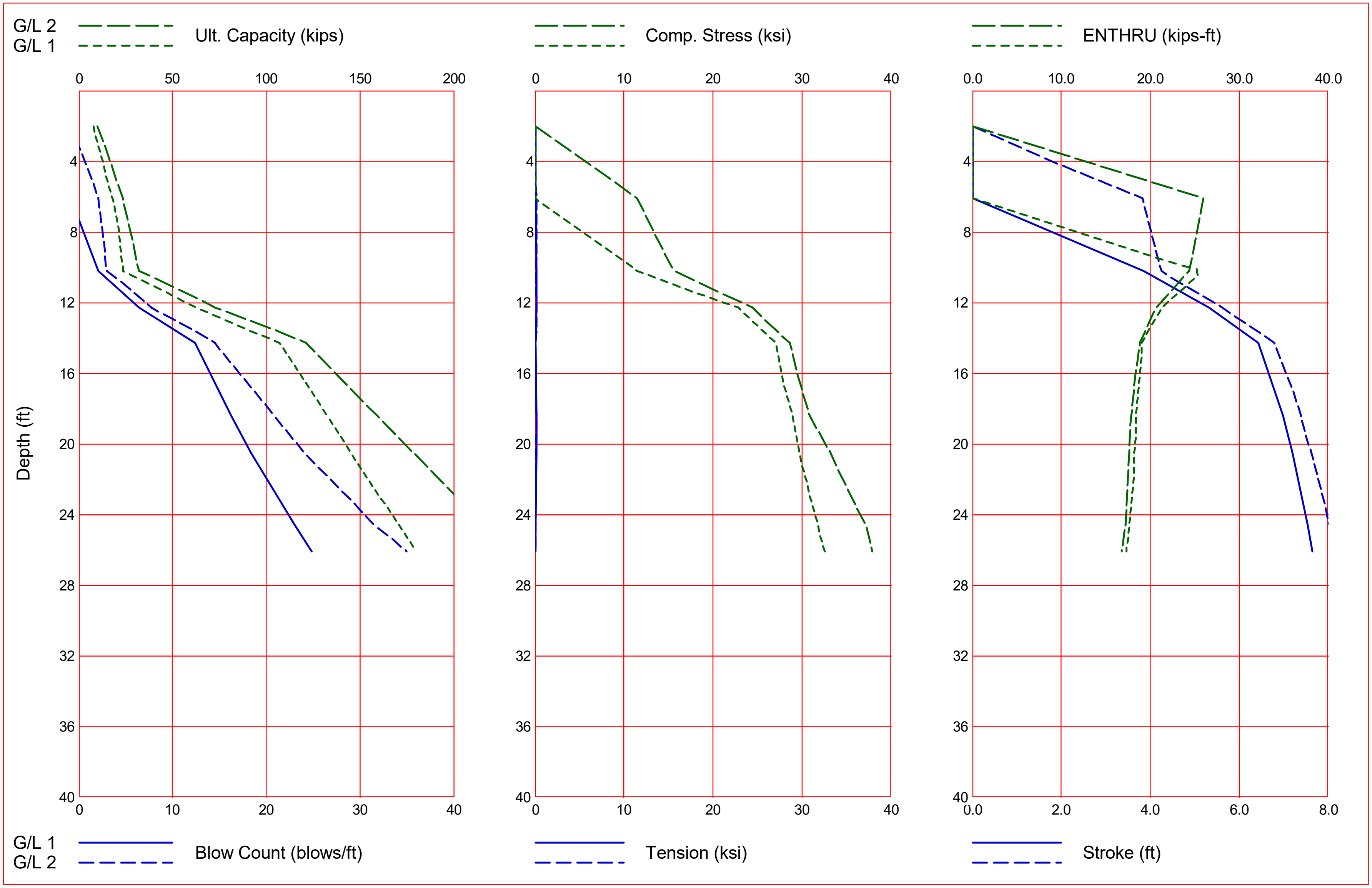
Gain/Loss 2 at Shaft and Toe 1.000 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
2.0	9.7	4.0	5.7	-1.0	0.000	0.000	0.00	0.0
6.1	23.4	12.1	11.3	2.1	11.440	-0.156	3.83	26.0
10.2	32.2	20.2	12.0	3.0	15.608	0.000	4.26	24.4
12.3	72.8	24.7	48.1	7.7	24.449	-0.177	5.62	20.6
14.3	121.5	36.7	84.8	14.5	28.680	0.000	6.79	18.8
18.4	159.3	74.5	84.8	20.8	30.830	-0.131	7.39	17.9
20.5	178.7	93.9	84.8	24.1	33.180	0.000	7.63	17.7
24.6	217.0	132.2	84.8	31.5	37.213	0.000	8.03	17.2
26.1	230.9	146.1	84.8	35.0	37.867	0.000	8.09	16.8

Total Continuous Driving Time 8.00 minutes; Total Number of Blows 329

Stantec Consulting Services
BRO-32 Rear Abutment
Gain/Loss 1 at Shaft and Toe 0.571 / 1.000

Feb 04 2021
GRLWEAP Version 2010
Gain/Loss 2 at Shaft and Toe 1.000 / 1.000



BRO-32 Forward Abut. Sand Sleeve

Hammer Information

Select from following list [8/3/2015-2003]: ID: 41

ID	Name	Type	Ram Wt	Energy/Power
40	DELMAG D 19-32	OED	4.0000	42.440
41	DELMAG D 19-42	OED	4.0000	43.240
42	DELMAG D200-42	OED	44.0900	492.044

Hammer parameters

Efficiency	0.8			
Pressure	1600	psi	Fixed	100 %
Stroke	10.81	ft	Variable	

Pile material

Concrete / Steel (selected) / Timber

Cushion Information

	Hammer	Pile	
Area	227.	0.	in^2
Elastic Modulus	530.	0.	ksi
Thickness	2.	0.	in
C.O.R.	0.8	0.	
Stiffness	0.	0.	kips/in
Helmet Weight	1.9		kips

Pile Information

Length	45.	ft	Auto	Segments
Penetration	45.	ft	Auto.	S-Length
Section Area	11.46	in^2	Auto.	S-St, Wt
Elast Modulus	29000.	ksi	0	Splices
Spec Weight	492.0	lb/ft^3		
Toe Area	113.1	in^2	Pile Type:	
Perimeter	3.14	ft	Unknown	
Pile Size	12.	in		

Resistance Gain/Loss Factors

	Shaft		Toe
1	0.57142	1	1.0
2	1.0	2	1.0
3	0.0	3	0.0
4	0.0	4	0.0
5	0.0	5	0.0

Incr. 0 Action >>

Soil Parameters

Quake

Shaft	0.1	in	Const
Toe	0.1	in	

Damping

Shaft	0.15	s/ft	Const
Toe	0.15	s/ft	Smith

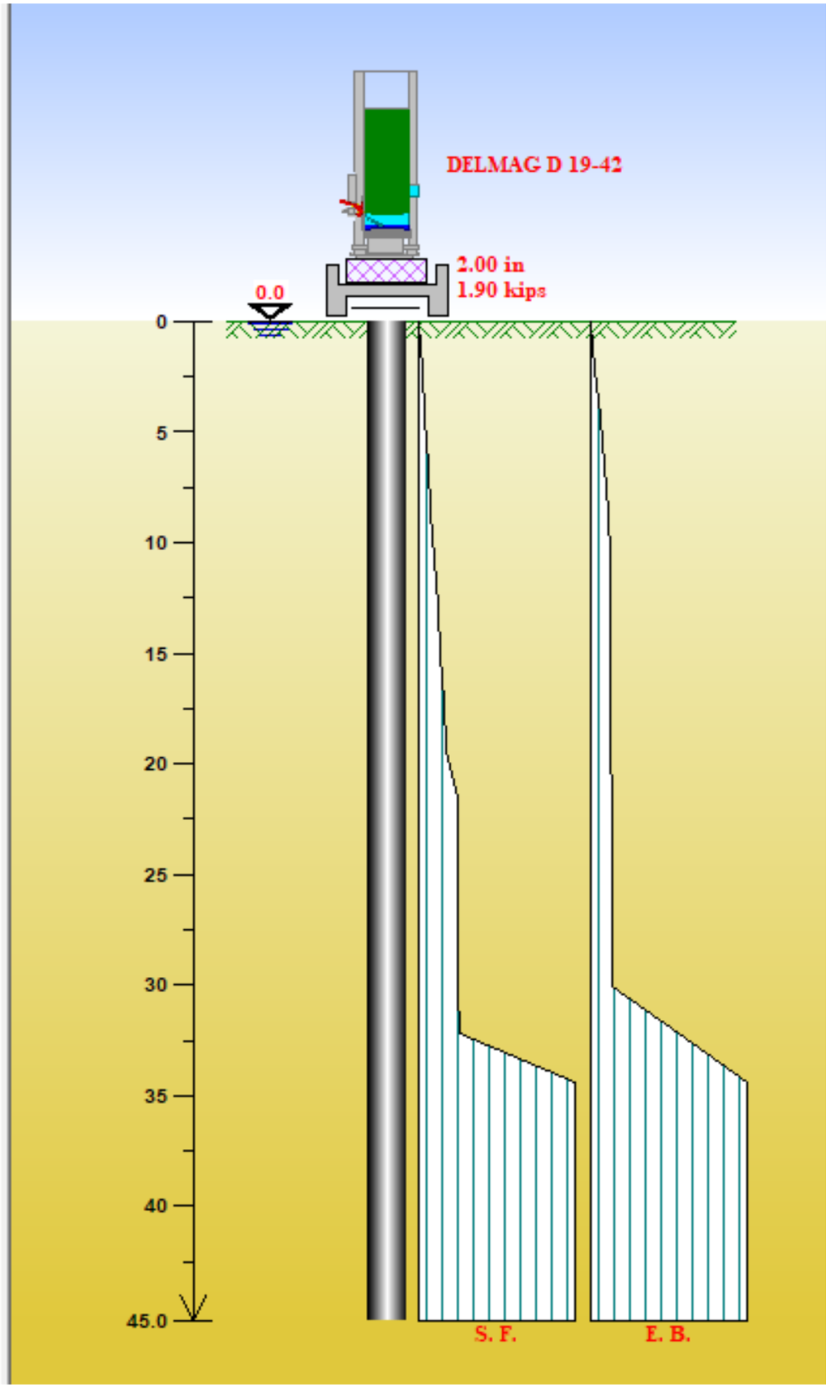
Shaft Resistance

Percentage 0 %

100%

Dist. Shape Num 0.0

Residual Stress Analysis: No



BRO-32 Forward Abut. Sand Sleeve

Resistance Distribution Input for Pile 1

General Information

Pile Length: 45.0 ft

Depths below ground surface and in pile penetration direction

Add Row | Insert Row | Delete Row

Depth	Unit Shaft Resist	Unit Toe Resist	Skin Quake	Toe Quake	Skin Damping	Toe Damping	Setup Factor	Limit Distance	Setup Time	Toe Area
ft	ksf	ksf	in	in	s/ft	s/ft		ft	hours	in^2
0.000	0.000	0.509	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
2.140	0.059	2.164	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
4.290	0.117	6.239	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
6.430	0.176	9.422	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
8.570	0.234	12.095	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
10.700	0.293	13.241	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
12.900	0.352	13.369	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
15.000	0.410	13.369	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
17.100	0.469	13.369	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
19.300	0.527	13.878	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
21.400	0.729	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
23.600	0.729	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
25.700	0.729	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
27.900	0.729	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
30.000	0.729	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
32.100	0.758	61.241	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
34.300	2.960	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
36.400	2.960	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
38.600	2.960	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
40.700	2.960	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
42.900	2.960	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
45.000	2.960	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00

Stantec Consulting Services Feb 04 2021
BRO-32 Forward Abut. Sand Sleeve GRLWEAP Version 2010

Gain/Loss 1 at Shaft and Toe 0.571 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
2.1	1.9	0.2	1.7	0.0	0.000	0.000	10.81	0.0
4.3	5.6	0.7	4.9	-1.0	0.000	0.000	0.00	0.0
11.3	15.0	4.6	10.4	-1.0	0.000	0.000	0.00	0.0
15.0	18.5	8.0	10.5	1.4	10.359	0.000	3.62	26.6
29.3	36.9	25.6	11.3	3.0	17.534	0.000	4.42	24.0
22.5	28.0	16.7	11.3	2.1	13.860	0.000	4.00	25.4
25.7	32.2	20.9	11.3	2.5	15.812	0.000	4.23	24.8
30.0	37.8	26.5	11.3	3.1	17.802	0.000	4.46	23.9
33.8	111.7	35.2	76.5	12.4	26.116	-0.366	6.36	19.2
36.4	136.1	51.3	84.8	15.8	27.672	0.000	6.86	19.0
40.7	162.6	77.8	84.8	19.9	28.711	-0.345	7.21	18.7
42.9	175.9	91.1	84.8	21.9	29.219	-0.295	7.38	18.7
45.0	189.1	104.3	84.8	24.2	29.696	-0.222	7.53	18.7

Total Continuous Driving Time 6.00 minutes; Total Number of Blows 273

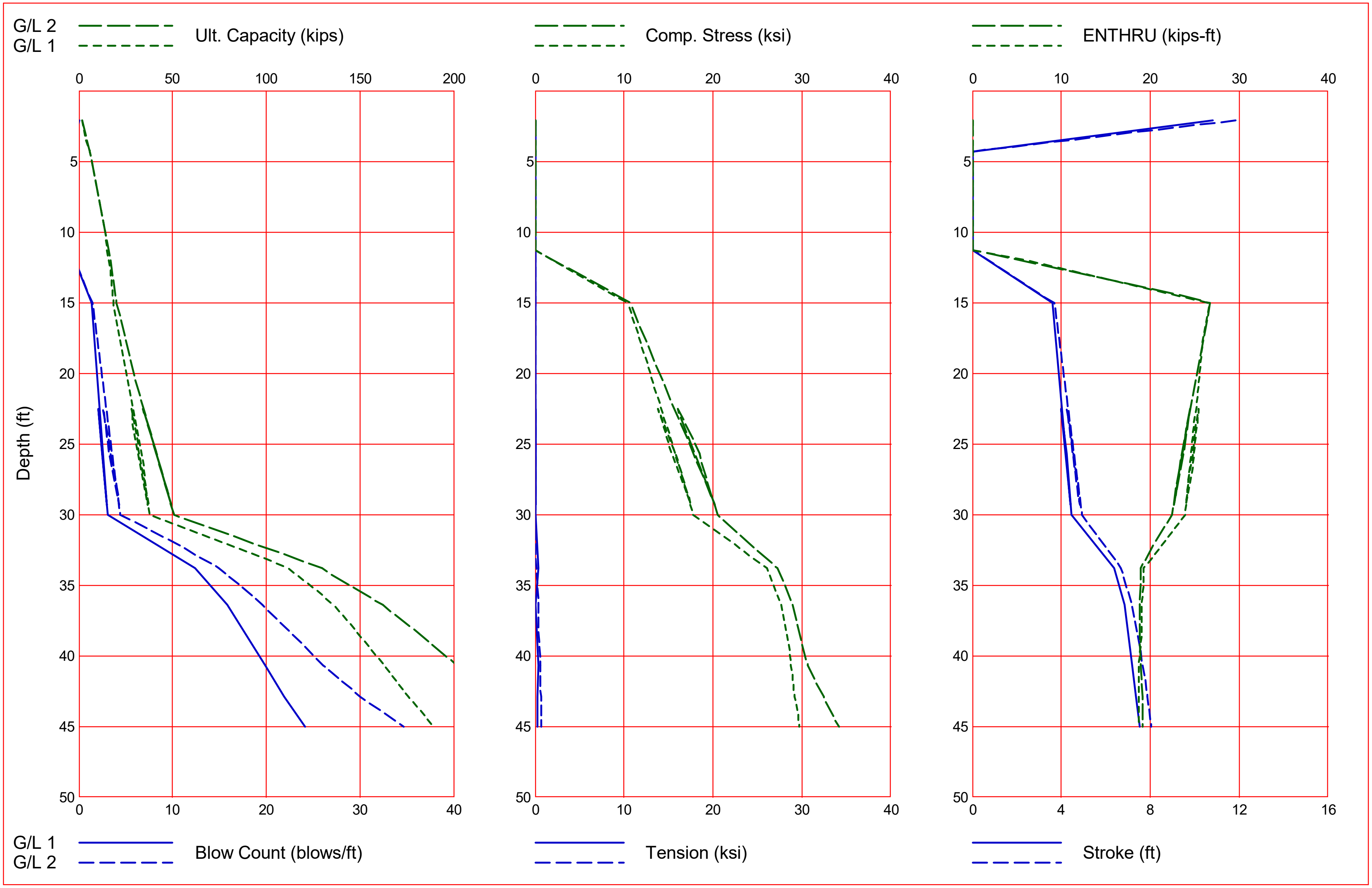
Gain/Loss 2 at Shaft and Toe 1.000 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
2.1	1.9	0.2	1.7	0.0	0.000	0.000	11.86	0.0
4.3	5.7	0.8	4.9	-1.0	0.000	0.000	0.00	0.0
11.3	15.9	5.5	10.4	-1.0	0.000	0.000	0.00	0.0
15.0	20.2	9.7	10.5	1.5	10.691	0.000	3.69	26.7
29.3	49.5	38.2	11.3	4.3	20.265	0.000	4.86	22.7
22.5	34.0	22.7	11.3	2.6	16.076	0.000	4.23	24.5
25.7	41.3	30.0	11.3	3.4	18.479	0.000	4.56	23.6
30.0	51.1	39.8	11.3	4.4	20.547	0.000	4.92	22.5
33.8	129.8	53.3	76.5	14.9	27.291	-0.121	6.69	18.9
36.4	162.2	77.4	84.8	19.6	28.912	-0.420	7.20	18.8
40.7	202.0	117.2	84.8	26.1	30.709	-0.607	7.66	18.9
42.9	221.9	137.1	84.8	30.0	32.429	-0.661	7.89	19.1
45.0	241.8	157.0	84.8	34.7	34.167	-0.710	8.04	19.1

Total Continuous Driving Time 8.00 minutes; Total Number of Blows 357

Stantec Consulting Services
BRO-32 Forward Abut. Sand Sleeve
Gain/Loss 1 at Shaft and Toe 0.571 / 1.000

Feb 04 2021
GRLWEAP Version 2010
Gain/Loss 2 at Shaft and Toe 1.000 / 1.000



BRO-32 Rear Abut. Sand Sleeve

Hammer Information

Select from following list [8/3/2015-2003]: ID: 41

ID	Name	Type	Ram Wt	Energy/Power
40	DELMAG D 19-32	OED	4.0000	42.440
41	DELMAG D 19-42	OED	4.0000	43.240
42	DELMAG D200-42	OED	44.0900	492.044

Hammer parameters

Efficiency	0.8		
Pressure	1600	psi	Fixed 100 %
Stroke	10.81	ft	Variable

Pile material

○ Concrete ● Steel ○ Timber

Cushion Information

	Hammer	Pile	
Area	227.	0.	in^2
Elastic Modulus	530.	0.	ksi
Thickness	2.	0.	in
C.O.R.	0.8	0.	
Stiffness	0.	0.	kips/in
Helmet Weight	1.9		kips

Pile Information

Length	43.	ft	Auto	Segments
Penetration	43.	ft	Auto.	S-Length
Section Area	11.46	in^2	Auto.	S-St, Wt
Elast Modulus	29000.	ksi	0	Splices
Spec Weight	492.0	lb/ft^3		
Toe Area	113.1	in^2	Pile Type:	
Perimeter	3.14	ft	Unknown	
Pile Size	12.	in		

Resistance Gain/Loss Factors

	Shaft		Toe
1	0.57142	1	1.0
2	1.0	2	1.0
3	0.0	3	0.0
4	0.0	4	0.0
5	0.0	5	0.0

Incr. 0 Action >>

Soil Parameters

Quake

Shaft	0.1	in	Const
Toe	0.1	in	

Damping

Shaft	0.15	s/ft	Const
Toe	0.15	s/ft	Smith

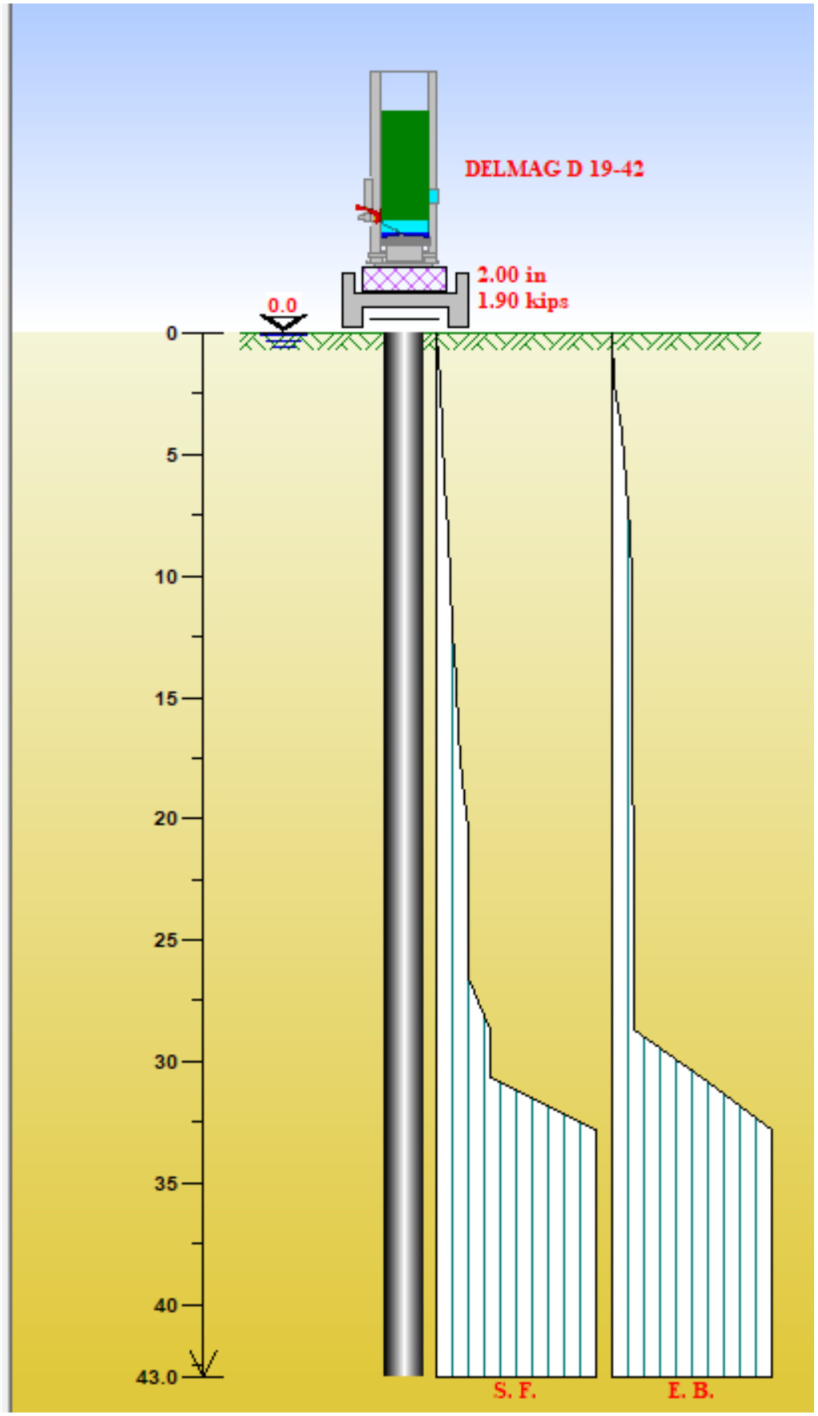
Shaft Resistance

Percentage 0 %

100%

Dist. Shape Num 0.0

Residual Stress Analysis: No



BRO-32 Rear Abut. Sand Sleeve

Resistance Distribution Input for Pile 1

General Information

Pile Length: 43.0 ft

Depths below ground surface and in pile penetration direction

Add Row Insert Row Delete Row

Depth ft	Unit Shaft Resist ksf	Unit Toe Resist ksf	Skin Quake in	Toe Quake in	Skin Damping s/ft	Toe Damping s/ft	Setup Factor	Limit Distance ft	Setup Time hours	Toe Area in^2
0.000	0.000	0.509	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
2.050	0.056	2.037	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
4.100	0.112	5.984	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
6.140	0.168	9.040	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
8.190	0.224	11.714	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
10.200	0.280	13.114	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
12.300	0.336	13.369	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
14.300	0.392	13.369	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
16.400	0.448	13.369	0.100	0.100	0.050	0.150	1.200	6.560	1.0	0.00
18.400	0.504	13.878	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
20.500	0.629	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
22.500	0.629	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
24.600	0.629	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
26.600	0.629	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
28.700	1.100	14.387	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
30.700	1.100	61.241	0.100	0.100	0.150	0.150	1.750	6.560	1.0	0.00
32.800	3.250	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
34.800	3.250	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
36.900	3.250	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
38.900	3.250	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
41.000	3.250	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00
43.000	3.250	107.968	0.100	0.100	0.150	0.150	1.500	6.560	1.0	0.00

Stantec Consulting Services Feb 04 2021
BRO-32 Rear Abut. Sand Sleeve GRLWEAP Version 2010

Gain/Loss 1 at Shaft and Toe 0.571 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
2.0	1.8	0.2	1.6	0.0	0.000	0.000	10.81	0.0
4.1	5.3	0.6	4.7	-1.0	0.000	0.000	0.00	0.0
10.8	14.5	4.2	10.4	-1.0	0.000	0.000	0.00	0.0
14.3	17.9	7.4	10.5	1.4	9.893	0.000	3.54	26.4
20.5	25.1	13.8	11.3	1.8	12.547	0.000	3.89	26.2
21.5	26.3	15.0	11.3	1.9	12.953	0.000	3.92	25.8
26.6	32.1	20.8	11.3	2.5	15.754	0.000	4.22	24.8
30.7	76.2	28.0	48.3	7.6	23.573	-0.393	5.64	20.6
32.3	109.9	33.8	76.1	12.2	26.079	-0.336	6.33	19.2
36.9	149.2	64.4	84.8	17.9	28.310	0.000	7.05	18.8
41.0	177.1	92.3	84.8	22.2	29.348	-0.299	7.41	18.7
43.0	191.0	106.2	84.8	24.5	30.002	-0.244	7.57	18.6

Total Continuous Driving Time 6.00 minutes; Total Number of Blows 261

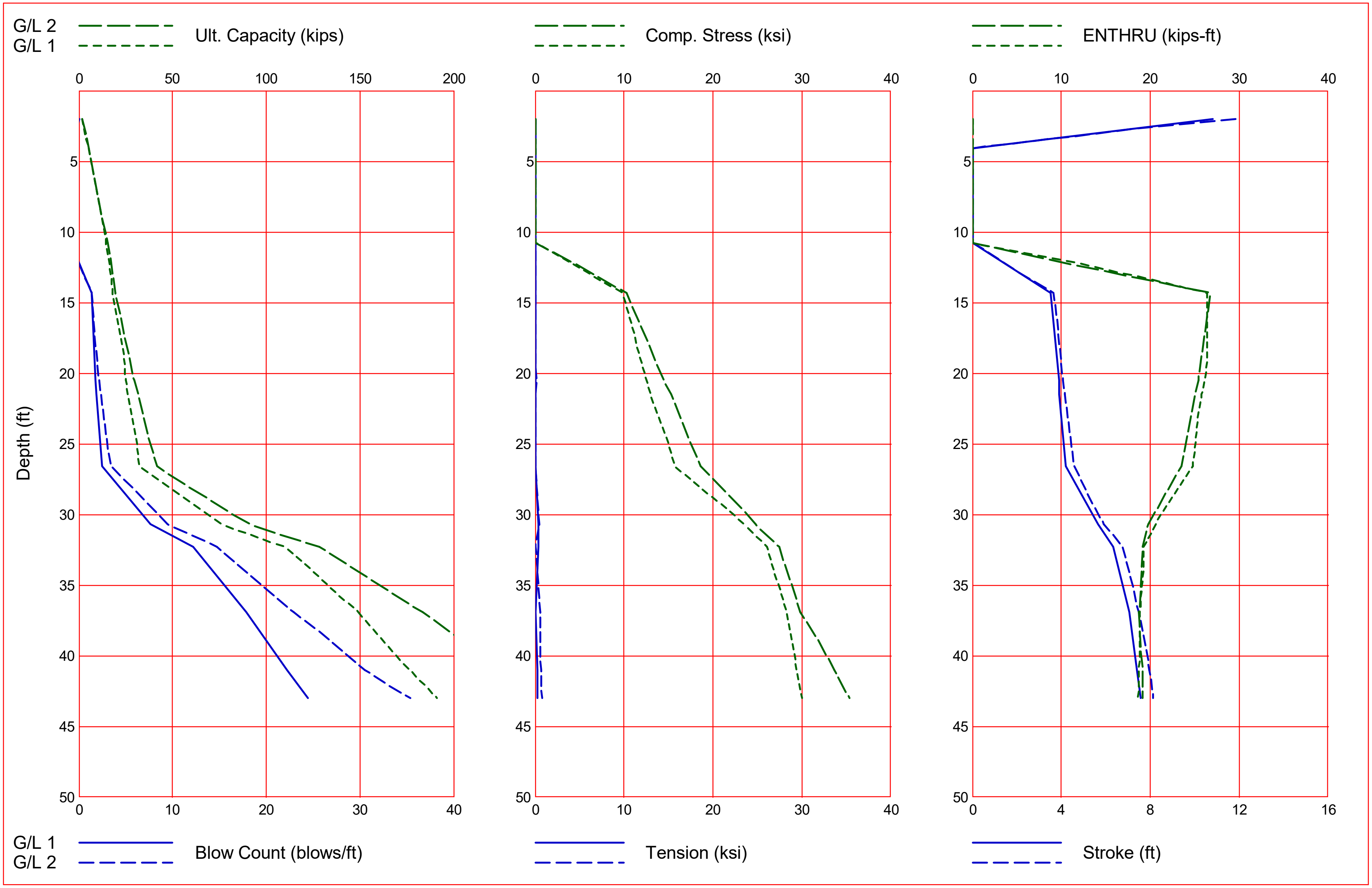
Gain/Loss 2 at Shaft and Toe 1.000 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
2.0	1.8	0.2	1.6	0.0	0.000	0.000	11.86	0.0
4.1	5.4	0.7	4.7	-1.0	0.000	0.000	0.00	0.0
10.8	15.4	5.0	10.4	-1.0	0.000	0.000	0.00	0.0
14.3	19.3	8.8	10.5	1.4	10.261	0.000	3.64	26.7
20.5	29.5	18.2	11.3	2.2	14.444	-0.146	4.07	25.4
21.5	31.6	20.3	11.3	2.4	15.306	-0.080	4.16	25.0
26.6	41.7	30.4	11.3	3.4	18.605	0.000	4.58	23.5
30.7	91.2	43.0	48.3	9.5	24.767	-0.504	5.93	19.8
32.3	128.6	52.6	76.1	14.7	27.512	-0.063	6.75	19.1
36.9	183.5	98.7	84.8	22.9	29.830	-0.559	7.48	18.7
41.0	225.3	140.5	84.8	30.5	33.656	-0.701	7.94	19.1
43.0	246.2	161.4	84.8	35.4	35.390	-0.776	8.12	19.1

Total Continuous Driving Time 8.00 minutes; Total Number of Blows 340

Stantec Consulting Services
BRO-32 Rear Abut. Sand Sleeve
Gain/Loss 1 at Shaft and Toe 0.571 / 1.000

Feb 04 2021
GRLWEAP Version 2010
Gain/Loss 2 at Shaft and Toe 1.000 / 1.000



APPENDIX F

MSE Wall Stability Analyses

AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.981

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	412+28.05

Description:

Rear Abutment - Drained conditions - Bearing

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Rear Abutm..... .....nt\Rear1 Abut-LT.BEN

Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	125.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{equiv.}$	28.0 °
Equivalent cohesion, $c_{equiv.}$	150.0 lb/ft ²

Water table is at wall base elevation

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 25.80 N γ= 16.72

SEISMICITY

Not Applicable

$$K_a = \tan^2(45-\phi/2) \qquad (15)$$

$$K = \frac{\sin^2(\theta+\phi')}{\sin^3\theta\left[1+\frac{\sin\phi'}{\sin\theta}\right]^2} \qquad (38)$$

$$K_a = \cos\beta \, \frac{\cos\beta-\sqrt{\cos^2\beta-\cos^2\phi}}{\cos\beta+\sqrt{\cos^2\beta-\cos^2\phi}} \qquad (16)$$

$$K_a = \frac{\sin^2(\theta+\phi)}{\sin^2\theta \;\sin(\theta-\delta)\left(1+\sqrt{\frac{\sin(\phi+\delta)\sin(\phi-\beta)}{\sin(\theta-\delta)\sin(\theta+\beta)}}\right)^2} \qquad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	25.76	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 22.76 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10[ft]

AASHTO 2007-2010 (LRFD) Input Data

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figure C11.5.5-2:

		Static		Combined Static/Seismic
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH, from Table 3.4.1-2 and Figure C11.5.5-2: $\gamma_{p\text{-}EH}$ 1.50
Load factor of active lateral earth pressure during earthquake (does not multiply P_{AE} and P_{IR}): $(\gamma_{p\text{-}EH})_{EQ}$ 1.50
Load factor for earthquake loads, EQ, from Table 3.4.1-1 (multiplies P_{AE} and P_{IR}): $\gamma_{p\text{-}EQ}$ 1.00

Resistance factor for shear resistance along common interfaces from Table 11.5.6-1:

		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation from Table 11.5.6-1:

	Static	Combined Static/Seismic
ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

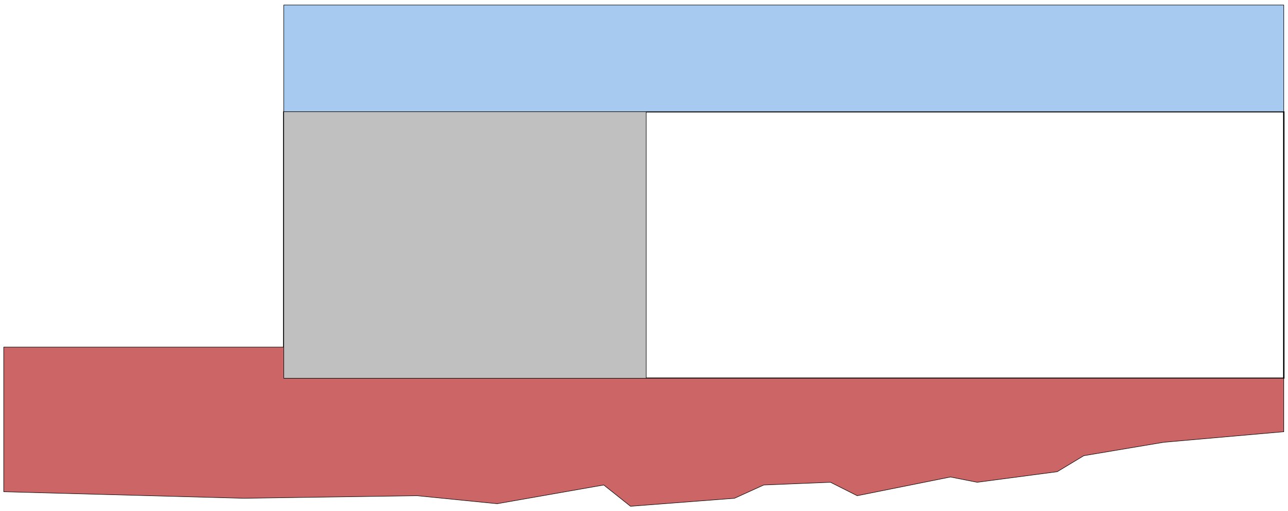
Bearing capacity, CDR = 2.70, factored bearing load = 4999 lb/ft².
Foundation Interface: Direct sliding, CDR = 2.653, Eccentricity, e/L = 0.0579, CDR-overturning = 8.63

#	METAL STRIP Elevation [ft]	Length [ft]	Type #	CONNECTION CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.50	35.00	1								
2	3.00	35.00	1								
3	6.00	35.00	1								
4	9.00	35.00	1								
5	12.00	35.00	1								
6	15.00	35.00	1								
7	18.00	35.00	1								
8	21.00	35.00	1								
9	24.00	35.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table is at wall base elevation)			
Factored bearing resistance. q-n	13487	N/A	[lb/ft ²]
Factored bearing load, σ_V	4998.8	N/A	[lb/ft ²]
Eccentricity, e	1.36	N/A	[ft]
Eccentricity, e/L	0.039	N/A	
CDR calculated	2.70	N/A	
Base length	35.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 116941.93 [lb/ft], L = 35.00, Unfactored e = 1.21 [ft], and Sigma = 3589.58 [lb/ft ²]



SCALE:

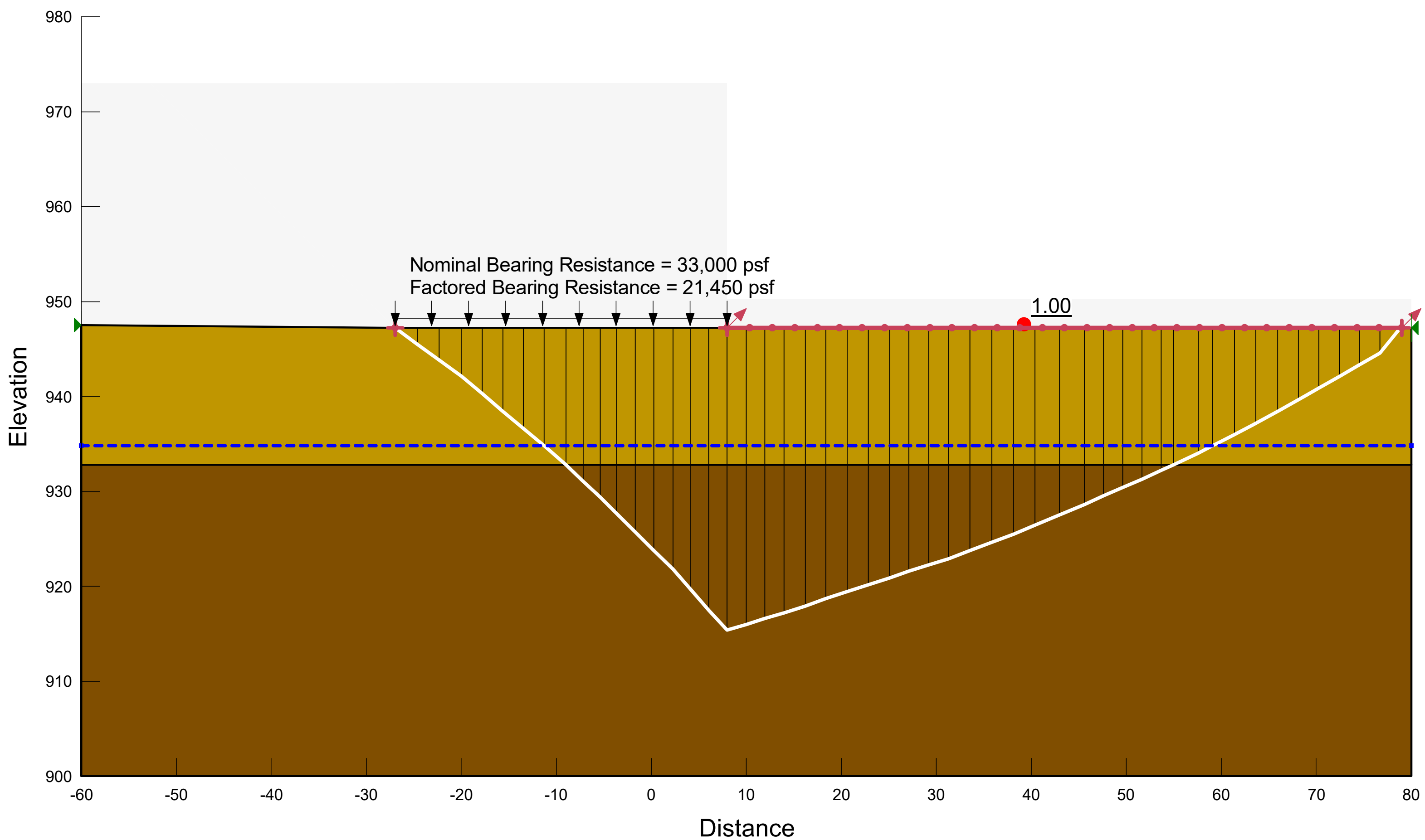
0 2 4 6 8 10[ft]

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Rear Abutment
MSE Wall Bearing Capacity Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.
Bearing load was determined using MSEW 3.0.

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Glacial Till	130	400	32
	Silty Clay	125	150	28

Bearing Capacity - Normal Groundwater
Drained Conditions



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.981

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	412+28.05

Description:

Rear Abutment - Drained conditions - Sliding Resistance

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Rear Abutm.....
.....nt\Rear1 Abut-LT.BEN

Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{\text{equiv.}}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction, $\phi_{\text{equiv.}}$	23.0 °
Equivalent cohesion, $c_{\text{equiv.}}$	0.0 lb/ft ^{2}

Water table is at wall base elevation

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 18.05 N γ= 8.20

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \qquad (15)$$

$$K = \frac{\sin^2(\theta+\phi')}{\sin^3\theta\left[1+\frac{\sin\phi'}{\sin\theta}\right]^2} \qquad (38)$$

$$K_a = \cos\beta \; \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}} \qquad (16)$$

$$K_a = \frac{\sin^2(\theta+\phi)}{\sin^2\theta \;\sin(\theta-\delta)\left(1+\sqrt{\frac{\sin(\phi+\delta)\sin(\phi-\beta)}{\sin(\theta-\delta)\sin(\theta+\beta)}}\right)^2} \qquad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	25.76	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 22.76 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10[ft]

AASHTO 2007-2010 (LRFD) Input Data

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figure C11.5.5-2:

		Static		Combined Static/Seismic
Sliding and Eccentricity	γ_{p-EV}	1.00	γ_{p-EQ}	1.00
Bearing Capacity	γ_{p-EV}	1.35	γ_{p-EQ}	1.35

Load factor of active lateral earth pressure, EH, from Table 3.4.1-2 and Figure C11.5.5-2: γ_{p-EH} 1.50

Load factor of active lateral earth pressure during earthquake (does not multiply P_{AE} and P_{IR}): $(\gamma_{p-EH})_{EQ}$ 1.50

Load factor for earthquake loads, EQ, from Table 3.4.1-1 (multiplies P_{AE} and P_{IR}): γ_{p-EQ} 1.00

Resistance factor for shear resistance along common interfaces from Table 11.5.6-1:

		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation from Table 11.5.6-1:

	Static	Combined Static/Seismic
ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

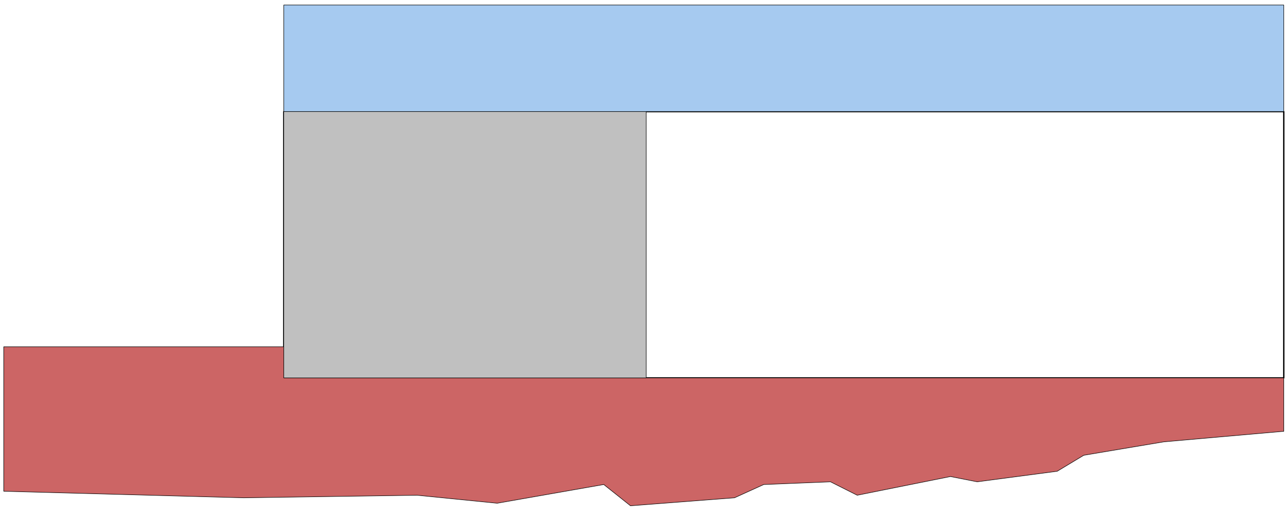
Bearing capacity, CDR = 1.08, factored bearing load = 4999 lb/ft².
Foundation Interface: Direct sliding, CDR = 1.941, Eccentricity, e/L = 0.0579, CDR-overturning = 8.63

METAL STRIP				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.50	35.00	1								
2	3.00	35.00	1								
3	6.00	35.00	1								
4	9.00	35.00	1								
5	12.00	35.00	1								
6	15.00	35.00	1								
7	18.00	35.00	1								
8	21.00	35.00	1								
9	24.00	35.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table is at wall base elevation)			
Factored bearing resistance. q-n	5383	N/A	[lb/ft ²]
Factored bearing load, σ_V	4998.8	N/A	[lb/ft ²]
Eccentricity, e	1.36	N/A	[ft]
Eccentricity, e/L	0.039	N/A	
CDR calculated	1.08	N/A	
Base length	35.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 116941.93 [lb/ft], L = 35.00, Unfactored e = 1.21 [ft], and Sigma = 3589.58 [lb/ft ²]



SCALE:

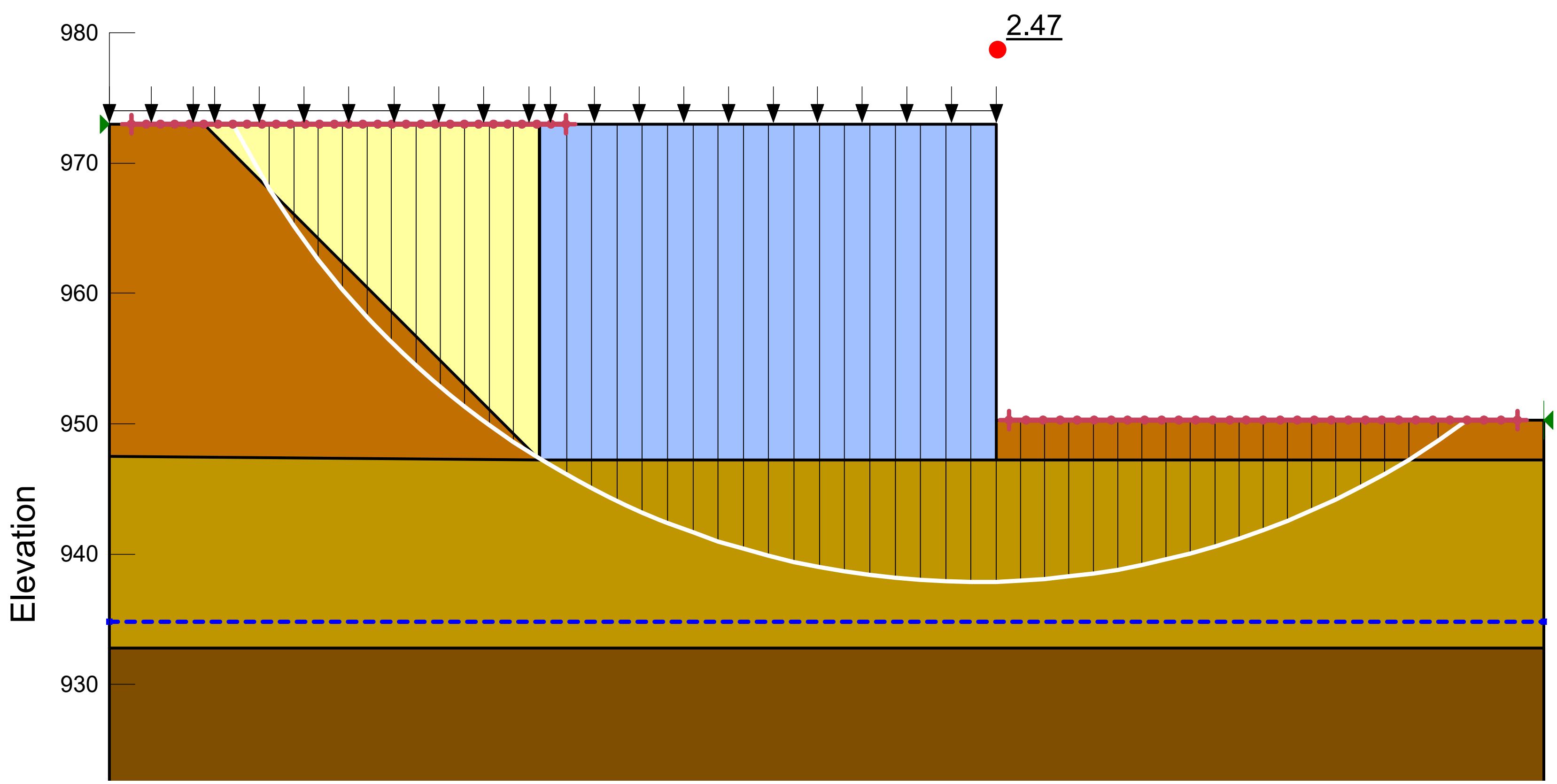
0 2 4 6 8 10[ft]

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Rear Abutment
MSE Wall Bearing Capacity Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.
Bearing load was determined using MSEW 3.0.

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Embankment Fill	125	200	26
	Glacial Till	130	400	32
	MSE Fill	120	3,000	34
	Retained Fill	120	0	30
	Silty Clay	125	150	28

Global Stability - Normal Groundwater
Drained Conditions



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.981

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	412+28.05

Description:

Rear Abutment - Undrained conditions - Bearing

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Rear Abutm.....
.....nt\Rear1 Abut-ST.BEN

Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{\text{equiv.}}$	125.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{\text{equiv.}}$	0.0 °
Equivalent cohesion, $c_{\text{equiv.}}$	1600.0 lb/ft ²

Water table is at wall base elevation

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 5.14 N γ= 0.00

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \qquad (15)$$

$$K = \frac{\sin^2(\theta + \phi')}{\sin^3\theta \left[1 + \frac{\sin\phi'}{\sin\theta}\right]^2} \qquad (38)$$

$$K_a = \cos\beta \; \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}} \qquad (16)$$

$$K_a = \frac{\sin^2(\theta + \phi)}{\sin^2\theta \; \sin(\theta - \delta) \left(1 + \sqrt{\frac{\sin(\phi + \delta)\sin(\phi - \beta)}{\sin(\theta - \delta)\sin(\theta + \beta)}}\right)^2} \qquad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	25.76	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 22.76 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10[ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, CDR = 1.07, factored bearing load = 4999 lb/ft².

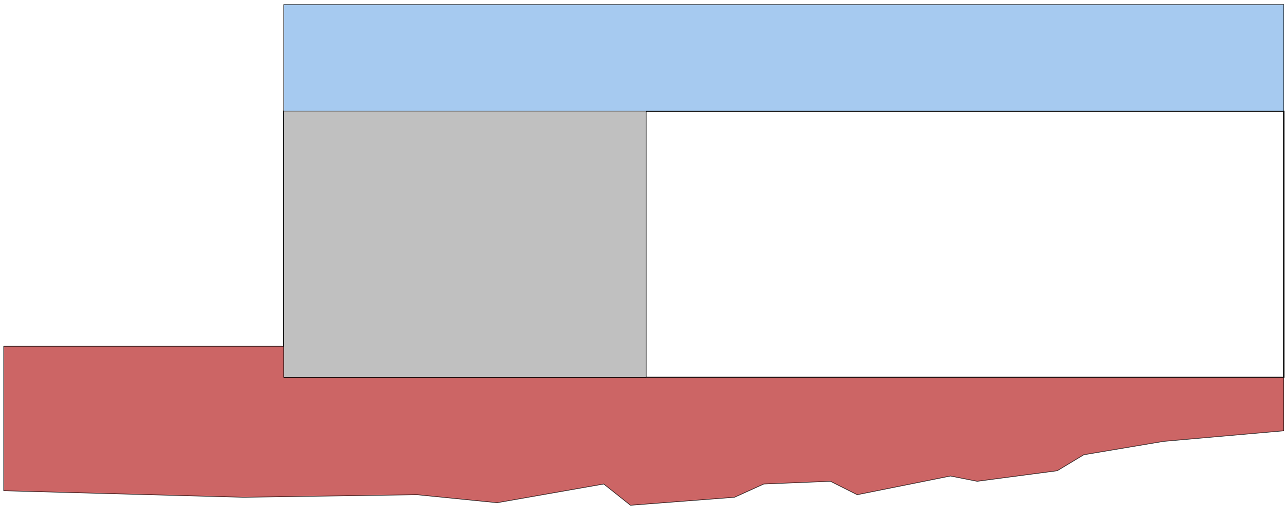
Foundation Interface: Direct sliding, CDR = 2.366, Eccentricity, e/L = 0.0579, CDR-overturning = 8.63

METAL STRIP				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.50	35.00	1								
2	3.00	35.00	1								
3	6.00	35.00	1								
4	9.00	35.00	1								
5	12.00	35.00	1								
6	15.00	35.00	1								
7	18.00	35.00	1								
8	21.00	35.00	1								
9	24.00	35.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table is at wall base elevation)			
Factored bearing resistance. q-n	5347	N/A	[lb/ft ²]
Factored bearing load, σ_V	4998.8	N/A	[lb/ft ²]
Eccentricity, e	1.36	N/A	[ft]
Eccentricity, e/L	0.039	N/A	
CDR calculated	1.07	N/A	
Base length	35.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 116941.93 [lb/ft], L = 35.00, Unfactored e = 1.21 [ft], and Sigma = 3589.58 [lb/ft ²]



SCALE:

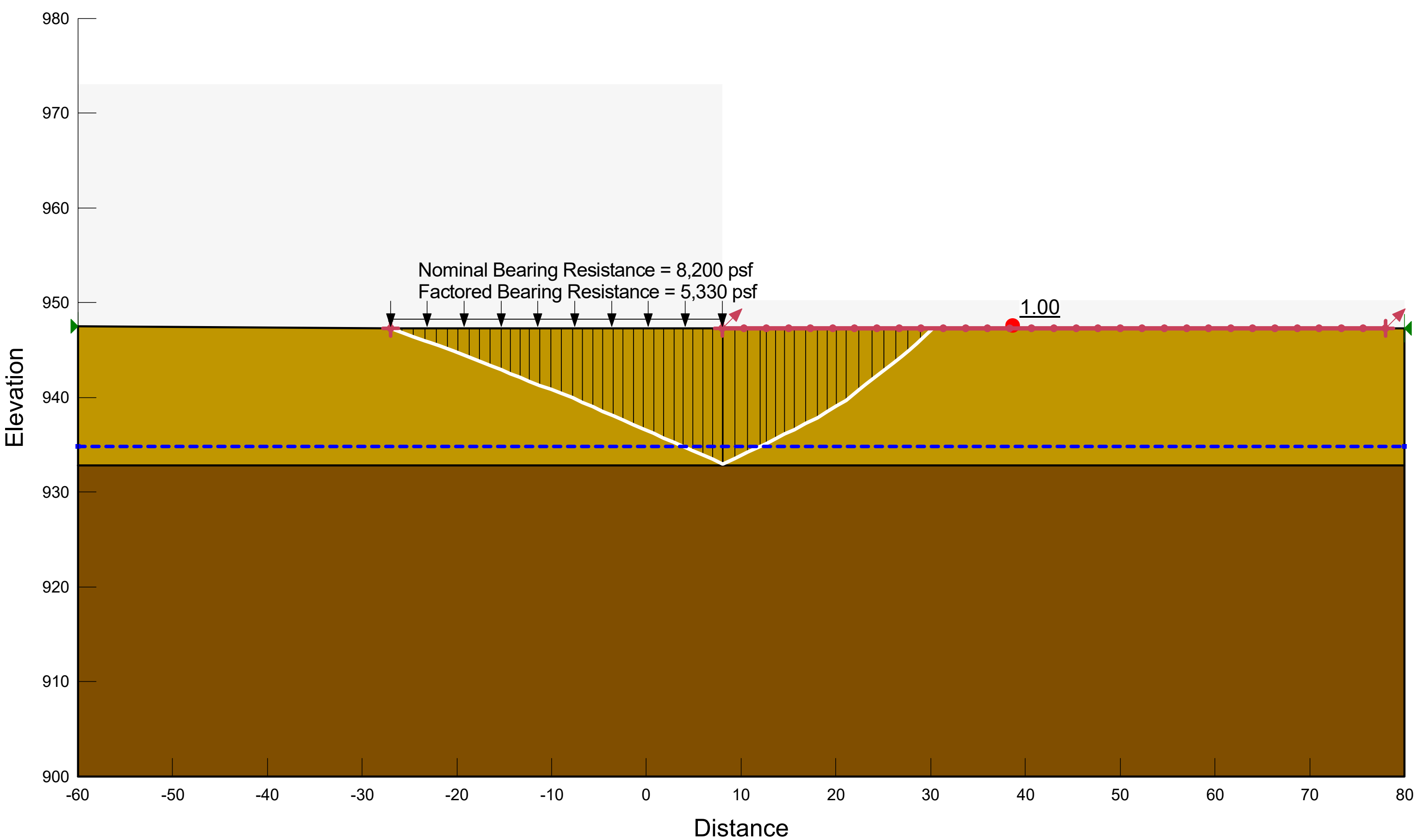
0 2 4 6 8 10[ft]

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Rear Abutment
MSE Wall Bearing Capacity Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.
Bearing load was determined using MSEW 3.0.

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Glacial Till	130	12,000	0
	Silty Clay	125	1,600	0

Bearing Capacity - Normal Groundwater
Undrained Conditions



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.981

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	412+28.05

Description:

Rear Abutment - Undrained conditions - Sliding Resistance

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Rear Abutm.....
.....nt\Rear1 Abut-ST.BEN

Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	125.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{equiv.}$	0.0 °
Equivalent cohesion, $c_{equiv.}$	1000.0 lb/ft ²

Water table is at wall base elevation

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 5.14 $N\gamma$= 0.00

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \qquad (15)$$

$$K = \frac{\sin^2(\theta + \phi')}{\sin^3\theta \left[1 + \frac{\sin\phi'}{\sin\theta}\right]^2} \qquad (38)$$

$$K_a = \cos\beta \; \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}} \qquad (16)$$

$$K_a = \frac{\sin^2(\theta + \phi)}{\sin^2\theta \;\; \sin(\theta - \delta) \left(1 + \sqrt{\frac{\sin(\phi + \delta)\sin(\phi - \beta)}{\sin(\theta - \delta)\sin(\theta + \beta)}}\right)^2} \qquad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	25.76	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 22.76 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M   S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10[ft]

ANALYSIS: CALCULATED FACTORS (Static conditions)

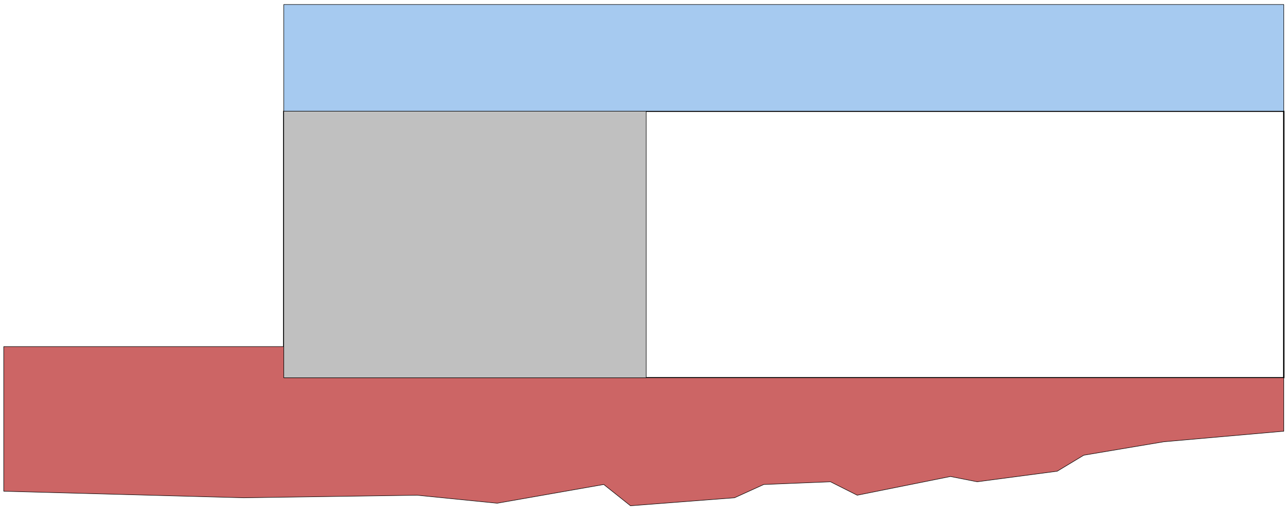
Bearing capacity, CDR = 0.67, factored bearing load = 4999 lb/ft².
Foundation Interface: Direct sliding, CDR = 1.479, Eccentricity, e/L = 0.0579, CDR-overturning = 8.63

METAL STRIP				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.50	35.00	1								
2	3.00	35.00	1								
3	6.00	35.00	1								
4	9.00	35.00	1								
5	12.00	35.00	1								
6	15.00	35.00	1								
7	18.00	35.00	1								
8	21.00	35.00	1								
9	24.00	35.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table is at wall base elevation)			
Factored bearing resistance. q-n	3342	N/A	[lb/ft ²]
Factored bearing load, σ_V	4998.8	N/A	[lb/ft ²]
Eccentricity, e	1.36	N/A	[ft]
Eccentricity, e/L	0.039	N/A	
CDR calculated	0.67	N/A	
Base length	35.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 116941.93 [lb/ft], L = 35.00, Unfactored e = 1.21 [ft], and Sigma = 3589.58 [lb/ft ²]



SCALE:

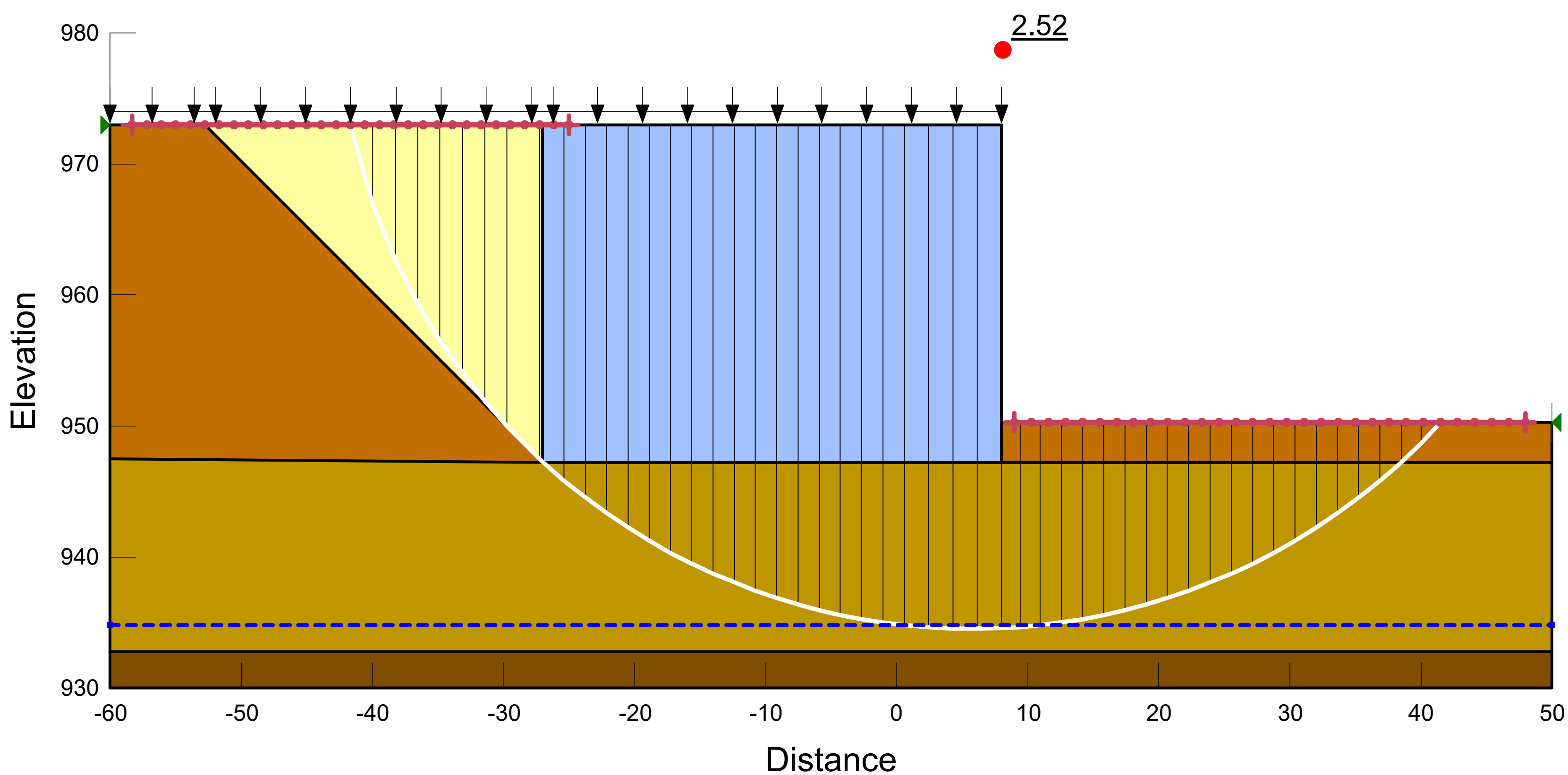
0 2 4 6 8 10[ft]

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Rear Abutment
MSE Wall Stability Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Embankment Fill	125	2,000	0
	Glacial Till	130	12,000	0
	MSE Fill	120	3,000	34
	Retained Fill	120	0	30
	Silty Clay	125	1,600	0

Global Stability - Normal Groundwater
Undrained Conditions



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.94

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	412+28.05

Description:

Rear Sloped Wall - Drained conditions - Bearing

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Rear Abutm.....
.....\Rear1 Sloped-LT.BEN

Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{\text{equiv.}}$	125.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{\text{equiv.}}$	28.0 °
Equivalent cohesion, $c_{\text{equiv.}}$	150.0 lb/ft ²

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 25.80 N γ= 16.72

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \quad (15)$$

$$K = \frac{\sin^2(\theta + \phi')}{\sin^3\theta \left[1 + \frac{\sin\phi'}{\sin\theta}\right]^2} \quad (38)$$

$$K_a = \cos\beta \; \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}} \quad (16)$$

$$K_a = \frac{\sin^2(\theta + \phi)}{\sin^2\theta \;\; \sin(\theta - \delta) \left(1 + \sqrt{\frac{\sin(\phi + \delta)\sin(\phi - \beta)}{\sin(\theta - \delta)\sin(\theta + \beta)}}\right)^2} \quad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	17.10	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 14.10 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 50.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10 [ft]

AASHTO 2007-2010 (LRFD) Input Data

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figure C11.5.5-2:

		Static		Combined Static/Seismic
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH, from Table 3.4.1-2 and Figure C11.5.5-2:	$\gamma_{p\text{-}EH}$	1.50
Load factor of active lateral earth pressure during earthquake (does not multiply P_{AE} and P_{IR}):	$(\gamma_{p\text{-}EH})_{EQ}$	1.50
Load factor for earthquake loads, EQ, from Table 3.4.1-1 (multiplies P_{AE} and P_{IR}):	$\gamma_{p\text{-}EQ}$	1.00

Resistance factor for shear resistance along common interfaces from Table 11.5.6-1:

		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation from Table 11.5.6-1:

	Static	Combined Static/Seismic
ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, CDR = 2.54, factored bearing load = 3686 lb/ft².

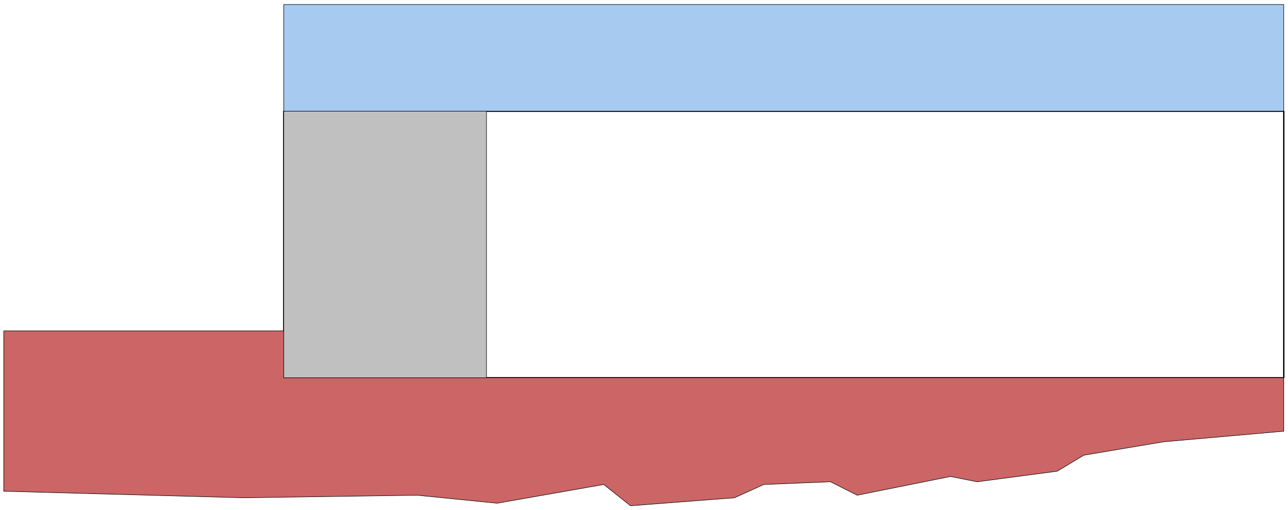
Foundation Interface: Direct sliding, CDR = 1.740, Eccentricity, e/L = 0.1565, CDR-overturning = 3.20

METAL STRIP				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.82	13.00	1								
2	2.46	13.00	1								
3	4.10	13.00	1								
4	5.74	13.00	1								
5	7.38	13.00	1								
6	9.02	13.00	1								
7	10.66	13.00	1								
8	12.30	13.00	1								
9	13.94	13.00	1								
10	15.58	13.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Factored bearing resistance. q-n	9360	N/A	[lb/ft ²]
Factored bearing load, σ_V	3686.1	N/A	[lb/ft ²]
Eccentricity, e	1.46	N/A	[ft]
Eccentricity, e/L	0.112	N/A	
CDR calculated	2.54	N/A	
Base length	13.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 27325.98 [lb/ft], L = 13.00, Unfactored e = 1.31 [ft], and Sigma = 2632.09 [lb/ft ²]



SCALE:

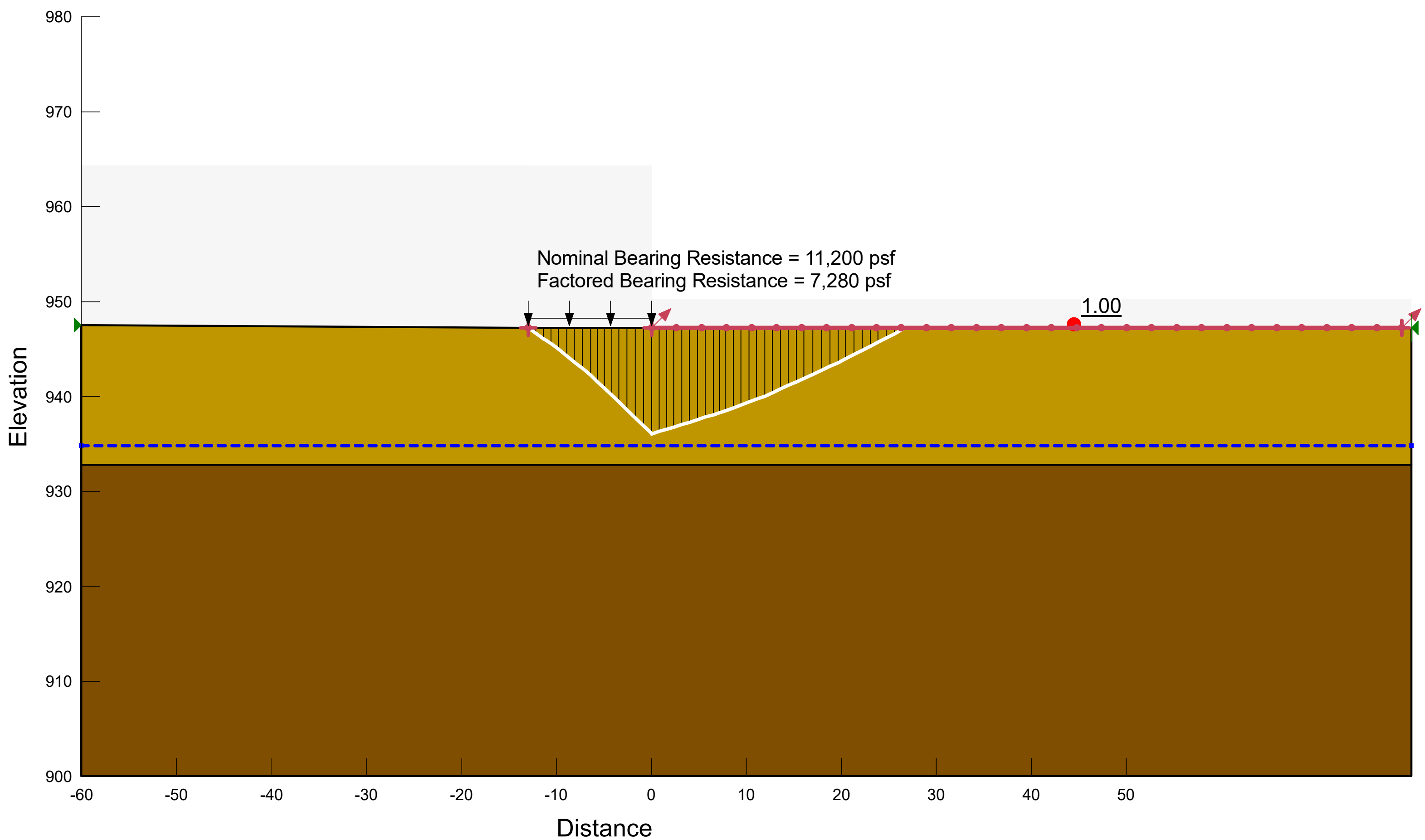
0 2 4 6 8 10 [ft]

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Rear Sloped
MSE Wall Bearing Capacity Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.
Bearing load was determined using MSEW 3.0.

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Glacial Till	130	400	32
	Silty Clay	125	150	28

Bearing Capacity - Normal Groundwater
Drained Conditions



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.94

PROJECT IDENTIFICATION

Title: Bridge BRO-32-0359
Project Number: BRO-32-4.16
Client: ODOT
Designer: DRP
Station Number: 412+28.05

Description:

Rear Sloped Wall - Drained conditions - Sliding Resistance

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Rear Abutm.....
.....\Rear1 Sloped-LT.BEN
Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction, $\phi_{equiv.}$	23.0 °
Equivalent cohesion, $c_{equiv.}$	0.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 18.05 N γ= 8.20

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \qquad (15)$$

$$K = \frac{\sin^2(\theta + \phi')}{\sin^3\theta\left[1 + \frac{\sin\phi'}{\sin\theta}\right]^2} \qquad (38)$$

$$K_a = \cos\beta \; \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}} \qquad (16)$$

$$K_a = \frac{\sin^2(\theta + \phi)}{\sin^2\theta \;\sin(\theta - \delta)\left(1 + \sqrt{\frac{\sin(\phi + \delta)\sin(\phi - \beta)}{\sin(\theta - \delta)\sin(\theta + \beta)}}\right)^2} \qquad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	17.10	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 14.10 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 50.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10 [ft]

AASHTO 2007-2010 (LRFD) Input Data

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figure C11.5.5-2:

		Static		Combined Static/Seismic
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH, from Table 3.4.1-2 and Figure C11.5.5-2: $\gamma_{p\text{-}EH}$ 1.50
Load factor of active lateral earth pressure during earthquake (does not multiply P_{AE} and P_{IR}): $(\gamma_{p\text{-}EH})_{EQ}$ 1.50
Load factor for earthquake loads, EQ, from Table 3.4.1-1 (multiplies P_{AE} and P_{IR}): $\gamma_{p\text{-}EQ}$ 1.00

Resistance factor for shear resistance along common interfaces from Table 11.5.6-1:

		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation from Table 11.5.6-1:

	Static	Combined Static/Seismic
ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, CDR = 0.91, factored bearing load = 3686 lb/ft².

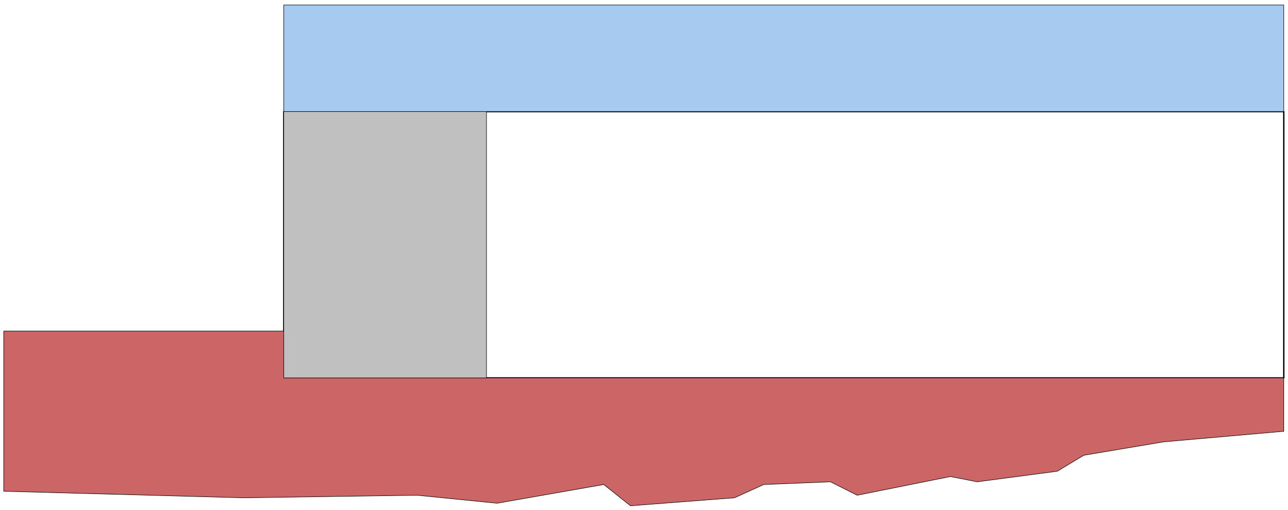
Foundation Interface: Direct sliding, CDR = 1.221, Eccentricity, e/L = 0.1565, CDR-overturning = 3.20

METAL STRIP				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.82	13.00	1								
2	2.46	13.00	1								
3	4.10	13.00	1								
4	5.74	13.00	1								
5	7.38	13.00	1								
6	9.02	13.00	1								
7	10.66	13.00	1								
8	12.30	13.00	1								
9	13.94	13.00	1								
10	15.58	13.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Factored bearing resistance. q-n	3358	N/A	[lb/ft ²]
Factored bearing load, σ_V	3686.1	N/A	[lb/ft ²]
Eccentricity, e	1.46	N/A	[ft]
Eccentricity, e/L	0.112	N/A	
CDR calculated	0.91	N/A	
Base length	13.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 27325.98 [lb/ft], L = 13.00, Unfactored e = 1.31 [ft], and Sigma = 2632.09 [lb/ft ²]



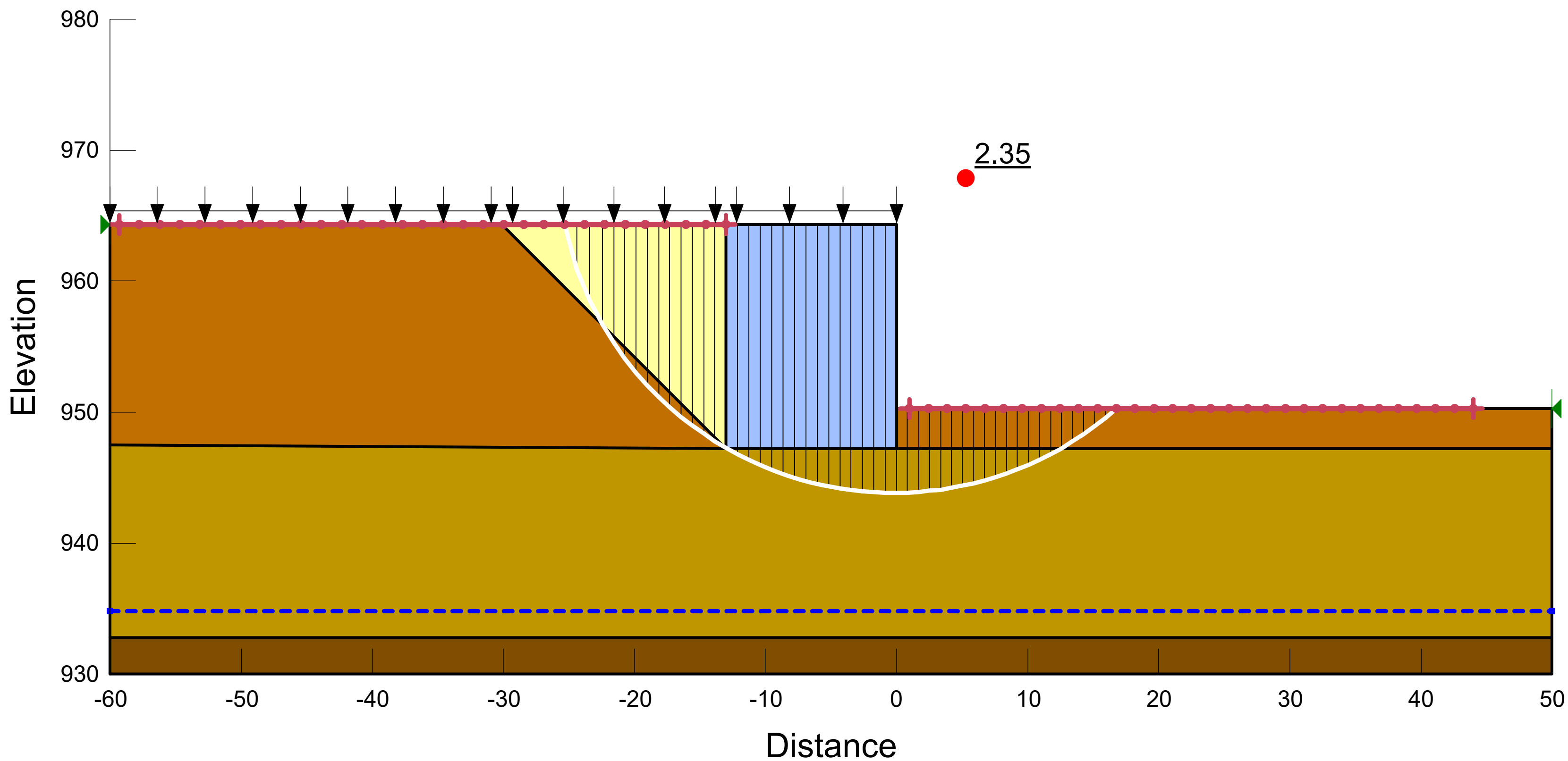
SCALE:

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Rear Sloped
MSE Wall Stability Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Embankment Fill	125	200	26
	Glacial Till	130	400	32
	MSE Fill	120	3,000	34
	Retained Fill	120	0	30
	Silty Clay	125	150	28

Global Stability - Normal Groundwater
Drained Conditions



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.94

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	412+28.05

Description:

Rear Sloped Wall - Undrained conditions - Bearing

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Rear Abutm.....
.....\Rear1 Sloped-ST.BEN
Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	125.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{equiv.}$	0.0 °
Equivalent cohesion, $c_{equiv.}$	1600.0 lb/ft ²

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 5.14 N γ= 0.00

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \qquad (15)$$

$$K = \frac{\sin^2(\theta+\phi')}{\sin^3\theta\left[1+\frac{\sin\phi'}{\sin\theta}\right]^2} \qquad (38)$$

$$K_a = \cos\beta\ \frac{\cos\beta-\sqrt{\cos^2\beta-\cos^2\phi}}{\cos\beta+\sqrt{\cos^2\beta-\cos^2\phi}} \qquad (16)$$

$$K_a = \frac{\sin^2(\theta+\phi)}{\sin^2\theta\ \sin(\theta-\delta)\left(1+\sqrt{\frac{\sin(\phi+\delta)\sin(\phi-\beta)}{\sin(\theta-\delta)\sin(\theta+\beta)}}\right)^2} \qquad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	17.10	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 14.10 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

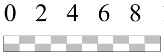
U N I F O R M   S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 50.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10 [ft]



AASHTO 2007-2010 (LRFD) Input Data

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figure C11.5.5-2:

		Static		Combined Static/Seismic
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH, from Table 3.4.1-2 and Figure C11.5.5-2: $\gamma_{p\text{-}EH}$ 1.50

Load factor of active lateral earth pressure during earthquake (does not multiply P_{AE} and P_{IR}): $(\gamma_{p\text{-}EH})_{EQ}$ 1.50

Load factor for earthquake loads, EQ, from Table 3.4.1-1 (multiplies P_{AE} and P_{IR}): $\gamma_{p\text{-}EQ}$ 1.00

Resistance factor for shear resistance along common interfaces from Table 11.5.6-1:

		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation from Table 11.5.6-1:

	Static	Combined Static/Seismic
ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

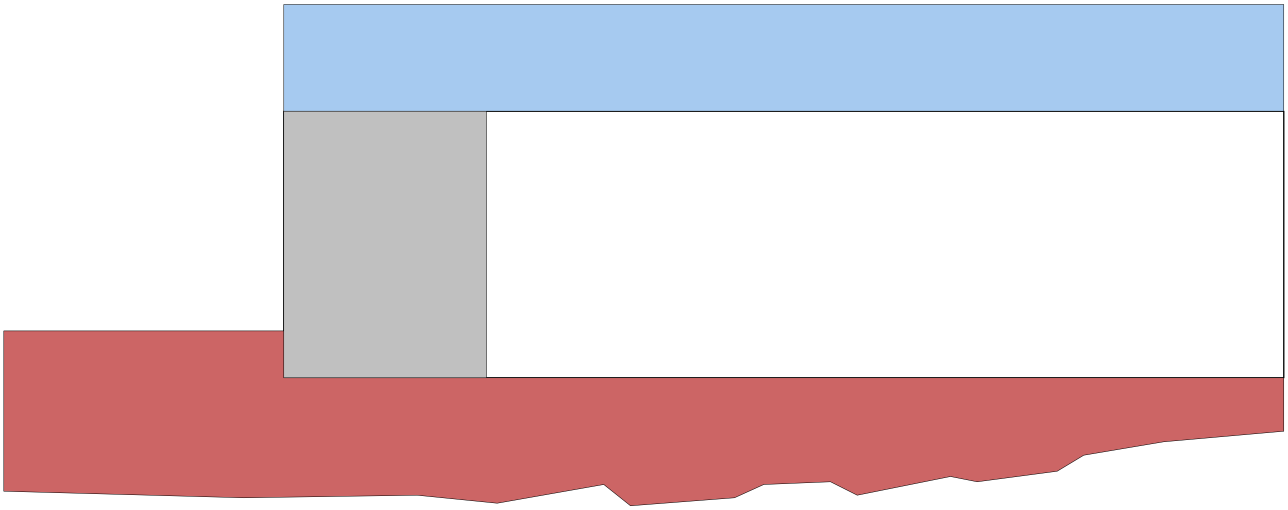
Bearing capacity, CDR = 1.45, factored bearing load = 3686 lb/ft².
Foundation Interface: Direct sliding, CDR = 1.941, Eccentricity, e/L = 0.1565, CDR-overturning = 3.20

METAL STRIP				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.82	13.00	1								
2	2.46	13.00	1								
3	4.10	13.00	1								
4	5.74	13.00	1								
5	7.38	13.00	1								
6	9.02	13.00	1								
7	10.66	13.00	1								
8	12.30	13.00	1								
9	13.94	13.00	1								
10	15.58	13.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Factored bearing resistance. q-n	5347	N/A	[lb/ft ²]
Factored bearing load, σ_V	3686.1	N/A	[lb/ft ²]
Eccentricity, e	1.46	N/A	[ft]
Eccentricity, e/L	0.112	N/A	
CDR calculated	1.45	N/A	
Base length	13.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 27325.98 [lb/ft], L = 13.00, Unfactored e = 1.31 [ft], and Sigma = 2632.09 [lb/ft ²]



SCALE:

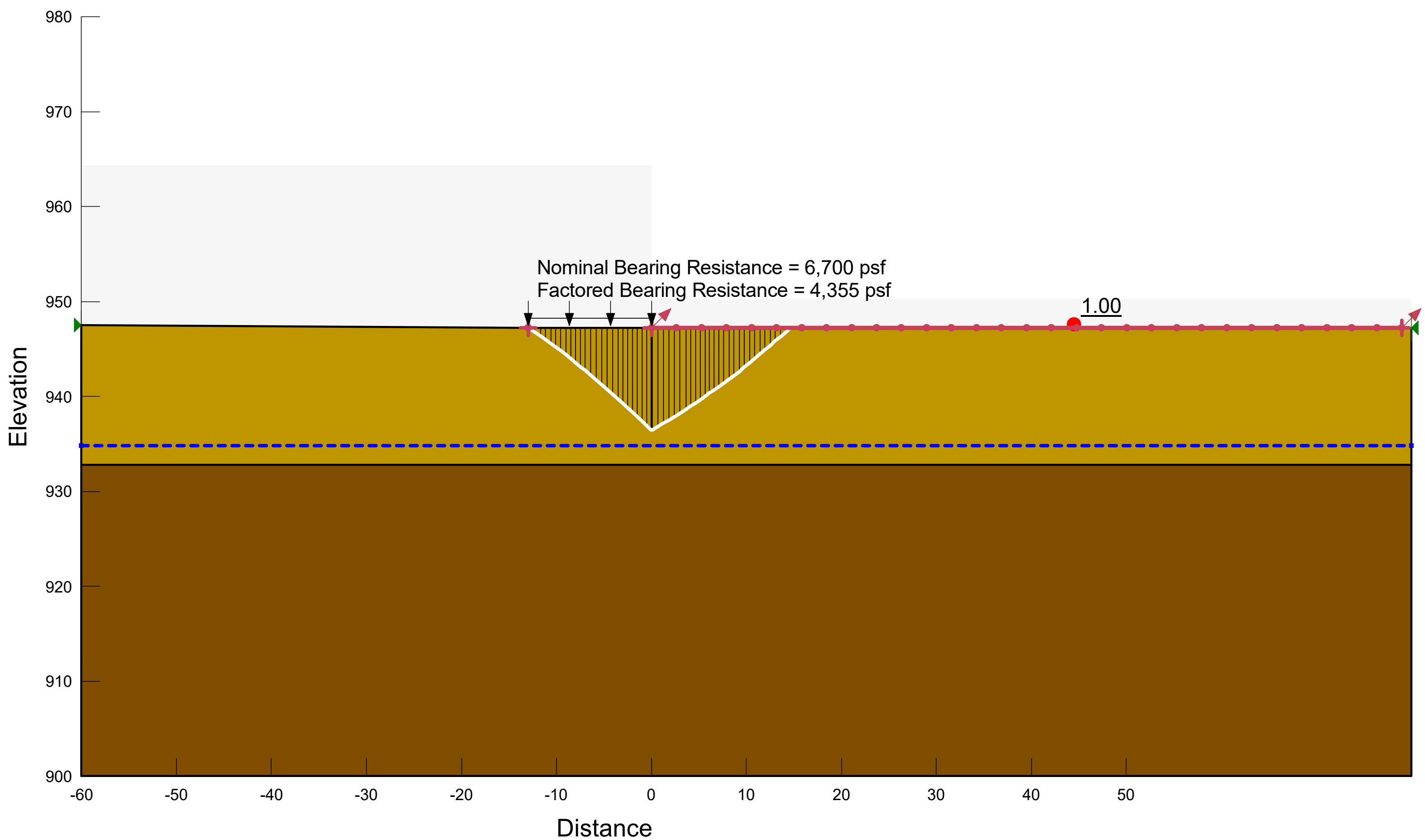
0 2 4 6 8 10 [ft]

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Rear Sloped
MSE Wall Bearing Capacity Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.
Bearing load was determined using MSEW 3.0.

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Glacial Till	130	12,000	0
	Silty Clay	125	1,600	0

Bearing Capacity - Normal Groundwater
Undrained Conditions



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.94

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	412+28.05

Description:

Rear Sloped Wall - Undrained conditions - Sliding Resistance

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Rear Abutm.....
.....\Rear1 Sloped-ST.BEN

Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft³
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft³
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	125.0 lb/ft³
Equivalent internal angle of friction, $\phi_{equiv.}$	0.0 °
Equivalent cohesion, $c_{equiv.}$	1000.0 lb/ft²

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 5.14 N_γ = 0.00

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \qquad (15)$$

$$K = \frac{\sin^2(\theta + \phi')}{\sin^3\theta \left[1 + \frac{\sin\phi'}{\sin\theta}\right]^2} \qquad (38)$$

$$K_a = \cos\beta \; \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}} \qquad (16)$$

$$K_a = \frac{\sin^2(\theta + \phi)}{\sin^2\theta \; \sin(\theta - \delta) \left(1 + \sqrt{\frac{\sin(\phi + \delta)\sin(\phi - \beta)}{\sin(\theta - \delta)\sin(\theta + \beta)}}\right)^2} \qquad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	17.10	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 14.10 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M   S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 50.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10 [ft]

AASHTO 2007-2010 (LRFD) Input Data

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figure C11.5.5-2:

		Static		Combined Static/Seismic
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH, from Table 3.4.1-2 and Figure C11.5.5-2:	$\gamma_{p\text{-}EH}$	1.50
Load factor of active lateral earth pressure during earthquake (does not multiply P_{AE} and P_{IR}):	$(\gamma_{p\text{-}EH})_{EQ}$	1.50
Load factor for earthquake loads, EQ, from Table 3.4.1-1 (multiplies P_{AE} and P_{IR}):	$\gamma_{p\text{-}EQ}$	1.00

Resistance factor for shear resistance along common interfaces from Table 11.5.6-1:

		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation from Table 11.5.6-1:

	Static	Combined Static/Seismic
ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

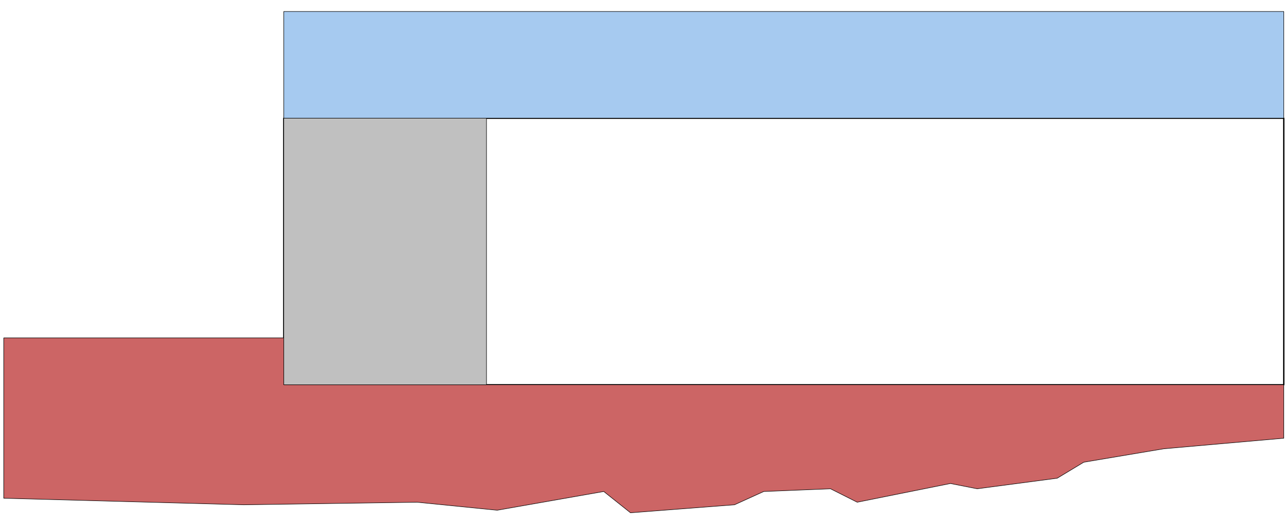
Bearing capacity, CDR = 0.91, factored bearing load = 3686 lb/ft².
Foundation Interface: Direct sliding, CDR = 1.402, Eccentricity, e/L = 0.1565, CDR-overturning = 3.20

METAL STRIP				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.82	13.00	1								
2	2.46	13.00	1								
3	4.10	13.00	1								
4	5.74	13.00	1								
5	7.38	13.00	1								
6	9.02	13.00	1								
7	10.66	13.00	1								
8	12.30	13.00	1								
9	13.94	13.00	1								
10	15.58	13.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Factored bearing resistance. q-n	3342	N/A	[lb/ft ²]
Factored bearing load, σ_V	3686.1	N/A	[lb/ft ²]
Eccentricity, e	1.46	N/A	[ft]
Eccentricity, e/L	0.112	N/A	
CDR calculated	0.91	N/A	
Base length	13.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 27325.98 [lb/ft], L = 13.00, Unfactored e = 1.31 [ft], and Sigma = 2632.09 [lb/ft ²]



SCALE:

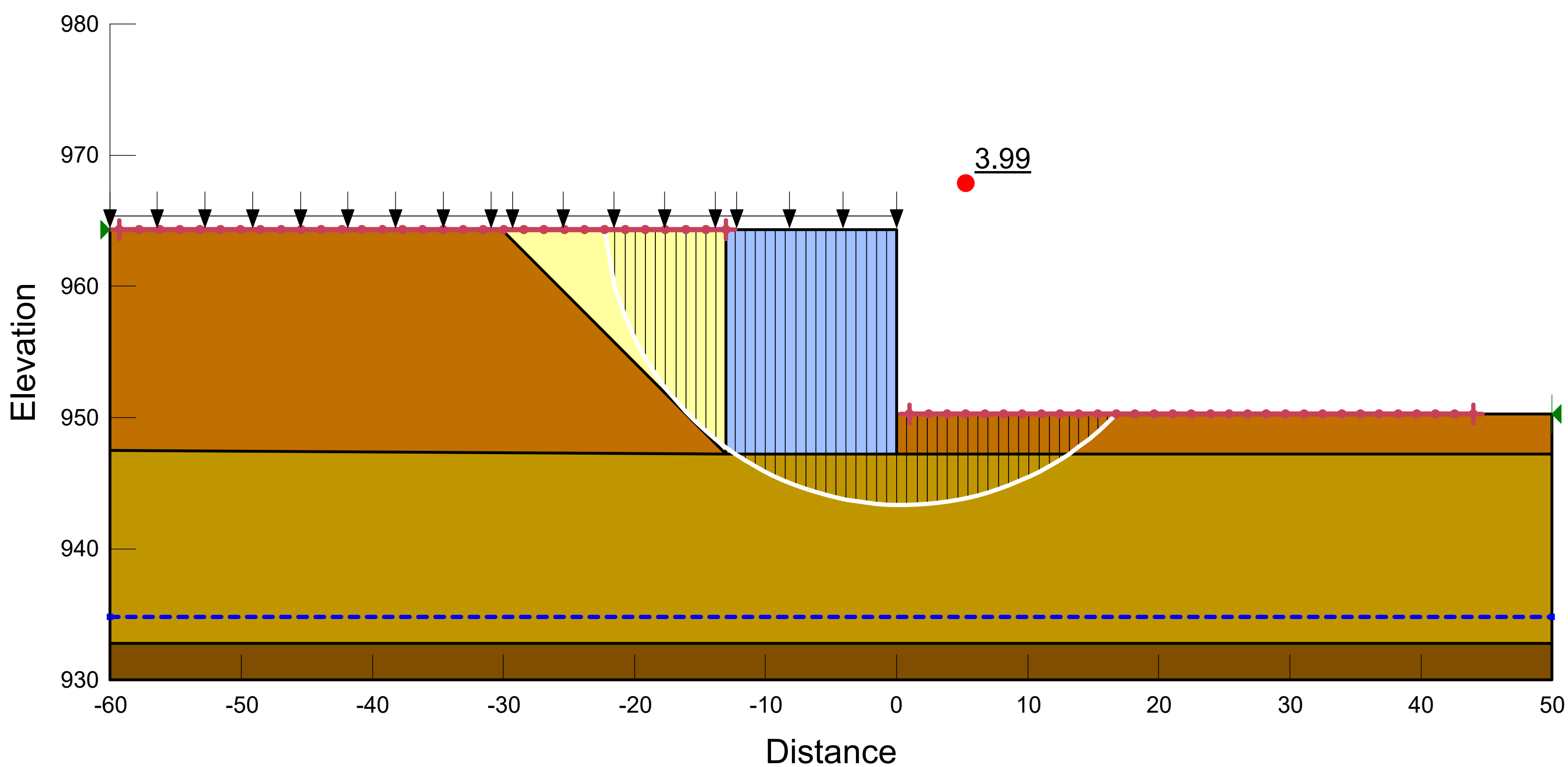
0 2 4 6 8 10 [ft]

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Rear Sloped
MSE Wall Stability Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Embankment Fill	125	2,000	0
	Glacial Till	130	12,000	0
	MSE Fill	120	3,000	34
	Retained Fill	120	0	30
	Silty Clay	125	1,600	0

Global Stability - Normal Groundwater
Undrained Conditions



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.94

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	414+08.99

Description:

Forward Abutment - Drained conditions - Bearing

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Forward Ab..... .....ment\Forward1-LT.BEN

Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	125.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{equiv.}$	28.0 °
Equivalent cohesion, $c_{equiv.}$	150.0 lb/ft ²

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 25.80 N γ= 16.72

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \qquad (15)$$

$$K = \frac{\sin^2(\theta + \phi')}{\sin^3\theta \left[1 + \frac{\sin\phi'}{\sin\theta}\right]^2} \qquad (38)$$

$$K_a = \cos\beta \; \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}} \qquad (16)$$

$$K_a = \frac{\sin^2(\theta + \phi)}{\sin^2\theta \;\; \sin(\theta - \delta) \left(1 + \sqrt{\frac{\sin(\phi + \delta)\sin(\phi - \beta)}{\sin(\theta - \delta)\sin(\theta + \beta)}}\right)^2} \qquad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	27.11	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 24.11 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M   S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10[ft]

AASHTO 2007-2010 (LRFD) Input Data

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figure C11.5.5-2:		Static		Combined Static/Seismic
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH, from Table 3.4.1-2 and Figure C11.5.5-2: $\gamma_{p\text{-}EH}$ 1.50
Load factor of active lateral earth pressure during earthquake (does not multiply P_{AE} and P_{IR}): $(\gamma_{p\text{-}EH})_{EQ}$ 1.50
Load factor for earthquake loads, EQ, from Table 3.4.1-1 (multiplies P_{AE} and P_{IR}): $\gamma_{p\text{-}EQ}$ 1.00

Resistance factor for shear resistance along common interfaces from Table 11.5.6-1:		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation from Table 11.5.6-1:	Static	Combined Static/Seismic
ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

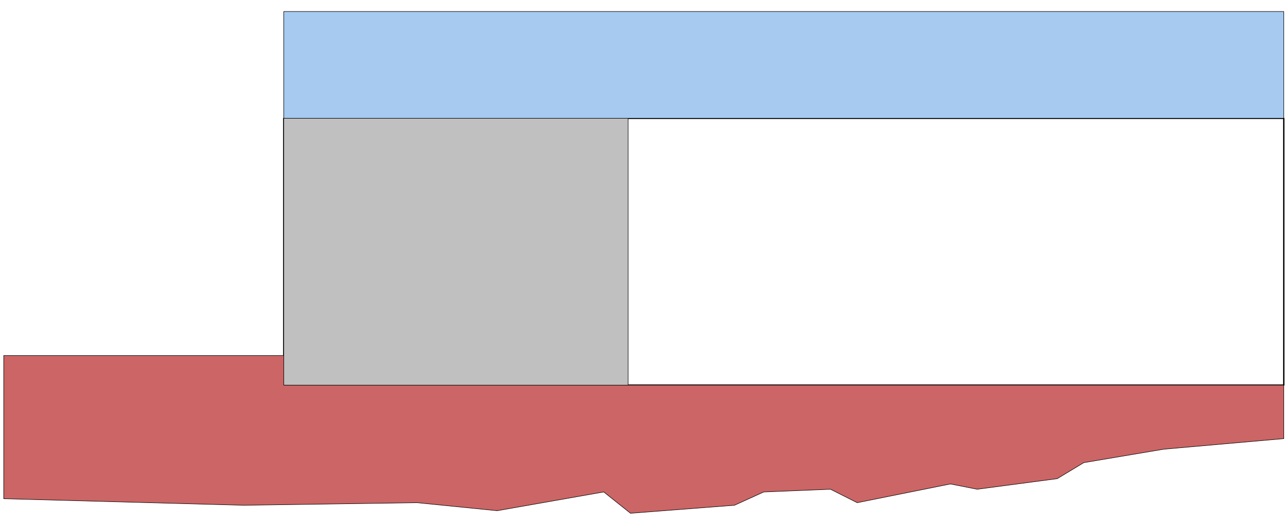
Bearing capacity, CDR = 4.59, factored bearing load = 5281 lb/ft².
Foundation Interface: Direct sliding, CDR = 2.530, Eccentricity, e/L = 0.0634, CDR-overturning = 7.88

METAL STRIP				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.50	35.00	1								
2	3.00	35.00	1								
3	6.00	35.00	1								
4	9.00	35.00	1								
5	12.00	35.00	1								
6	15.00	35.00	1								
7	18.00	35.00	1								
8	21.00	35.00	1								
9	24.00	35.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Factored bearing resistance. q-n	24253	N/A	[lb/ft ²]
Factored bearing load, σ_V	5280.7	N/A	[lb/ft ²]
Eccentricity, e	1.50	N/A	[ft]
Eccentricity, e/L	0.043	N/A	
CDR calculated	4.59	N/A	
Base length	35.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 122611.92 [lb/ft], L = 35.00, Unfactored e = 1.33 [ft], and Sigma = 3792.07 [lb/ft ²]



SCALE:

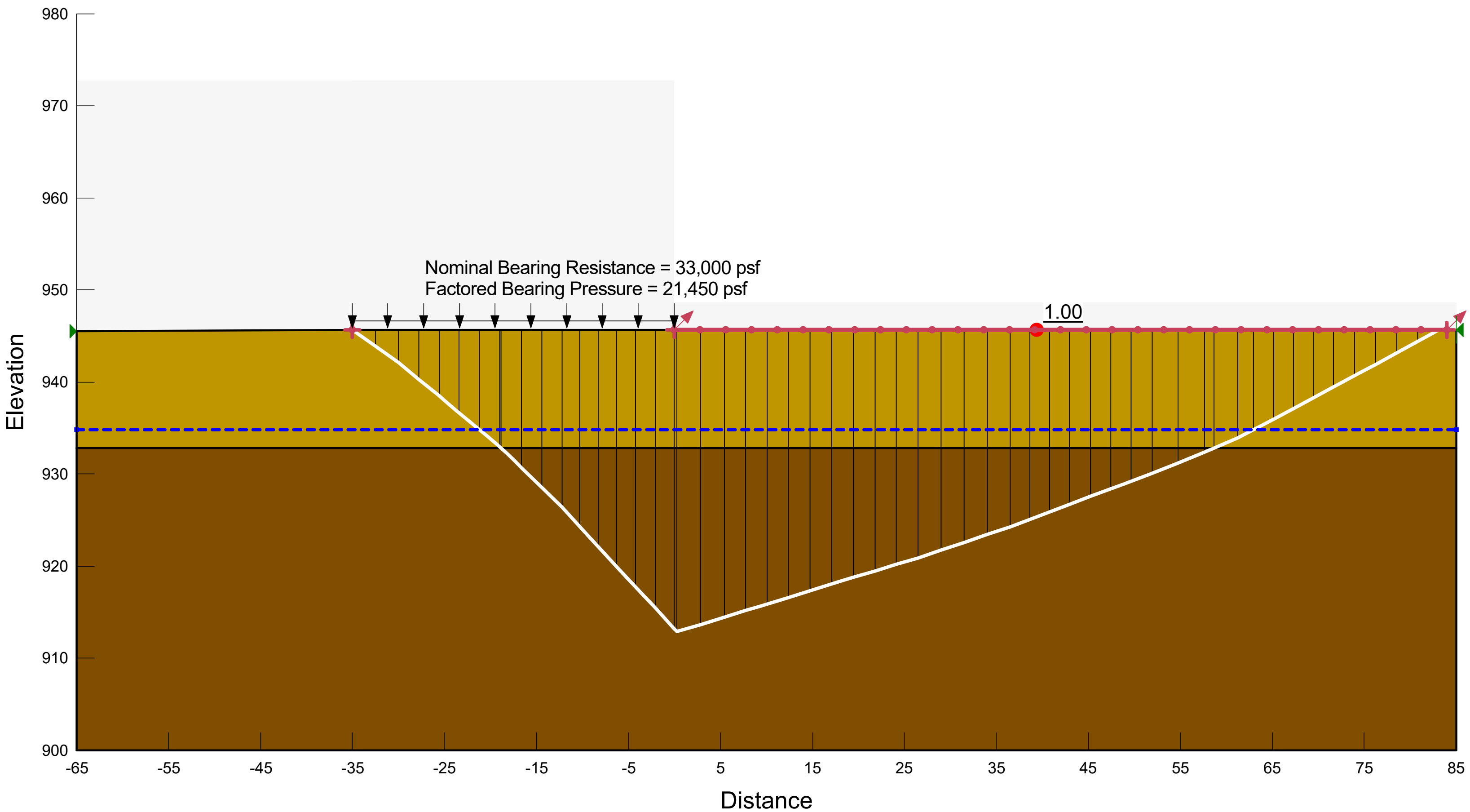
0 2 4 6 8 10[ft]

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Forward Abutment
MSE Wall Bearing Capacity Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.
Bearing load determined using MSEW 3.0.

Bearing Capacity - Normal Groundwater
Drained Conditions

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Glacial Till	130	400	32
	Silty Clay	125	150	28



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359
MSEW(3.0): Update # 14.94

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	414+08.99

Description:

Forward Abutment - Drained conditions - Sliding Resistance

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Forward Ab..... .....ment\Forward1-LT.BEN

Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{\text{equiv.}}$	125.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{\text{equiv.}}$	23.0 °
Equivalent cohesion, $c_{\text{equiv.}}$	0.0 lb/ft ²

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 18.05 N γ= 8.20

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \qquad (15)$$

$$K = \frac{\sin^2(\theta+\phi')}{\sin^3\theta\left[1+\frac{\sin\phi'}{\sin\theta}\right]^2} \qquad (38)$$

$$K_a = \cos\beta \; \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}} \qquad (16)$$

$$K_a = \frac{\sin^2(\theta+\phi)}{\sin^2\theta \; \sin(\theta-\delta)\left(1+\sqrt{\frac{\sin(\phi+\delta)\sin(\phi-\beta)}{\sin(\theta-\delta)\sin(\theta+\beta)}}\right)^2} \qquad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	27.11	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 24.11 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10[ft]

AASHTO 2007-2010 (LRFD) Input Data

EXTERNAL STABILITY

			Static		Combined Static/Seismic
Load factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figure C11.5.5-2:			Static		Combined Static/Seismic
	Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
	Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH, from Table 3.4.1-2 and Figure C11.5.5-2: $\gamma_{p\text{-}EH}$ 1.50

Load factor of active lateral earth pressure during earthquake (does not multiply P_{AE} and P_{IR}): $(\gamma_{p\text{-}EH})_{EQ}$ 1.50

Load factor for earthquake loads, EQ, from Table 3.4.1-1 (multiplies P_{AE} and P_{IR}): $\gamma_{p\text{-}EQ}$ 1.00

			Static	Combined Static/Seismic
Resistance factor for shear resistance along common interfaces from Table 11.5.6-1:			Static	Combined Static/Seismic
	Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
	Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

		Static	Combined Static/Seismic
Resistance factor for bearing capacity of shallow foundation from Table 11.5.6-1:		Static	Combined Static/Seismic
	ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

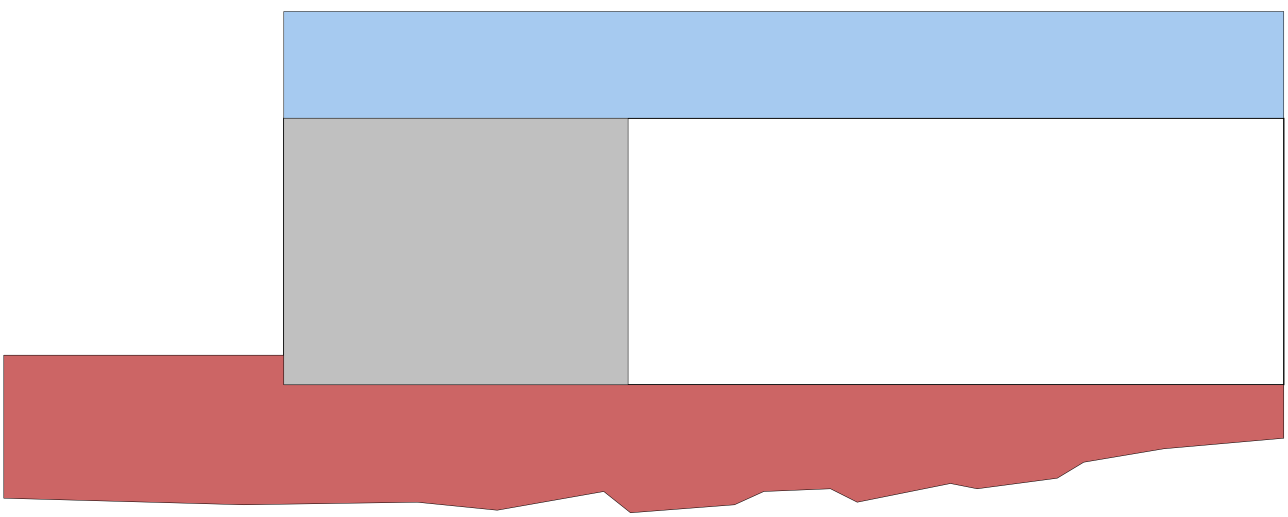
Bearing capacity, CDR = 2.02, factored bearing load = 5281 lb/ft².
Foundation Interface: Direct sliding, CDR = 1.859, Eccentricity, e/L = 0.0634, CDR-overturning = 7.88

METAL STRIP				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.50	35.00	1								
2	3.00	35.00	1								
3	6.00	35.00	1								
4	9.00	35.00	1								
5	12.00	35.00	1								
6	15.00	35.00	1								
7	18.00	35.00	1								
8	21.00	35.00	1								
9	24.00	35.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Factored bearing resistance. q-n	10665	N/A	[lb/ft ²]
Factored bearing load, σ_V	5280.7	N/A	[lb/ft ²]
Eccentricity, e	1.50	N/A	[ft]
Eccentricity, e/L	0.043	N/A	
CDR calculated	2.02	N/A	
Base length	35.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 122611.92 [lb/ft], L = 35.00, Unfactored e = 1.33 [ft], and Sigma = 3792.07 [lb/ft ²]



SCALE:

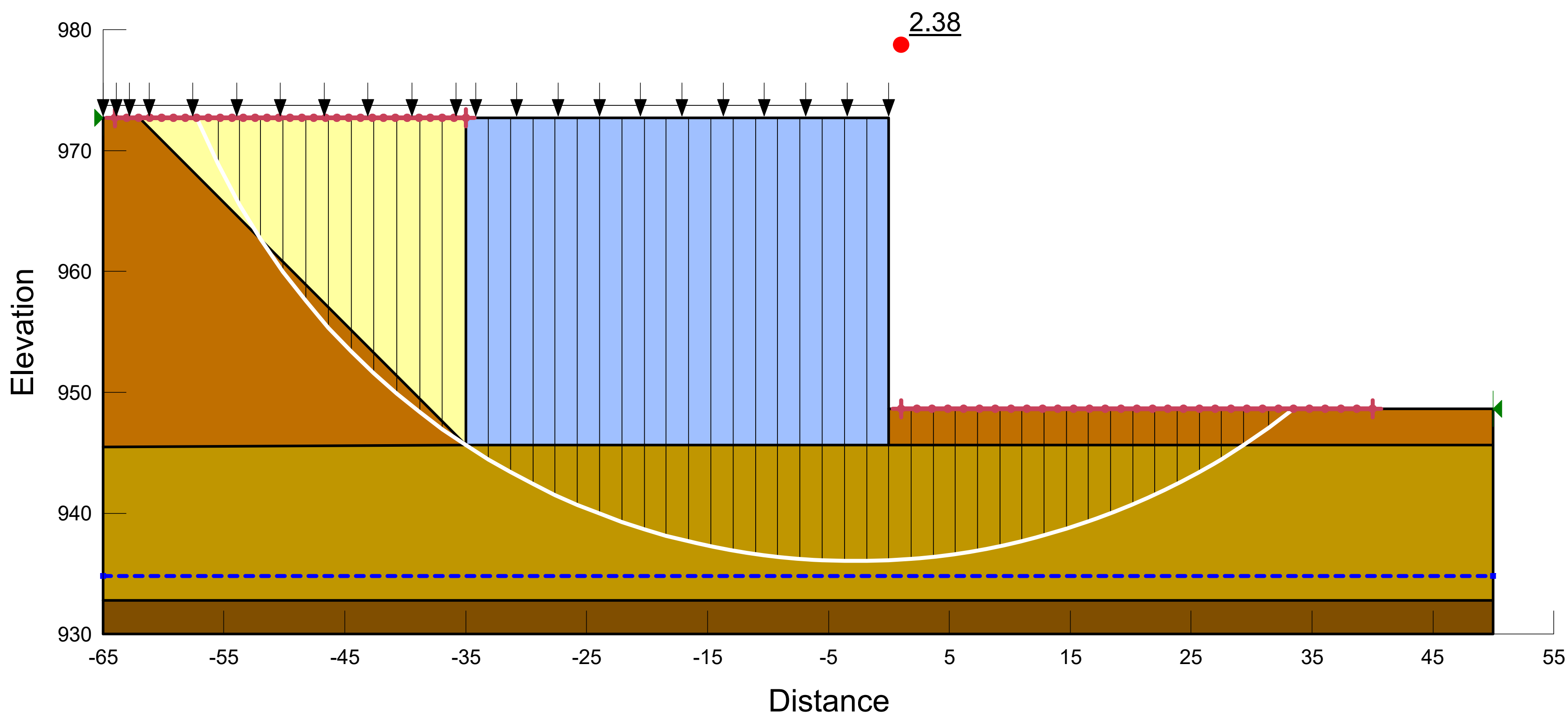
0 2 4 6 8 10[ft]

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Forward Abutment
MSE Wall Stability Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Global Stability - Normal Groundwater
Drained Conditions

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Embankment Fill	125	200	26
	Glacial Till	130	400	32
	MSE Fill	120	3,000	34
	Retained Fill	120	0	30
	Silty Clay	125	150	28



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.94

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	414+08.99

Description:

Forward Abutment - Undrained conditions - Bearing

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Forward Ab.....
.....ment\Forward1-ST.BEN

Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{\text{equiv.}}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction, $\phi_{\text{equiv.}}$	0.0 °
Equivalent cohesion, $c_{\text{equiv.}}$	1600.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 5.14 N γ= 0.00

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \qquad (15)$$

$$K = \frac{\sin^2(\theta + \phi')}{\sin^3\theta \left[1 + \frac{\sin\phi'}{\sin\theta}\right]^2} \qquad (38)$$

$$K_a = \cos\beta \; \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}} \qquad (16)$$

$$K_a = \frac{\sin^2(\theta + \phi)}{\sin^2\theta \;\; \sin(\theta - \delta) \left(1 + \sqrt{\frac{\sin(\phi + \delta)\,\sin(\phi - \beta)}{\sin(\theta - \delta)\,\sin(\theta + \beta)}}\right)^2} \qquad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	27.11	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 24.11 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M   S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10[ft]

AASHTO 2007-2010 (LRFD) Input Data

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figure C11.5.5-2:		Static		Combined Static/Seismic
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH, from Table 3.4.1-2 and Figure C11.5.5-2: $\gamma_{p\text{-}EH}$ 1.50

Load factor of active lateral earth pressure during earthquake (does not multiply P_{AE} and P_{IR}): $(\gamma_{p\text{-}EH})_{EQ}$ 1.50

Load factor for earthquake loads, EQ, from Table 3.4.1-1 (multiplies P_{AE} and P_{IR}): $\gamma_{p\text{-}EQ}$ 1.00

Resistance factor for shear resistance along common interfaces from Table 11.5.6-1:		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation from Table 11.5.6-1:	Static	Combined Static/Seismic
ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, CDR = 1.01, factored bearing load = 5281 lb/ft².

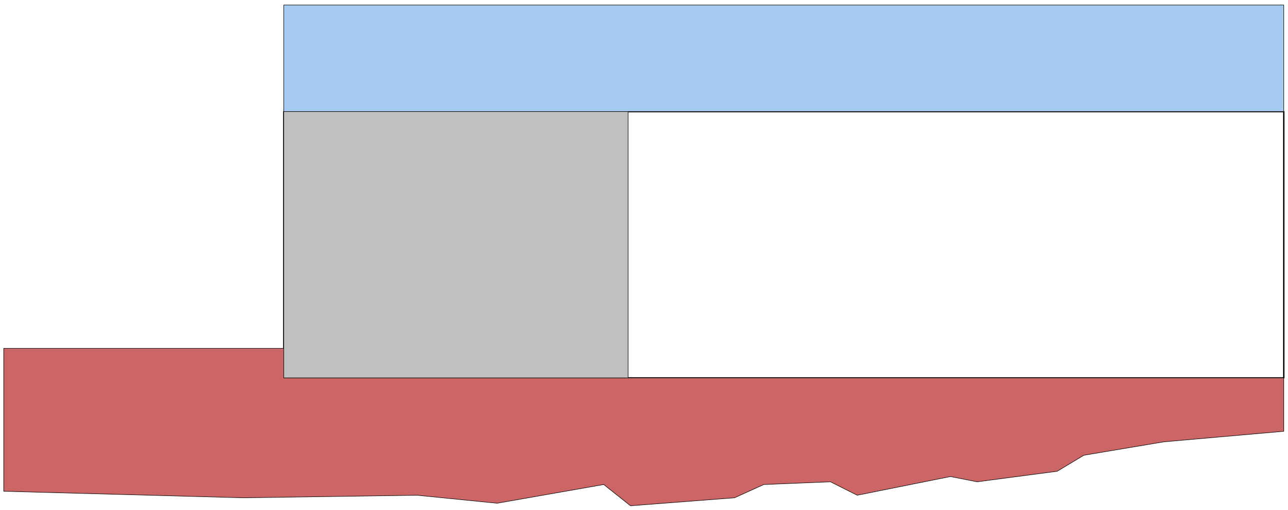
Foundation Interface: Direct sliding, CDR = 2.154, Eccentricity, e/L = 0.0634, CDR-overturning = 7.88

	METAL STRIP			CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.50	35.00	1								
2	3.00	35.00	1								
3	6.00	35.00	1								
4	9.00	35.00	1								
5	12.00	35.00	1								
6	15.00	35.00	1								
7	18.00	35.00	1								
8	21.00	35.00	1								
9	24.00	35.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Factored bearing resistance. q-n	5347	N/A	[lb/ft ²]
Factored bearing load, σ_V	5280.7	N/A	[lb/ft ²]
Eccentricity, e	1.50	N/A	[ft]
Eccentricity, e/L	0.043	N/A	
CDR calculated	1.01	N/A	
Base length	35.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 122611.92 [lb/ft], L = 35.00, Unfactored e = 1.33 [ft], and Sigma = 3792.07 [lb/ft ²]



SCALE:

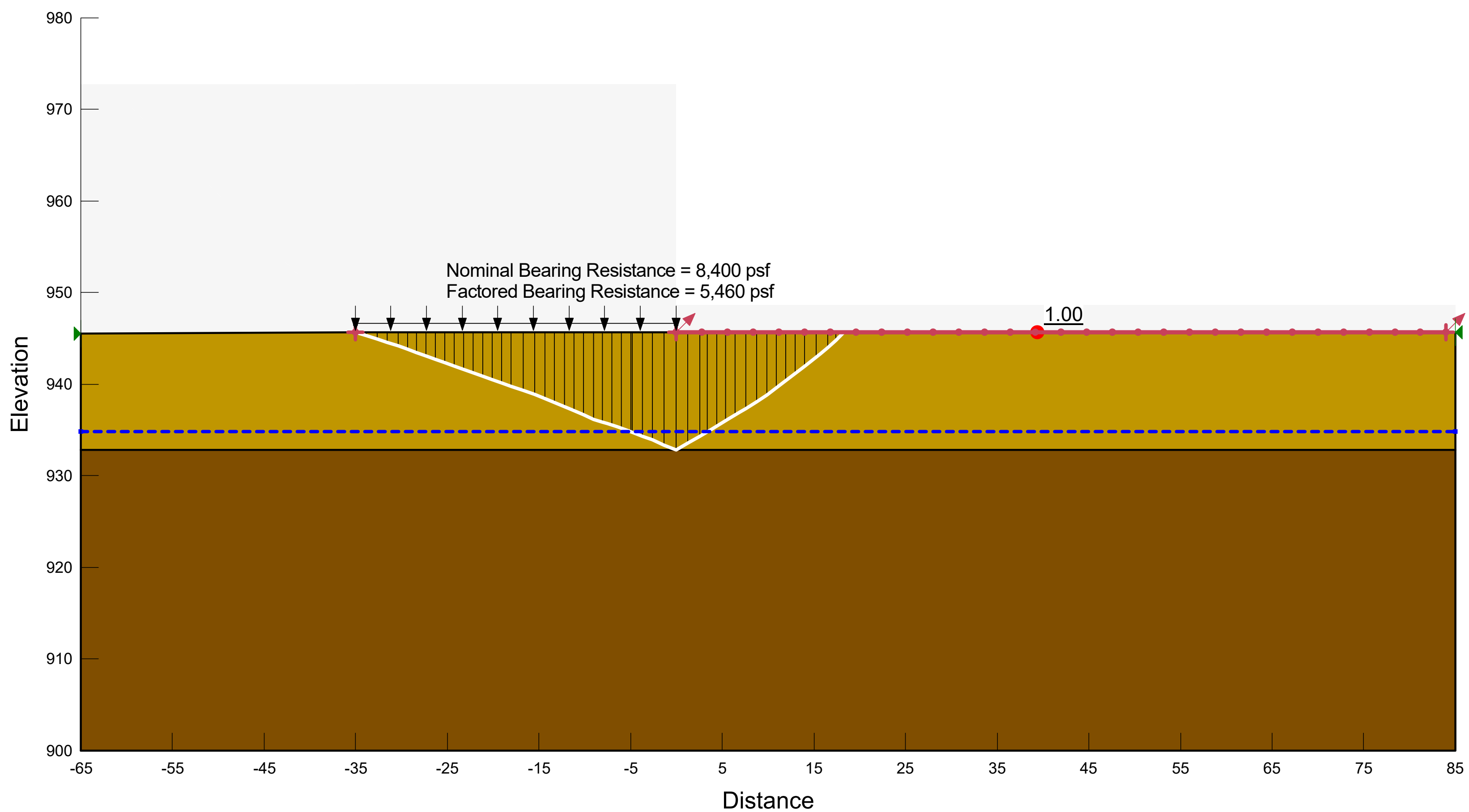
0 2 4 6 8 10[ft]

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Forward Abutment
MSE Wall Bearing Capacity Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.
Bearing load was determined using MSEW 3.0.

Bearing Capacity - Normal Groundwater
Undrained Conditions

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Glacial Till	130	12,000	0
	Silty Clay	125	1,600	0



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.94

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	414+08.99

Description:

Forward Abutment - Undrained conditions - Sliding Resistance

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Forward Ab.....
.....ment\Forward1-ST.BEN

Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	125.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{equiv.}$	0.0 °
Equivalent cohesion, $c_{equiv.}$	1000.0 lb/ft ²

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 5.14 $N_\gamma = 0.00$

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \qquad (15)$$

$$K = \frac{\sin^2(\theta+\phi')}{\sin^3\theta\left[1+\frac{\sin\phi'}{\sin\theta}\right]^2} \qquad (38)$$

$$K_a = \cos\beta\ \frac{\cos\beta-\sqrt{\cos^2\beta-\cos^2\phi}}{\cos\beta+\sqrt{\cos^2\beta-\cos^2\phi}} \qquad (16)$$

$$K_a = \frac{\sin^2(\theta+\phi)}{\sin^2\theta\ \sin(\theta-\delta)\left(1+\sqrt{\frac{\sin(\phi+\delta)\sin(\phi-\beta)}{\sin(\theta-\delta)\sin(\theta+\beta)}}\right)^2} \qquad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	27.11	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 24.11 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 250.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10[ft]

AASHTO 2007-2010 (LRFD) Input Data

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figure C11.5.5-2:		Static		Combined Static/Seismic
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH, from Table 3.4.1-2 and Figure C11.5.5-2:	$\gamma_{p\text{-}EH}$	1.50
Load factor of active lateral earth pressure during earthquake (does not multiply P_{AE} and P_{IR}):	$(\gamma_{p\text{-}EH})_{EQ}$	1.50
Load factor for earthquake loads, EQ, from Table 3.4.1-1 (multiplies P_{AE} and P_{IR}):	$\gamma_{p\text{-}EQ}$	1.00

Resistance factor for shear resistance along common interfaces from Table 11.5.6-1:		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation from Table 11.5.6-1:		Static	Combined Static/Seismic
	ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

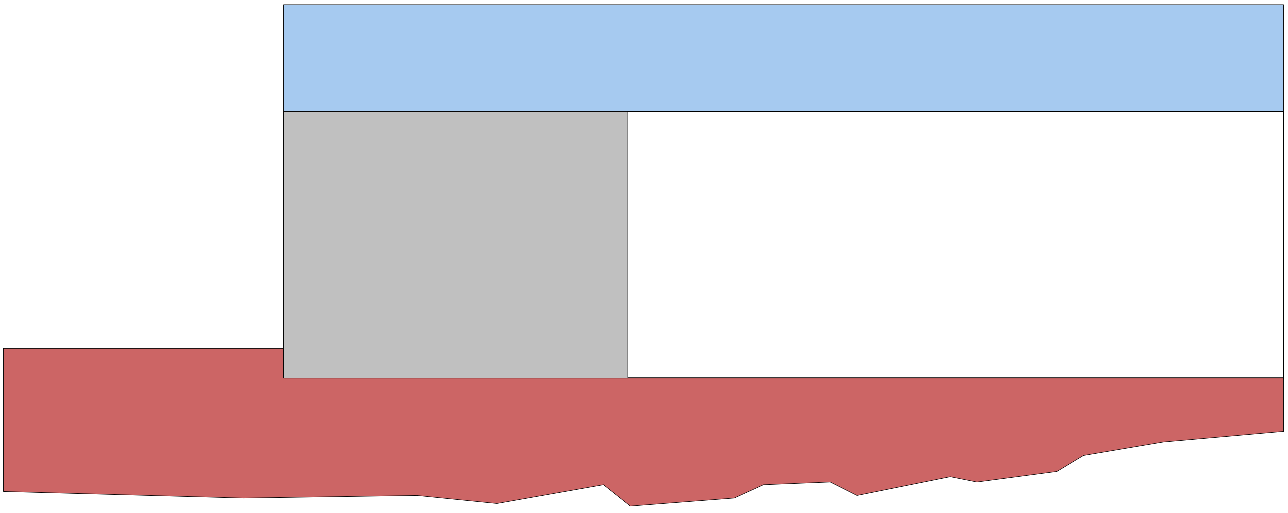
Bearing capacity, CDR = 0.63, factored bearing load = 5281 lb/ft².
Foundation Interface: Direct sliding, CDR = 1.346, Eccentricity, e/L = 0.0634, CDR-overturning = 7.88

#	METAL STRIP Elevation [ft]	Length [ft]	Type #	CONNECTION CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.50	35.00	1								
2	3.00	35.00	1								
3	6.00	35.00	1								
4	9.00	35.00	1								
5	12.00	35.00	1								
6	15.00	35.00	1								
7	18.00	35.00	1								
8	21.00	35.00	1								
9	24.00	35.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Factored bearing resistance. q-n	3342	N/A	[lb/ft ^{2}]
Factored bearing load, σ_V	5280.7	N/A	[lb/ft ^{2}]
Eccentricity, e	1.50	N/A	[ft]
Eccentricity, e/L	0.043	N/A	
CDR calculated	0.63	N/A	
Base length	35.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 122611.92 [lb/ft], L = 35.00, Unfactored e = 1.33 [ft], and Sigma = 3792.07 [lb/ft ^{2}]



SCALE:

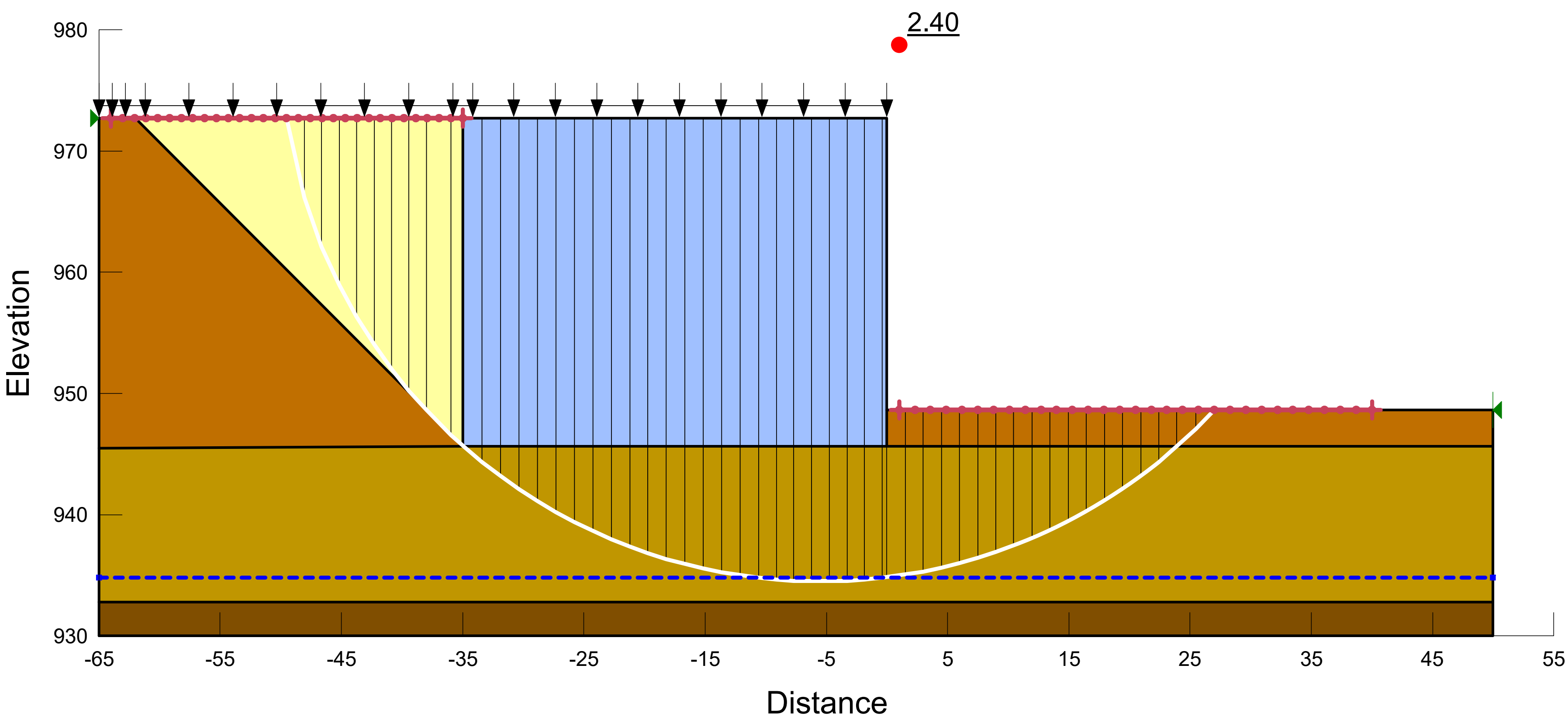
0 2 4 6 8 10[ft]

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Forward Abutment
MSE Wall Stability Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Embankment Fill	125	2,000	0
	Glacial Till	130	12,000	0
	MSE Fill	120	3,000	34
	Retained Fill	120	0	30
	Silty Clay	125	1,600	0

Global Stability - Normal Groundwater
Undrained Conditions



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.94

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	414+08.99

Description:

Forward Sloped Wall - Drained conditions - Bearing

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Forward Ab.....
.....rward1-Sloped-LT.BEN

Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{equiv.}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction, $\phi_{equiv.}$	28.0 °
Equivalent cohesion, $c_{equiv.}$	150.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 25.80 N γ= 16.72

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \qquad (15)$$

$$K = \frac{\sin^2(\theta+\phi')}{\sin^3\theta\left[1+\frac{\sin\phi'}{\sin\theta}\right]^2} \qquad (38)$$

$$K_a = \cos\beta \; \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}} \qquad (16)$$

$$K_a = \frac{\sin^2(\theta+\phi)}{\sin^2\theta \; \sin(\theta-\delta)\left(1+\sqrt{\frac{\sin(\phi+\delta)\sin(\phi-\beta)}{\sin(\theta-\delta)\sin(\theta+\beta)}}\right)^2} \qquad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	18.47	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 15.47 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 50.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10 [ft]

AASHTO 2007-2010 (LRFD) Input Data

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figure C11.5.5-2:

		Static		Combined Static/Seismic
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH, from Table 3.4.1-2 and Figure C11.5.5-2: $\gamma_{p\text{-}EH}$ 1.50

Load factor of active lateral earth pressure during earthquake (does not multiply P_{AE} and P_{IR}): $(\gamma_{p\text{-}EH})_{EQ}$ 1.50

Load factor for earthquake loads, EQ, from Table 3.4.1-1 (multiplies P_{AE} and P_{IR}): $\gamma_{p\text{-}EQ}$ 1.00

Resistance factor for shear resistance along common interfaces from Table 11.5.6-1:

		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation from Table 11.5.6-1:

	Static	Combined Static/Seismic
ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

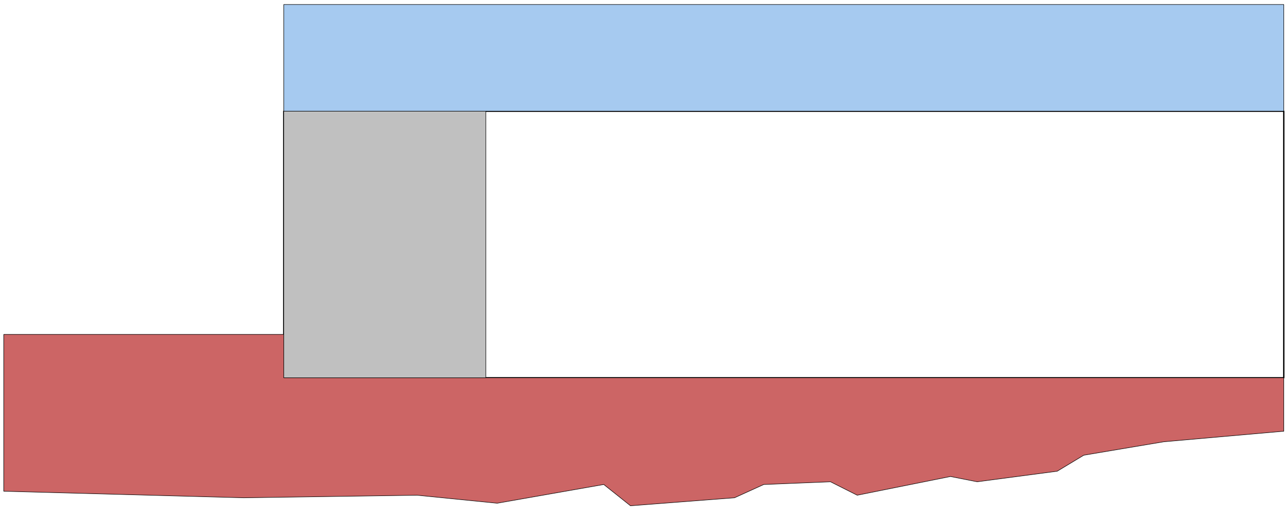
Bearing capacity, CDR = 2.49, factored bearing load = 3975 lb/ft².
Foundation Interface: Direct sliding, CDR = 1.726, Eccentricity, e/L = 0.1565, CDR-overturning = 3.19

	METAL STRIP			CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.50	14.00	1								
2	3.00	14.00	1								
3	6.00	14.00	1								
4	9.00	14.00	1								
5	12.00	14.00	1								
6	15.00	14.00	1								
7	18.00	14.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Factored bearing resistance. q-n	9882	N/A	[lb/ft ²]
Factored bearing load, σ_V	3975.0	N/A	[lb/ft ²]
Eccentricity, e	1.58	N/A	[ft]
Eccentricity, e/L	0.113	N/A	
CDR calculated	2.49	N/A	
Base length	14.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 31729.58 [lb/ft], L = 14.00, Unfactored e = 1.41 [ft], and Sigma = 2839.83 [lb/ft ²]



SCALE:

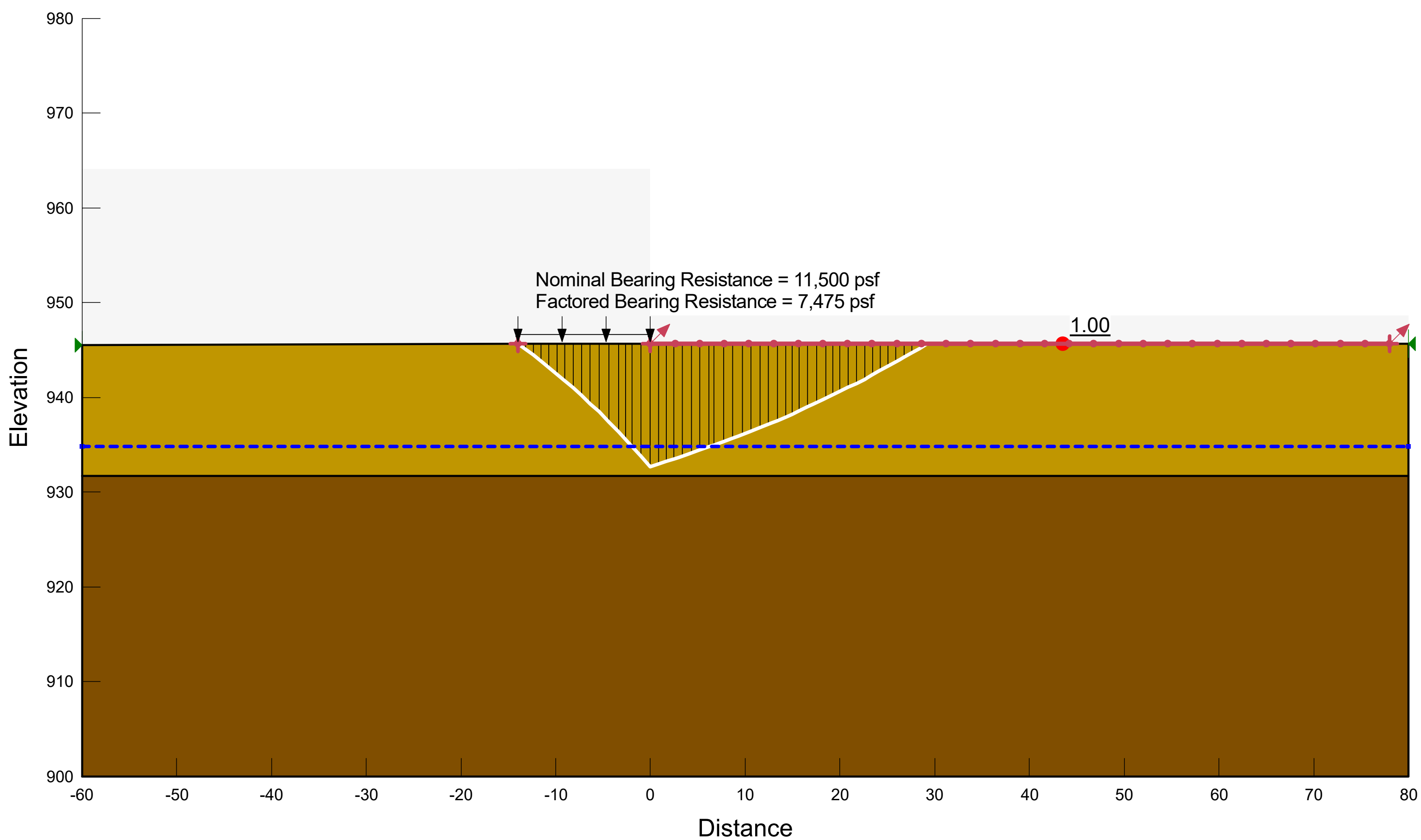
0 2 4 6 8 10 [ft]

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Forward Sloped
MSE Wall Bearing Capacity Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.
Bearing load was determined using MSEW 3.0.

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Glacial Till	130	400	32
	Silty Clay	125	150	28

Bearing Capacity - Normal Groundwater
Drained Conditions



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.94

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	414+08.99

Description:

Forward Sloped Wall - Drained conditions - Sliding Resistance

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Forward Ab.....
.....rward1-Sloped-LT.BEN
Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{\text{equiv.}}$	125.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{\text{equiv.}}$	23.0 °
Equivalent cohesion, $c_{\text{equiv.}}$	0.0 lb/ft ²

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 18.05 N γ= 8.20

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \qquad (15)$$

$$K = \frac{\sin^2(\theta+\phi')}{\sin^3\theta\left[1+\frac{\sin\phi'}{\sin\theta}\right]^2} \qquad (38)$$

$$K_a = \cos\beta \; \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}} \qquad (16)$$

$$K_a = \frac{\sin^2(\theta+\phi)}{\sin^2\theta \; \sin(\theta-\delta)\left(1+\sqrt{\frac{\sin(\phi+\delta)\sin(\phi-\beta)}{\sin(\theta-\delta)\sin(\theta+\beta)}}\right)^2} \qquad (17)$$

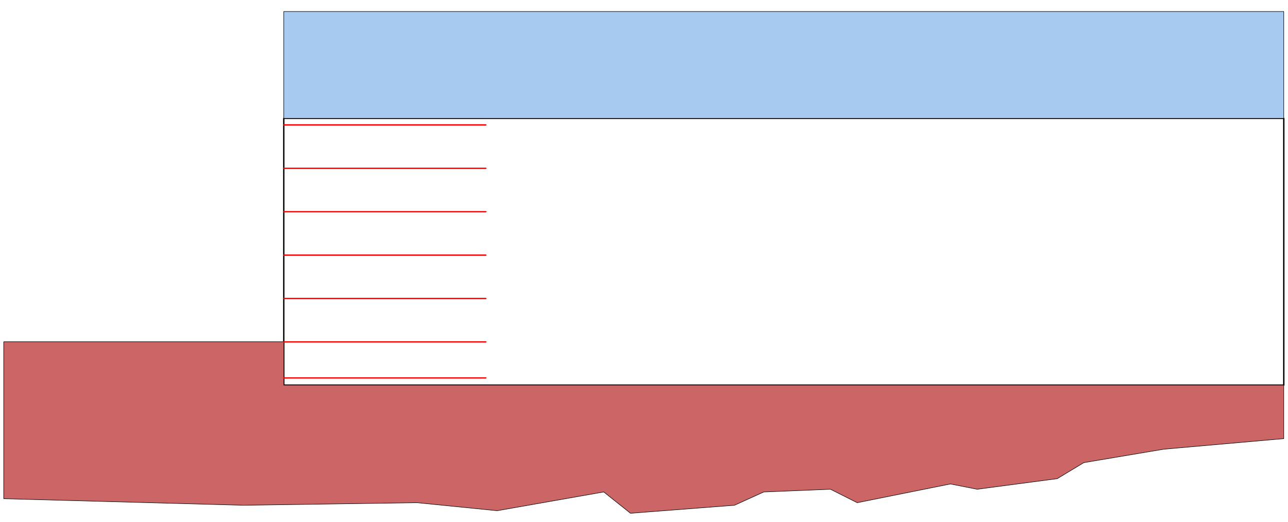
INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	18.47	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 15.47 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M   S U R C H A R G E

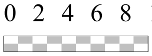
Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 50.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:



SCALE:

0 2 4 6 8 10 [ft]



AASHTO 2007-2010 (LRFD) Input Data

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figure C11.5.5-2:

		Static		Combined Static/Seismic
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH, from Table 3.4.1-2 and Figure C11.5.5-2:	$\gamma_{p\text{-}EH}$	1.50
Load factor of active lateral earth pressure during earthquake (does not multiply P_{AE} and P_{IR}):	$(\gamma_{p\text{-}EH})_{EQ}$	1.50
Load factor for earthquake loads, EQ, from Table 3.4.1-1 (multiplies P_{AE} and P_{IR}):	$\gamma_{p\text{-}EQ}$	1.00

Resistance factor for shear resistance along common interfaces from Table 11.5.6-1:

		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation from Table 11.5.6-1:

	Static	Combined Static/Seismic
ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, CDR = 0.91, factored bearing load = 3975 lb/ft².

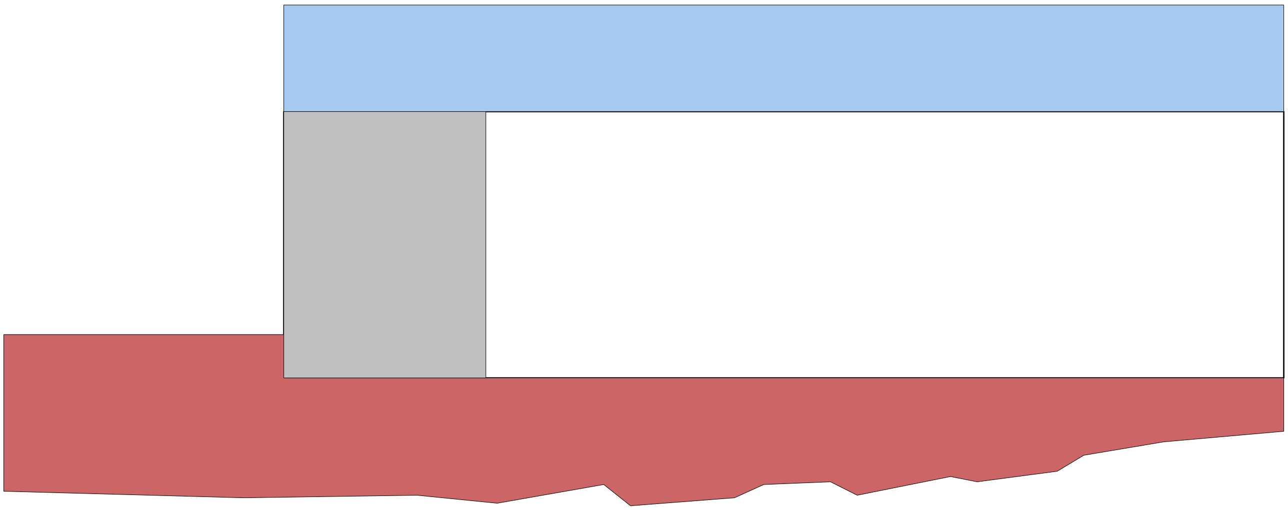
Foundation Interface: Direct sliding, CDR = 1.223, Eccentricity, e/L = 0.1565, CDR-overturning = 3.19

	METAL STRIP			CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.50	14.00	1								
2	3.00	14.00	1								
3	6.00	14.00	1								
4	9.00	14.00	1								
5	12.00	14.00	1								
6	15.00	14.00	1								
7	18.00	14.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Factored bearing resistance. q-n	3614	N/A	[lb/ft ²]
Factored bearing load, σ_V	3975.0	N/A	[lb/ft ²]
Eccentricity, e	1.58	N/A	[ft]
Eccentricity, e/L	0.113	N/A	
CDR calculated	0.91	N/A	
Base length	14.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 31729.58 [lb/ft], L = 14.00, Unfactored e = 1.41 [ft], and Sigma = 2839.83 [lb/ft ²]



SCALE:

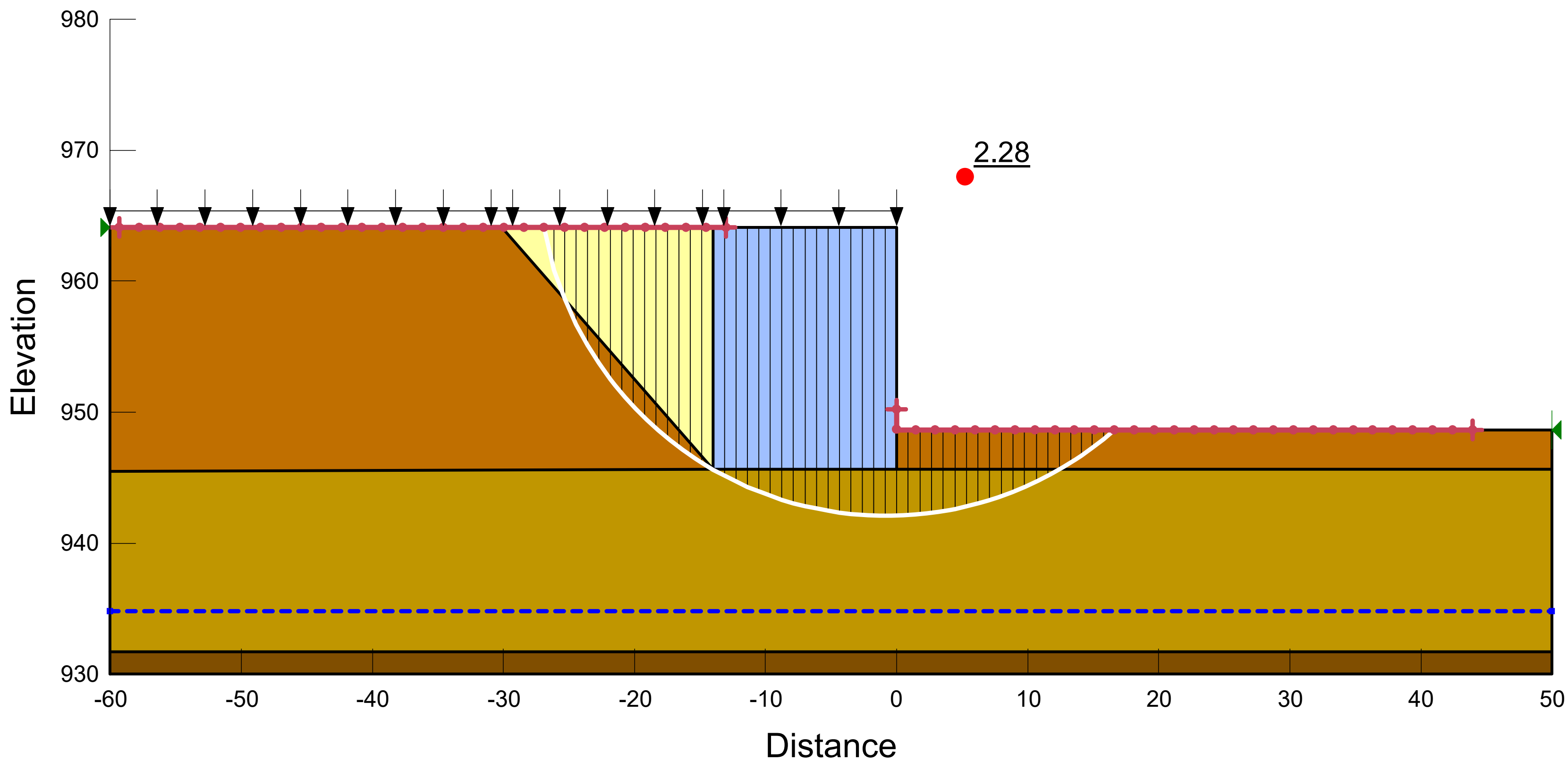
0 2 4 6 8 10 [ft]

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Forward Sloped
MSE Wall Stability Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.

Global Stability - Normal Groundwater
Drained Conditions

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Embankment Fill	125	200	26
	Glacial Till	130	400	32
	MSE Fill	120	3,000	34
	Retained Fill	120	0	30
	Silty Clay	125	150	28



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.94

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	414+08.99

Description:

Forward Sloped Wall - Undrained conditions - Bearing

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Forward Ab.....
.....rward1-Sloped-ST.BEN

Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ^{3}
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{\text{equiv.}}$	125.0 lb/ft ^{3}
Equivalent internal angle of friction, $\phi_{\text{equiv.}}$	0.0 °
Equivalent cohesion, $c_{\text{equiv.}}$	1600.0 lb/ft ^{2}

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 5.14 $N\gamma = 0.00$

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \quad (15)$$

$$K = \frac{\sin^2(\theta+\phi')}{\sin^3\theta\left[1+\frac{\sin\phi'}{\sin\theta}\right]^2} \quad (38)$$

$$K_a = \cos\beta \; \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}} \quad (16)$$

$$K_a = \frac{\sin^2(\theta+\phi)}{\sin^2\theta \;\; \sin(\theta-\delta)\left(1+\sqrt{\frac{\sin(\phi+\delta)\sin(\phi-\beta)}{\sin(\theta-\delta)\sin(\theta+\beta)}}\right)^2} \quad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	18.47	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 15.47 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

U N I F O R M   S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 50.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10 [ft]

AASHTO 2007-2010 (LRFD) Input Data

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figure C11.5.5-2:		Static		Combined Static/Seismic
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH, from Table 3.4.1-2 and Figure C11.5.5-2:	$\gamma_{p\text{-}EH}$	1.50
Load factor of active lateral earth pressure during earthquake (does not multiply P_{AE} and P_{IR}):	$(\gamma_{p\text{-}EH})_{EQ}$	1.50
Load factor for earthquake loads, EQ, from Table 3.4.1-1 (multiplies P_{AE} and P_{IR}):	$\gamma_{p\text{-}EQ}$	1.00

Resistance factor for shear resistance along common interfaces from Table 11.5.6-1:		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation from Table 11.5.6-1:		Static	Combined Static/Seismic
	ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, CDR = 1.35, factored bearing load = 3975 lb/ft².

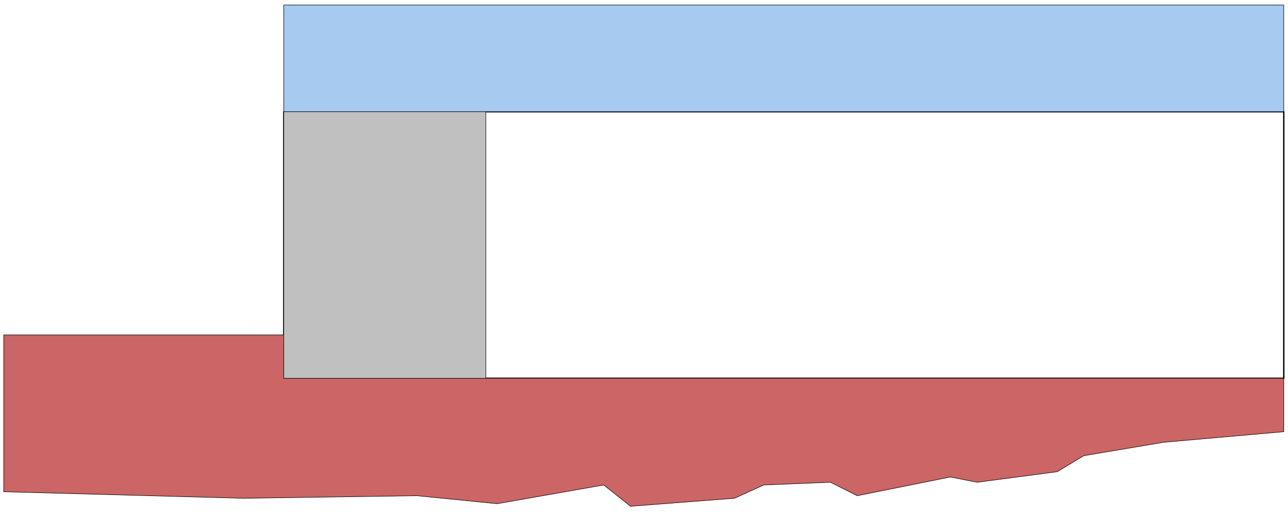
Foundation Interface: Direct sliding, CDR = 1.943, Eccentricity, e/L = 0.1565, CDR-overturning = 3.19

METAL STRIP				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.50	14.00	1								
2	3.00	14.00	1								
3	6.00	14.00	1								
4	9.00	14.00	1								
5	12.00	14.00	1								
6	15.00	14.00	1								
7	18.00	14.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Factored bearing resistance. q-n	5347	N/A	[lb/ft ²]
Factored bearing load, σ_V	3975.0	N/A	[lb/ft ²]
Eccentricity, e	1.58	N/A	[ft]
Eccentricity, e/L	0.113	N/A	
CDR calculated	1.35	N/A	
Base length	14.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 31729.58 [lb/ft], L = 14.00, Unfactored e = 1.41 [ft], and Sigma = 2839.83 [lb/ft ²]



SCALE:

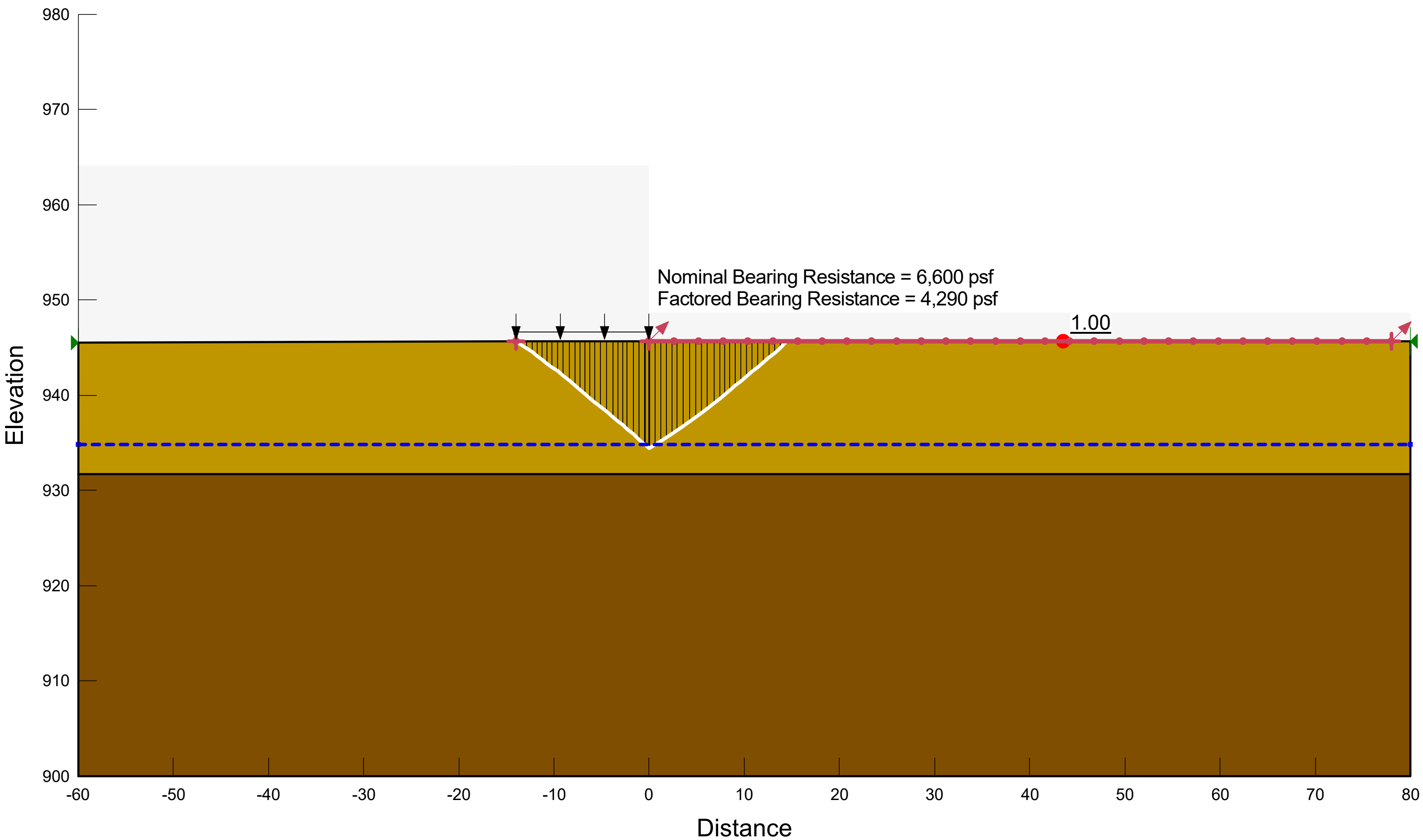
0 2 4 6 8 10 [ft]

Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Forward Sloped
MSE Wall Stability Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.
Bearing load was determined using MSEW 3.0.

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Glacial Till	130	12,000	0
	Silty Clay	125	1,600	0

Bearing Capacity - Normal Groundwater
Undrained Conditions



AASHTO 2007-2010 (LRFD)
Bridge BRO-32-0359

MSEW(3.0): Update # 14.94

PROJECT IDENTIFICATION

Title:	Bridge BRO-32-0359
Project Number:	BRO-32-4.16
Client:	ODOT
Designer:	DRP
Station Number:	414+08.99

Description:

Forward Sloped Wall - Undrained conditions - Sliding Resistance

Company's information:

Name: Stantec
Street:

Cincinnati, OH
Telephone #:
Fax #:
E-Mail:

Original file path and name: C:\Users\dpleiman\Documents\BRO-32\MSE Walls\Forward Ab.....
.....rward1-Sloped-ST.BEN
Original date and time of creating this file: Tue Aug 04 10:49:44 2020

PROGRAM MODE: ANALYSIS
of a SIMPLE STRUCTURE
using METAL STRIPS as reinforcing material.

SOIL DATA

REINFORCED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	34.0 °

RETAINED SOIL

Unit weight, γ	120.0 lb/ft ³
Design value of internal angle of friction, ϕ	30.0 °

FOUNDATION SOIL (Considered as an equivalent uniform soil)

Equivalent unit weight, $\gamma_{\text{equiv.}}$	125.0 lb/ft ³
Equivalent internal angle of friction, $\phi_{\text{equiv.}}$	0.0 °
Equivalent cohesion, $c_{\text{equiv.}}$	1000.0 lb/ft ²

Water table does not affect bearing capacity

LATERAL EARTH PRESSURE COEFFICIENTS

Ka (internal stability) = 0.2827 (if batter is less than 10°, Ka is calculated from eq. 15. Otherwise, eq. 38 is utilized)
Ka (external stability) = 0.3333 (if batter is less than 10°, Ka is calculated from eq. 16. Otherwise, eq. 17 is utilized)

BEARING CAPACITY

Bearing capacity coefficients (calculated by MSEW): Nc = 5.14 N γ= 0.00

SEISMICITY

Not Applicable

$$K_a = \tan^2(45 - \phi/2) \qquad (15)$$

$$K = \frac{\sin^2(\theta + \phi')}{\sin^3\theta \left[1 + \frac{\sin\phi'}{\sin\theta}\right]^2} \qquad (38)$$

$$K_a = \cos\beta \; \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}} \qquad (16)$$

$$K_a = \frac{\sin^2(\theta + \phi)}{\sin^2\theta \;\; \sin(\theta - \delta) \left(1 + \sqrt{\frac{\sin(\phi + \delta)\sin(\phi - \beta)}{\sin(\theta - \delta)\sin(\theta + \beta)}}\right)^2} \qquad (17)$$

INPUT DATA: Geometry and Surcharge loads (of a SIMPLE STRUCTURE)

Design height, Hd	18.47	[ft]	{ Embedded depth is E = 3.00 ft, and height above top of finished bottom grade is H = 15.47 ft }
Batter, ω	0.0	[deg]	
Backslope, β	0.0	[deg]	
Backslope rise	0.0	[ft]	Broken back equivalent angle, I = 0.00° (see Fig. 25 in DEMO 82)

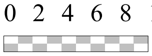
U N I F O R M   S U R C H A R G E

Uniformly distributed dead load is 0.0 [lb/ft ²], and live load is 50.0 [lb/ft ²]

ANALYZED REINFORCEMENT LAYOUT:

SCALE:

0 2 4 6 8 10 [ft]



AASHTO 2007-2010 (LRFD) Input Data

EXTERNAL STABILITY

Load factor for vertical earth pressure, EV, from Table 3.4.1-2 and Figure C11.5.5-2:

		Static		Combined Static/Seismic
Sliding and Eccentricity	$\gamma_{p\text{-}EV}$	1.00	$\gamma_{p\text{-}EQ}$	1.00
Bearing Capacity	$\gamma_{p\text{-}EV}$	1.35	$\gamma_{p\text{-}EQ}$	1.35

Load factor of active lateral earth pressure, EH, from Table 3.4.1-2 and Figure C11.5.5-2:	$\gamma_{p\text{-}EH}$	1.50
Load factor of active lateral earth pressure during earthquake (does not multiply P_{AE} and P_{IR}):	$(\gamma_{p\text{-}EH})_{EQ}$	1.50
Load factor for earthquake loads, EQ, from Table 3.4.1-1 (multiplies P_{AE} and P_{IR}):	$\gamma_{p\text{-}EQ}$	1.00

Resistance factor for shear resistance along common interfaces from Table 11.5.6-1:

		Static	Combined Static/Seismic
Reinforced Soil and Foundation	ϕ_τ	1.00	1.00
Reinforced Soil and Reinforcement	ϕ_τ	1.00	1.00

Resistance factor for bearing capacity of shallow foundation from Table 11.5.6-1:

	Static	Combined Static/Seismic
ϕ_b	0.65	0.65

ANALYSIS: CALCULATED FACTORS (Static conditions)

Bearing capacity, CDR = 0.84, factored bearing load = 3975 lb/ft².

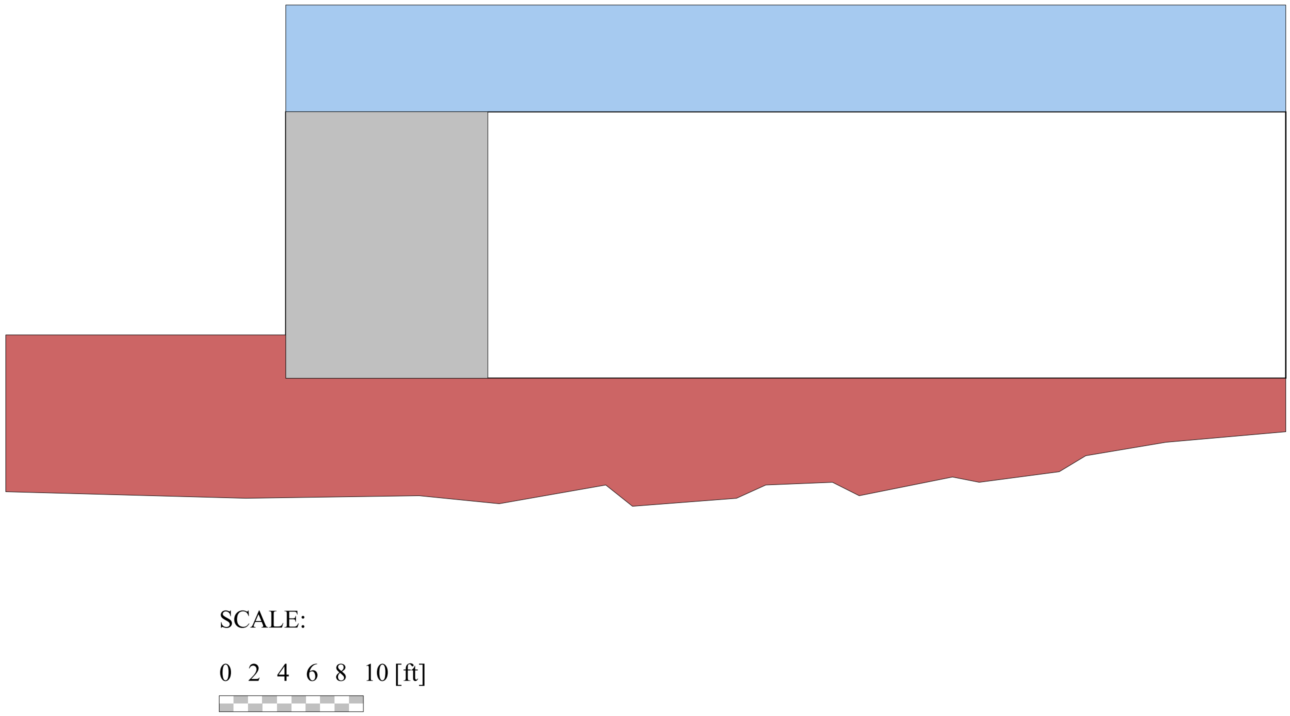
Foundation Interface: Direct sliding, CDR = 1.300, Eccentricity, e/L = 0.1565, CDR-overturning = 3.19

METAL STRIP				CONNECTION							
#	Elevation [ft]	Length [ft]	Type #	CDR [pullout resistance]	CDR [connection break]	CDR [metal strip strength]	Metal strip strength CDR	Pullout resistance CDR	Direct sliding CDR	Eccentricity e/L	Product name
1	0.50	14.00	1								
2	3.00	14.00	1								
3	6.00	14.00	1								
4	9.00	14.00	1								
5	12.00	14.00	1								
6	15.00	14.00	1								
7	18.00	14.00	1								

BEARING CAPACITY for GIVEN LAYOUT

	STATIC	SEISMIC	UNITS
(Water table does not affect bearing capacity)			
Factored bearing resistance. q-n	3342	N/A	[lb/ft ²]
Factored bearing load, σ_V	3975.0	N/A	[lb/ft ²]
Eccentricity, e	1.58	N/A	[ft]
Eccentricity, e/L	0.113	N/A	
CDR calculated	0.84	N/A	
Base length	14.00	N/A	[ft]

Unfactored applied bearing pressure = (Unfactored R) / [L - 2 * (Unfactored e)] =
Unfactored R = 31729.58 [lb/ft], L = 14.00, Unfactored e = 1.41 [ft], and Sigma = 2839.83 [lb/ft ²]

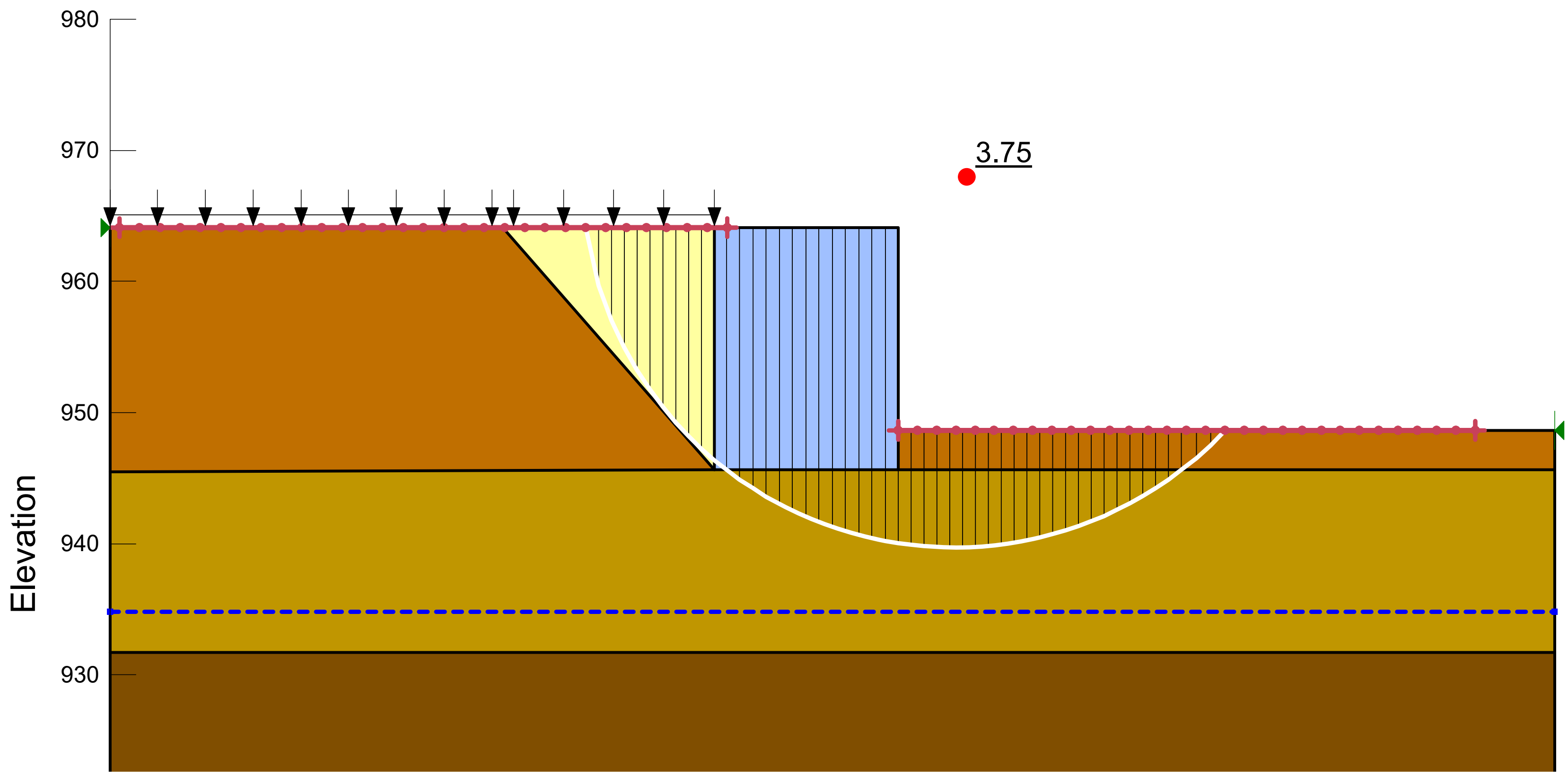


Ohio Dept. of Transportation
Bruce Lunsford Way over SR 32
BRO-32-0359 Forward Sloped
MSE Wall Stability Analysis
Brown Co., OH

Note: The results of the analysis shown here are based on available subsurface information, soil properties, and profile information.
The drawing depicts approximate subsurface conditions based on provided drawing information and specific borings at the time of analysis.
No warranties can be made regarding the continuity of subsurface conditions.
Bearing load was determined using MSEW 3.0.

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Embankment Fill	125	2,000	0
	Glacial Till	130	12,000	0
	MSE Fill	120	3,000	34
	Retained Fill	120	0	30
	Silty Clay	125	1,600	0

Global Stability - Normal Groundwater
Undrained Conditions



APPENDIX G

Settlement Analyses

Stantec

Performed by: Lauren Talbot
Reviewed by: Eric Kistner

173620122 BRO 32-0359
LEDT 8.12.2020

SETTLE ANALYSIS SUMMARY
BRO 32-0359: BRUCE LUNSFORD'S WAY OVER STATE ROUTE 32

Analysis completed in Settle3 Version 5.001. All Elevations in feet (MSL).

BACKGROUND

Bottom of MSE Wall Elevations:

- Rear Abutment: 943.5
- Forward Abutment: 943.0

Existing Ground Surface Elevations at MSE Wall Face:

- Rear Abutment: 945.5
- Forward Abutment 945.0

Planned Layout for Pile Locations:

- Piles sit ~6' back from MSE wall face

Final Grading for Embankment:

- 2H:1V parallel to MSE wall face (and SR32)
- No turn back

Points of Interest (POI):

- Pile location (downdrag)
- MSE wall face
- Along MSE wall face: center, edge, midpoint(s) along embankment (differential settlement)
- Parallel to MSE wall face at pile location: center, edge, midpoint(s) along embankment (differential settlement)

Max Settlement of Soils Around Driven Piles:

- 0.4 inches for downdrag via FHWA GEC 012 – Volume I, September 2016

ASSUMPTIONS AND PARAMETERS

Settlement Analysis:

- Dead loads only, no traffic surcharge or live loads
- Boussinesq stress computation method
- Negligible settlement within embankment
- Consolidation settlement in silty clay and silt and clay layers
- Immediate settlement and consolidation settlement in sandy silt layers due to both cohesive and granular properties
- Soil below sandy silt layers modelled has negligible settlement
- Water at existing ground surface (gs)
- All layers double drained

Rear Abutment Embankment Dimensions:

- 34’ wide top of embankment (estimate)
- 29.5' total abutment height (top of leveling pad to roadway surface)
- 18.9’ MSE wall height
- Embankment and bottom of MSE wall sits 2.0’ below existing ground surface

Forward Abutment Embankment Dimensions:

- 34’ wide top of embankment (estimate)
- 29.9' total abutment height (top of leveling pad to roadway surface)
- 18.5’ MSE wall height
- Embankment and bottom of MSE wall sits 2.0’ below existing ground surface

Embankment Materials:

- Reinforced fill & retained wedge fill for MSE wall:
    - Unit weight = 120 pcf (ODOT SS840)
- Abutment wall backfill above MSE wall:
    - Unit weight = 125 pcf

Rear Abutment Foundation Soils:

- Silt and Clay
  - Elevation 945.5 - 932.8
  - Moist unit weight = 129 pcf (lab testing)
  - Wet unit weight = 129 pcf (calculated)
  - Other consolidation parameters via Homan Way Bridge Preliminary Geotechnical Report (CTL Engineering) and Stantec lab testing
    - Different laboratory results from CTL and Stantec used to create two separate material models, with subsequent settlement results presented as ranges
- Sandy Silt
  - Elevation 932.8 - 895.8
  - Moist unit weight = 135 pcf (lab testing)
  - Wet unit weight = 139 pcf (calculated)
  - Cv and Cvr via NAVFAC DM7.01-144, Figure 4, approximate
  - Es and Esur via Settle3 lookup for silt, maximum value of range given sand content and high blow counts
  - Other consolidation parameters via Bowles (1995) and Holtz & Kovacs (2010)

Forward Abutment Foundation Soils:

- Silty Clay
  - Elevation 945.0 - 931.7
  - Moist unit weight = 129 pcf (lab testing)
  - Wet unit weight = 129 pcf (calculated)
  - Other consolidation parameters via Homan Way Bridge Preliminary Geotechnical Report (CTL Engineering) and Stantec lab testing
    - Different laboratory results from CTL and Stantec used to create two separate material models, with subsequent settlement results presented as ranges
- Sandy Silt
  - Elevation 931.7 - 895.2
  - Moist unit weight = 135 pcf (lab testing)
  - Wet unit weight = 140 pcf (calculated)
  - Cv and Cvr via NAVFAC DM7.01-144, Figure 4, approximate
  - Es and Esur via Settle3 lookup for silt, maximum value of range given sand content and high blow counts
  - Other consolidation parameters via Bowles (1995) and Holtz & Kovacs (2010)

RESULTS

All results presented as ranges due to separate material models for the “silty clay” and “silt and clay” layers based on CTL laboratory results and Stantec laboratory results, respectively

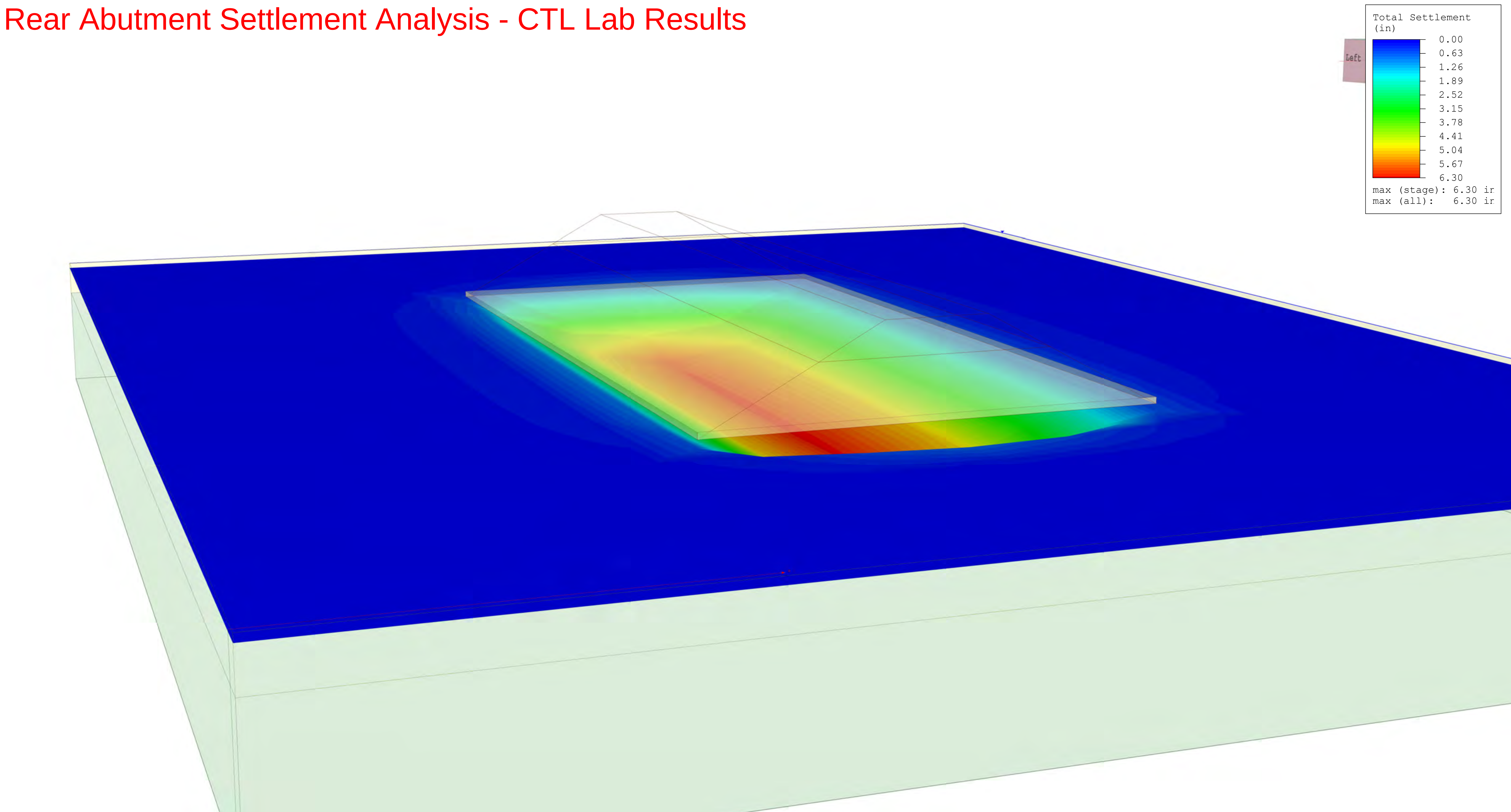
<u>Rear Abutment:</u>

- Pile Location:
    - 4.42”-7.25” estimated total settlement at pile location:
        - (Consolidation settlement) + (immediate settlement)
    - 2.61”-5.44” total consolidation settlement
        - 80% of total consolidation settlement after 68-2 days
        - 90% of total consolidation settlement after 118-8 days
        - 95% of total consolidation settlement after 174-34 days
    - 1.81” immediate settlement
    - Differential Settlement at Pile Location Parallel to MSE Wall Face:
        - 3.79”-6.36” maximum differential settlement:
            - (Total settlement at center) – (total settlement at edge)
        - 4.42”-7.25” total settlement at center of embankment
        - 3.60”-6.15” total settlement at edge of abutment wall backfill
        - 0.63”-0.89” total settlement at edge of embankment
- MSE Wall Face:
    - 3.55”-5.84” estimated total settlement at MSE wall face:
        - (Consolidation settlement) + (immediate settlement)
    - 2.13”-4.41” total consolidation settlement
        - 80% of total consolidation settlement after 74-3 days
        - 90% of total consolidation settlement after 125-10 days
        - 95% of total consolidation settlement after 182-37 days
    - 1.43” immediate settlement
    - Differential Settlement at MSE Wall Face:
        - 2.92”-4.86” maximum differential settlement:
            - (Total settlement at center) – (total settlement at edge)
        - 3.55”-5.84” total settlement at center of embankment
        - 2.83”-4.79” total settlement at edge of abutment wall backfill
        - 0.63”-0.98” total settlement at edge of embankment
- Maximum Embankment Settlement:
    - 6.30”-8.95” maximum total settlement under embankment
    - 3.44”-6.10” total consolidation settlement and 2.85” immediate settlement
- Recommendations:
    - 85%-93% of total consolidation settlement at pile location is required to eliminate downdrag, requiring 87-20 days before driving
        - Must be <0.4" difference between when piles are driven and final consolidation
            - (Total consolidation) – (85%-93% total consolidation after 87-20 days)
            - CTL Laboratory Testing (85%, 87 days): 2.61” – 2.22” = 0.39” < 0.4”
            - Stantec Laboratory Testing (93%, 20 days): 5.44” – 5.05” = 0.39” < 0.4”

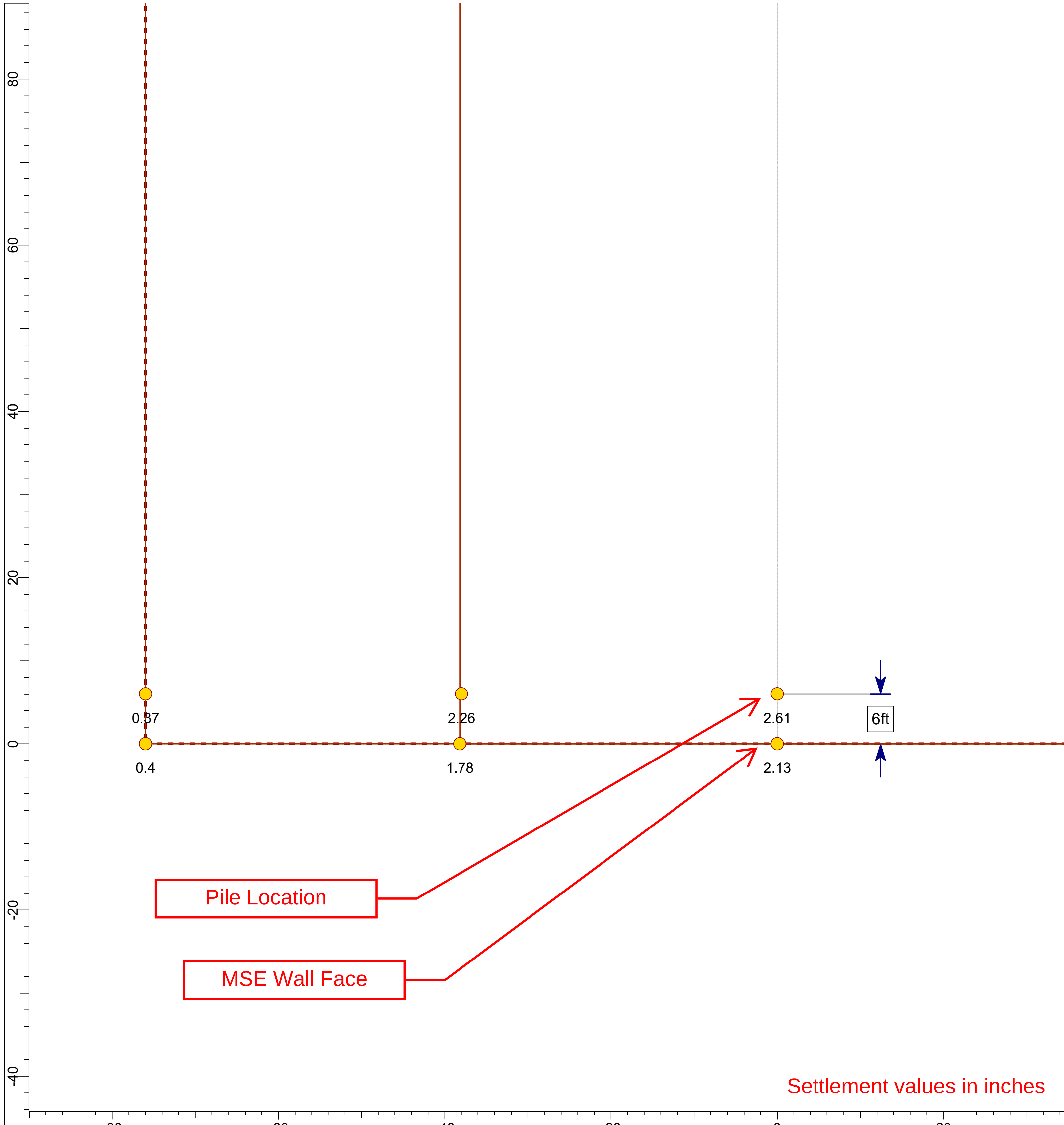
Forward Abutment:

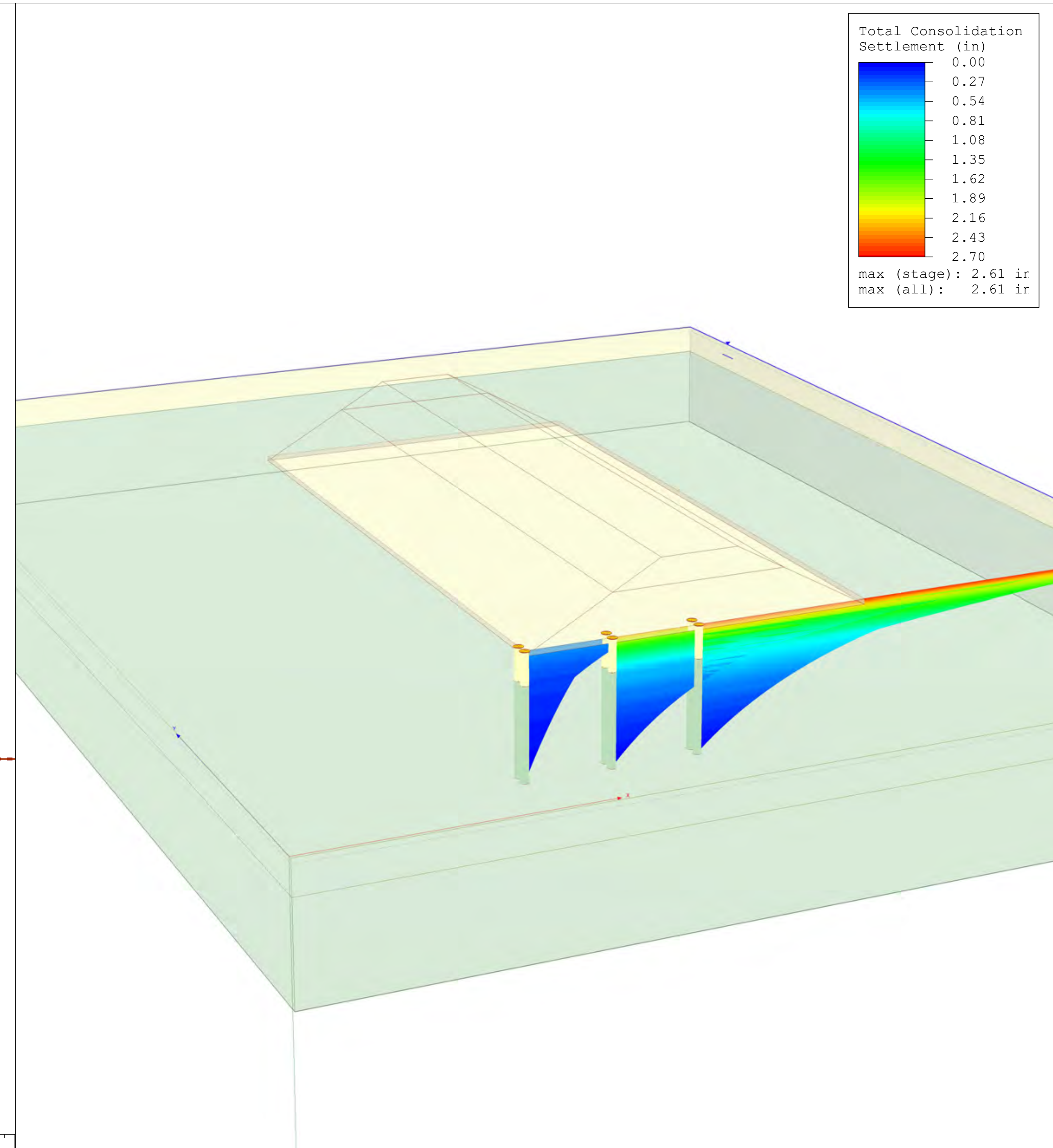
- Pile Location:
  - 4.47”-7.69” estimated total settlement at pile location:
    - (Consolidation settlement) + (immediate settlement)
  - 2.67”-5.88” total consolidation settlement
    - 80% of total consolidation settlement after 74-4 days
    - 90% of total consolidation settlement after 129-9 days
    - 95% of total consolidation settlement after 192-29 days
  - 1.80” immediate settlement
  - Differential Settlement at Pile Location Parallel to MSE Wall Face:
    - 3.82”-6.74” maximum differential settlement:
      - (Total settlement at center) – (total settlement at edge)
    - 4.47”-7.69” total settlement at center of embankment
    - 3.56”-6.41” total settlement at edge of abutment wall backfill
    - 0.65”-0.95” total settlement at edge of embankment
- MSE Wall Face:
  - 3.60”-6.21” estimated total settlement at MSE wall face:
    - (Consolidation settlement) + (immediate settlement)
  - 2.17”-4.78” total consolidation settlement
    - 80% of total consolidation settlement after 79-4 days
    - 90% of total consolidation settlement after 136-10 days
    - 95% of total consolidation settlement after 201-32 days
  - 1.43” immediate settlement
  - Differential Settlement at MSE Wall Face:
    - 2.96”-5.17” maximum differential settlement:
      - (Total settlement at center) – (total settlement at edge)
    - 3.60”-6.21” total settlement at center of embankment
    - 2.81”-5.01” total settlement at edge of abutment wall backfill
    - 0.64”-1.04” total settlement at edge of embankment
- Maximum Embankment Settlement:
  - 6.45”-9.47” maximum total settlement under embankment
  - 3.60”-6.62” total consolidation settlement and 2.85” immediate settlement
- Recommendations:
  - 85%-93% of total consolidation settlement at pile location is required to eliminate downdrag, requiring 98-19 days before driving
    - Must be <0.4" difference between when piles are driven and final consolidation
      - (Total consolidation) – (85%-93% total consolidation after 98-19 days)
      - CTL Laboratory Testing (85%, 98 days): 2.67” – 2.28” = 0.39” < 0.4”
      - Stantec Laboratory Testing (93%, 19 days): 5.88” – 5.49” = 0.39” < 0.4”

Rear Abutment Settlement Analysis - CTL Lab Results



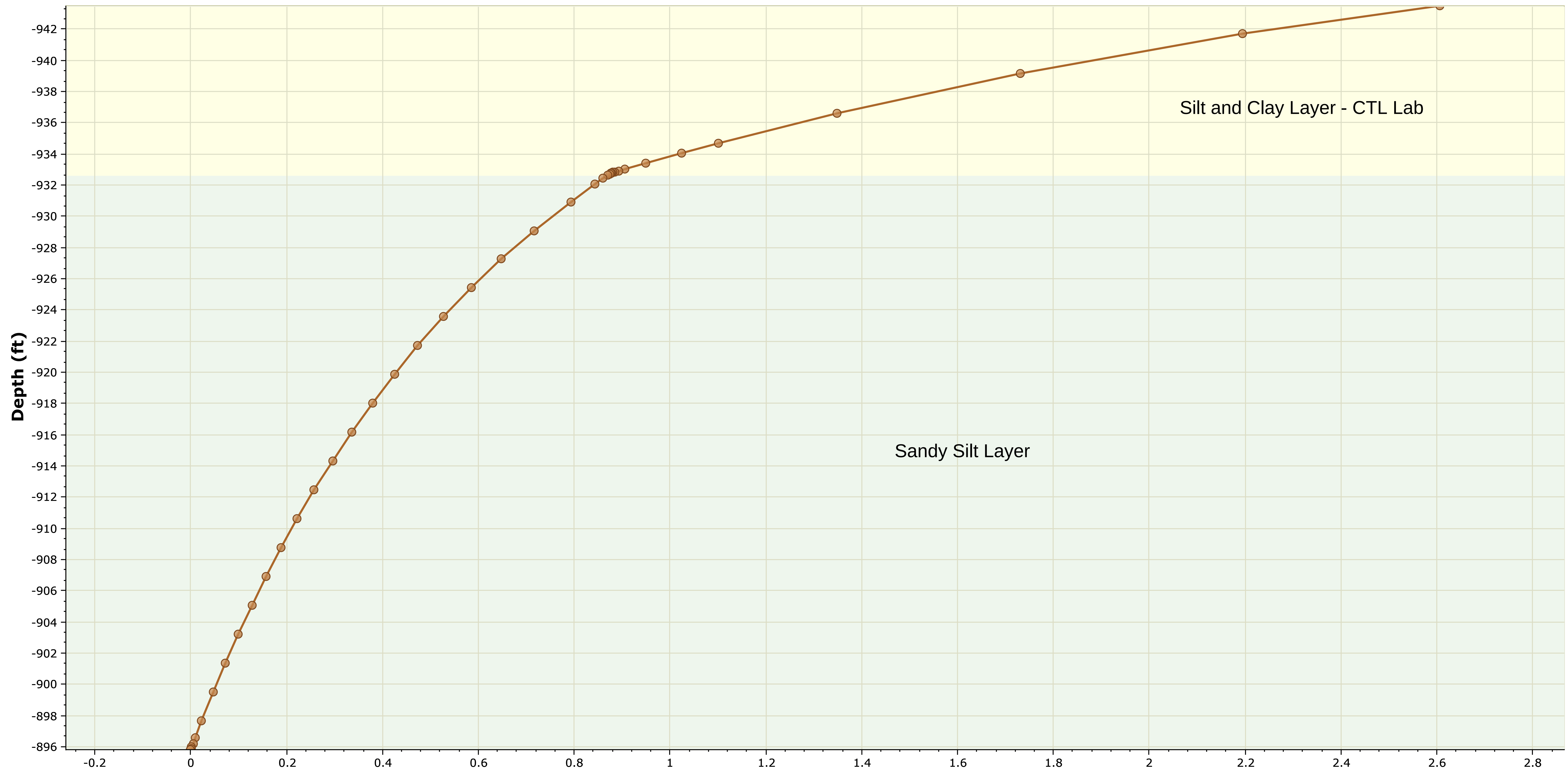
rocscience	Project	BRO 32-0359	
	Analysis Description	Rear Abutment Settlement Analysis	
	Drawn By: LEDT	Company: Stantec	
SETTLE3 5.001	Date: 8/4/2020	File Name: 173620122 BRO 32-0359 Rear Abutment.s3z - CTL Lab	





SETTLE3 5.001	*Project*	BRO 32-0359	
	Analysis Description	Rear Abutment Settlement Analysis	
	Drawn By LEDT	*Company* Stantec	
	Date 8/4/2020	*File Name* 173620122 BRO 32-0359 Rear Abutment.s3z - CTL Lab	

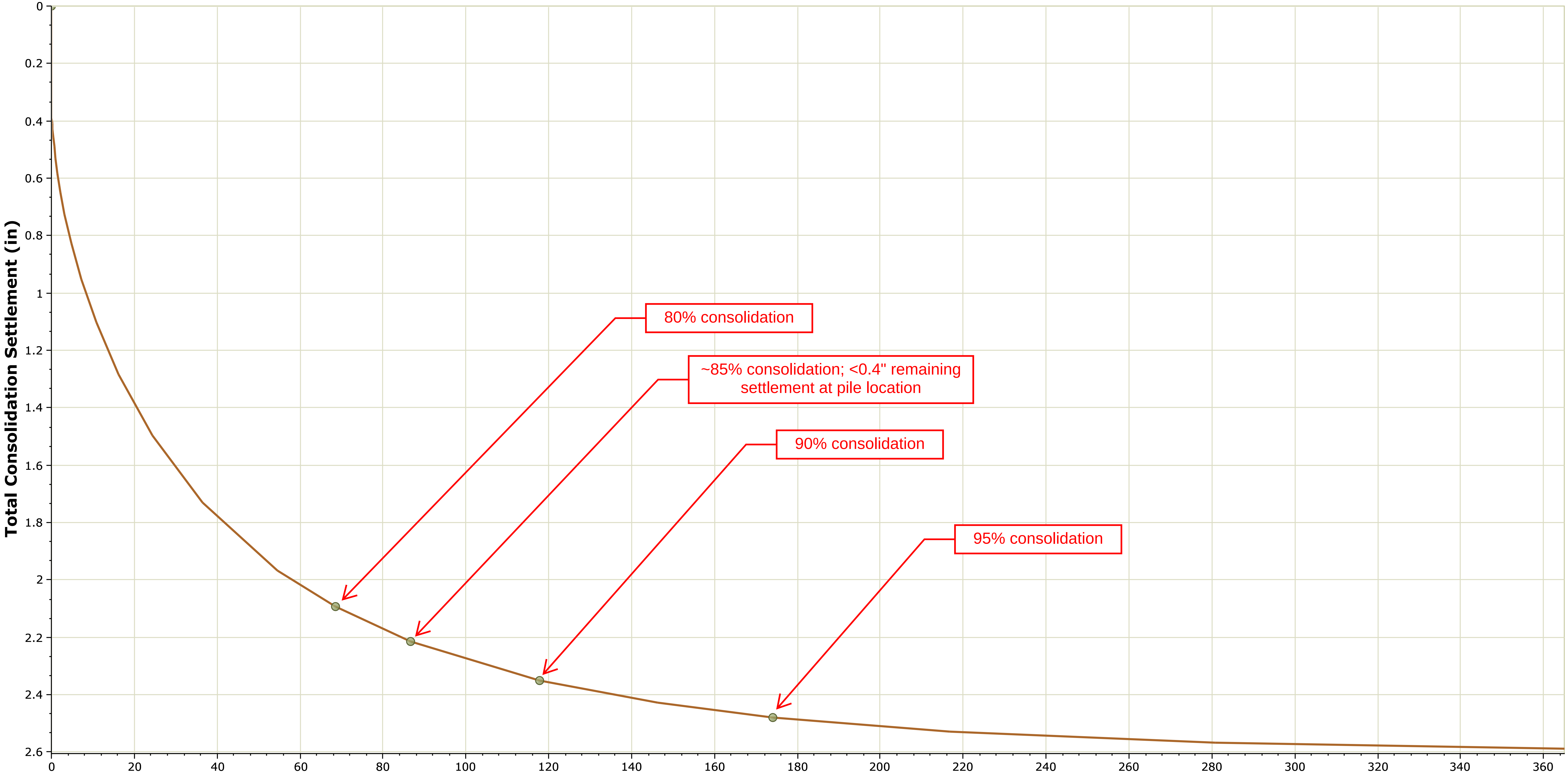
Total Consolidation Settlement vs. Depth at Pile Location



Time = ~10 years

rocscience SETTLE3 5.001	*Project* BRO 32-0359		
	Analysis Description Rear Abutment Settlement Analysis		
	Drawn By LEDT	*Company* Stantec	
	Date 8/4/2020	*File Name* 173620122 BRO 32-0359 Rear Abutment.s3z - CTL Lab	

Time vs. Total Consolidation Settlement at Pile Location



Total Consolidation Settlement at Depth = -943.5 ft

Project	BRO 32-0359
Analysis Description	Rear Abutment Settlement Analysis
Drawn By LEDT	*Company* Stantec
Date 8/4/2020	*File Name* 173620122 BRO 32-0359 Rear Abutment.s3z - CTL Lab

SETTLE3 5.001

Settle3 Analysis Information
BRO 32-0359

Project Settings

Document Name	173620122 BRO 32-0359 Rear Abutment.s3z - CTL Lab
Project Title	BRO 32-0359
Analysis	Rear Abutment Settlement Analysis
Author	LEDT
Company	Stantec
Date Created	8/4/2020

Comments

Project #: 173620122	
Stress Computation Method	Boussinesq
Time-dependent Consolidation Analysis	
Time Units	days
Permeability Units	feet/day
Minimum settlement ratio for subgrade modulus	0.9

Use average properties to calculate layered stresses

Improve consolidation accuracy

Ignore negative effective stresses in settlement calculations

Stage Settings

Stage #	Name	Time [days]
1	Stage 1	0
2	80% Pile Location	68.44
3	<0.4" Remaining Settlment at Pile Location	86.59
4	90% Pile Location	117.83
5	95% Pile Location	174.01
6	10 years	3650

Results

Notes:

Results for Pile Location

Time taken to compute: 6.41768 seconds

Stage: Stage 1 = 0 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	1.81402
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.1332	3.68002
Effective Stress XX [ksf]	-1.05113	5.5761
Effective Stress YY [ksf]	-0.227352	7.24465
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0	0.00540076
Pore Water Pressure [ksf]	-0.065471	4.45084
Excess Pore Water Pressure [ksf]	-0.065471	2.96852
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1.63105	20.2662
Void Ratio	0.292979	0.73
Permeability [ft/d]	5.01736e-005	0.000553307
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	16.5906
Undrained Shear Strength	0	0

Stage: 80% Pile Location = 68.44 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	3.90729
Total Consolidation Settlement [in]	0	2.09327
Virgin Consolidation Settlement [in]	0	0.000227729
Recompression Consolidation Settlement [in]	0	2.09305
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00154586	0.018137
Pore Water Pressure [ksf]	0	2.97838
Excess Pore Water Pressure [ksf]	0	1.72906
Degree of Consolidation [%]	0	99.9537
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	26.1713
Void Ratio	0.287757	0.732797
Permeability [ft/d]	5.01736e-005	0.000553307
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	55.0387	80.208
Undrained Shear Strength	0	0.194585

Stage: <0.4" Remaining Settlment at Pile Location = 86.59 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.02954
Total Consolidation Settlement [in]	0	2.21552
Virgin Consolidation Settlement [in]	0	0.000298773
Recompression Consolidation Settlement [in]	0	2.21522
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00150611	0.0182991
Pore Water Pressure [ksf]	0	2.97648
Excess Pore Water Pressure [ksf]	-0.00360052	1.46428
Degree of Consolidation [%]	0	99.9681
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	26.1105
Void Ratio	0.287756	0.732763
Permeability [ft/d]	5.01736e-005	0.000553307
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	61.5288	86.3583
Undrained Shear Strength	0	0.194585

Stage: 90% Pile Location = 117.83 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.16632
Total Consolidation Settlement [in]	0	2.3523
Virgin Consolidation Settlement [in]	0	0.00037856
Recompression Consolidation Settlement [in]	0	2.35192
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00143306	0.0184803
Pore Water Pressure [ksf]	0	2.97648
Excess Pore Water Pressure [ksf]	-0.00440279	1.08616
Degree of Consolidation [%]	0	99.9832
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	25.9998
Void Ratio	0.287756	0.732699
Permeability [ft/d]	5.01736e-005	0.000553307
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	71.065	92.8107
Undrained Shear Strength	0	0.194585

Stage: 95% Pile Location = 174.01 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.29263
Total Consolidation Settlement [in]	0	2.47861
Virgin Consolidation Settlement [in]	0	0.00050621
Recompression Consolidation Settlement [in]	0	2.4781
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00132828	0.0186651
Pore Water Pressure [ksf]	0	2.97648
Excess Pore Water Pressure [ksf]	-0.00343193	0.629465
Degree of Consolidation [%]	0	99.9947
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	25.8431
Void Ratio	0.287756	0.732609
Permeability [ft/d]	5.01736e-005	0.000553307
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	83.0843	97.728
Undrained Shear Strength	0	0.194585

Stage: 10 years = 3650 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.41936
Total Consolidation Settlement [in]	0	2.60534
Virgin Consolidation Settlement [in]	0	0.00856627
Recompression Consolidation Settlement [in]	0	2.59677
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00117305	0.0188876
Pore Water Pressure [ksf]	0	2.97648
Excess Pore Water Pressure [ksf]	-0.00380174	0.00328077
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	25.6153
Void Ratio	0.287755	0.732474
Permeability [ft/d]	5.01736e-005	0.000553307
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	99.9994	100
Undrained Shear Strength	0	0.215447

Embankments

Notes:

Embankment bottom sits at Elevation 943.5 ft

1. Embankment: "MSE Wall Reinforced Fill and Retained Wedge Fill"

Label	MSE Wall Reinforced Fill and Retained Wedge Fill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	152

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	18.9	0.12	26.5651	0

2. Embankment: "Abutment Wall Backfill"

Label	Abutment Wall Backfill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	76.4

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	10.6	0.125	26.5651	0

Excavations

1. Excavation: "Excavation to Bottom of MSE Wall"

Depth	-943.5 ft
Installation Stage	Stage 1 = 0 d

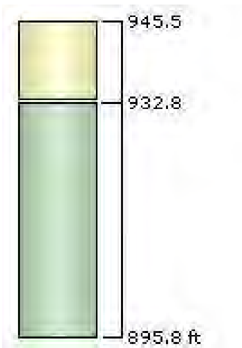
Coordinates

X [ft]	Y [ft]
76	0
76	300
-76	300
-76	0

Soil Layers

Ground Surface Drained: Yes

Layer #	Type	Thickness [ft]	Depth [ft]	Drained at Bottom
1	Silt and Clay - Rear Abutment	12.7	-945.5	Yes
2	Sandy Silt - Rear Abutment	37	-932.8	Yes



Soil Properties

Property	Silt and Clay - Rear Abutment	Sandy Silt - Rear Abutment
Color		
Unit Weight [kips/ft^3]	0.129	0.135
Saturated Unit Weight [kips/ft^3]	0.129	0.139
K0	1	1
Immediate Settlement	Disabled	Enabled
Es [ksf]	-	417.709
Esur [ksf]	-	417.709
Primary Consolidation	Enabled	Enabled
Material Type	Non-Linear	Non-Linear
Cc	0.11	0.139
Cr	0.027	0.009
e0	0.73	0.3
Pc [ksf]	3.2	6
Cv [ft^2/d]	0.1	2.5
Cvr [ft^2/d]	0.1	2.5
B-bar	1	1
Undrained Su A [kips/ft2]	0	0
Undrained Su S	0.2	0.2
Undrained Su m	0.8	0.8
Piezo Line ID	1	1

Groundwater

Groundwater method	Piezometric Lines
Water Unit Weight	0.0624 kips/ft^3

Piezometric Line Entities

ID	Depth (ft)
1	-945.5 ft

Query Points

Point #	Query Point Name	(X,Y) Location	Number of Divisions
4	MSE Wall Face	0, 0	Auto: 50
5	Pile Location (6' from MSE Wall Face)	0, 6	Auto: 50
6	Differential Settlement Midpoint PL	-38, 6	Auto: 50
7	Differential Settlement Midpoint MSEWF	-38.2, 0	Auto: 50
8	Differential Settlement Edge PL	-76, 6	Auto: 50
9	Differential Settlement Edge MSEWF	-76, 0	Auto: 50

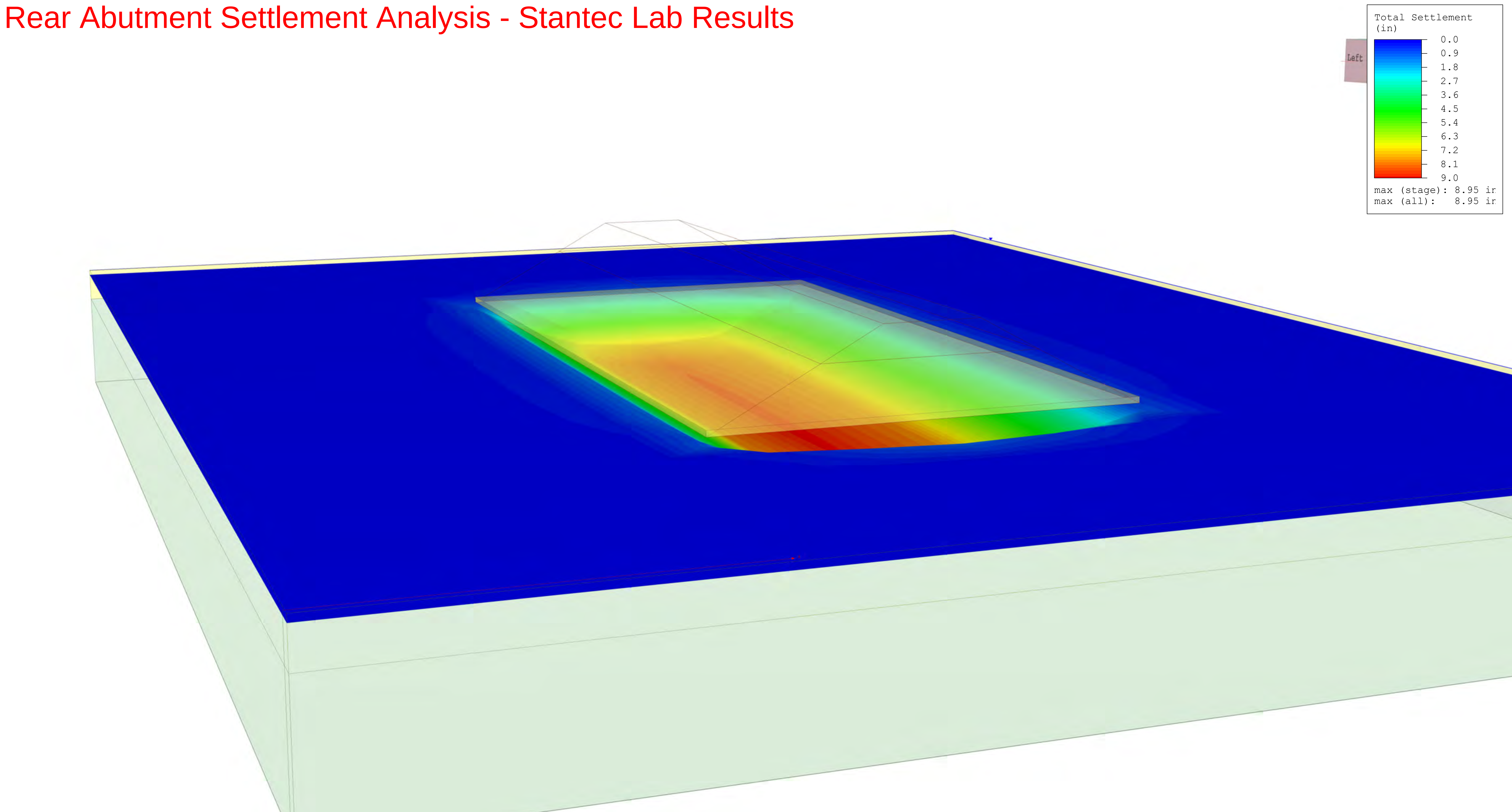
Query Lines

Line #	Query Line Name	Start Location	End Location	Horizontal Divisions	Vertical Divisions
1	MSE Wall Face Differential Settlement	-76, 0	76, 0	152	Auto: 50
2	Pile Location Differential Settlement	-76, 6	76, 6	152	Auto: 50

Time Points

Point #	(X,Y) Location	Depth	Goal Type	Goal	Time Until Goal
1	0, 0	-943.5 ft	Degree of Consolidation	80%	73.6176 d
2	0, 0	-943.5 ft	Degree of Consolidation	90%	124.837 d
3	0, 0	-943.5 ft	Degree of Consolidation	95%	182.456 d
4	0, 6	-943.5 ft	Degree of Consolidation	80%	68.4399 d
5	0, 6	-943.5 ft	Degree of Consolidation	90%	117.825 d
6	0, 6	-943.5 ft	Degree of Consolidation	95%	174.006 d
7	0, 6	-943.5 ft	Total Settlement	3.95 in	86.5877 d

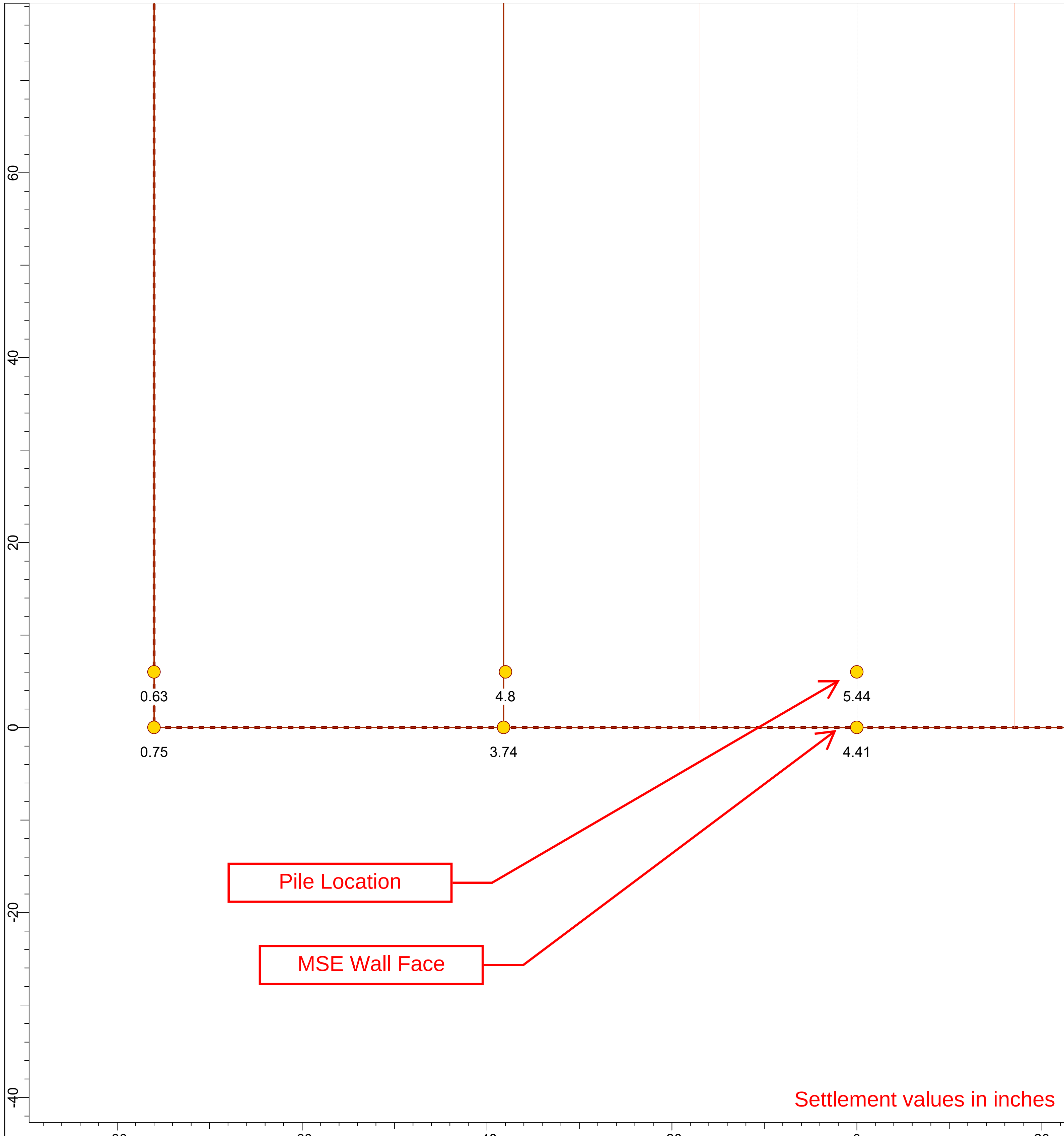
Rear Abutment Settlement Analysis - Stantec Lab Results

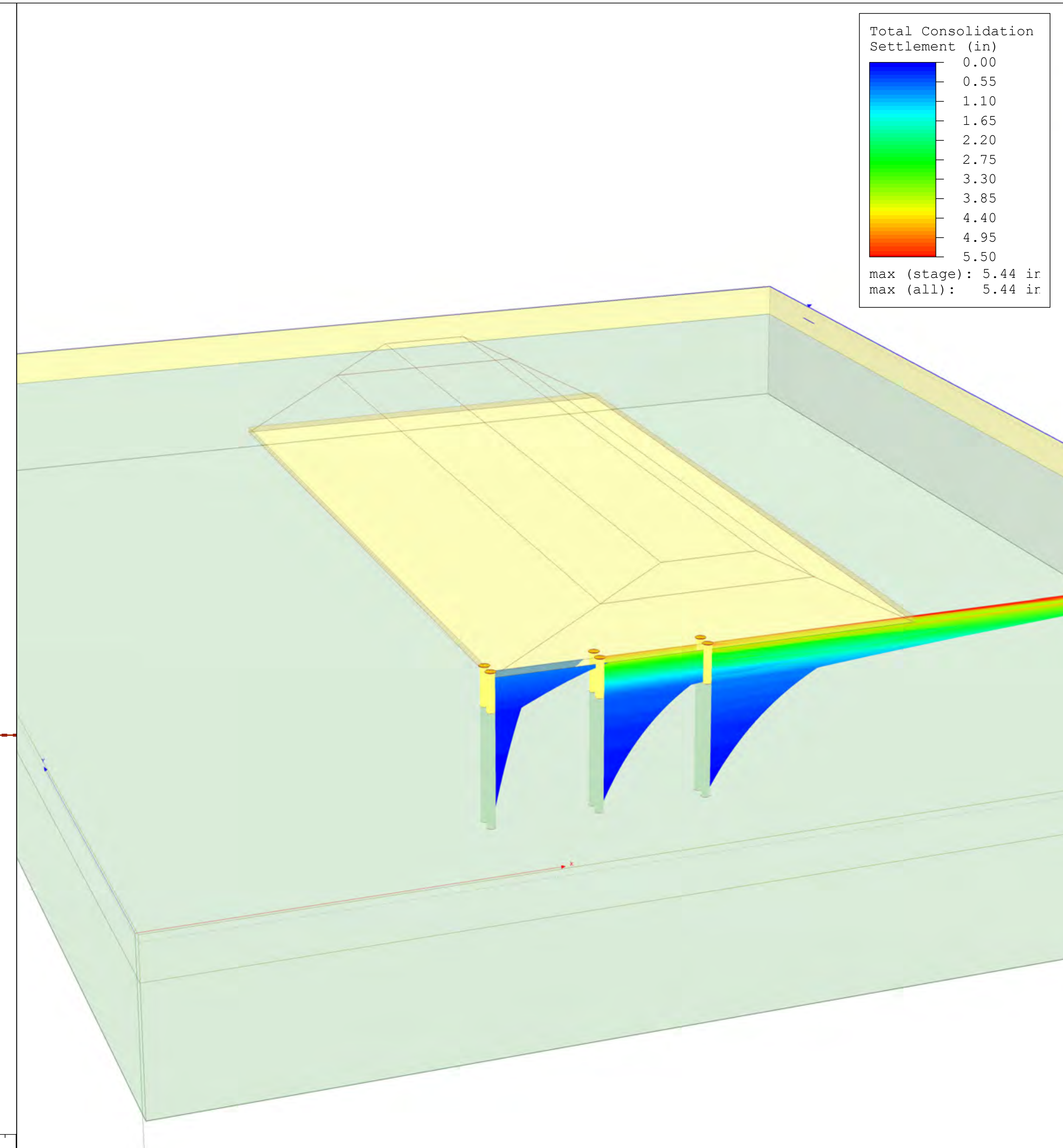


rocscience

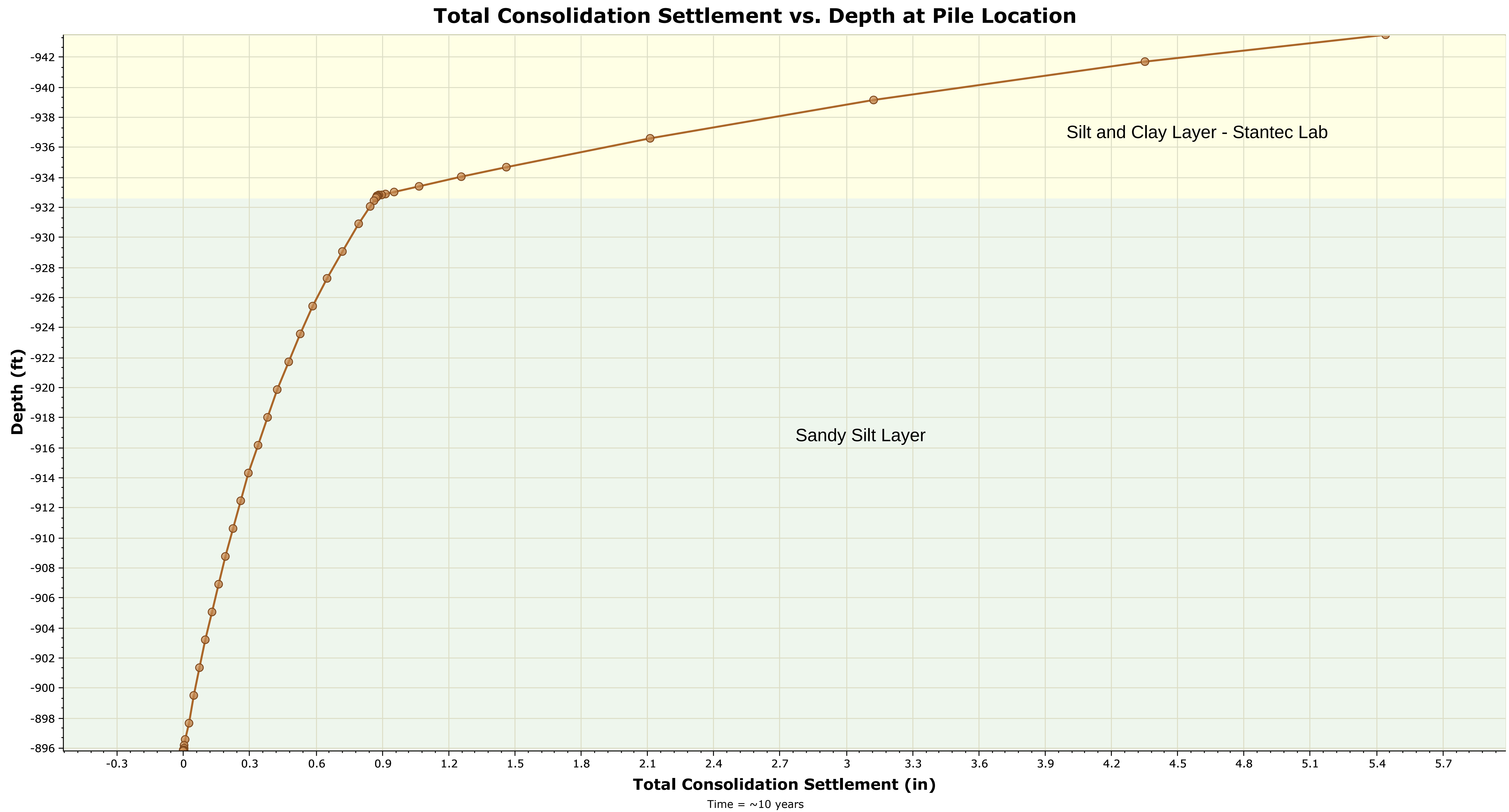
Project	BRO 32-0359		
Analysis Description	Rear Abutment Settlement Analysis		
Drawn By	LEDT	Company	Stantec
Date	8/12/2020	File Name	173620122 BRO 32-0359 Rear Abutment - Stantec Lab.s3z

SETTLE3 5.001



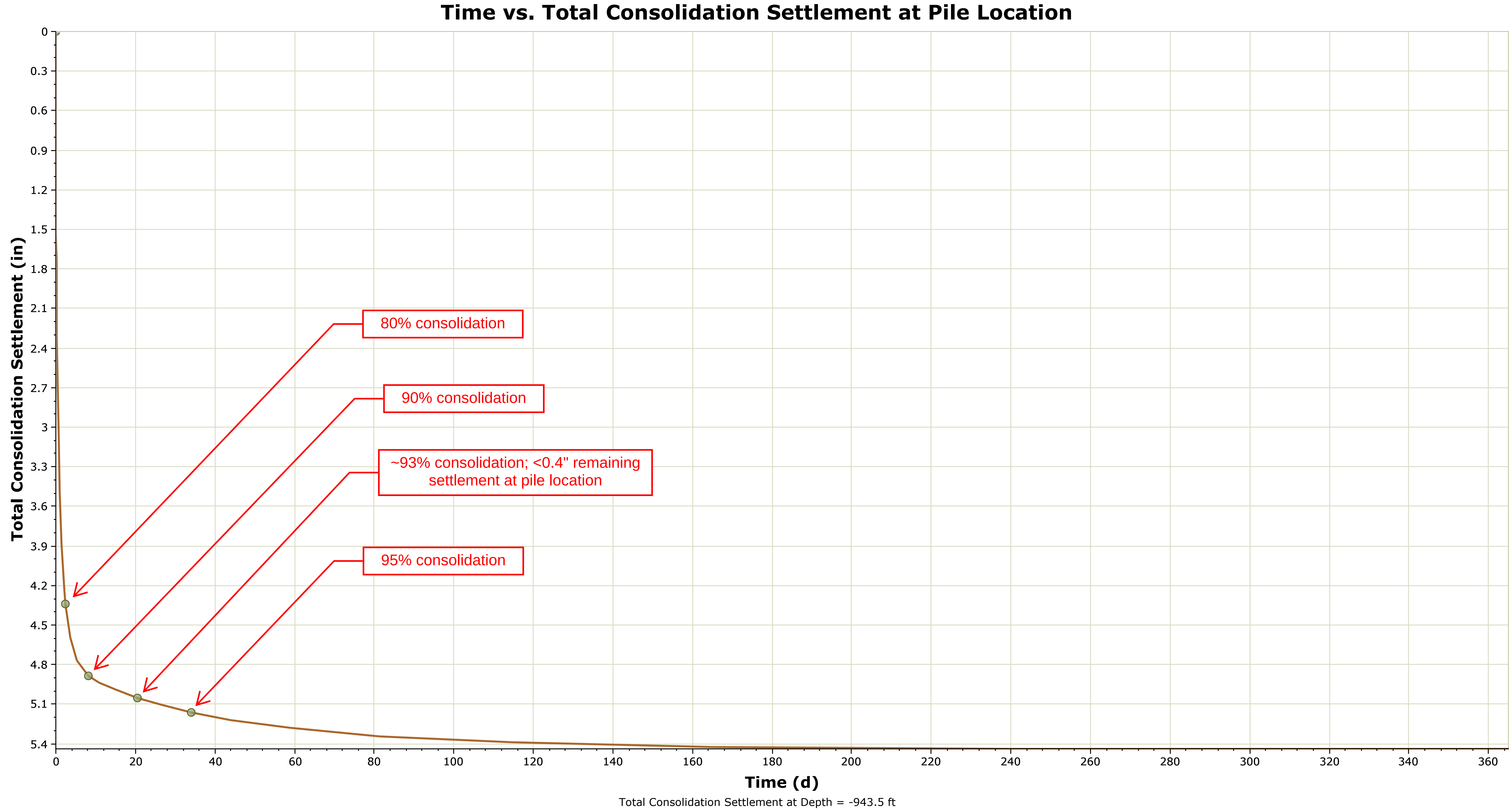


rocscience	Project	BRO 32-0359	
	Analysis Description	Rear Abutment Settlement Analysis	
	Drawn By	LEDT	Company: Stantec
SETTLE3 5.001	Date	8/12/2020	File Name: 173620122 BRO 32-0359 Rear Abutment - Stantec Lab.s3z



Project	BRO 32-0359		
Analysis Description	Rear Abutment Settlement Analysis		
Drawn By	LEDT	Company	Stantec
Date	8/12/2020	File Name	173620122 BRO 32-0359 Rear Abutment - Stantec Lab.s3z

SETTLE3 5.001



Project	BRO 32-0359		
Analysis Description	Rear Abutment Settlement Analysis		
Drawn By	LEDT	Company	Stantec
Date	8/12/2020	File Name	173620122 BRO 32-0359 Rear Abutment - Stantec Lab.s3z

SETTLE3 5.001

Settle3 Analysis Information
BRO 32-0359

Project Settings

Document Name	173620122 BRO 32-0359 Rear Abutment - Stantec Lab.s3z
Project Title	BRO 32-0359
Analysis	Rear Abutment Settlement Analysis
Author	LEDT
Company	Stantec
Date Created	8/12/2020
Comments	
Project #: 173620122	
Stress Computation Method	Boussinesq
Time-dependent Consolidation Analysis	
Time Units	days
Permeability Units	feet/day
Minimum settlement ratio for subgrade modulus	0.9

Use average properties to calculate layered stresses

Improve consolidation accuracy

Ignore negative effective stresses in settlement calculations

Stage Settings

Stage #	Name	Time [days]
1	Stage 1	0
2	Stantec 80% PL	2.41
3	Stantec 90% PL	8.25
4	Stantec <0.4" PL	20.46
5	Stantec 95% PL	34.11
6	10 years	3650

Results

Notes:

Results for Pile Location

Time taken to compute: 7.25256 seconds

Stage: Stage 1 = 0 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	1.81402
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.1332	3.68002
Effective Stress XX [ksf]	-1.05113	5.5761
Effective Stress YY [ksf]	-0.227352	7.24465
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0	0.00540076
Pore Water Pressure [ksf]	-0.065471	4.45084
Excess Pore Water Pressure [ksf]	-0.065471	2.96852
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	6	9
Over-consolidation Ratio	1.63105	56.9988
Void Ratio	0.292979	0.692
Permeability [ft/d]	0.000127648	0.0432989
Coefficient of Consolidation [ft^2/d]	2.5	6
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	16.5906
Undrained Shear Strength	0	0

Stage: Stantec 80% PL = 2.41 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	6.15638
Total Consolidation Settlement [in]	0	4.34237
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	4.34237
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00365211	0.0492531
Pore Water Pressure [ksf]	0	4.057
Excess Pore Water Pressure [ksf]	0	2.00323
Degree of Consolidation [%]	0	99.6061
Pre-consolidation Stress [ksf]	6	9
Over-consolidation Ratio	1.16587	72.8909
Void Ratio	0.287774	0.698874
Permeability [ft/d]	0.000127648	0.0432989
Coefficient of Consolidation [ft^2/d]	2.5	6
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	15.6688	82.479
Undrained Shear Strength	0	0

Stage: Stantec 90% PL = 8.25 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	6.69682
Total Consolidation Settlement [in]	0	4.8828
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	4.8828
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00312713	0.0500427
Pore Water Pressure [ksf]	0	3.84224
Excess Pore Water Pressure [ksf]	0	1.83311
Degree of Consolidation [%]	0	99.7865
Pre-consolidation Stress [ksf]	6	9
Over-consolidation Ratio	1.16522	72.0702
Void Ratio	0.287764	0.69843
Permeability [ft/d]	0.000127648	0.0432989
Coefficient of Consolidation [ft^2/d]	2.5	6
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	28.5998	99.4434
Undrained Shear Strength	0	0

Stage: Stantec <0.4" PL = 20.46 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	6.86634
Total Consolidation Settlement [in]	0	5.05232
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	5.05232
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00310956	0.0500675
Pore Water Pressure [ksf]	0	3.59035
Excess Pore Water Pressure [ksf]	0	1.54785
Degree of Consolidation [%]	0	99.8684
Pre-consolidation Stress [ksf]	6	9
Over-consolidation Ratio	1.16496	72.0431
Void Ratio	0.28776	0.698415
Permeability [ft/d]	0.000127648	0.0432989
Coefficient of Consolidation [ft^2/d]	2.5	6
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	45.0177	99.9996
Undrained Shear Strength	0	0

Stage: Stantec 95% PL = 34.11 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	6.97612
Total Consolidation Settlement [in]	0	5.16211
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	5.16211
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00310954	0.0500675
Pore Water Pressure [ksf]	0	3.32884
Excess Pore Water Pressure [ksf]	0	1.20198
Degree of Consolidation [%]	0	99.9052
Pre-consolidation Stress [ksf]	6	9
Over-consolidation Ratio	1.16483	72.0431
Void Ratio	0.287758	0.698415
Permeability [ft/d]	0.000127648	0.0432989
Coefficient of Consolidation [ft^2/d]	2.5	6
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	58.1495	100
Undrained Shear Strength	0	0

Stage: 10 years = 3650 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	7.2535
Total Consolidation Settlement [in]	0	5.43948
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	5.43948
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00310954	0.0500675
Pore Water Pressure [ksf]	0	2.97648
Excess Pore Water Pressure [ksf]	-1.63447e-017	1.56848e-017
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [ksf]	6	9
Over-consolidation Ratio	1.16432	72.0431
Void Ratio	0.287755	0.698415
Permeability [ft/d]	0.000127648	0.0432989
Coefficient of Consolidation [ft^2/d]	2.5	6
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	100	100
Undrained Shear Strength	0	0

Embankments

Notes:

Embankment bottom sits at Elevation 943.5 ft

1. Embankment: "MSE Wall Reinforced Fill and Retained Wedge Fill"

Label	MSE Wall Reinforced Fill and Retained Wedge Fill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	152

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	18.9	0.12	26.5651	0

2. Embankment: "Abutment Wall Backfill"

Label	Abutment Wall Backfill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	76.4

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	10.6	0.125	26.5651	0

Excavations

1. Excavation: "Excavation to Bottom of MSE"

Depth	-943.5 ft
Installation Stage	Stage 1 = 0 d

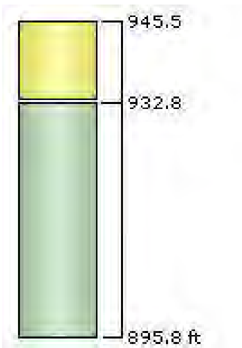
Coordinates

X [ft]	Y [ft]
-76	0
76	0
76	300
-76	300

Soil Layers

Ground Surface Drained: Yes

Layer #	Type	Thickness [ft]	Depth [ft]	Drained at Bottom
1	Silt and Clay - Rear Abutment - Stantec Lab	12.7	-945.5	Yes
2	Sandy Silt - Rear Abutment	37	-932.8	Yes



Soil Properties

Property	Sandy Silt - Rear Abutment	Silt and Clay - Rear Abutment - Stantec Lab
Color		
Unit Weight [kips/ft^3]	0.135	0.129
Saturated Unit Weight [kips/ft^3]	0.139	0.129
K0	1	1
Immediate Settlement	Enabled	Disabled
Es [ksf]	417.709	-
Esur [ksf]	417.709	-
Primary Consolidation	Enabled	Enabled
Material Type	Non-Linear	Non-Linear
Cc	0.139	0.305
Cr	0.009	0.07
e0	0.3	0.692
Pc [ksf]	6	9
Cv [ft^2/d]	2.5	6
Cvr [ft^2/d]	2.5	6
B-bar	1	1
Undrained Su A [kips/ft2]	0	0
Undrained Su S	0.2	0.2
Undrained Su m	0.8	0.8
Piezo Line ID	1	1

Groundwater

Groundwater method	Piezometric Lines
Water Unit Weight	0.0624 kips/ft^3

Piezometric Line Entities

ID	Depth (ft)
1	-945.5 ft

Query Points

Point #	Query Point Name	(X,Y) Location	Number of Divisions
4	MSE Wall Face	0, 0	Auto: 50
5	Pile Location (6' from MSE Wall Face)	0, 6	Auto: 50
6	Differential Settlement Midpoint PL	-38, 6	Auto: 50
7	Differential Settlement Midpoint MSEWF	-38.2, 0	Auto: 50
8	Differential Settlement Edge PL	-76, 6	Auto: 50
9	Differential Settlement Edge MSEWF	-76, 0	Auto: 50

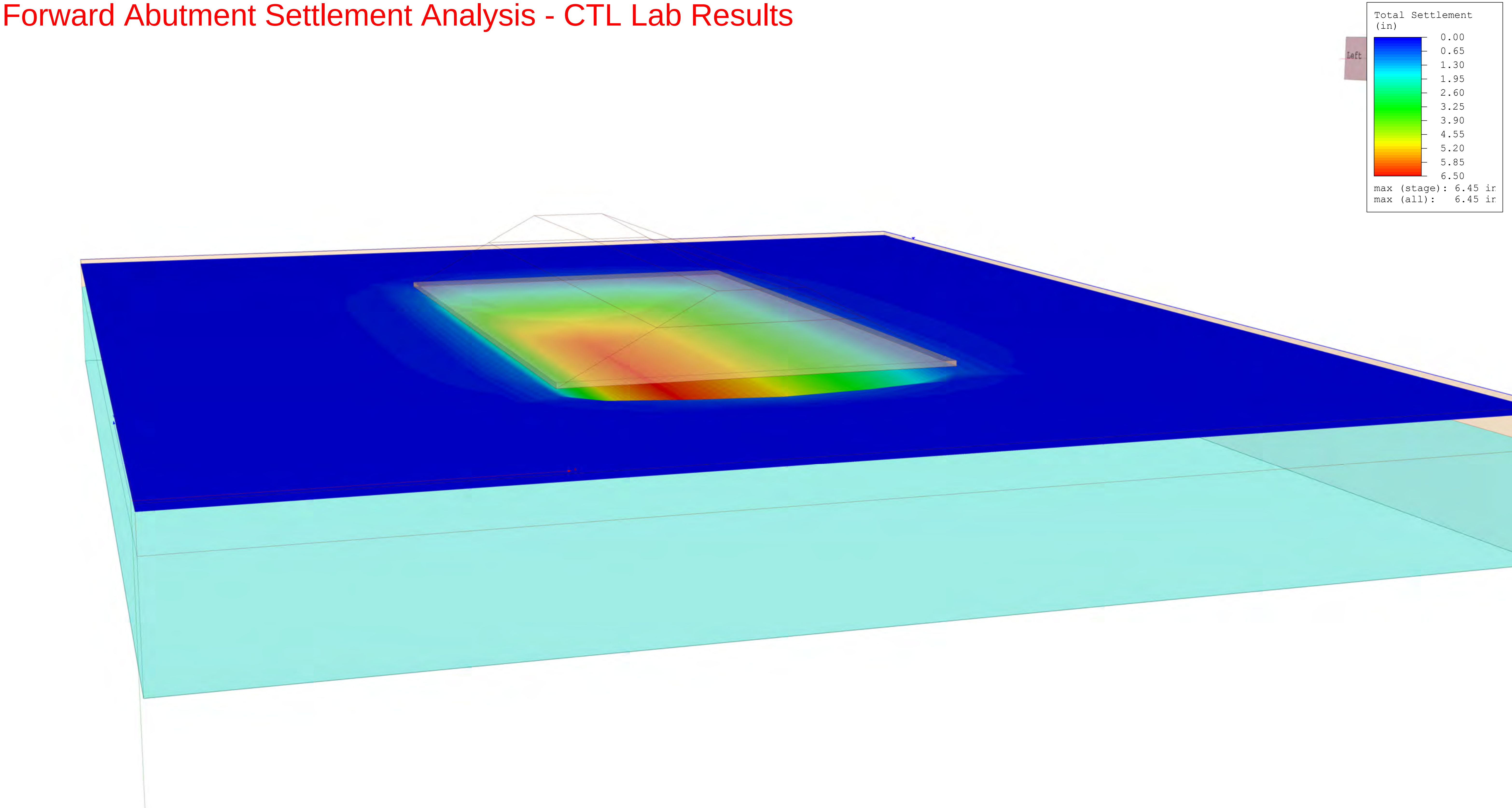
Query Lines

Line #	Query Line Name	Start Location	End Location	Horizontal Divisions	Vertical Divisions
1	MSE Wall Face Differential Settlement	-76, 0	76, 0	152	Auto: 50
2	Pile Location Differential Settlement	-76, 6	76, 6	152	Auto: 50

Time Points

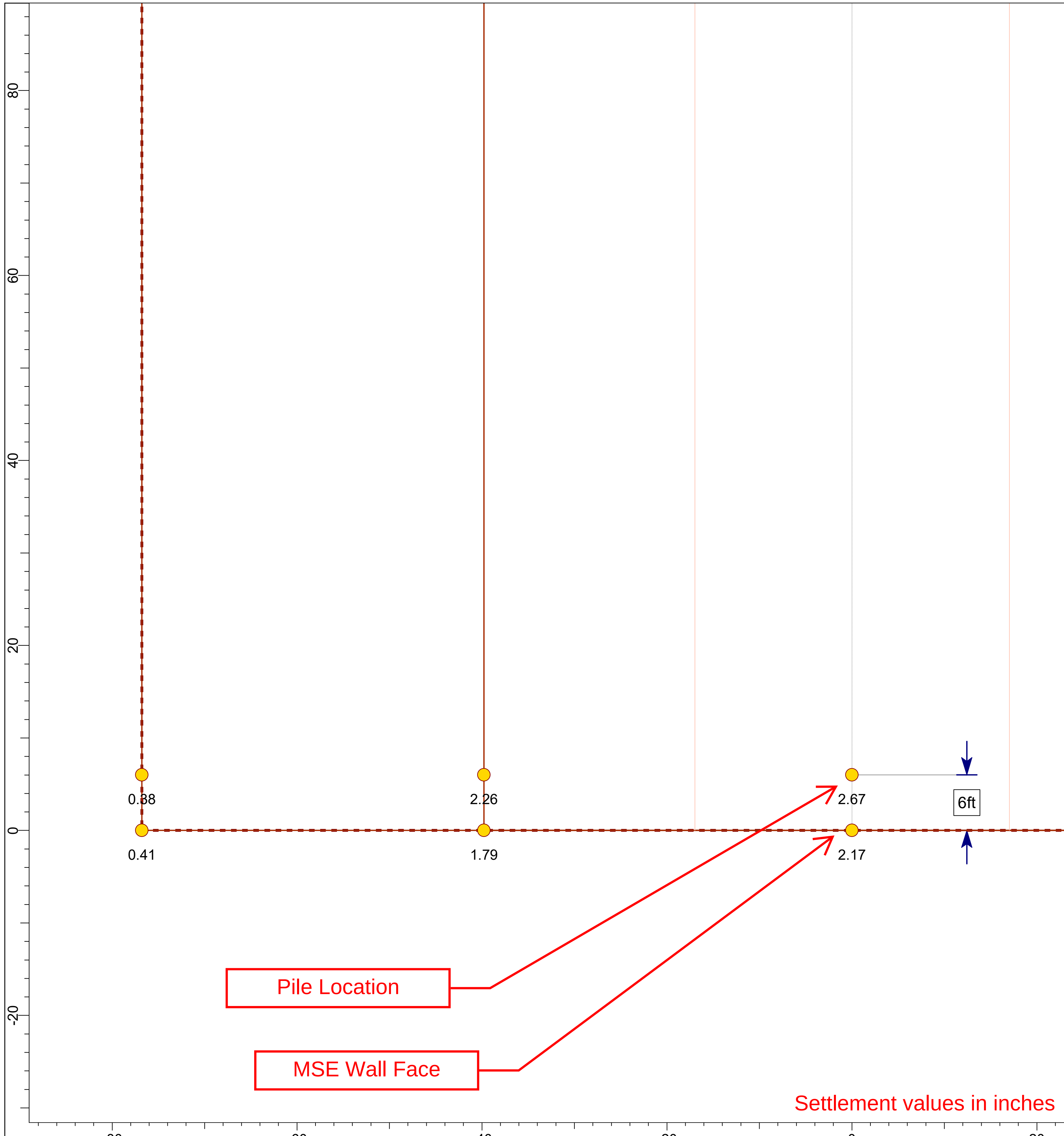
Point #	(X,Y) Location	Depth	Goal Type	Goal	Time Until Goal
1	0, 6	-943.5 ft	Degree of Consolidation	80%	2.40896 d
2	0, 6	-943.5 ft	Degree of Consolidation	90%	8.2493 d
3	0, 6	-943.5 ft	Degree of Consolidation	95%	34.1099 d
4	0, 0	-943.5 ft	Degree of Consolidation	80%	2.68162 d
5	0, 0	-943.5 ft	Degree of Consolidation	90%	9.83502 d
6	0, 0	-943.5 ft	Degree of Consolidation	95%	37.2989 d
7	0, 6	-943.5 ft	Total Settlement	3.95 in	0.240279 d
8	0, 6	-943.5 ft	Total Settlement	6.75 in	20.4614 d

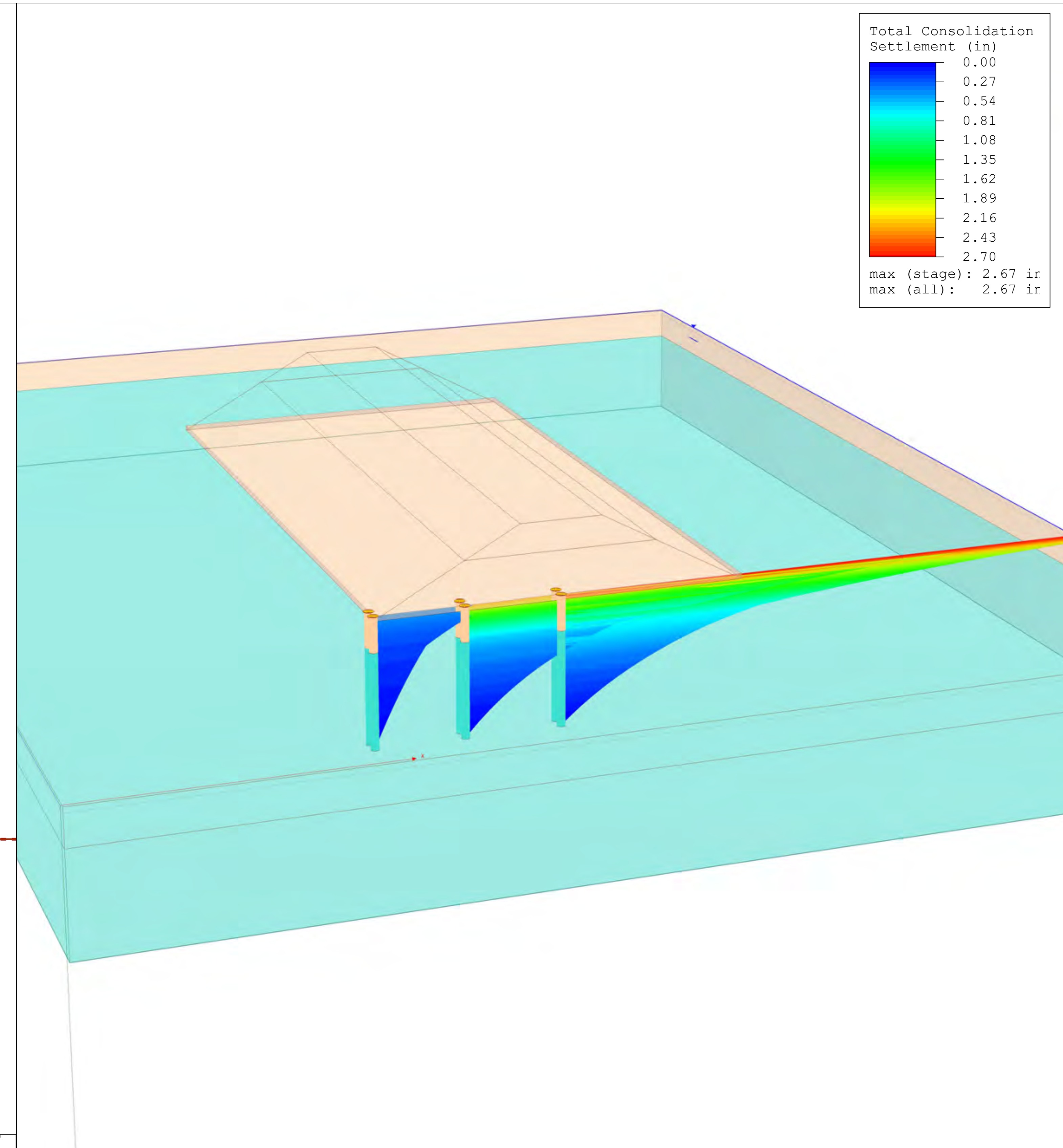
Forward Abutment Settlement Analysis - CTL Lab Results



Project	BRO 32-0359	
Analysis Description	Forward Abutment Settlement Analysis	
Drawn By: LEDT	Company: Stantec	
Date: 8/12/2020	File Name: 173620122 BRO 32-0359 Forward Abutment - CTL Lab.s3z	

SETTLE3 5.001





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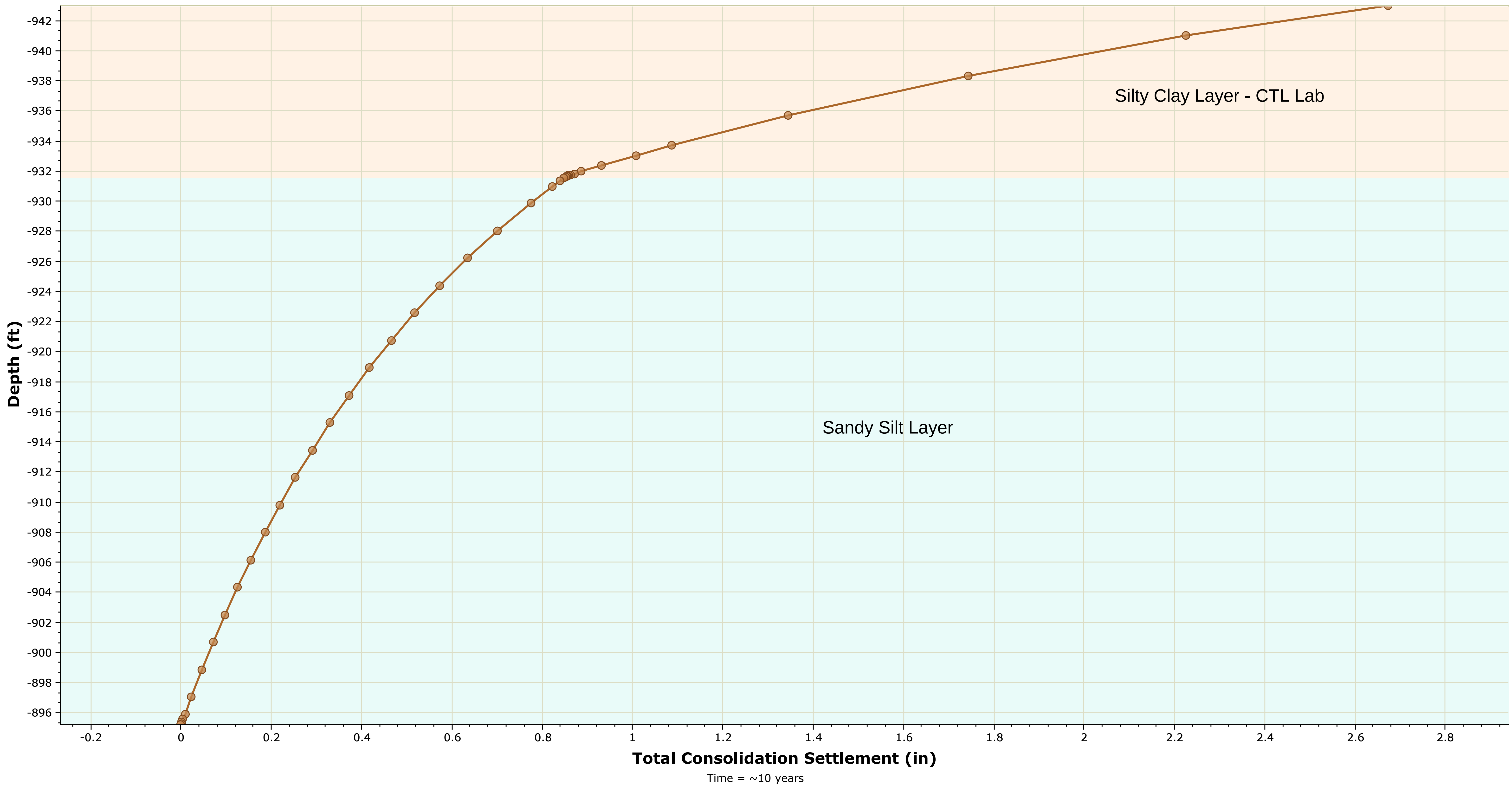
SETTLE3 5.001

Project	BRO 32-0359		
Analysis Description	Forward Abutment Settlement Analysis		
Drawn By	LEDT	*Company*	Stantec
Date	8/12/2020	*File Name*	173620122 BRO 32-0359 Forward Abutment - CTL Lab.s3z

Total Consolidation Settlement vs. Depth at Pile Location



Project	BRO 32-0359		
Analysis Description	Forward Abutment Settlement Analysis		
Drawn By	LEDT	*Company*	Stantec
Date	8/12/2020	*File Name*	173620122 BRO 32-0359 Forward Abutment - CTL Lab.s3z

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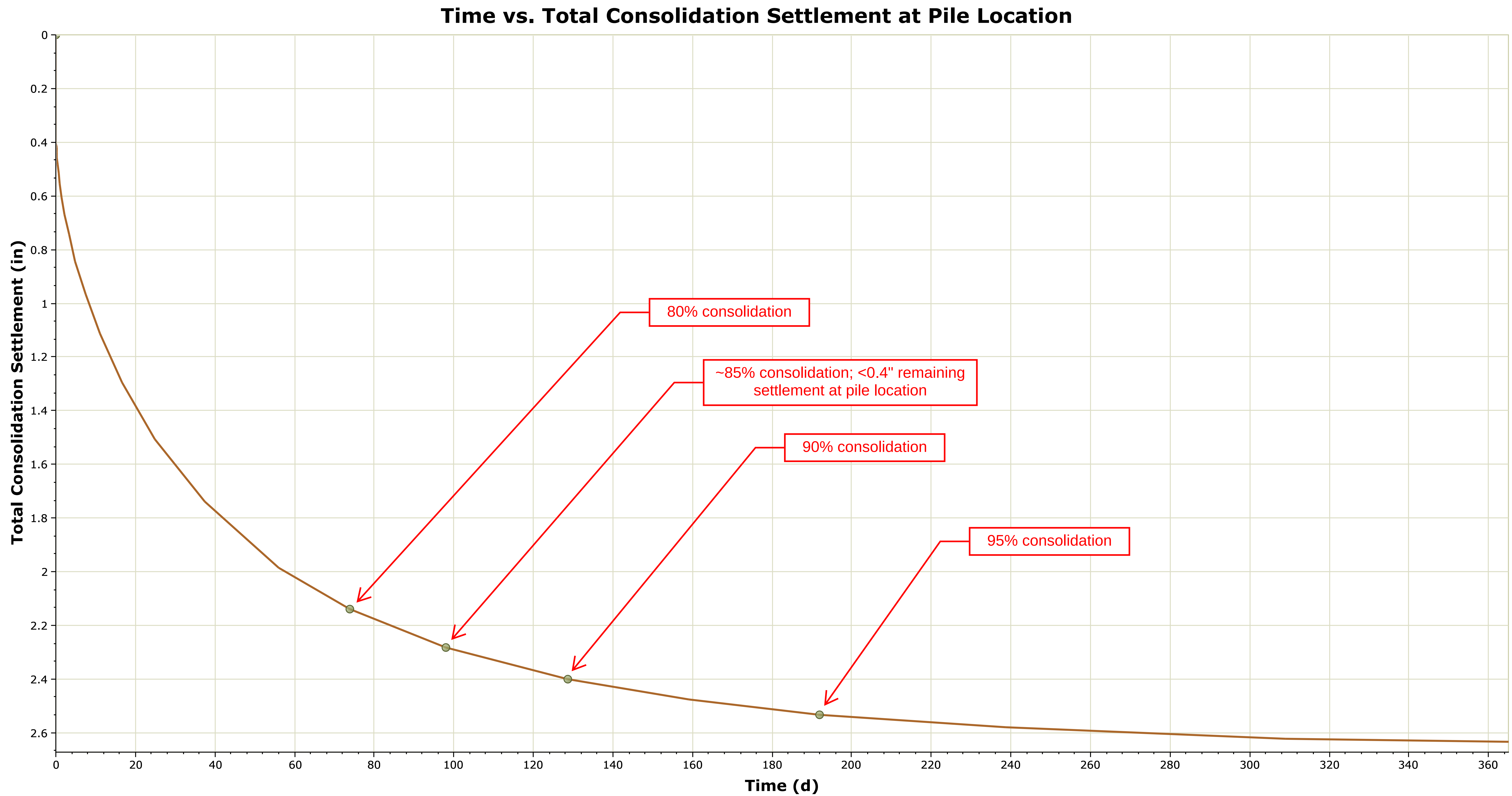


Total Consolidation Settlement at Depth = -943 ft

Project	BRO 32-0359		
Analysis Description	Forward Abutment Settlement Analysis		
Drawn By	LEDT	*Company*	Stantec
Date	8/12/2020	*File Name*	173620122 BRO 32-0359 Forward Abutment - CTL Lab.s3z

SETTLE3 5.001

Settle3 Analysis Information
BRO 32-0359

Project Settings

Document Name	173620122 BRO 32-0359 Forward Abutment - CTL Lab.s3z
Project Title	BRO 32-0359
Analysis	Forward Abutment Settlement Analysis
Author	LEDT
Company	Stantec
Date Created	8/12/2020
Comments	
Project #: 173620122	
Stress Computation Method	Boussinesq
Time-dependent Consolidation Analysis	
Time Units	days
Permeability Units	feet/day
Minimum settlement ratio for subgrade modulus	0.9

Use average properties to calculate layered stresses

Improve consolidation accuracy

Ignore negative effective stresses in settlement calculations

Stage Settings

Stage #	Name	Time [days]
1	Stage 1	0
2	CTL 80% PL	73.93
3	CTL <0.4" PL	98.09
4	CTL 90% PL	128.55
5	CTL 95% PL	191.84
6	10 years	3650

Results

Notes:

Results for Pile Location

Time taken to compute: 6.98931 seconds

Stage: Stage 1 = 0 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	1.80249
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.1332	3.71818
Effective Stress XX [ksf]	-0.770197	5.6386
Effective Stress YY [ksf]	-0.289841	7.32776
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0	0.00538421
Pore Water Pressure [ksf]	-0.0653159	4.476
Excess Pore Water Pressure [ksf]	-0.0653159	2.99588
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1.61431	19.74
Void Ratio	0.293001	0.73
Permeability [ft/d]	4.79101e-005	0.000528427
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	17.1342
Undrained Shear Strength	0	0

Stage: CTL 80% PL = 73.93 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	3.94237
Total Consolidation Settlement [in]	0	2.13988
Virgin Consolidation Settlement [in]	0	0.00104129
Recompression Consolidation Settlement [in]	0	2.13884
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00136947	0.0179351
Pore Water Pressure [ksf]	0	2.98272
Excess Pore Water Pressure [ksf]	-0.00656079	1.74545
Degree of Consolidation [%]	0	99.96
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	25.1056
Void Ratio	0.287918	0.732591
Permeability [ft/d]	4.79101e-005	0.000528427
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	54.9311	82.9027
Undrained Shear Strength	0	0.190311

Stage: CTL <0.4" PL = 98.09 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.08607
Total Consolidation Settlement [in]	0	2.28358
Virgin Consolidation Settlement [in]	0	0.0011493
Recompression Consolidation Settlement [in]	0	2.28243
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00131503	0.0181411
Pore Water Pressure [ksf]	0	2.98272
Excess Pore Water Pressure [ksf]	-0.000393117	1.42531
Degree of Consolidation [%]	0	99.9759
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	25.0271
Void Ratio	0.287918	0.732544
Permeability [ft/d]	4.79101e-005	0.000528427
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	62.7551	89.6972
Undrained Shear Strength	0	0.190311

Stage: CTL 90% PL = 128.55 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.20227
Total Consolidation Settlement [in]	0	2.39979
Virgin Consolidation Settlement [in]	0	0.00125778
Recompression Consolidation Settlement [in]	0	2.39853
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00124512	0.0183089
Pore Water Pressure [ksf]	0	2.98272
Excess Pore Water Pressure [ksf]	0	1.09432
Degree of Consolidation [%]	0	99.9873
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	24.9272
Void Ratio	0.287917	0.732484
Permeability [ft/d]	4.79101e-005	0.000528427
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	71.0672	94.5597
Undrained Shear Strength	0	0.190311

Stage: CTL 95% PL = 191.84 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.33479
Total Consolidation Settlement [in]	0	2.53231
Virgin Consolidation Settlement [in]	0	0.0024624
Recompression Consolidation Settlement [in]	0	2.52984
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00113069	0.0185095
Pore Water Pressure [ksf]	0	2.98272
Excess Pore Water Pressure [ksf]	-0.00237121	0.630299
Degree of Consolidation [%]	0	99.9966
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	24.7658
Void Ratio	0.287917	0.732385
Permeability [ft/d]	4.79101e-005	0.000528427
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	83.235	98.5567
Undrained Shear Strength	0	0.190311

Stage: 10 years = 3650 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.47491
Total Consolidation Settlement [in]	0	2.67242
Virgin Consolidation Settlement [in]	0	0.032974
Recompression Consolidation Settlement [in]	0	2.63945
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.000964949	0.0187427
Pore Water Pressure [ksf]	0	2.98272
Excess Pore Water Pressure [ksf]	-0.00617684	0.00486728
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	24.5369
Void Ratio	0.287917	0.732241
Permeability [ft/d]	4.79101e-005	0.000528427
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	99.999	100
Undrained Shear Strength	0	0.254199

Embankments

Notes:

Embankment bottom sits at Elevation 943.0 ft

1. Embankment: "MSE Wall Reinforced Fill and Retained Wedge Fill"

Label	MSE Wall Reinforced Fill and Retained Wedge Fill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	153.6

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	18.5	0.12	26.5651	0

2. Embankment: "Abutment Wall Backfill"

Label	Abutment Wall Backfill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	79.6

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	11.4	0.125	26.5651	0

Excavations

1. Excavation: "Excavation to Bottom of MSE"

Depth	-943 ft
Installation Stage	Stage 1 = 0 d

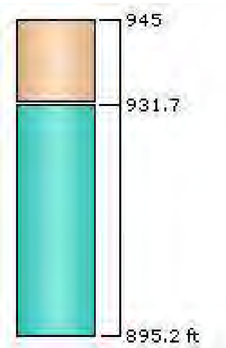
Coordinates

X [ft]	Y [ft]
76.8	0
76.8	300
-76.8	300
-76.8	0

Soil Layers

Ground Surface Drained: Yes

Layer #	Type	Thickness [ft]	Depth [ft]	Drained at Bottom
1	Silty Clay - Forward Abutment - CTL Lab	13.3	-945	Yes
2	Sandy Silt - Forward Abutment	36.5	-931.7	Yes



Soil Properties

Property	Silty Clay - Forward Abutment - CTL Lab	Sandy Silt - Forward Abutment
Color		
Unit Weight [kips/ft^3]	0.129	0.135
Saturated Unit Weight [kips/ft^3]	0.129	0.14
K0	1	1
Immediate Settlement	Disabled	Enabled
Es [ksf]	-	417.709
Esur [ksf]	-	417.709
Primary Consolidation	Enabled	Enabled
Material Type	Non-Linear	Non-Linear
Cc	0.11	0.139
Cr	0.027	0.009
e0	0.73	0.3
Pc [ksf]	3.2	6
Cv [ft^2/d]	0.1	2.5
Cvr [ft^2/d]	0.1	2.5
B-bar	1	1
Undrained Su A [kips/ft2]	0	0
Undrained Su S	0.2	0.2
Undrained Su m	0.8	0.8
Piezo Line ID	1	1

Groundwater

Groundwater method	Piezometric Lines
Water Unit Weight	0.0624 kips/ft^3

Piezometric Line Entities

ID	Depth (ft)
1	-945 ft

Query Points

Point #	Query Point Name	(X,Y) Location	Number of Divisions
1	Pile Location	0, 6	Auto: 50
2	MSE Wall Face	0, 0	Auto: 50
3	Differential Settlement Edge PL	-76.8, 6	Auto: 50
4	Differential Settlement Edge MSEWF	-76.8, 0	Auto: 50
5	Differential Settlement Midpoint PL	-39.8, 6	Auto: 50
6	Differential Settlement Midpoint MSEWF	-39.8, 0	Auto: 50

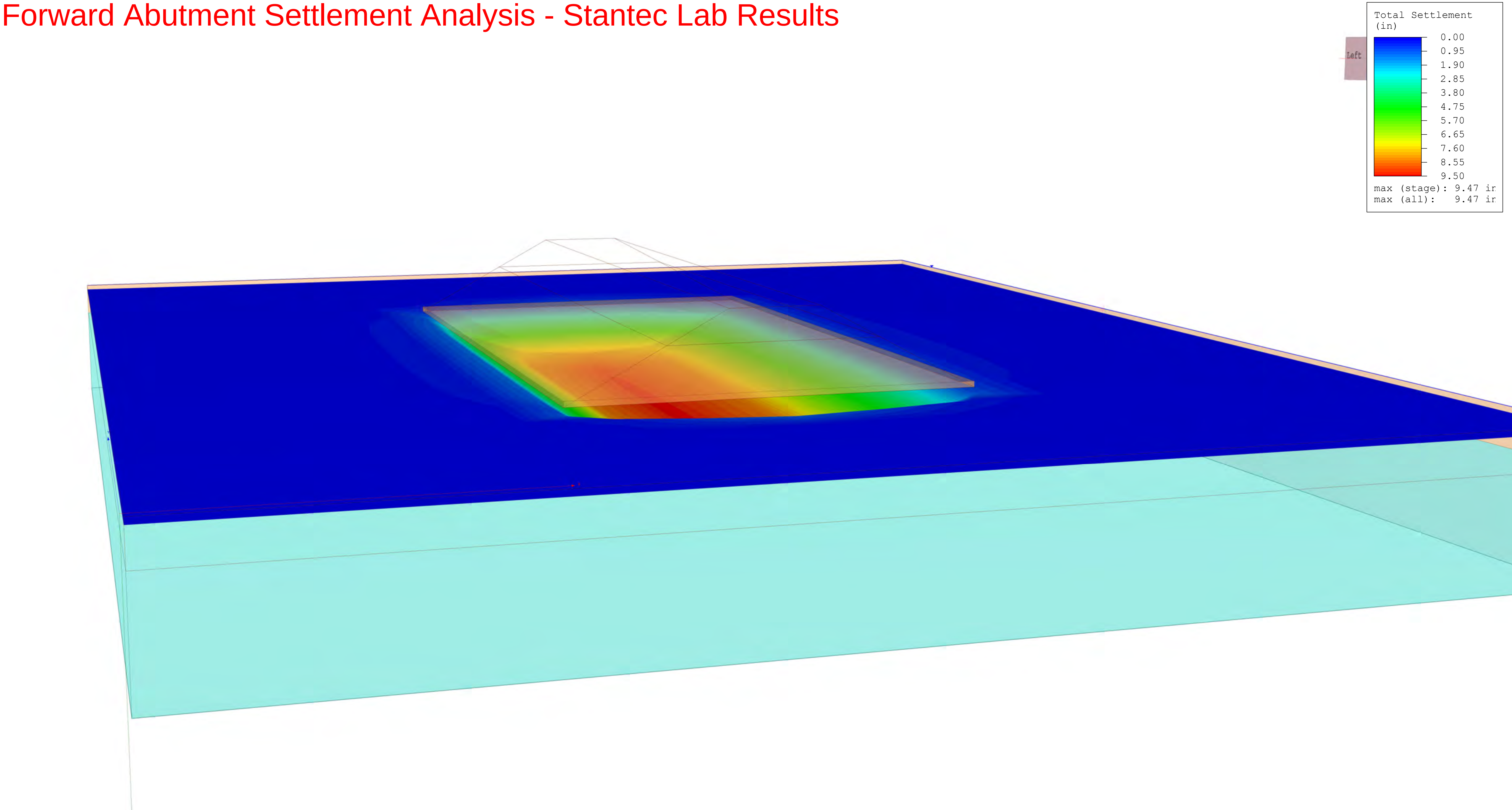
Query Lines

Line #	Query Line Name	Start Location	End Location	Horizontal Divisions	Vertical Divisions
1	Pile Location Differential Settlement	-76.8, 6	76.8, 6	154	Auto: 50
2	MSE Wall Face Differential Settlement	-76.8, 0	76.8, 0	154	Auto: 50

Time Points

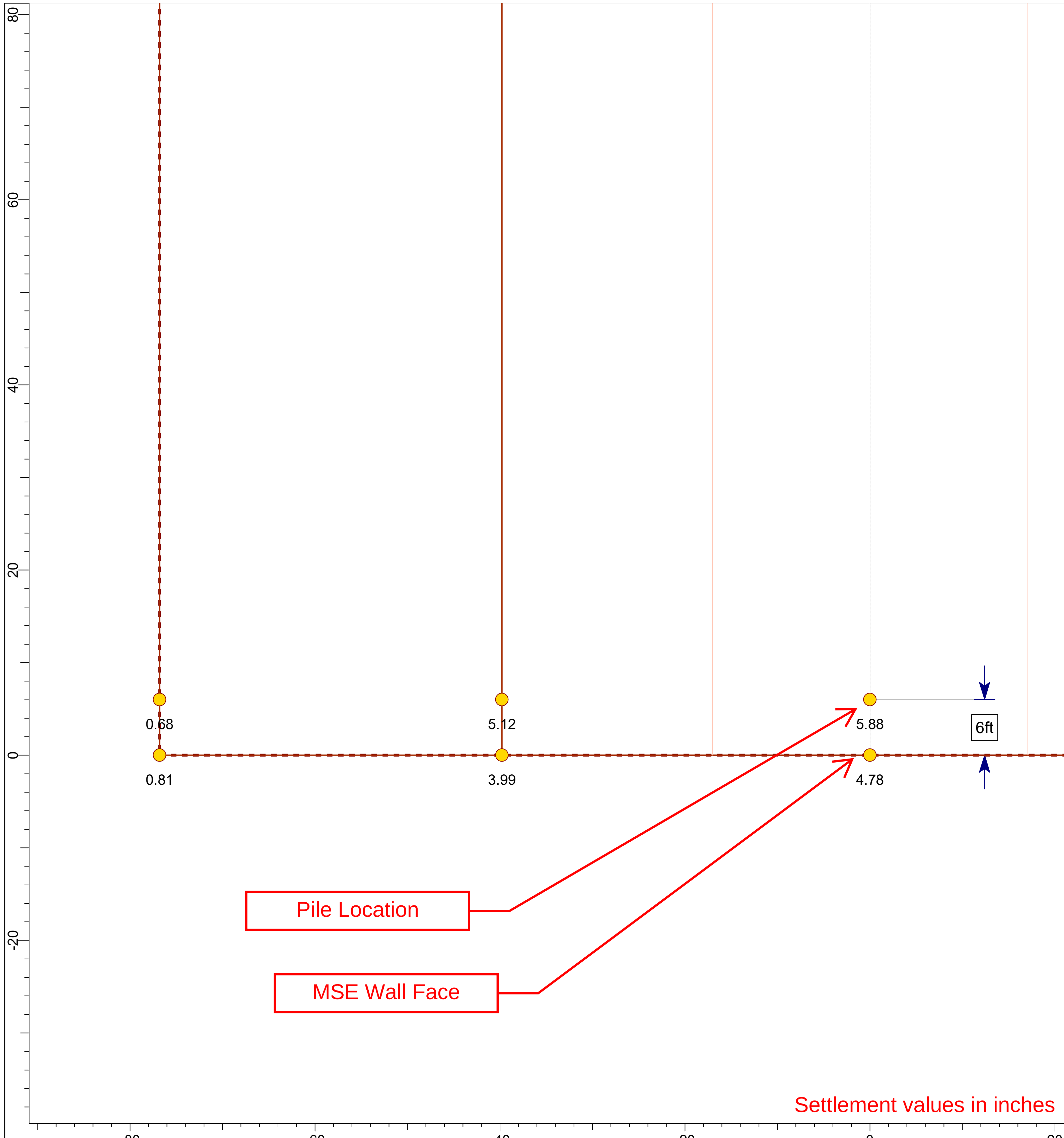
Point #	(X,Y) Location	Depth	Goal Type	Goal	Time Until Goal
1	0, 6	-943 ft	Degree of Consolidation	80%	73.9285 d
2	0, 6	-943 ft	Degree of Consolidation	90%	128.553 d
3	0, 6	-943 ft	Degree of Consolidation	95%	191.843 d
4	0, 0	-943 ft	Degree of Consolidation	80%	79.376 d
5	0, 0	-943 ft	Degree of Consolidation	90%	136.15 d
6	0, 0	-943 ft	Degree of Consolidation	95%	201.133 d
7	0, 6	-943 ft	Total Settlement	4 in	98.0858 d

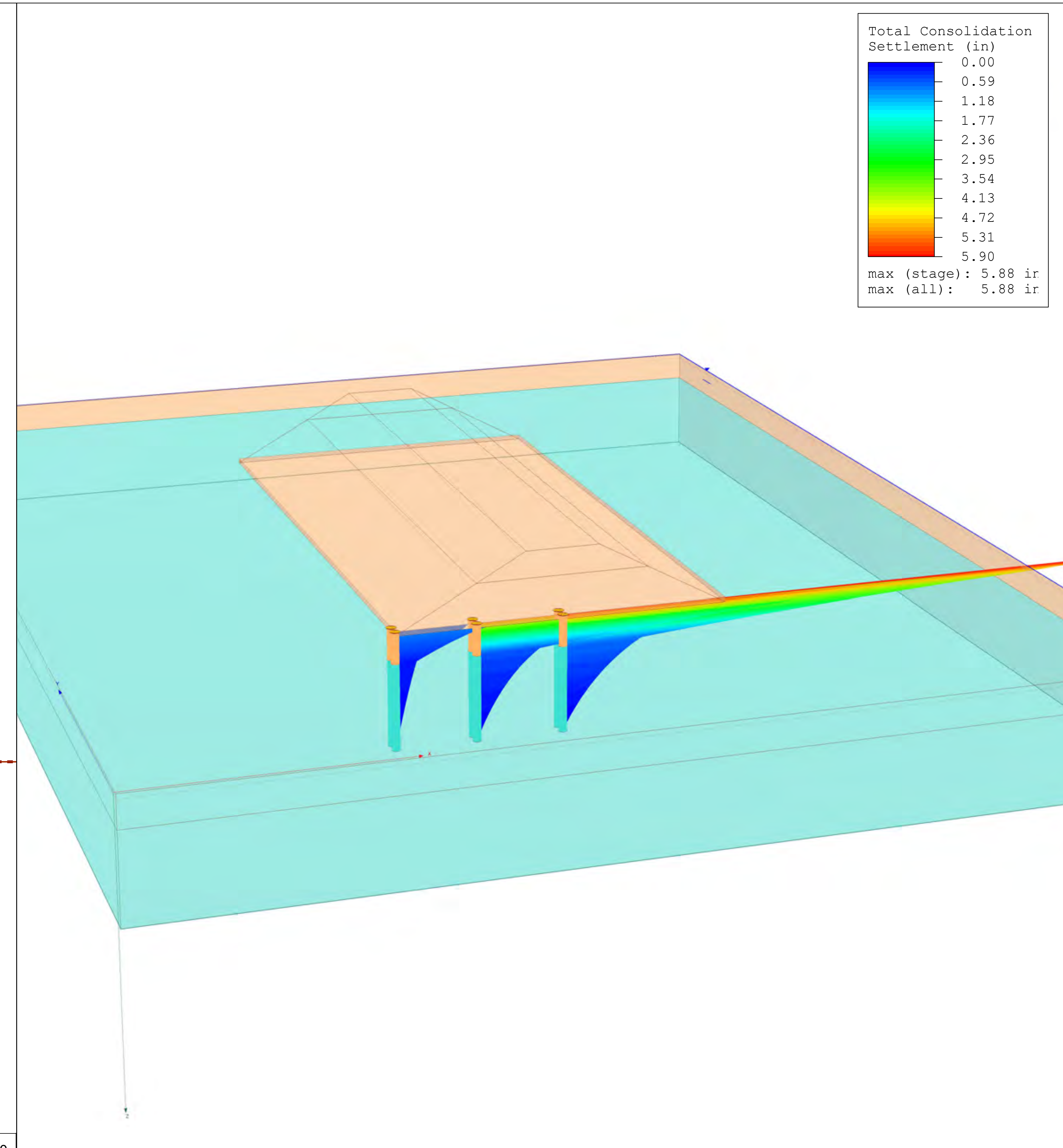
Forward Abutment Settlement Analysis - Stantec Lab Results



Project	BRO 32-0359		
Analysis Description	Forward Abutment Settlement Analysis		
Drawn By	LEDT	Company	Stantec
Date	8/12/2020	File Name	173620122 BRO 32-0359 Forward Abutment - Stantec Lab.s3z

SETTLE3 5.001

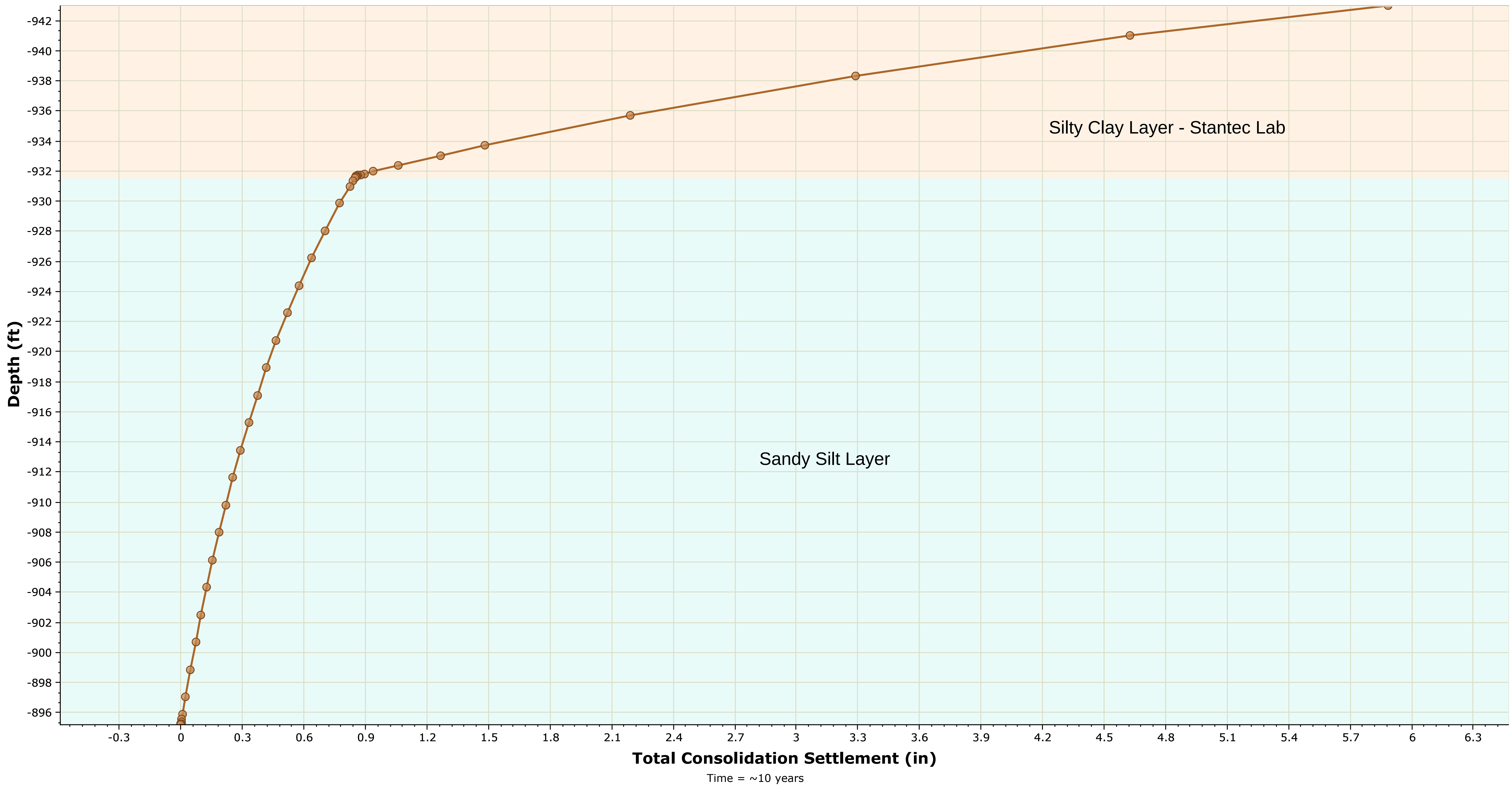




SETTLE3 5.001

Project	BRO 32-0359		
Analysis Description	Forward Abutment Settlement Analysis		
Drawn By	LEDT	Company	Stantec
Date	8/12/2020	File Name	173620122 BRO 32-0359 Forward Abutment - Stantec Lab.s3z

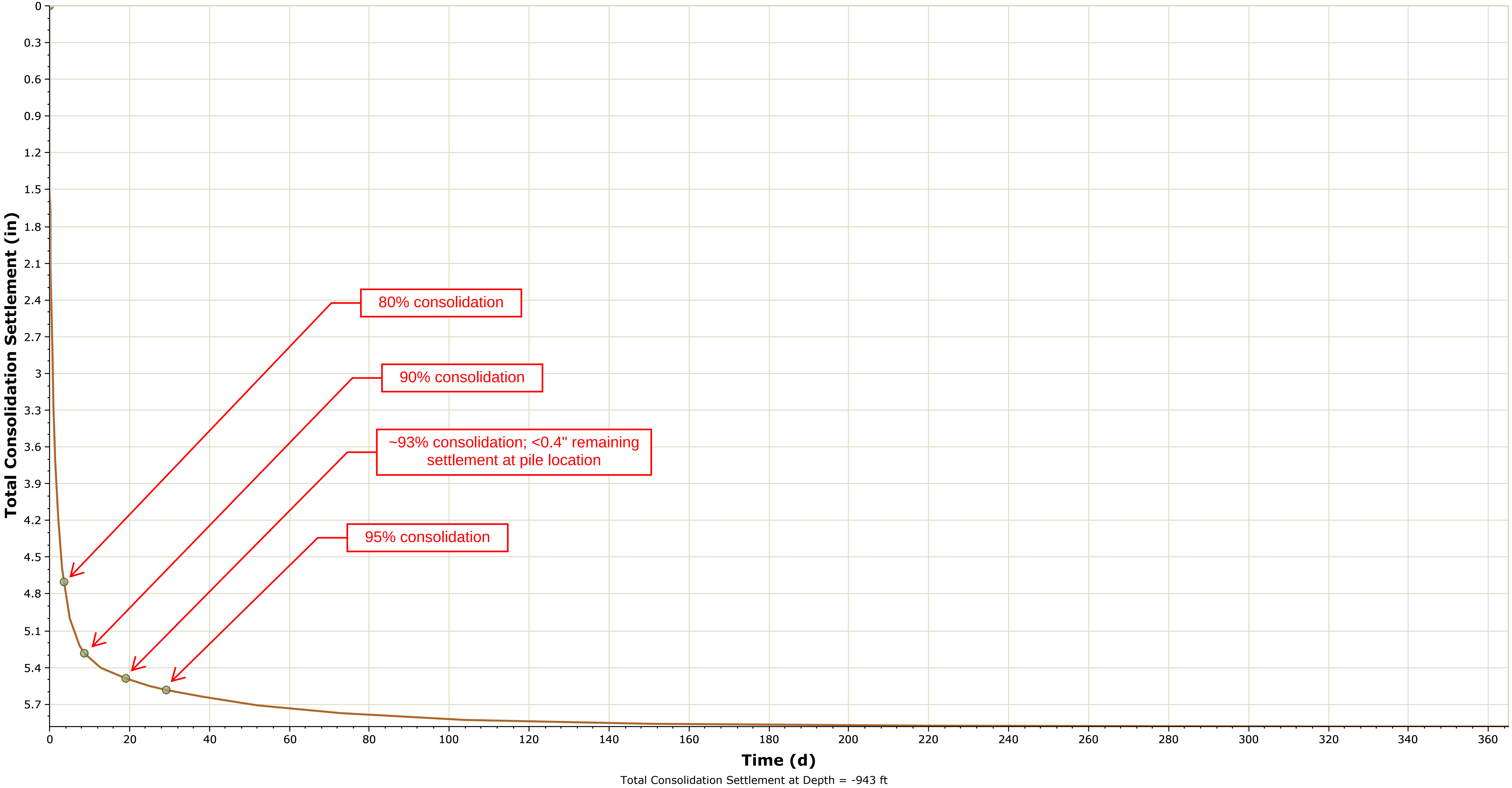
Total Consolidation Settlement vs. Depth at Pile Location



Project	BRO 32-0359
Analysis Description	Forward Abutment Settlement Analysis
Drawn By LEDT	*Company* Stantec
Date 8/12/2020	*File Name* 173620122 BRO 32-0359 Forward Abutment - Stantec Lab.s3z

SETTLE3 5.001

Time vs. Total Consolidation Settlement at Pile Location



Project	BRO 32-0359		
Analysis Description	Forward Abutment Settlement Analysis		
Drawn By	LEDT	Company	Stantec
Date	8/12/2020	File Name	173620122 BRO 32-0359 Forward Abutment - Stantec Lab.s3z

SETTLE3 5.001

Settle3 Analysis Information
BRO 32-0359

Project Settings

Document Name	173620122 BRO 32-0359 Forward Abutment - Stantec Lab.s3z
Project Title	BRO 32-0359
Analysis	Forward Abutment Settlement Analysis
Author	LEDT
Company	Stantec
Date Created	8/12/2020
Comments	
Project #: 173620122	
Stress Computation Method	Boussinesq
Time-dependent Consolidation Analysis	
Time Units	days
Permeability Units	feet/day
Minimum settlement ratio for subgrade modulus	0.9

Use average properties to calculate layered stresses

Improve consolidation accuracy

Ignore negative effective stresses in settlement calculations

Stage Settings

Stage #	Name	Time [days]
1	Stage 1	0
2	Stantec 80% PL	3.56
3	Stantec 90% PL	8.77
4	Stantec <0.4" PL	19.06
5	Stantec 95% PL	29.26
6	10 years	3650

Results

Notes:

Results for Pile Location

Time taken to compute: 9.18329 seconds

Stage: Stage 1 = 0 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	1.80249
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.1332	3.71818
Effective Stress XX [ksf]	-0.770197	5.6386
Effective Stress YY [ksf]	-0.289841	7.32776
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0	0.00538421
Pore Water Pressure [ksf]	-0.0653159	4.476
Excess Pore Water Pressure [ksf]	-0.0653159	2.99588
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	6	8
Over-consolidation Ratio	1.61431	49.3501
Void Ratio	0.293001	0.484
Permeability [ft/d]	0.000126337	0.0297801
Coefficient of Consolidation [ft^2/d]	2.5	4
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	17.1342
Undrained Shear Strength	0	0

Stage: Stantec 80% PL = 3.56 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	6.50215
Total Consolidation Settlement [in]	0	4.69966
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	4.69966
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00341254	0.0515298
Pore Water Pressure [ksf]	0	4.02167
Excess Pore Water Pressure [ksf]	0	1.96107
Degree of Consolidation [%]	0	99.677
Pre-consolidation Stress [ksf]	6	8
Over-consolidation Ratio	1.15283	62.2144
Void Ratio	0.287931	0.489919
Permeability [ft/d]	0.000126337	0.0297801
Coefficient of Consolidation [ft^2/d]	2.5	4
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	19.1834	79.5022
Undrained Shear Strength	0	0

Stage: Stantec 90% PL = 8.77 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	7.08659
Total Consolidation Settlement [in]	0	5.28411
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	5.28411
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00282268	0.0524409
Pore Water Pressure [ksf]	0	3.85559
Excess Pore Water Pressure [ksf]	0	1.82698
Degree of Consolidation [%]	0	99.7958
Pre-consolidation Stress [ksf]	6	8
Over-consolidation Ratio	1.15243	61.4818
Void Ratio	0.287925	0.489481
Permeability [ft/d]	0.000126337	0.0297801
Coefficient of Consolidation [ft^2/d]	2.5	4
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	29.843	96.7687
Undrained Shear Strength	0	0

Stage: Stantec <0.4" PL = 19.06 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	7.29517
Total Consolidation Settlement [in]	0	5.49268
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	5.49268
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00271108	0.0525968
Pore Water Pressure [ksf]	0	3.63389
Excess Pore Water Pressure [ksf]	0	1.58385
Degree of Consolidation [%]	0	99.8648
Pre-consolidation Stress [ksf]	6	8
Over-consolidation Ratio	1.15221	61.3458
Void Ratio	0.287922	0.489398
Permeability [ft/d]	0.000126337	0.0297801
Coefficient of Consolidation [ft^2/d]	2.5	4
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	43.9877	99.9161
Undrained Shear Strength	0	0

Stage: Stantec 95% PL = 29.26 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	7.3856
Total Consolidation Settlement [in]	0	5.58312
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	5.58312
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00270819	0.0526008
Pore Water Pressure [ksf]	0	3.42786
Excess Pore Water Pressure [ksf]	0	1.30975
Degree of Consolidation [%]	0	99.8959
Pre-consolidation Stress [ksf]	6	8
Over-consolidation Ratio	1.1521	61.3423
Void Ratio	0.28792	0.489396
Permeability [ft/d]	0.000126337	0.0297801
Coefficient of Consolidation [ft^2/d]	2.5	4
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	54.5631	99.9978
Undrained Shear Strength	0	0

Stage: 10 years = 3650 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	7.68585
Total Consolidation Settlement [in]	0	5.88336
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	5.88336
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00270811	0.0526009
Pore Water Pressure [ksf]	0	2.98272
Excess Pore Water Pressure [ksf]	-1.61455e-017	2.1021e-017
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [ksf]	6	8
Over-consolidation Ratio	1.15156	61.3422
Void Ratio	0.287917	0.489396
Permeability [ft/d]	0.000126337	0.0297801
Coefficient of Consolidation [ft^2/d]	2.5	4
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	100	100
Undrained Shear Strength	0	0

Embankments

Notes:

Embankment bottom sits at Elevation 943.0 ft

1. Embankment: "MSE Wall Reinforced Fill and Retained Wedge Fill"

Label	MSE Wall Reinforced Fill and Retained Wedge Fill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	153.6

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	18.5	0.12	26.5651	0

2. Embankment: "Abutment Wall Backfill"

Label	Abutment Wall Backfill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	79.6

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	11.4	0.125	26.5651	0

Excavations

1. Excavation: "Excavation to Bottom of MSE"

Depth	-943 ft
Installation Stage	Stage 1 = 0 d

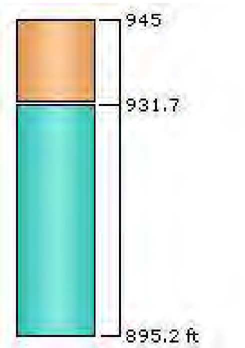
Coordinates

X [ft]	Y [ft]
76.8	0
76.8	300
-76.8	300
-76.8	0

Soil Layers

Ground Surface Drained: Yes

Layer #	Type	Thickness [ft]	Depth [ft]	Drained at Bottom
1	Silty Clay - Forward Abutment - Stantec Lab	13.3	-945	Yes
2	Sandy Silt - Forward Abutment	36.5	-931.7	Yes



Soil Properties

Property	Sandy Silt - Forward Abutment	Silty Clay - Forward Abutment - Stantec Lab
Color		
Unit Weight [kips/ft^3]	0.135	0.129
Saturated Unit Weight [kips/ft^3]	0.14	0.129
K0	1	1
Immediate Settlement	Enabled	Disabled
Es [ksf]	417.709	-
Esur [ksf]	417.709	-
Primary Consolidation	Enabled	Enabled
Material Type	Non-Linear	Non-Linear
Cc	0.139	0.205
Cr	0.009	0.065
e0	0.3	0.484
Pc [ksf]	6	8
Cv [ft^2/d]	2.5	4
Cvr [ft^2/d]	2.5	4
B-bar	1	1
Undrained Su A [kips/ft2]	0	0
Undrained Su S	0.2	0.2
Undrained Su m	0.8	0.8
Piezo Line ID	1	1

Groundwater

Groundwater method Piezometric Lines
Water Unit Weight 0.0624 kips/ft^3

Piezometric Line Entities

ID	Depth (ft)
1	-945 ft

Query Points

Point #	Query Point Name	(X,Y) Location	Number of Divisions
1	Pile Location	0, 6	Auto: 50
2	MSE Wall Face	0, 0	Auto: 50
3	Differential Settlement Edge PL	-76.8, 6	Auto: 50
4	Differential Settlement Edge MSEWF	-76.8, 0	Auto: 50
5	Differential Settlement Midpoint PL	-39.8, 6	Auto: 50
6	Differential Settlement Midpoint MSEWF	-39.8, 0	Auto: 50

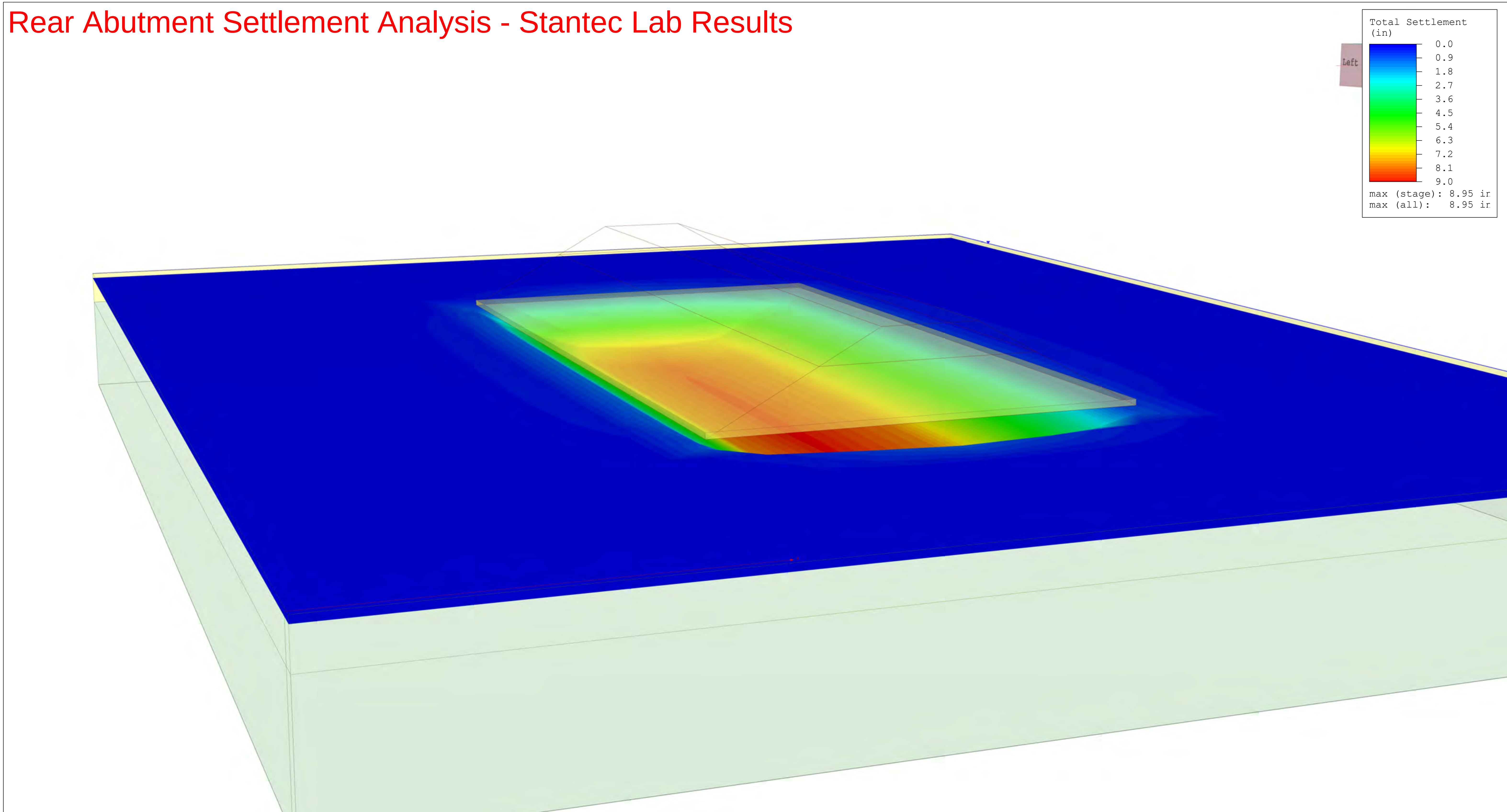
Query Lines

Line #	Query Line Name	Start Location	End Location	Horizontal Divisions	Vertical Divisions
1	Pile Location Differential Settlement	-76.8, 6	76.8, 6	154	Auto: 50
2	MSE Wall Face Differential Settlement	-76.8, 0	76.8, 0	154	Auto: 50

Time Points

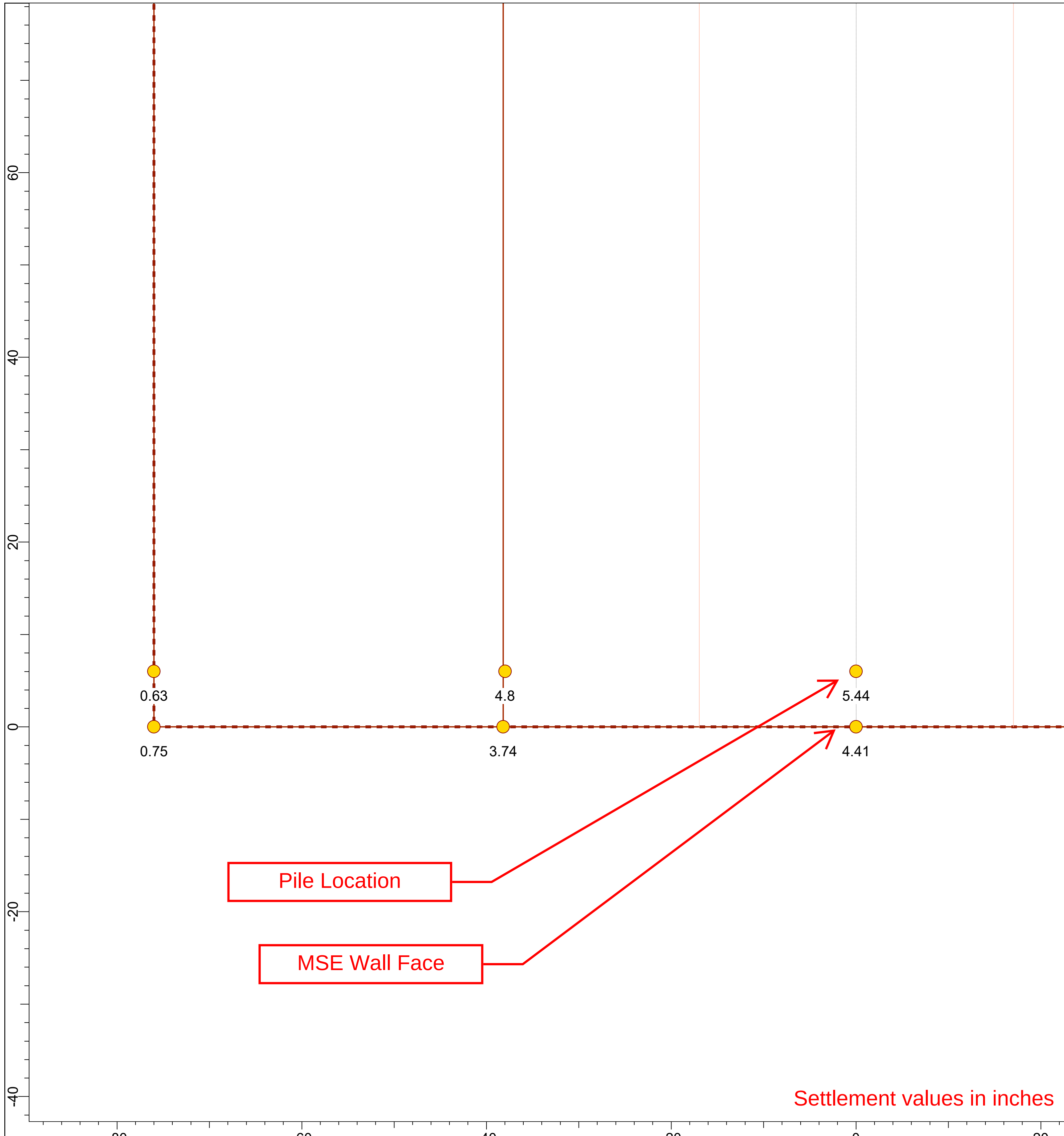
Point #	(X,Y) Location	Depth	Goal Type	Goal	Time Until Goal
1	0, 6	-943 ft	Degree of Consolidation	80%	3.56231 d
2	0, 6	-943 ft	Degree of Consolidation	90%	8.76738 d
3	0, 6	-943 ft	Degree of Consolidation	95%	29.2612 d
4	0, 0	-943 ft	Degree of Consolidation	80%	3.93341 d
5	0, 0	-943 ft	Degree of Consolidation	90%	9.72494 d
6	0, 0	-943 ft	Degree of Consolidation	95%	32.2528 d
7	0, 6	-943 ft	Total Settlement	4 in	0.325587 d
8	0, 6	-943 ft	Total Settlement	7.17 in	19.0605 d

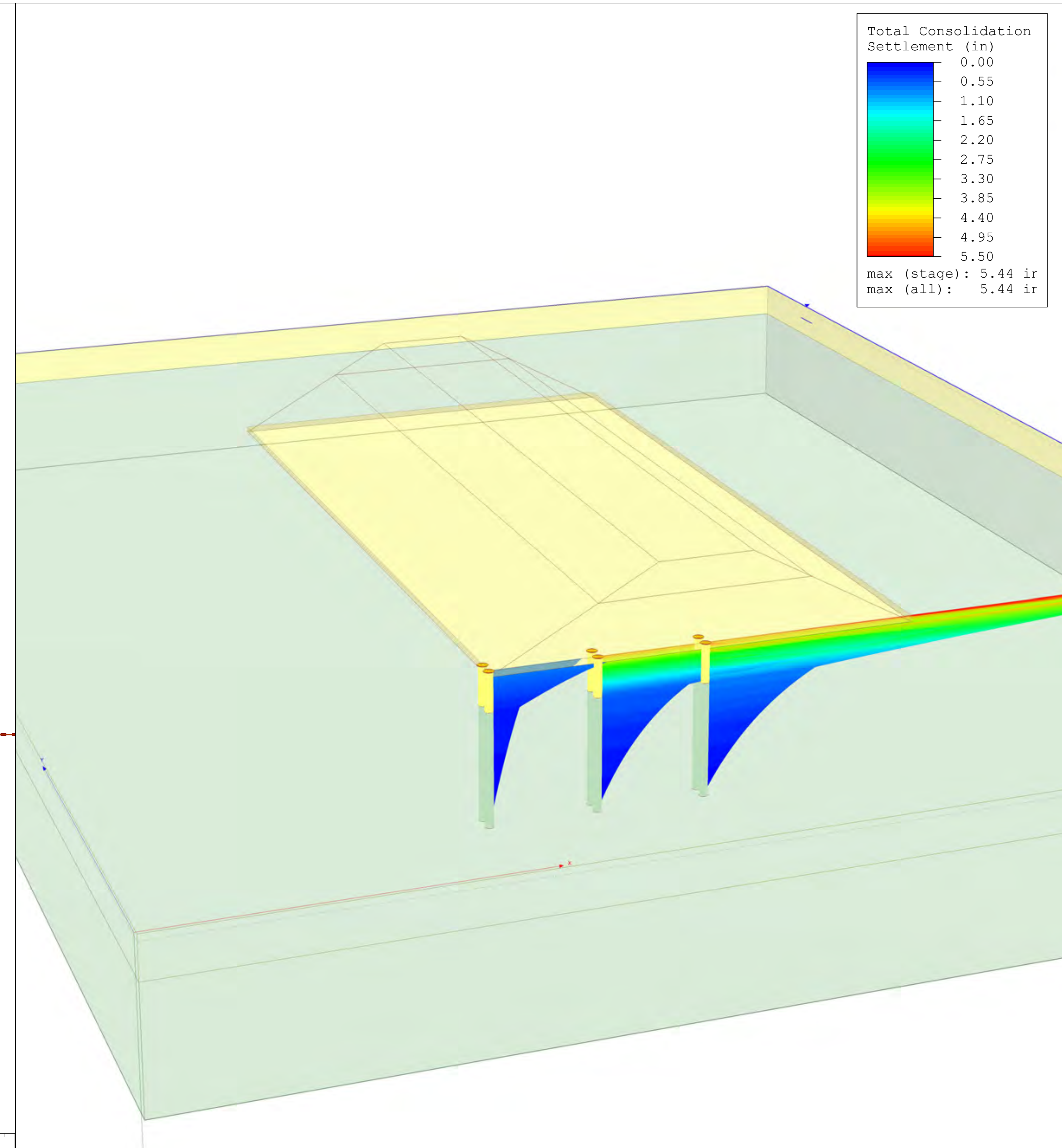
Rear Abutment Settlement Analysis - Stantec Lab Results



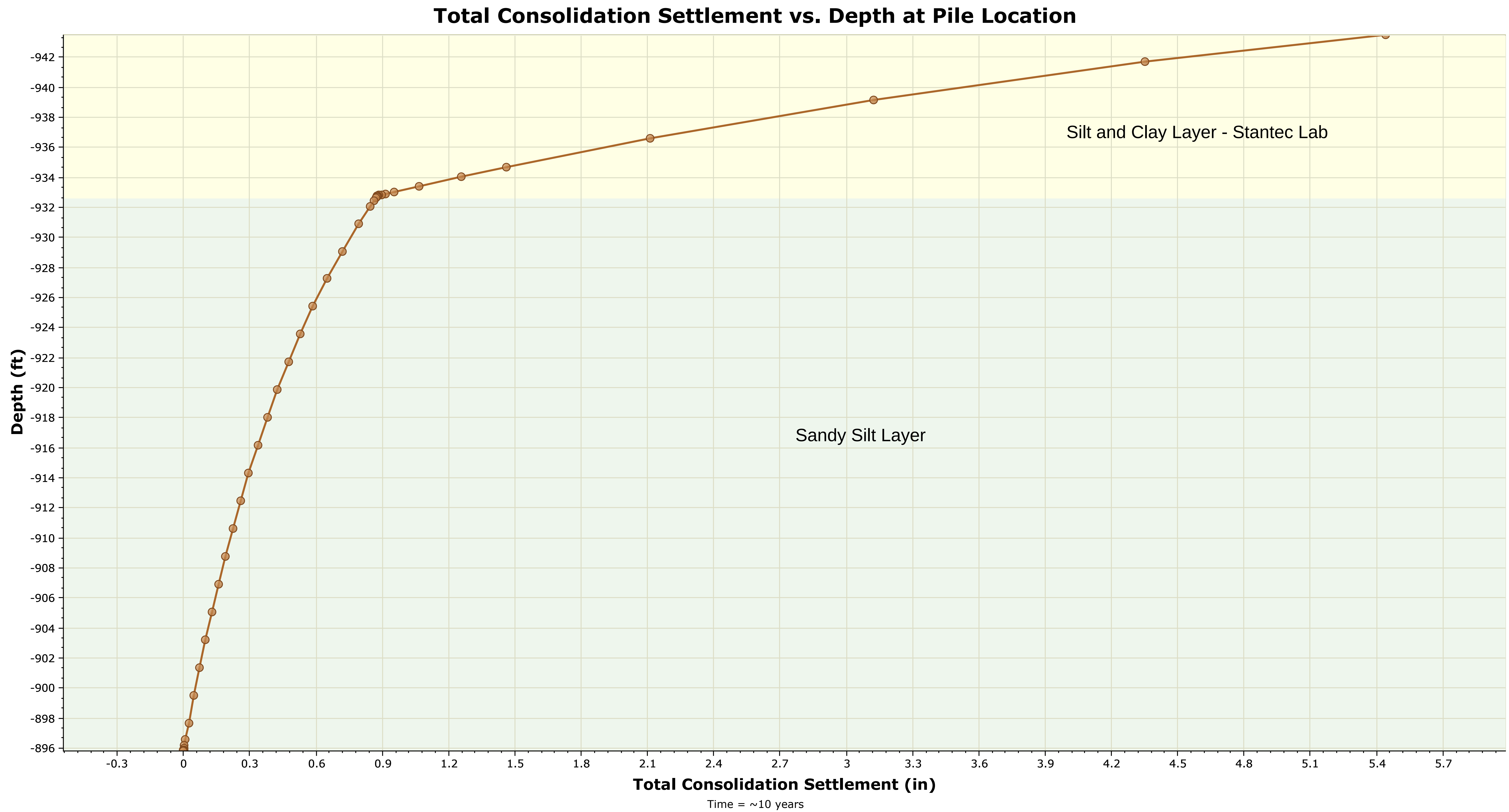
Project	BRO 32-0359		
Analysis Description	Rear Abutment Settlement Analysis		
Drawn By	LEDT	Company	Stantec
Date	8/12/2020	File Name	173620122 BRO 32-0359 Rear Abutment - Stantec Lab.s3z

SETTLE3 5.001



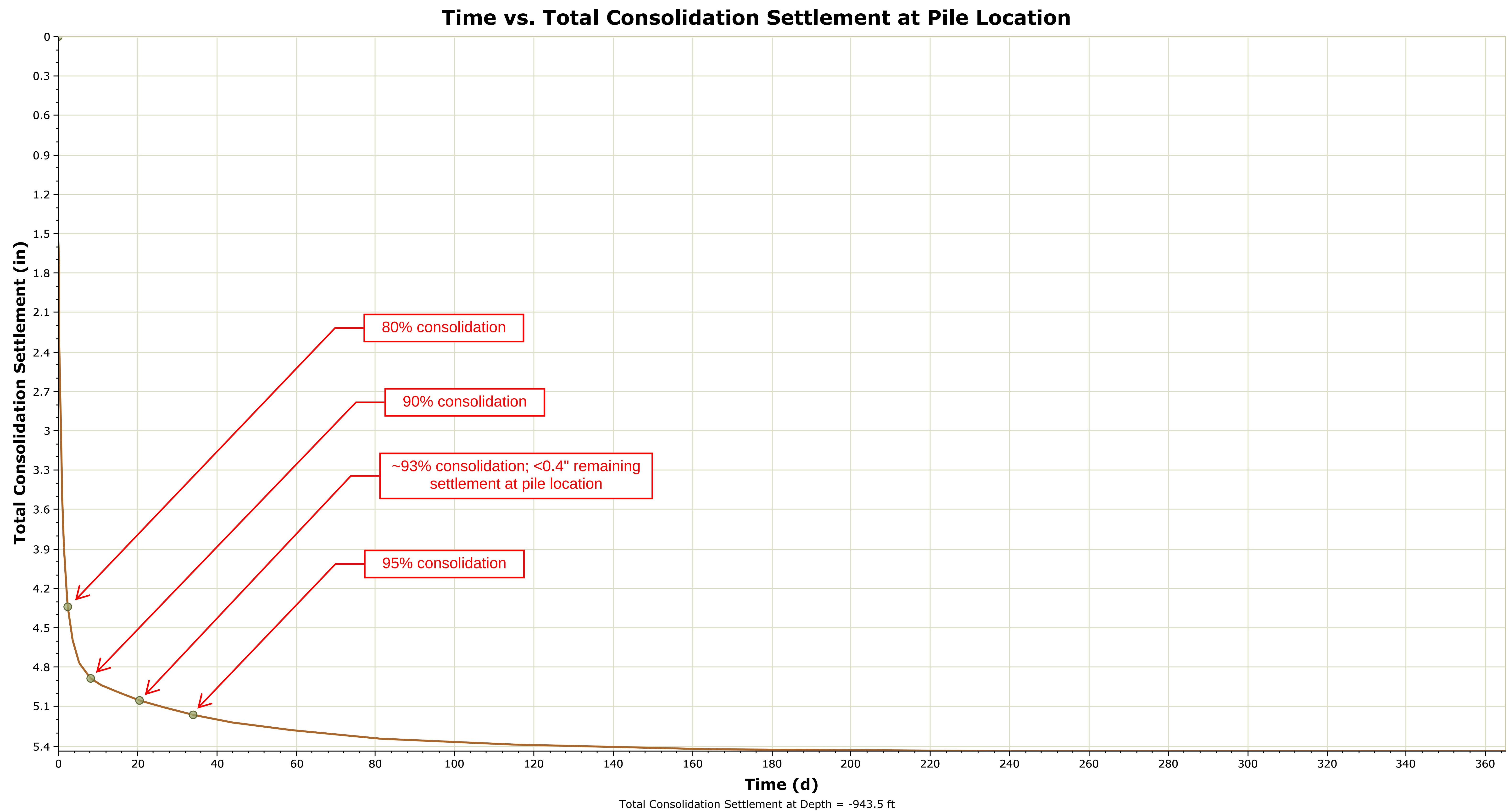


SETTLE3 5.001	Project	BRO 32-0359	
	Analysis Description	Rear Abutment Settlement Analysis	
	Drawn By: LEDT	Company: Stantec	
	Date: 8/12/2020	File Name: 173620122 BRO 32-0359 Rear Abutment - Stantec Lab.s3z	



Project	BRO 32-0359		
Analysis Description	Rear Abutment Settlement Analysis		
Drawn By	LEDT	Company	Stantec
Date	8/12/2020	File Name	173620122 BRO 32-0359 Rear Abutment - Stantec Lab.s3z

SETTLE3 5.001



SETTLE3 5.001	Project	BRO 32-0359	
	Analysis Description	Rear Abutment Settlement Analysis	
	Drawn By: LEDT	Company: Stantec	
	Date: 8/12/2020	File Name: 173620122 BRO 32-0359 Rear Abutment - Stantec Lab.s3z	

Settle3 Analysis Information
BRO 32-0359

Project Settings

Document Name	173620122 BRO 32-0359 Rear Abutment - Stantec Lab.s3z
Project Title	BRO 32-0359
Analysis	Rear Abutment Settlement Analysis
Author	LEDT
Company	Stantec
Date Created	8/12/2020
Comments	
Project #: 173620122	
Stress Computation Method	Boussinesq
Time-dependent Consolidation Analysis	
Time Units	days
Permeability Units	feet/day
Minimum settlement ratio for subgrade modulus	0.9

Use average properties to calculate layered stresses

Improve consolidation accuracy

Ignore negative effective stresses in settlement calculations

Stage Settings

Stage #	Name	Time [days]
1	Stage 1	0
2	Stantec 80% PL	2.41
3	Stantec 90% PL	8.25
4	Stantec <0.4" PL	20.46
5	Stantec 95% PL	34.11
6	10 years	3650

Results

Notes:

Results for Pile Location

Time taken to compute: 7.25256 seconds

Stage: Stage 1 = 0 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	1.81402
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.1332	3.68002
Effective Stress XX [ksf]	-1.05113	5.5761
Effective Stress YY [ksf]	-0.227352	7.24465
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0	0.00540076
Pore Water Pressure [ksf]	-0.065471	4.45084
Excess Pore Water Pressure [ksf]	-0.065471	2.96852
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	6	9
Over-consolidation Ratio	1.63105	56.9988
Void Ratio	0.292979	0.692
Permeability [ft/d]	0.000127648	0.0432989
Coefficient of Consolidation [ft^2/d]	2.5	6
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	16.5906
Undrained Shear Strength	0	0

Stage: Stantec 80% PL = 2.41 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	6.15638
Total Consolidation Settlement [in]	0	4.34237
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	4.34237
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00365211	0.0492531
Pore Water Pressure [ksf]	0	4.057
Excess Pore Water Pressure [ksf]	0	2.00323
Degree of Consolidation [%]	0	99.6061
Pre-consolidation Stress [ksf]	6	9
Over-consolidation Ratio	1.16587	72.8909
Void Ratio	0.287774	0.698874
Permeability [ft/d]	0.000127648	0.0432989
Coefficient of Consolidation [ft^2/d]	2.5	6
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	15.6688	82.479
Undrained Shear Strength	0	0

Stage: Stantec 90% PL = 8.25 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	6.69682
Total Consolidation Settlement [in]	0	4.8828
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	4.8828
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00312713	0.0500427
Pore Water Pressure [ksf]	0	3.84224
Excess Pore Water Pressure [ksf]	0	1.83311
Degree of Consolidation [%]	0	99.7865
Pre-consolidation Stress [ksf]	6	9
Over-consolidation Ratio	1.16522	72.0702
Void Ratio	0.287764	0.69843
Permeability [ft/d]	0.000127648	0.0432989
Coefficient of Consolidation [ft^2/d]	2.5	6
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	28.5998	99.4434
Undrained Shear Strength	0	0

Stage: Stantec <0.4" PL = 20.46 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	6.86634
Total Consolidation Settlement [in]	0	5.05232
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	5.05232
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00310956	0.0500675
Pore Water Pressure [ksf]	0	3.59035
Excess Pore Water Pressure [ksf]	0	1.54785
Degree of Consolidation [%]	0	99.8684
Pre-consolidation Stress [ksf]	6	9
Over-consolidation Ratio	1.16496	72.0431
Void Ratio	0.28776	0.698415
Permeability [ft/d]	0.000127648	0.0432989
Coefficient of Consolidation [ft^2/d]	2.5	6
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	45.0177	99.9996
Undrained Shear Strength	0	0

Stage: Stantec 95% PL = 34.11 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	6.97612
Total Consolidation Settlement [in]	0	5.16211
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	5.16211
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00310954	0.0500675
Pore Water Pressure [ksf]	0	3.32884
Excess Pore Water Pressure [ksf]	0	1.20198
Degree of Consolidation [%]	0	99.9052
Pre-consolidation Stress [ksf]	6	9
Over-consolidation Ratio	1.16483	72.0431
Void Ratio	0.287758	0.698415
Permeability [ft/d]	0.000127648	0.0432989
Coefficient of Consolidation [ft^2/d]	2.5	6
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	58.1495	100
Undrained Shear Strength	0	0

Stage: 10 years = 3650 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	7.2535
Total Consolidation Settlement [in]	0	5.43948
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	5.43948
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00310954	0.0500675
Pore Water Pressure [ksf]	0	2.97648
Excess Pore Water Pressure [ksf]	-1.63447e-017	1.56848e-017
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [ksf]	6	9
Over-consolidation Ratio	1.16432	72.0431
Void Ratio	0.287755	0.698415
Permeability [ft/d]	0.000127648	0.0432989
Coefficient of Consolidation [ft^2/d]	2.5	6
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	100	100
Undrained Shear Strength	0	0

Embankments

Notes:

Embankment bottom sits at Elevation 943.5 ft

1. Embankment: "MSE Wall Reinforced Fill and Retained Wedge Fill"

Label	MSE Wall Reinforced Fill and Retained Wedge Fill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	152

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	18.9	0.12	26.5651	0

2. Embankment: "Abutment Wall Backfill"

Label	Abutment Wall Backfill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	76.4

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	10.6	0.125	26.5651	0

Excavations

1. Excavation: "Excavation to Bottom of MSE"

Depth	-943.5 ft
Installation Stage	Stage 1 = 0 d

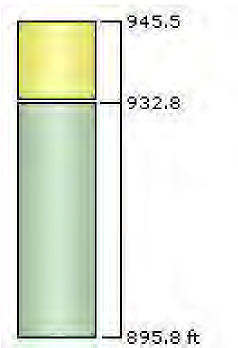
Coordinates

X [ft]	Y [ft]
-76	0
76	0
76	300
-76	300

Soil Layers

Ground Surface Drained: Yes

Layer #	Type	Thickness [ft]	Depth [ft]	Drained at Bottom
1	Silt and Clay - Rear Abutment - Stantec Lab	12.7	-945.5	Yes
2	Sandy Silt - Rear Abutment	37	-932.8	Yes



Soil Properties

Property	Sandy Silt - Rear Abutment	Silt and Clay - Rear Abutment - Stantec Lab
Color		
Unit Weight [kips/ft^3]	0.135	0.129
Saturated Unit Weight [kips/ft^3]	0.139	0.129
K0	1	1
Immediate Settlement	Enabled	Disabled
Es [ksf]	417.709	-
Esur [ksf]	417.709	-
Primary Consolidation	Enabled	Enabled
Material Type	Non-Linear	Non-Linear
Cc	0.139	0.305
Cr	0.009	0.07
e0	0.3	0.692
Pc [ksf]	6	9
Cv [ft^2/d]	2.5	6
Cvr [ft^2/d]	2.5	6
B-bar	1	1
Undrained Su A [kips/ft2]	0	0
Undrained Su S	0.2	0.2
Undrained Su m	0.8	0.8
Piezo Line ID	1	1

Groundwater

Groundwater method	Piezometric Lines
Water Unit Weight	0.0624 kips/ft^3

Piezometric Line Entities

ID	Depth (ft)
1	-945.5 ft

Query Points

Point #	Query Point Name	(X,Y) Location	Number of Divisions
4	MSE Wall Face	0, 0	Auto: 50
5	Pile Location (6' from MSE Wall Face)	0, 6	Auto: 50
6	Differential Settlement Midpoint PL	-38, 6	Auto: 50
7	Differential Settlement Midpoint MSEWF	-38.2, 0	Auto: 50
8	Differential Settlement Edge PL	-76, 6	Auto: 50
9	Differential Settlement Edge MSEWF	-76, 0	Auto: 50

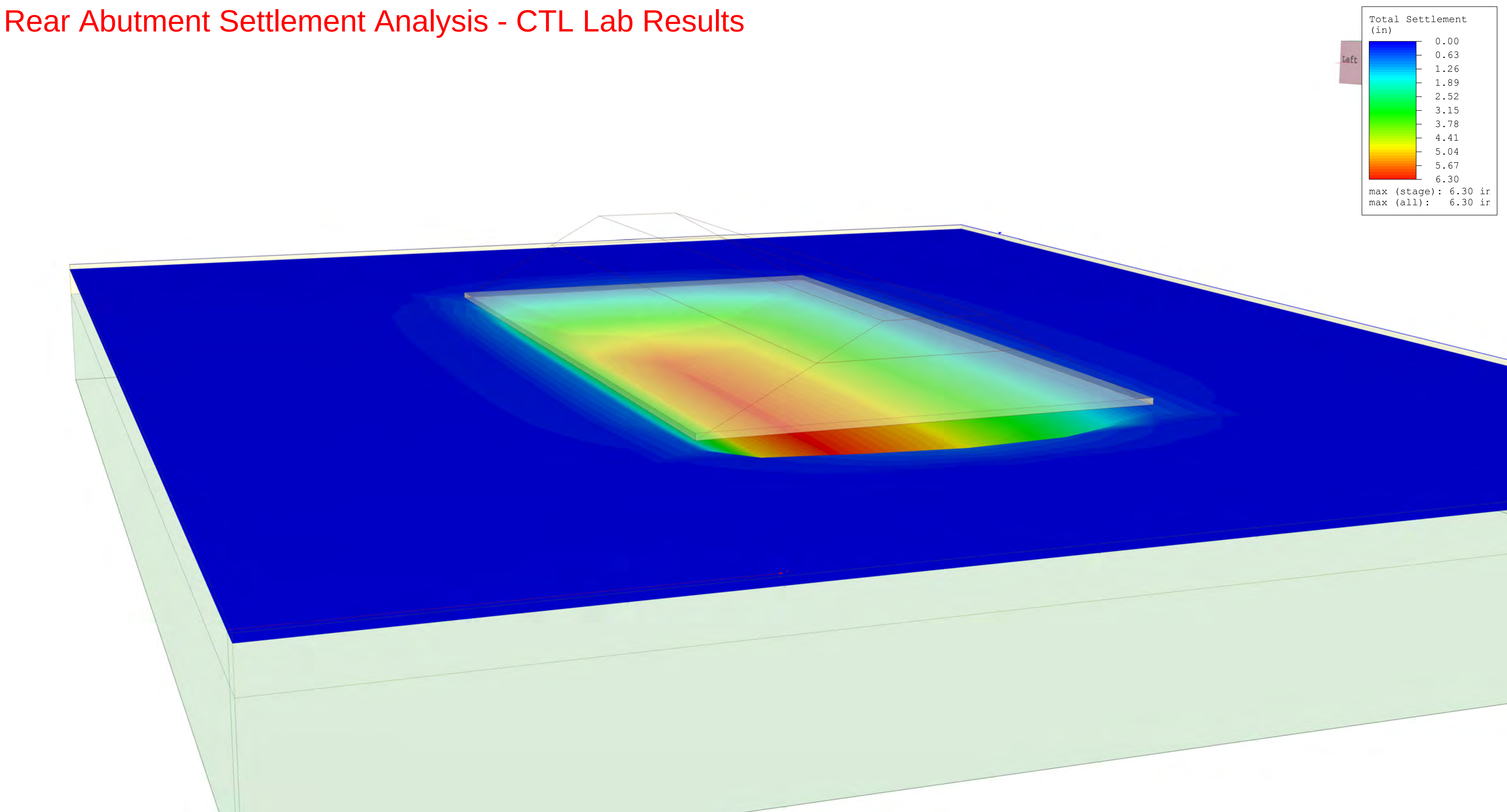
Query Lines

Line #	Query Line Name	Start Location	End Location	Horizontal Divisions	Vertical Divisions
1	MSE Wall Face Differential Settlement	-76, 0	76, 0	152	Auto: 50
2	Pile Location Differential Settlement	-76, 6	76, 6	152	Auto: 50

Time Points

Point #	(X,Y) Location	Depth	Goal Type	Goal	Time Until Goal
1	0, 6	-943.5 ft	Degree of Consolidation	80%	2.40896 d
2	0, 6	-943.5 ft	Degree of Consolidation	90%	8.2493 d
3	0, 6	-943.5 ft	Degree of Consolidation	95%	34.1099 d
4	0, 0	-943.5 ft	Degree of Consolidation	80%	2.68162 d
5	0, 0	-943.5 ft	Degree of Consolidation	90%	9.83502 d
6	0, 0	-943.5 ft	Degree of Consolidation	95%	37.2989 d
7	0, 6	-943.5 ft	Total Settlement	3.95 in	0.240279 d
8	0, 6	-943.5 ft	Total Settlement	6.75 in	20.4614 d

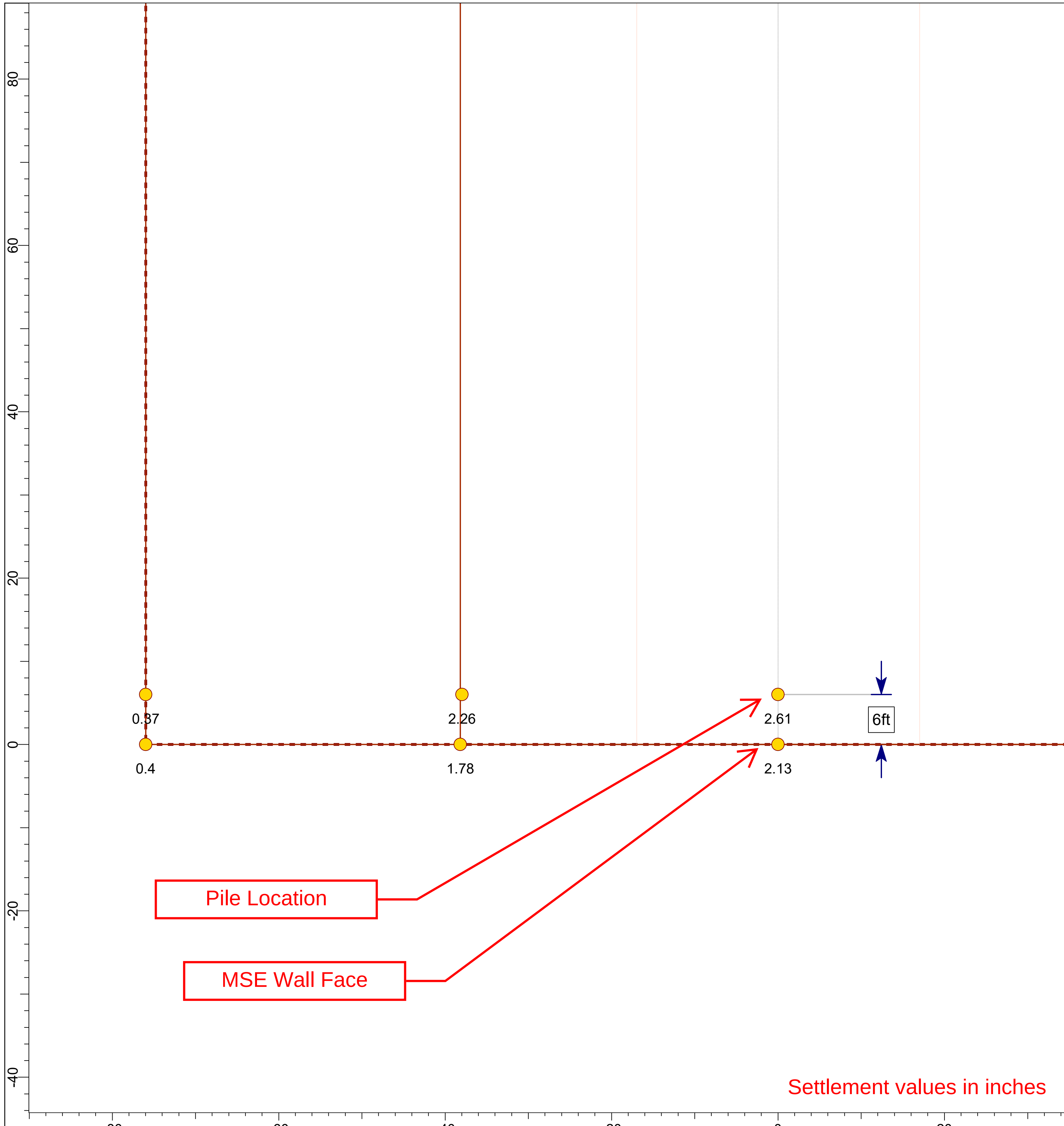
Rear Abutment Settlement Analysis - CTL Lab Results

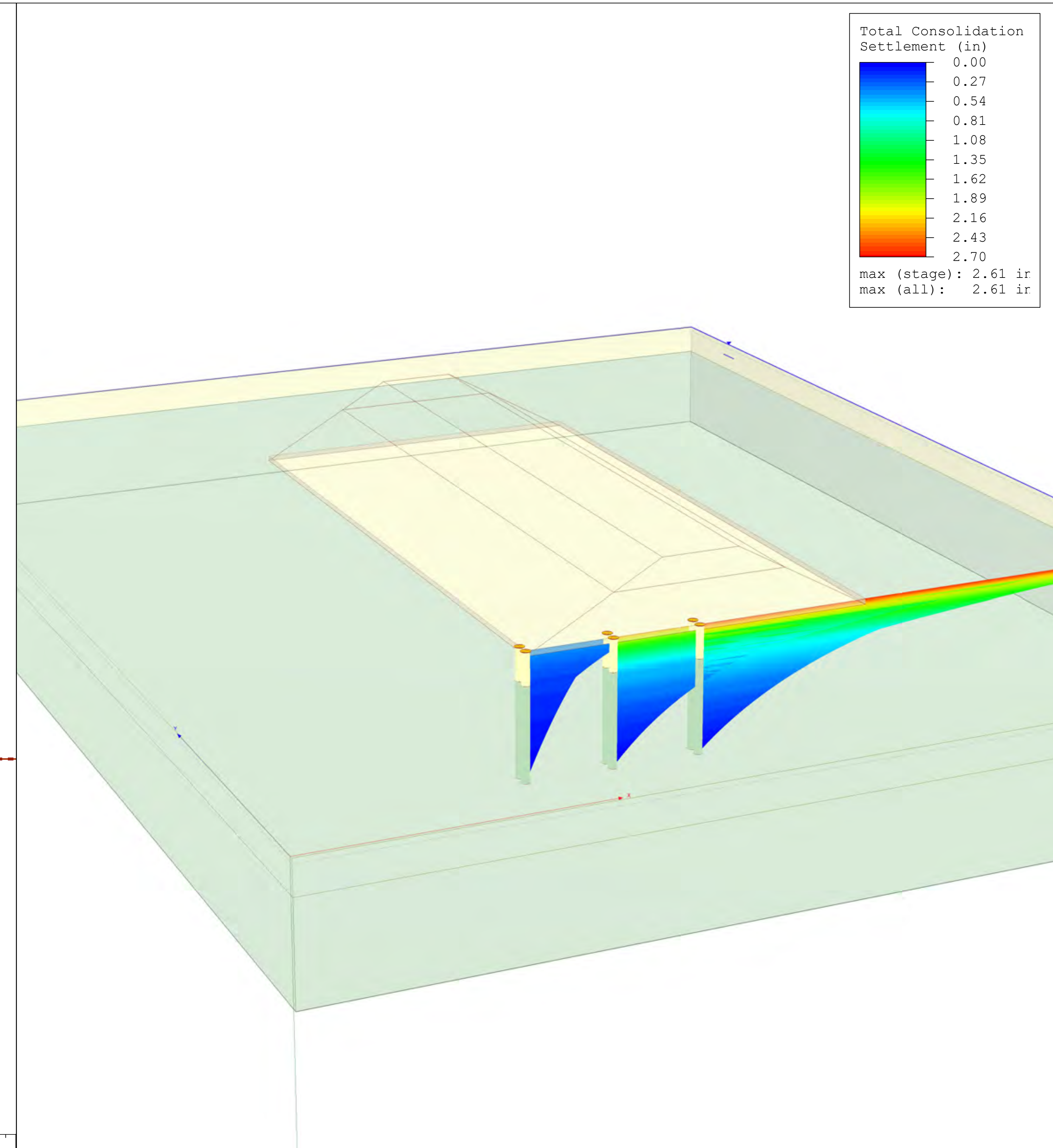


rocscience

SETTLE3 5.001

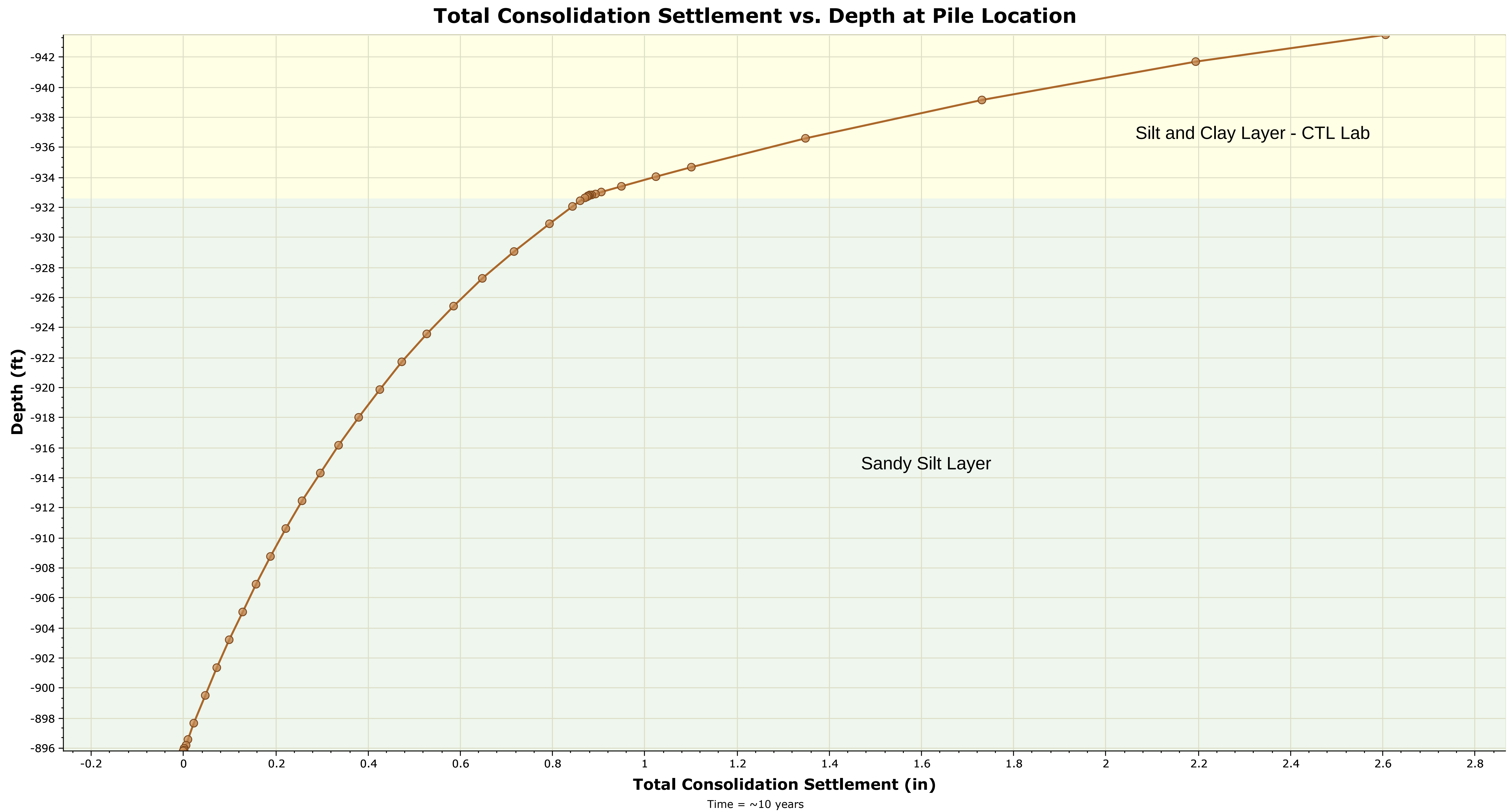
Project	BRO 32-0359		
Analysis Description	Rear Abutment Settlement Analysis		
Drawn By	LEDT	*Company*	Stantec
Date	8/4/2020	*File Name*	173620122 BRO 32-0359 Rear Abutment.s3z - CTL Lab





Project	BRO 32-0359		
Analysis Description	Rear Abutment Settlement Analysis		
Drawn By	LEDT	Company	Stantec
Date	8/4/2020	File Name	173620122 BRO 32-0359 Rear Abutment.s3z - CTL Lab

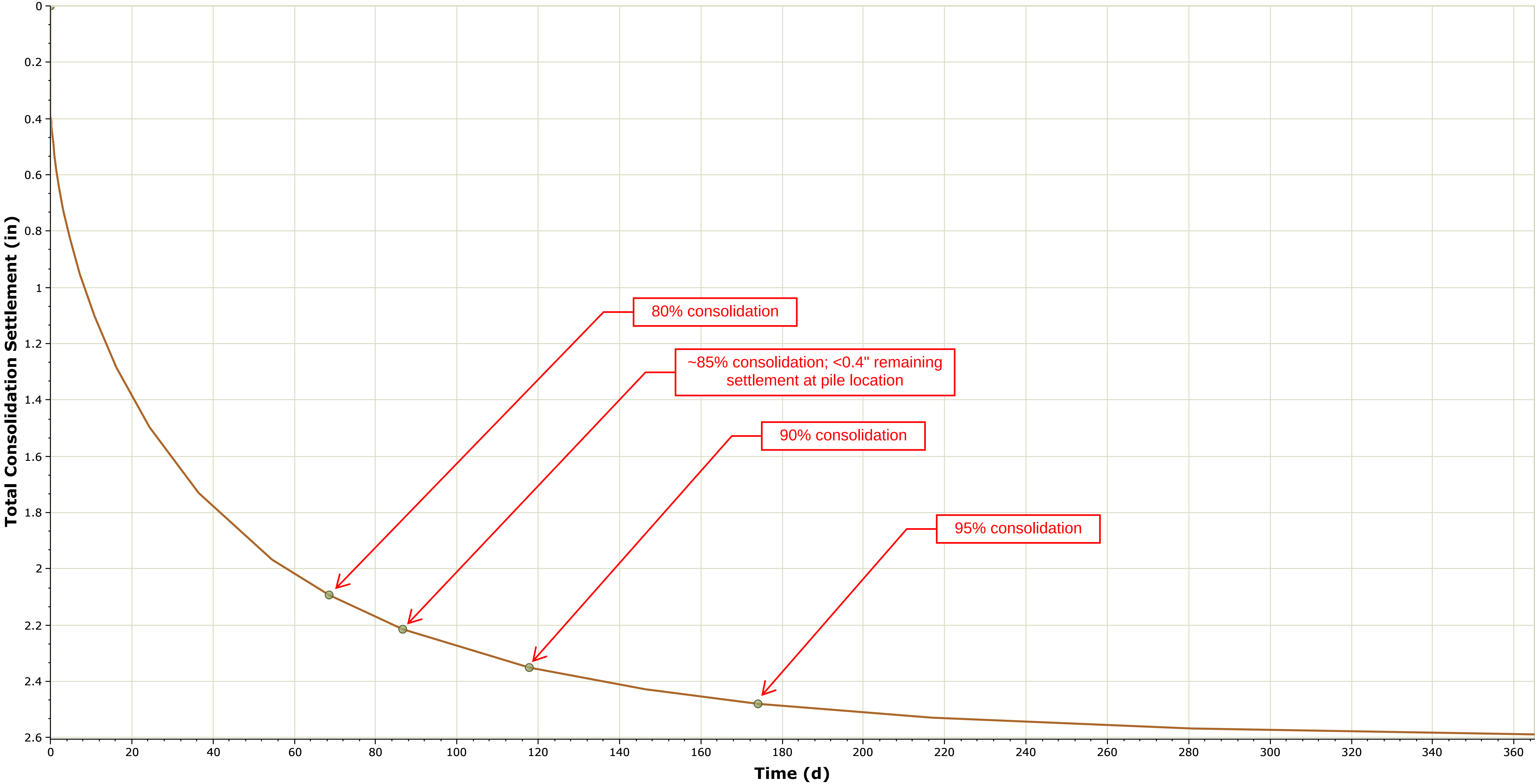
SETTLE3 5.001



SETTLE3 5.001

Project	BRO 32-0359		
Analysis Description	Rear Abutment Settlement Analysis		
Drawn By	LEDT	Company	Stantec
Date	8/4/2020	File Name	173620122 BRO 32-0359 Rear Abutment.s3z - CTL Lab

Time vs. Total Consolidation Settlement at Pile Location



Total Consolidation Settlement at Depth = -943.5 ft

Project	BRO 32-0359		
Analysis Description	Rear Abutment Settlement Analysis		
Drawn By	LEDT	*Company*	Stantec
Date	8/4/2020	*File Name*	173620122 BRO 32-0359 Rear Abutment.s3z - CTL Lab

SETTLE3 5.001

Settle3 Analysis Information
BRO 32-0359

Project Settings

Document Name	173620122 BRO 32-0359 Rear Abutment.s3z - CTL Lab
Project Title	BRO 32-0359
Analysis	Rear Abutment Settlement Analysis
Author	LEDT
Company	Stantec
Date Created	8/4/2020

Comments

Project #: 173620122	
Stress Computation Method	Boussinesq
Time-dependent Consolidation Analysis	
Time Units	days
Permeability Units	feet/day
Minimum settlement ratio for subgrade modulus	0.9

Use average properties to calculate layered stresses

Improve consolidation accuracy

Ignore negative effective stresses in settlement calculations

Stage Settings

Stage #	Name	Time [days]
1	Stage 1	0
2	80% Pile Location	68.44
3	<0.4" Remaining Settlment at Pile Location	86.59
4	90% Pile Location	117.83
5	95% Pile Location	174.01
6	10 years	3650

Results

Notes:

Results for Pile Location

Time taken to compute: 6.41768 seconds

Stage: Stage 1 = 0 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	1.81402
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.1332	3.68002
Effective Stress XX [ksf]	-1.05113	5.5761
Effective Stress YY [ksf]	-0.227352	7.24465
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0	0.00540076
Pore Water Pressure [ksf]	-0.065471	4.45084
Excess Pore Water Pressure [ksf]	-0.065471	2.96852
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1.63105	20.2662
Void Ratio	0.292979	0.73
Permeability [ft/d]	5.01736e-005	0.000553307
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	16.5906
Undrained Shear Strength	0	0

Stage: 80% Pile Location = 68.44 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	3.90729
Total Consolidation Settlement [in]	0	2.09327
Virgin Consolidation Settlement [in]	0	0.000227729
Recompression Consolidation Settlement [in]	0	2.09305
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00154586	0.018137
Pore Water Pressure [ksf]	0	2.97838
Excess Pore Water Pressure [ksf]	0	1.72906
Degree of Consolidation [%]	0	99.9537
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	26.1713
Void Ratio	0.287757	0.732797
Permeability [ft/d]	5.01736e-005	0.000553307
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	55.0387	80.208
Undrained Shear Strength	0	0.194585

Stage: <0.4" Remaining Settlment at Pile Location = 86.59 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.02954
Total Consolidation Settlement [in]	0	2.21552
Virgin Consolidation Settlement [in]	0	0.000298773
Recompression Consolidation Settlement [in]	0	2.21522
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00150611	0.0182991
Pore Water Pressure [ksf]	0	2.97648
Excess Pore Water Pressure [ksf]	-0.00360052	1.46428
Degree of Consolidation [%]	0	99.9681
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	26.1105
Void Ratio	0.287756	0.732763
Permeability [ft/d]	5.01736e-005	0.000553307
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	61.5288	86.3583
Undrained Shear Strength	0	0.194585

Stage: 90% Pile Location = 117.83 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.16632
Total Consolidation Settlement [in]	0	2.3523
Virgin Consolidation Settlement [in]	0	0.00037856
Recompression Consolidation Settlement [in]	0	2.35192
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00143306	0.0184803
Pore Water Pressure [ksf]	0	2.97648
Excess Pore Water Pressure [ksf]	-0.00440279	1.08616
Degree of Consolidation [%]	0	99.9832
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	25.9998
Void Ratio	0.287756	0.732699
Permeability [ft/d]	5.01736e-005	0.000553307
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	71.065	92.8107
Undrained Shear Strength	0	0.194585

Stage: 95% Pile Location = 174.01 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.29263
Total Consolidation Settlement [in]	0	2.47861
Virgin Consolidation Settlement [in]	0	0.00050621
Recompression Consolidation Settlement [in]	0	2.4781
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00132828	0.0186651
Pore Water Pressure [ksf]	0	2.97648
Excess Pore Water Pressure [ksf]	-0.00343193	0.629465
Degree of Consolidation [%]	0	99.9947
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	25.8431
Void Ratio	0.287756	0.732609
Permeability [ft/d]	5.01736e-005	0.000553307
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	83.0843	97.728
Undrained Shear Strength	0	0.194585

Stage: 10 years = 3650 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.41936
Total Consolidation Settlement [in]	0	2.60534
Virgin Consolidation Settlement [in]	0	0.00856627
Recompression Consolidation Settlement [in]	0	2.59677
Immediate Settlement [in]	0	1.81402
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190271	2.84372
Loading Stress XX [ksf]	-1.30913	2.12682
Loading Stress YY [ksf]	-0.887388	3.43983
Effective Stress ZZ [ksf]	0.067729	5.15438
Effective Stress XX [ksf]	0.0670317	6.99831
Effective Stress YY [ksf]	-0.212616	8.65391
Total Stress ZZ [ksf]	0.067729	8.13086
Total Stress XX [ksf]	0.0670317	9.97479
Total Stress YY [ksf]	-0.212616	11.6304
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00117305	0.0188876
Pore Water Pressure [ksf]	0	2.97648
Excess Pore Water Pressure [ksf]	-0.00380174	0.00328077
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	25.6153
Void Ratio	0.287755	0.732474
Permeability [ft/d]	5.01736e-005	0.000553307
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	99.9994	100
Undrained Shear Strength	0	0.215447

Embankments

Notes:

Embankment bottom sits at Elevation 943.5 ft

1. Embankment: "MSE Wall Reinforced Fill and Retained Wedge Fill"

Label	MSE Wall Reinforced Fill and Retained Wedge Fill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	152

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	18.9	0.12	26.5651	0

2. Embankment: "Abutment Wall Backfill"

Label	Abutment Wall Backfill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	76.4

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	10.6	0.125	26.5651	0

Excavations

1. Excavation: "Excavation to Bottom of MSE Wall"

Depth	-943.5 ft
Installation Stage	Stage 1 = 0 d

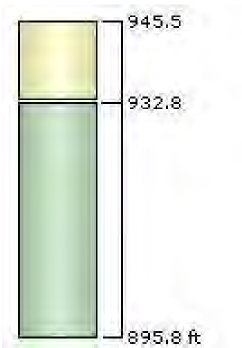
Coordinates

X [ft]	Y [ft]
76	0
76	300
-76	300
-76	0

Soil Layers

Ground Surface Drained: Yes

Layer #	Type	Thickness [ft]	Depth [ft]	Drained at Bottom
1	Silt and Clay - Rear Abutment	12.7	-945.5	Yes
2	Sandy Silt - Rear Abutment	37	-932.8	Yes



Soil Properties

Property	Silt and Clay - Rear Abutment	Sandy Silt - Rear Abutment
Color		
Unit Weight [kips/ft^3]	0.129	0.135
Saturated Unit Weight [kips/ft^3]	0.129	0.139
K0	1	1
Immediate Settlement	Disabled	Enabled
Es [ksf]	-	417.709
Esur [ksf]	-	417.709
Primary Consolidation	Enabled	Enabled
Material Type	Non-Linear	Non-Linear
Cc	0.11	0.139
Cr	0.027	0.009
e0	0.73	0.3
Pc [ksf]	3.2	6
Cv [ft^2/d]	0.1	2.5
Cvr [ft^2/d]	0.1	2.5
B-bar	1	1
Undrained Su A [kips/ft2]	0	0
Undrained Su S	0.2	0.2
Undrained Su m	0.8	0.8
Piezo Line ID	1	1

Groundwater

Groundwater method	Piezometric Lines
Water Unit Weight	0.0624 kips/ft^3

Piezometric Line Entities

ID	Depth (ft)
1	-945.5 ft

Query Points

Point #	Query Point Name	(X,Y) Location	Number of Divisions
4	MSE Wall Face	0, 0	Auto: 50
5	Pile Location (6' from MSE Wall Face)	0, 6	Auto: 50
6	Differential Settlement Midpoint PL	-38, 6	Auto: 50
7	Differential Settlement Midpoint MSEWF	-38.2, 0	Auto: 50
8	Differential Settlement Edge PL	-76, 6	Auto: 50
9	Differential Settlement Edge MSEWF	-76, 0	Auto: 50

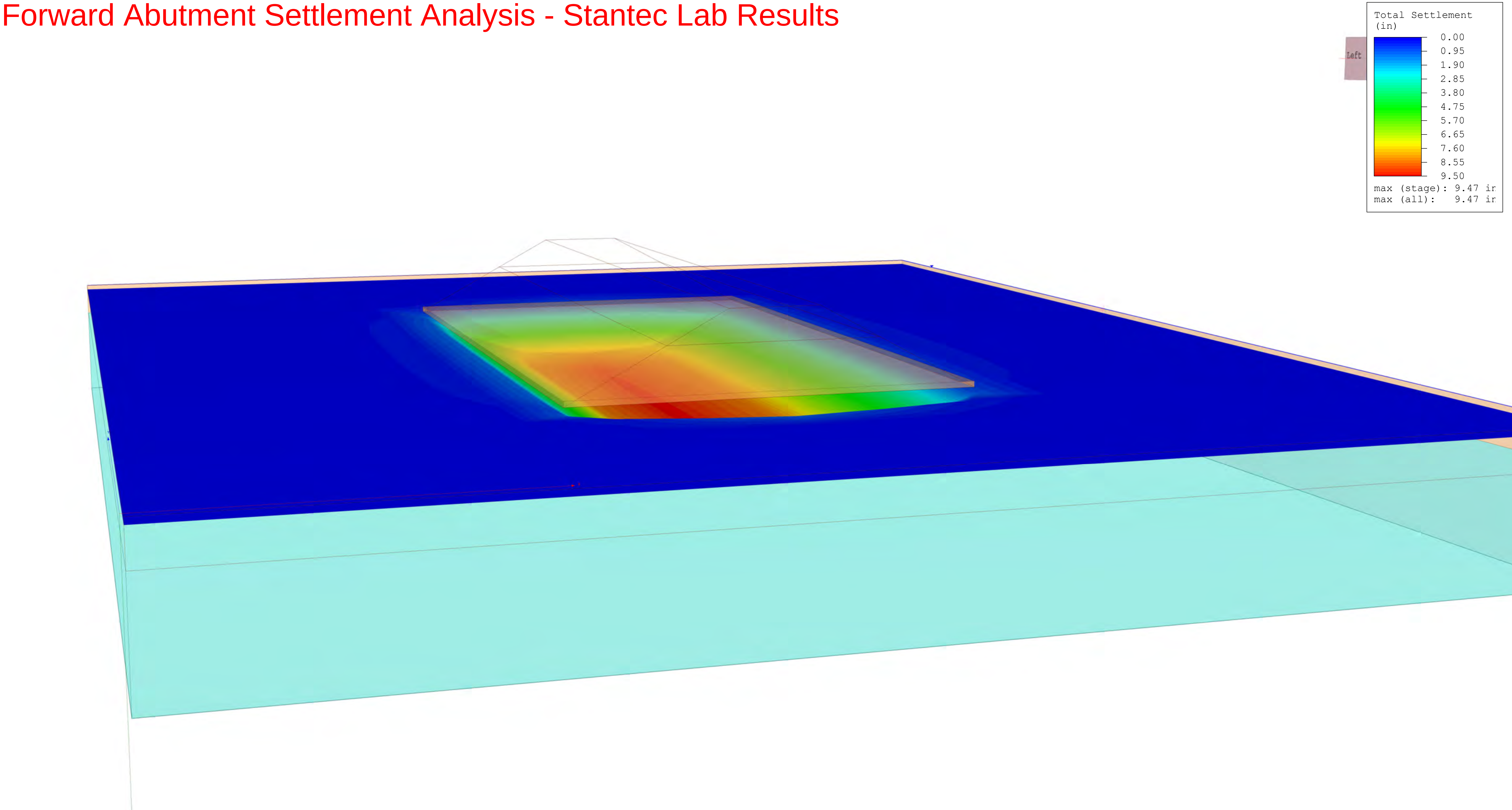
Query Lines

Line #	Query Line Name	Start Location	End Location	Horizontal Divisions	Vertical Divisions
1	MSE Wall Face Differential Settlement	-76, 0	76, 0	152	Auto: 50
2	Pile Location Differential Settlement	-76, 6	76, 6	152	Auto: 50

Time Points

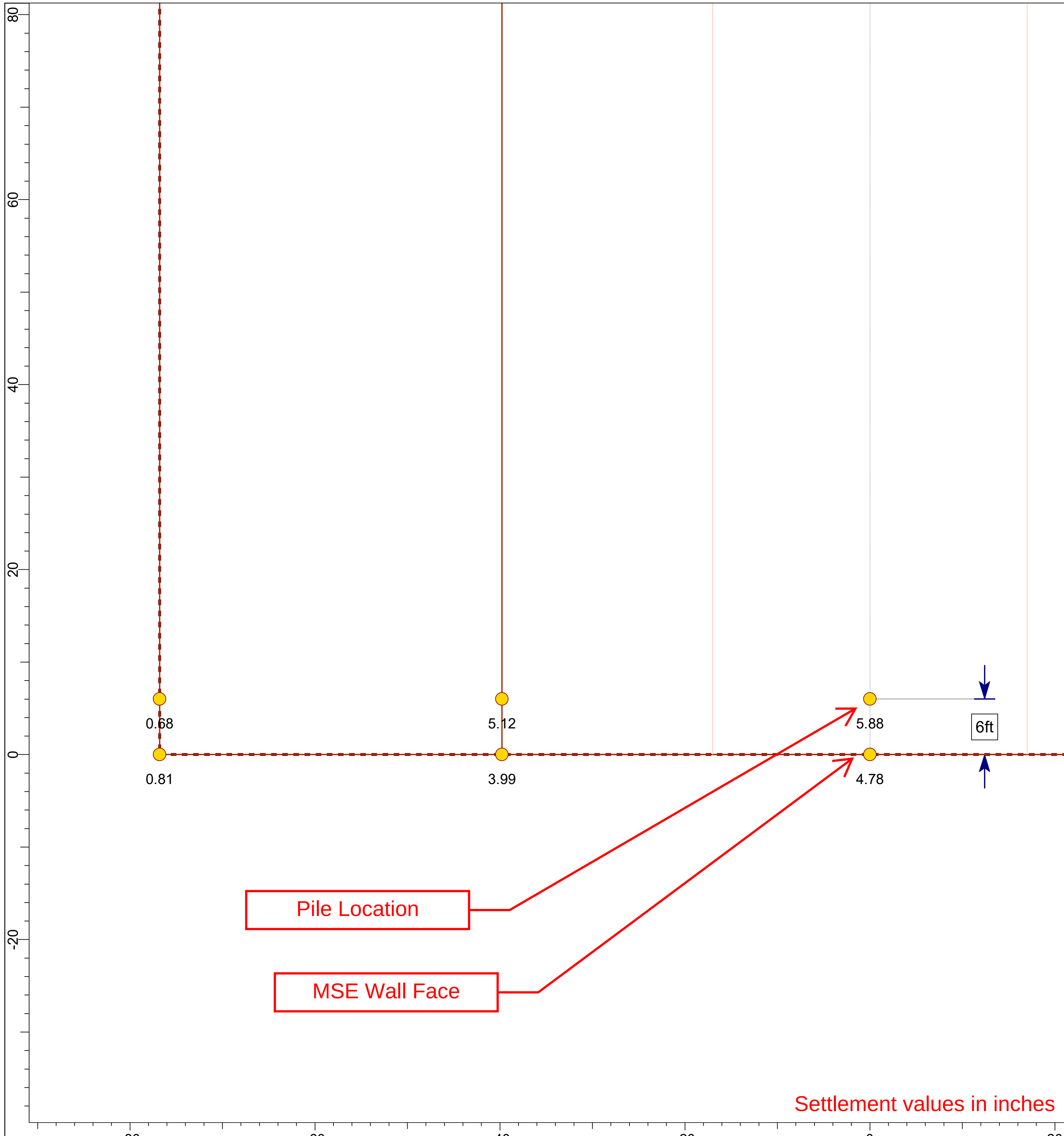
Point #	(X,Y) Location	Depth	Goal Type	Goal	Time Until Goal
1	0, 0	-943.5 ft	Degree of Consolidation	80%	73.6176 d
2	0, 0	-943.5 ft	Degree of Consolidation	90%	124.837 d
3	0, 0	-943.5 ft	Degree of Consolidation	95%	182.456 d
4	0, 6	-943.5 ft	Degree of Consolidation	80%	68.4399 d
5	0, 6	-943.5 ft	Degree of Consolidation	90%	117.825 d
6	0, 6	-943.5 ft	Degree of Consolidation	95%	174.006 d
7	0, 6	-943.5 ft	Total Settlement	3.95 in	86.5877 d

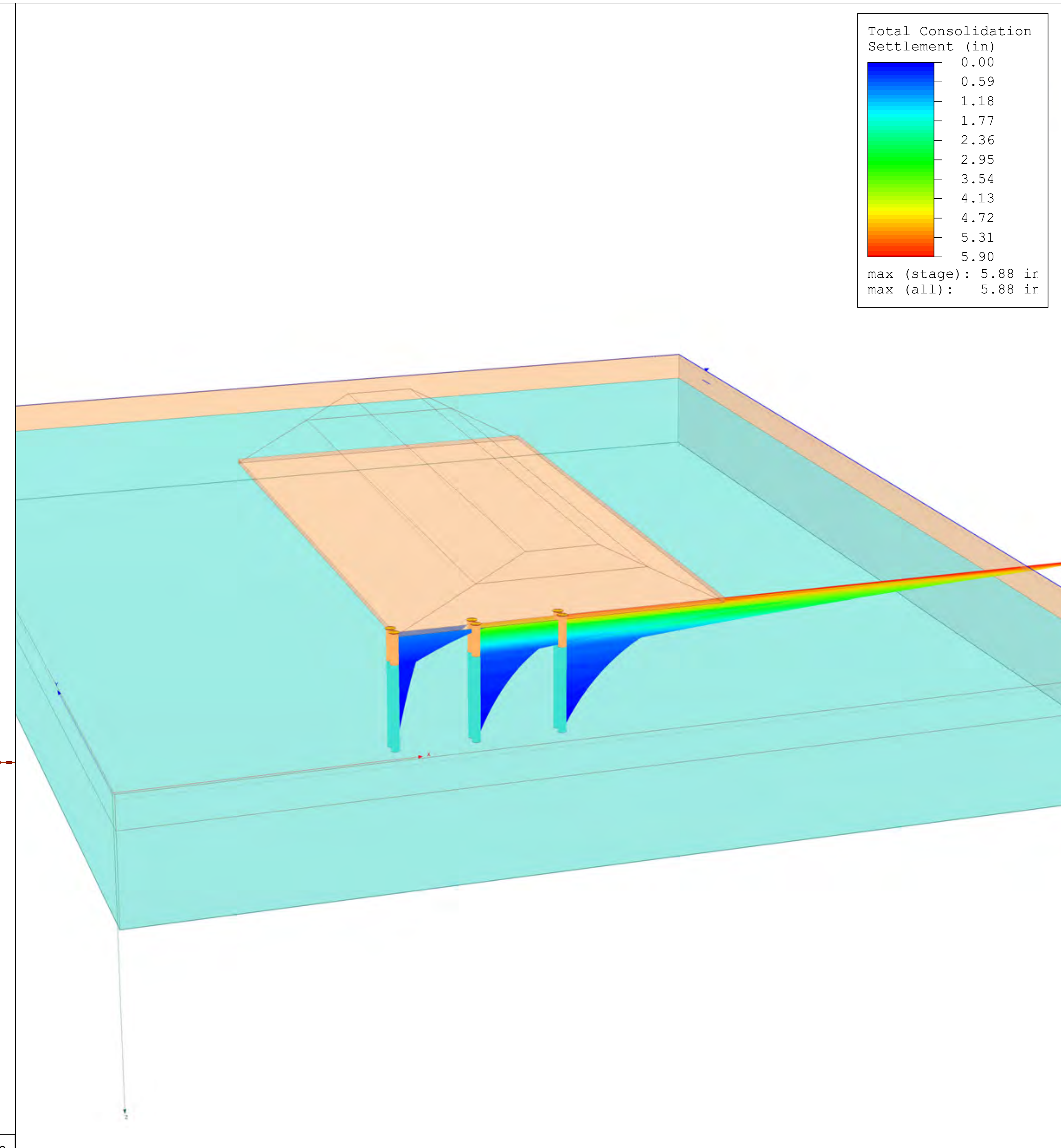
Forward Abutment Settlement Analysis - Stantec Lab Results



Project	BRO 32-0359		
Analysis Description	Forward Abutment Settlement Analysis		
Drawn By	LEDT	Company	Stantec
Date	8/12/2020	File Name	173620122 BRO 32-0359 Forward Abutment - Stantec Lab.s3z

SETTLE3 5.001

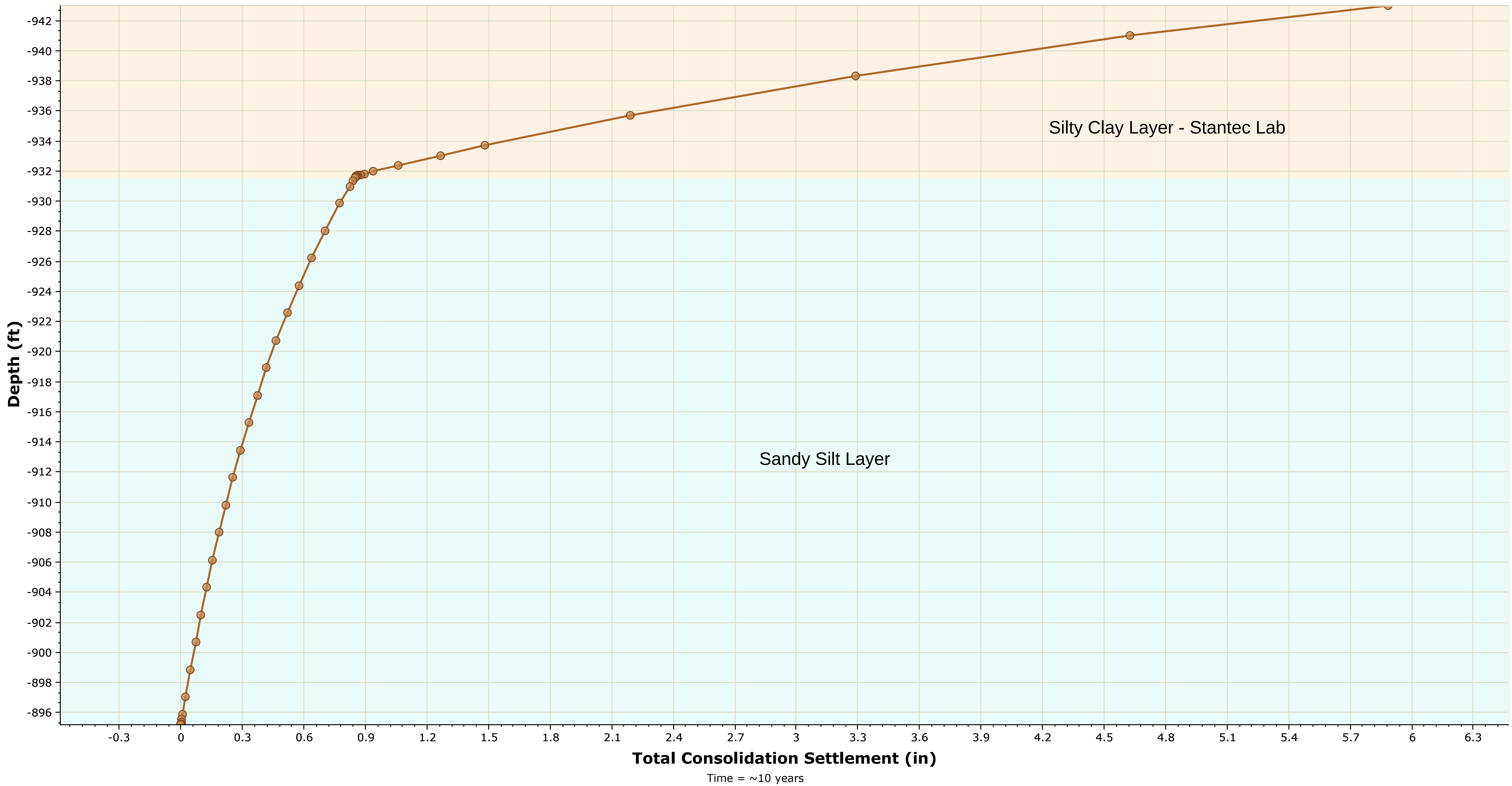




Project	BRO 32-0359		
Analysis Description	Forward Abutment Settlement Analysis		
Drawn By	LEDT	*Company*	Stantec
Date	8/12/2020	*File Name*	173620122 BRO 32-0359 Forward Abutment - Stantec Lab.s3z

SETTLE3 5.001

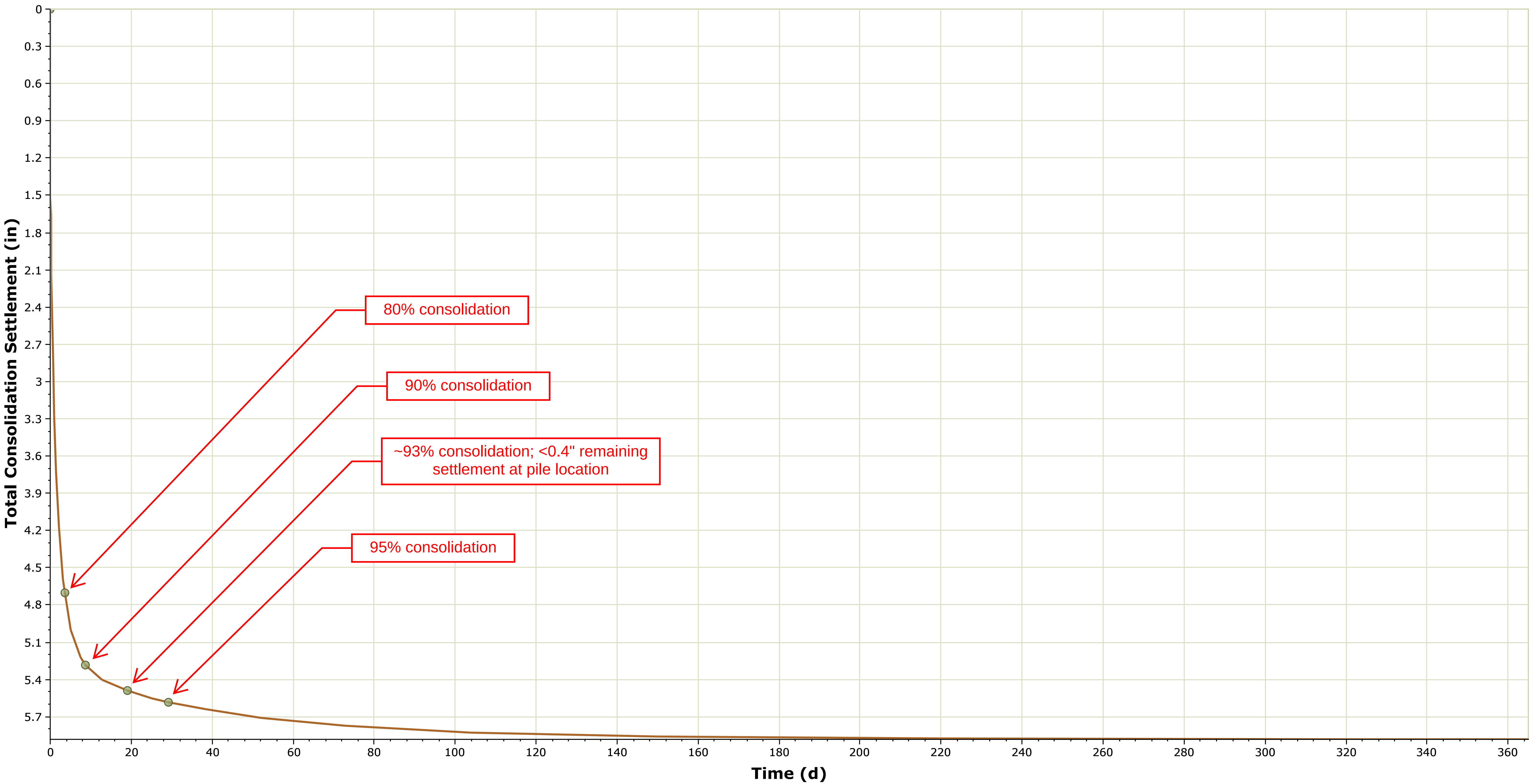
Total Consolidation Settlement vs. Depth at Pile Location



Project	BRO 32-0359		
Analysis Description	Forward Abutment Settlement Analysis		
Drawn By	LEDT	Company	Stantec
Date	8/12/2020	File Name	173620122 BRO 32-0359 Forward Abutment - Stantec Lab.s3z

SETTLE3 5.001

Time vs. Total Consolidation Settlement at Pile Location



Total Consolidation Settlement at Depth = -943 ft

SETTLE3 5.001	Project	BRO 32-0359	
	Analysis Description	Forward Abutment Settlement Analysis	
	Drawn By	LEDT	Company: Stantec
	Date	8/12/2020	File Name: 173620122 BRO 32-0359 Forward Abutment - Stantec Lab.s3z

Settle3 Analysis Information
BRO 32-0359

Project Settings

Document Name	173620122 BRO 32-0359 Forward Abutment - Stantec Lab.s3z
Project Title	BRO 32-0359
Analysis	Forward Abutment Settlement Analysis
Author	LEDT
Company	Stantec
Date Created	8/12/2020
Comments	
Project #: 173620122	
Stress Computation Method	Boussinesq
Time-dependent Consolidation Analysis	
Time Units	days
Permeability Units	feet/day
Minimum settlement ratio for subgrade modulus	0.9

Use average properties to calculate layered stresses

Improve consolidation accuracy

Ignore negative effective stresses in settlement calculations

Stage Settings

Stage #	Name	Time [days]
1	Stage 1	0
2	Stantec 80% PL	3.56
3	Stantec 90% PL	8.77
4	Stantec <0.4" PL	19.06
5	Stantec 95% PL	29.26
6	10 years	3650

Results

Notes:

Results for Pile Location

Time taken to compute: 9.18329 seconds

Stage: Stage 1 = 0 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	1.80249
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.1332	3.71818
Effective Stress XX [ksf]	-0.770197	5.6386
Effective Stress YY [ksf]	-0.289841	7.32776
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0	0.00538421
Pore Water Pressure [ksf]	-0.0653159	4.476
Excess Pore Water Pressure [ksf]	-0.0653159	2.99588
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	6	8
Over-consolidation Ratio	1.61431	49.3501
Void Ratio	0.293001	0.484
Permeability [ft/d]	0.000126337	0.0297801
Coefficient of Consolidation [ft^2/d]	2.5	4
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	17.1342
Undrained Shear Strength	0	0

Stage: Stantec 80% PL = 3.56 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	6.50215
Total Consolidation Settlement [in]	0	4.69966
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	4.69966
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00341254	0.0515298
Pore Water Pressure [ksf]	0	4.02167
Excess Pore Water Pressure [ksf]	0	1.96107
Degree of Consolidation [%]	0	99.677
Pre-consolidation Stress [ksf]	6	8
Over-consolidation Ratio	1.15283	62.2144
Void Ratio	0.287931	0.489919
Permeability [ft/d]	0.000126337	0.0297801
Coefficient of Consolidation [ft^2/d]	2.5	4
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	19.1834	79.5022
Undrained Shear Strength	0	0

Stage: Stantec 90% PL = 8.77 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	7.08659
Total Consolidation Settlement [in]	0	5.28411
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	5.28411
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00282268	0.0524409
Pore Water Pressure [ksf]	0	3.85559
Excess Pore Water Pressure [ksf]	0	1.82698
Degree of Consolidation [%]	0	99.7958
Pre-consolidation Stress [ksf]	6	8
Over-consolidation Ratio	1.15243	61.4818
Void Ratio	0.287925	0.489481
Permeability [ft/d]	0.000126337	0.0297801
Coefficient of Consolidation [ft^2/d]	2.5	4
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	29.843	96.7687
Undrained Shear Strength	0	0

Stage: Stantec <0.4" PL = 19.06 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	7.29517
Total Consolidation Settlement [in]	0	5.49268
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	5.49268
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00271108	0.0525968
Pore Water Pressure [ksf]	0	3.63389
Excess Pore Water Pressure [ksf]	0	1.58385
Degree of Consolidation [%]	0	99.8648
Pre-consolidation Stress [ksf]	6	8
Over-consolidation Ratio	1.15221	61.3458
Void Ratio	0.287922	0.489398
Permeability [ft/d]	0.000126337	0.0297801
Coefficient of Consolidation [ft^2/d]	2.5	4
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	43.9877	99.9161
Undrained Shear Strength	0	0

Stage: Stantec 95% PL = 29.26 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	7.3856
Total Consolidation Settlement [in]	0	5.58312
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	5.58312
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00270819	0.0526008
Pore Water Pressure [ksf]	0	3.42786
Excess Pore Water Pressure [ksf]	0	1.30975
Degree of Consolidation [%]	0	99.8959
Pre-consolidation Stress [ksf]	6	8
Over-consolidation Ratio	1.1521	61.3423
Void Ratio	0.28792	0.489396
Permeability [ft/d]	0.000126337	0.0297801
Coefficient of Consolidation [ft^2/d]	2.5	4
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	54.5631	99.9978
Undrained Shear Strength	0	0

Stage: 10 years = 3650 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	7.68585
Total Consolidation Settlement [in]	0	5.88336
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	5.88336
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00270811	0.0526009
Pore Water Pressure [ksf]	0	2.98272
Excess Pore Water Pressure [ksf]	-1.61455e-017	2.1021e-017
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [ksf]	6	8
Over-consolidation Ratio	1.15156	61.3422
Void Ratio	0.287917	0.489396
Permeability [ft/d]	0.000126337	0.0297801
Coefficient of Consolidation [ft^2/d]	2.5	4
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	100	100
Undrained Shear Strength	0	0

Embankments

Notes:

Embankment bottom sits at Elevation 943.0 ft

1. Embankment: "MSE Wall Reinforced Fill and Retained Wedge Fill"

Label	MSE Wall Reinforced Fill and Retained Wedge Fill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	153.6

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	18.5	0.12	26.5651	0

2. Embankment: "Abutment Wall Backfill"

Label	Abutment Wall Backfill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	79.6

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	11.4	0.125	26.5651	0

Excavations

1. Excavation: "Excavation to Bottom of MSE"

Depth	-943 ft
Installation Stage	Stage 1 = 0 d

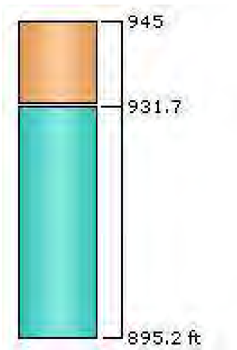
Coordinates

X [ft]	Y [ft]
76.8	0
76.8	300
-76.8	300
-76.8	0

Soil Layers

Ground Surface Drained: Yes

Layer #	Type	Thickness [ft]	Depth [ft]	Drained at Bottom
1	Silty Clay - Forward Abutment - Stantec Lab	13.3	-945	Yes
2	Sandy Silt - Forward Abutment	36.5	-931.7	Yes



Soil Properties

Property	Sandy Silt - Forward Abutment	Silty Clay - Forward Abutment - Stantec Lab
Color		
Unit Weight [kips/ft^3]	0.135	0.129
Saturated Unit Weight [kips/ft^3]	0.14	0.129
K0	1	1
Immediate Settlement	Enabled	Disabled
Es [ksf]	417.709	-
Esur [ksf]	417.709	-
Primary Consolidation	Enabled	Enabled
Material Type	Non-Linear	Non-Linear
Cc	0.139	0.205
Cr	0.009	0.065
e0	0.3	0.484
Pc [ksf]	6	8
Cv [ft^2/d]	2.5	4
Cvr [ft^2/d]	2.5	4
B-bar	1	1
Undrained Su A [kips/ft2]	0	0
Undrained Su S	0.2	0.2
Undrained Su m	0.8	0.8
Piezo Line ID	1	1

Groundwater

Groundwater method	Piezometric Lines
Water Unit Weight	0.0624 kips/ft^3

Piezometric Line Entities

ID	Depth (ft)
1	-945 ft

Query Points

Point #	Query Point Name	(X,Y) Location	Number of Divisions
1	Pile Location	0, 6	Auto: 50
2	MSE Wall Face	0, 0	Auto: 50
3	Differential Settlement Edge PL	-76.8, 6	Auto: 50
4	Differential Settlement Edge MSEWF	-76.8, 0	Auto: 50
5	Differential Settlement Midpoint PL	-39.8, 6	Auto: 50
6	Differential Settlement Midpoint MSEWF	-39.8, 0	Auto: 50

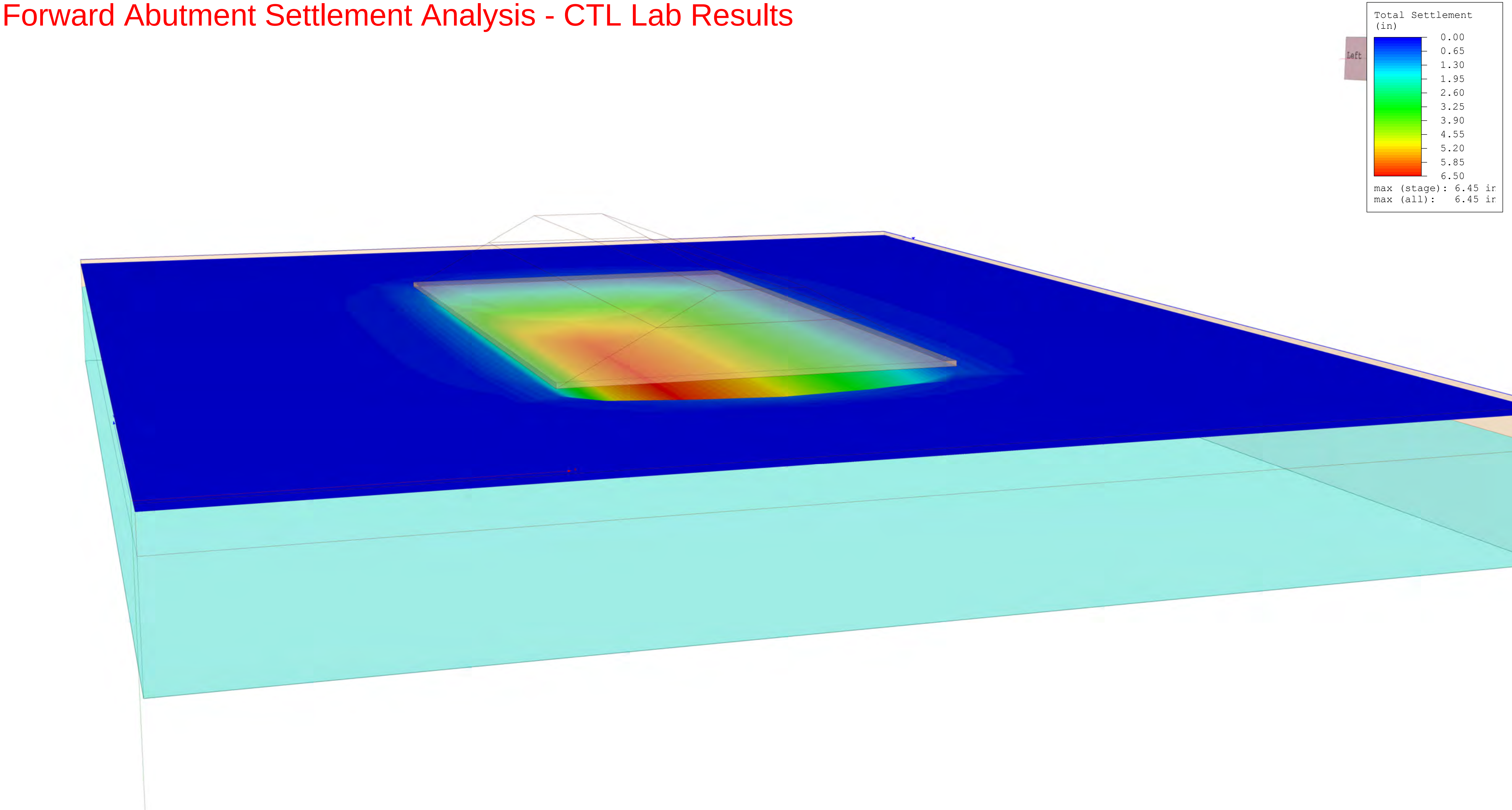
Query Lines

Line #	Query Line Name	Start Location	End Location	Horizontal Divisions	Vertical Divisions
1	Pile Location Differential Settlement	-76.8, 6	76.8, 6	154	Auto: 50
2	MSE Wall Face Differential Settlement	-76.8, 0	76.8, 0	154	Auto: 50

Time Points

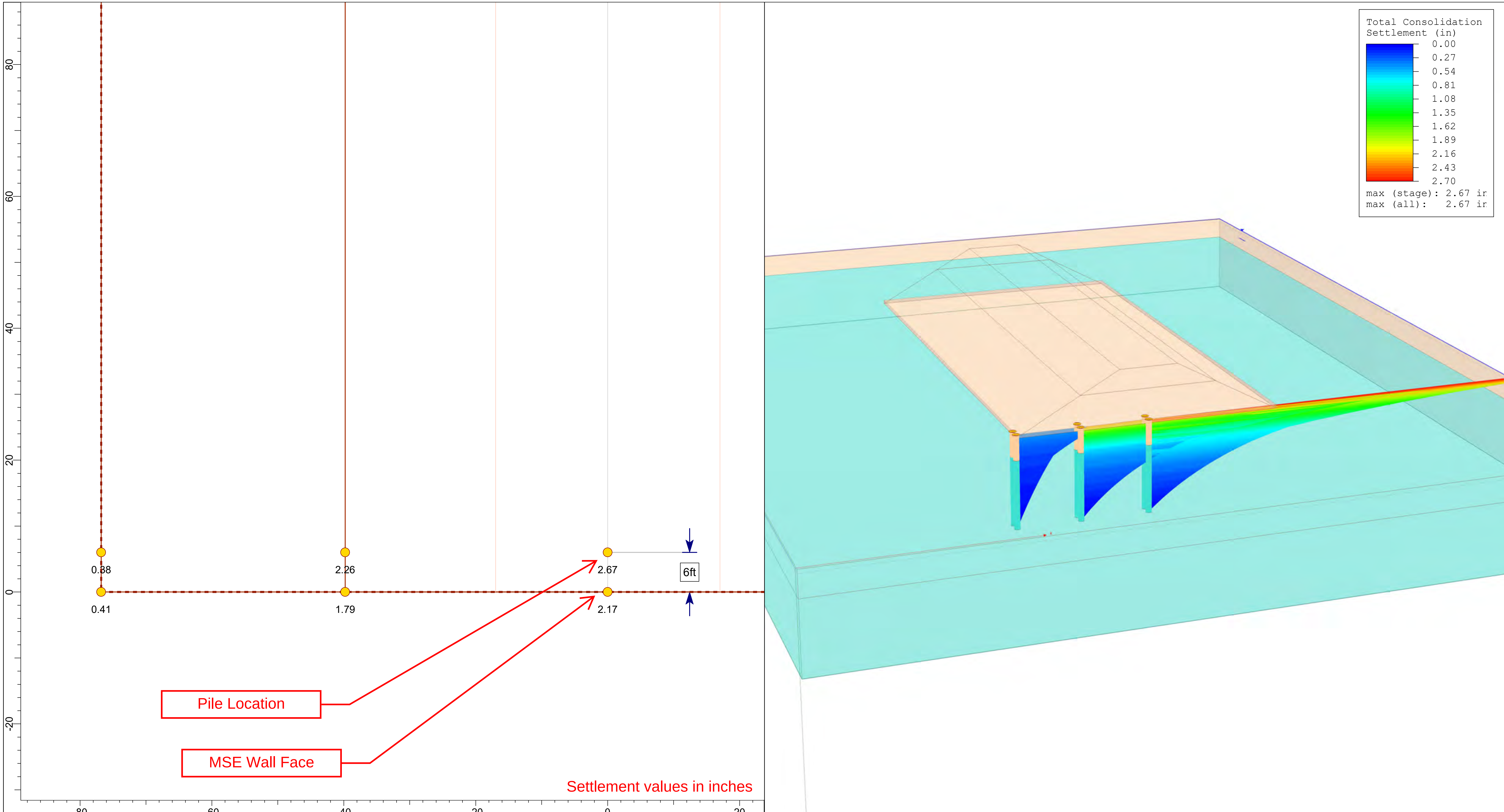
Point #	(X,Y) Location	Depth	Goal Type	Goal	Time Until Goal
1	0, 6	-943 ft	Degree of Consolidation	80%	3.56231 d
2	0, 6	-943 ft	Degree of Consolidation	90%	8.76738 d
3	0, 6	-943 ft	Degree of Consolidation	95%	29.2612 d
4	0, 0	-943 ft	Degree of Consolidation	80%	3.93341 d
5	0, 0	-943 ft	Degree of Consolidation	90%	9.72494 d
6	0, 0	-943 ft	Degree of Consolidation	95%	32.2528 d
7	0, 6	-943 ft	Total Settlement	4 in	0.325587 d
8	0, 6	-943 ft	Total Settlement	7.17 in	19.0605 d

Forward Abutment Settlement Analysis - CTL Lab Results



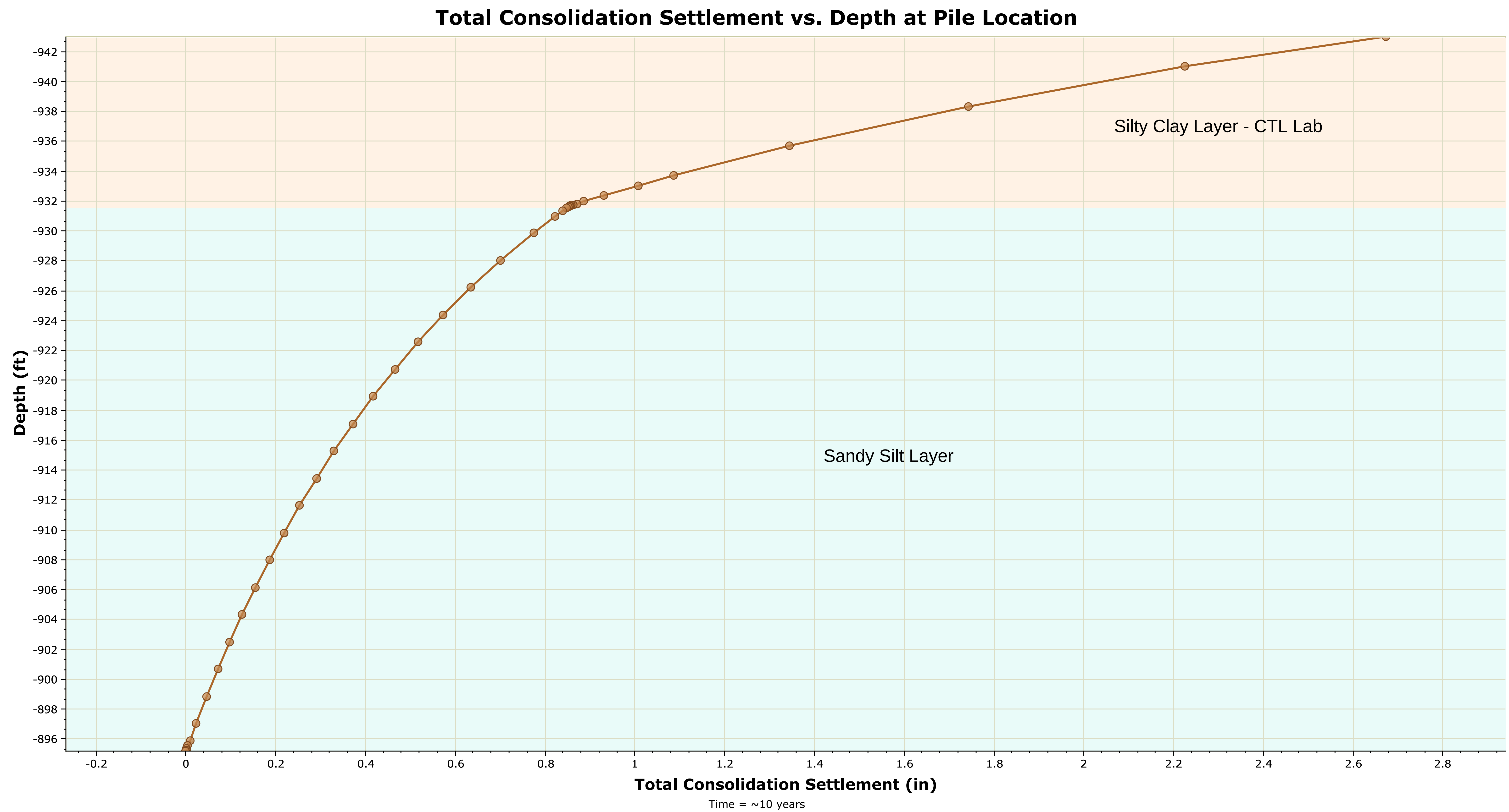
Project	BRO 32-0359		
Analysis Description	Forward Abutment Settlement Analysis		
Drawn By	LEDT	Company	Stantec
Date	8/12/2020	File Name	173620122 BRO 32-0359 Forward Abutment - CTL Lab.s3z

SETTLE3 5.001



SETTLE3 5.001

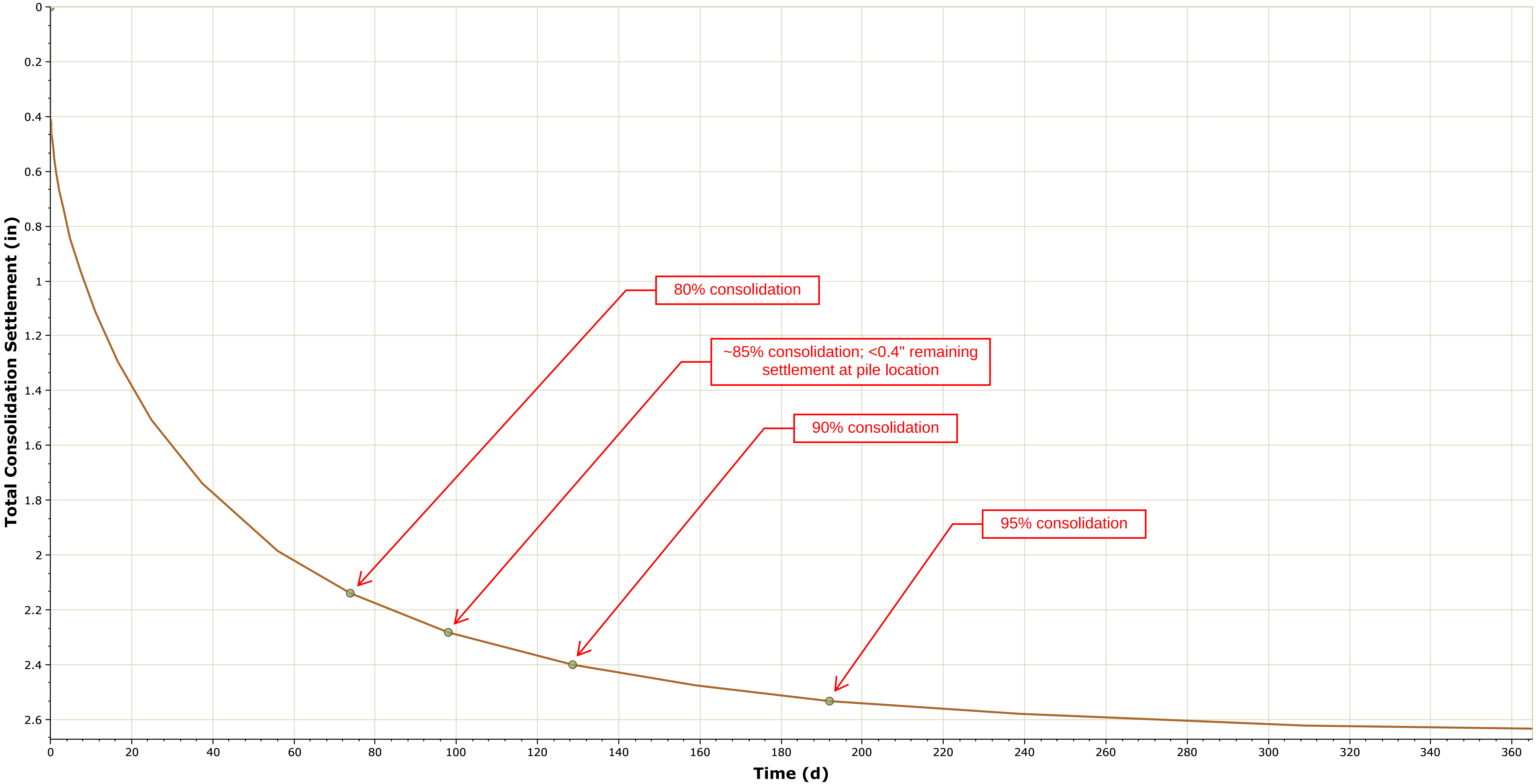
Project	BRO 32-0359
Analysis Description	Forward Abutment Settlement Analysis
Drawn By LEDT	*Company* Stantec
Date 8/12/2020	*File Name* 173620122 BRO 32-0359 Forward Abutment - CTL Lab.s3z



Project	BRO 32-0359
Analysis Description	Forward Abutment Settlement Analysis
Drawn By	LEDT
Company	Stantec
Date	8/12/2020
File Name	173620122 BRO 32-0359 Forward Abutment - CTL Lab.s3z

SETTLE3 5.001

Time vs. Total Consolidation Settlement at Pile Location



Total Consolidation Settlement at Depth = -943 ft

SETTLE3 5.001

Project	BRO 32-0359
Analysis Description	Forward Abutment Settlement Analysis
Drawn By LEDT	*Company* Stantec
Date 8/12/2020	*File Name* 173620122 BRO 32-0359 Forward Abutment - CTL Lab.s3z

Settle3 Analysis Information
BRO 32-0359

Project Settings

Document Name	173620122 BRO 32-0359 Forward Abutment - CTL Lab.s3z
Project Title	BRO 32-0359
Analysis	Forward Abutment Settlement Analysis
Author	LEDT
Company	Stantec
Date Created	8/12/2020
Comments	
Project #: 173620122	
Stress Computation Method	Boussinesq
Time-dependent Consolidation Analysis	
Time Units	days
Permeability Units	feet/day
Minimum settlement ratio for subgrade modulus	0.9

Use average properties to calculate layered stresses

Improve consolidation accuracy

Ignore negative effective stresses in settlement calculations

Stage Settings

Stage #	Name	Time [days]
1	Stage 1	0
2	CTL 80% PL	73.93
3	CTL <0.4" PL	98.09
4	CTL 90% PL	128.55
5	CTL 95% PL	191.84
6	10 years	3650

Results

Notes:

Results for Pile Location

Time taken to compute: 6.98931 seconds

Stage: Stage 1 = 0 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	1.80249
Total Consolidation Settlement [in]	0	0
Virgin Consolidation Settlement [in]	0	0
Recompression Consolidation Settlement [in]	0	0
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.1332	3.71818
Effective Stress XX [ksf]	-0.770197	5.6386
Effective Stress YY [ksf]	-0.289841	7.32776
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	0	0.00538421
Pore Water Pressure [ksf]	-0.0653159	4.476
Excess Pore Water Pressure [ksf]	-0.0653159	2.99588
Degree of Consolidation [%]	0	0
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1.61431	19.74
Void Ratio	0.293001	0.73
Permeability [ft/d]	4.79101e-005	0.000528427
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	0	17.1342
Undrained Shear Strength	0	0

Stage: CTL 80% PL = 73.93 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	3.94237
Total Consolidation Settlement [in]	0	2.13988
Virgin Consolidation Settlement [in]	0	0.00104129
Recompression Consolidation Settlement [in]	0	2.13884
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00136947	0.0179351
Pore Water Pressure [ksf]	0	2.98272
Excess Pore Water Pressure [ksf]	-0.00656079	1.74545
Degree of Consolidation [%]	0	99.96
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	25.1056
Void Ratio	0.287918	0.732591
Permeability [ft/d]	4.79101e-005	0.000528427
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	54.9311	82.9027
Undrained Shear Strength	0	0.190311

Stage: CTL <0.4" PL = 98.09 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.08607
Total Consolidation Settlement [in]	0	2.28358
Virgin Consolidation Settlement [in]	0	0.0011493
Recompression Consolidation Settlement [in]	0	2.28243
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00131503	0.0181411
Pore Water Pressure [ksf]	0	2.98272
Excess Pore Water Pressure [ksf]	-0.000393117	1.42531
Degree of Consolidation [%]	0	99.9759
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	25.0271
Void Ratio	0.287918	0.732544
Permeability [ft/d]	4.79101e-005	0.000528427
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	62.7551	89.6972
Undrained Shear Strength	0	0.190311

Stage: CTL 90% PL = 128.55 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.20227
Total Consolidation Settlement [in]	0	2.39979
Virgin Consolidation Settlement [in]	0	0.00125778
Recompression Consolidation Settlement [in]	0	2.39853
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00124512	0.0183089
Pore Water Pressure [ksf]	0	2.98272
Excess Pore Water Pressure [ksf]	0	1.09432
Degree of Consolidation [%]	0	99.9873
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	24.9272
Void Ratio	0.287917	0.732484
Permeability [ft/d]	4.79101e-005	0.000528427
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	71.0672	94.5597
Undrained Shear Strength	0	0.190311

Stage: CTL 95% PL = 191.84 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.33479
Total Consolidation Settlement [in]	0	2.53231
Virgin Consolidation Settlement [in]	0	0.0024624
Recompression Consolidation Settlement [in]	0	2.52984
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.00113069	0.0185095
Pore Water Pressure [ksf]	0	2.98272
Excess Pore Water Pressure [ksf]	-0.00237121	0.630299
Degree of Consolidation [%]	0	99.9966
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	24.7658
Void Ratio	0.287917	0.732385
Permeability [ft/d]	4.79101e-005	0.000528427
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	83.235	98.5567
Undrained Shear Strength	0	0.190311

Stage: 10 years = 3650 d

Data Type	Minimum	Maximum
Total Settlement [in]	0	4.47491
Total Consolidation Settlement [in]	0	2.67242
Virgin Consolidation Settlement [in]	0	0.032974
Recompression Consolidation Settlement [in]	0	2.63945
Immediate Settlement [in]	0	1.80249
Secondary Settlement [in]	0	0
Loading Stress ZZ [ksf]	-0.190116	2.87108
Loading Stress XX [ksf]	-1.0282	2.13741
Loading Stress YY [ksf]	-0.898725	3.48478
Effective Stress ZZ [ksf]	0.0678841	5.21146
Effective Stress XX [ksf]	0.138871	7.07912
Effective Stress YY [ksf]	-0.224264	8.75433
Total Stress ZZ [ksf]	0.0678841	8.19418
Total Stress XX [ksf]	0.138871	10.0618
Total Stress YY [ksf]	-0.224264	11.7371
Modulus of Subgrade Reaction (Total) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Immediate) [ksf/ft]	0	0
Modulus of Subgrade Reaction (Consolidation) [ksf/ft]	0	0
Total Strain	-0.000964949	0.0187427
Pore Water Pressure [ksf]	0	2.98272
Excess Pore Water Pressure [ksf]	-0.00617684	0.00486728
Degree of Consolidation [%]	0	100
Pre-consolidation Stress [ksf]	3.2	6
Over-consolidation Ratio	1	24.5369
Void Ratio	0.287917	0.732241
Permeability [ft/d]	4.79101e-005	0.000528427
Coefficient of Consolidation [ft^2/d]	0.1	2.5
Hydroconsolidation Settlement [in]	0	0
Average Degree of Consolidation [%]	99.999	100
Undrained Shear Strength	0	0.254199

Embankments

Notes:

Embankment bottom sits at Elevation 943.0 ft

1. Embankment: "MSE Wall Reinforced Fill and Retained Wedge Fill"

Label	MSE Wall Reinforced Fill and Retained Wedge Fill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	153.6

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	18.5	0.12	26.5651	0

2. Embankment: "Abutment Wall Backfill"

Label	Abutment Wall Backfill
Center Line	(0, 0) to (0, 300)
Near End Angle	90 degrees
Far End Angle	90 degrees
Number of Layers	1
Base Width	79.6

Layer	Stage	Left Bench Width (ft)	Left Angle (deg)	Height (ft)	Unit Weight (kips/ ft^3)	Right Angle (deg)	Right Bench Width (ft)
1	Stage 1 = 0 d	0	26.5651	11.4	0.125	26.5651	0

Excavations

1. Excavation: "Excavation to Bottom of MSE"

Depth	-943 ft
Installation Stage	Stage 1 = 0 d

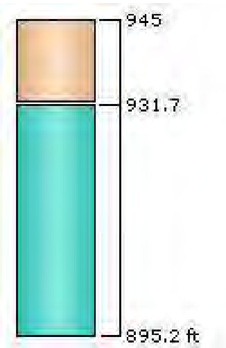
Coordinates

X [ft]	Y [ft]
76.8	0
76.8	300
-76.8	300
-76.8	0

Soil Layers

Ground Surface Drained: Yes

Layer #	Type	Thickness [ft]	Depth [ft]	Drained at Bottom
1	Silty Clay - Forward Abutment - CTL Lab	13.3	-945	Yes
2	Sandy Silt - Forward Abutment	36.5	-931.7	Yes



Soil Properties

Property	Silty Clay - Forward Abutment - CTL Lab	Sandy Silt - Forward Abutment
Color		
Unit Weight [kips/ft^3]	0.129	0.135
Saturated Unit Weight [kips/ft^3]	0.129	0.14
K0	1	1
Immediate Settlement	Disabled	Enabled
Es [ksf]	-	417.709
Esur [ksf]	-	417.709
Primary Consolidation	Enabled	Enabled
Material Type	Non-Linear	Non-Linear
Cc	0.11	0.139
Cr	0.027	0.009
e0	0.73	0.3
Pc [ksf]	3.2	6
Cv [ft^2/d]	0.1	2.5
Cvr [ft^2/d]	0.1	2.5
B-bar	1	1
Undrained Su A [kips/ft2]	0	0
Undrained Su S	0.2	0.2
Undrained Su m	0.8	0.8
Piezo Line ID	1	1

Groundwater

Groundwater method	Piezometric Lines
Water Unit Weight	0.0624 kips/ft^3

Piezometric Line Entities

ID	Depth (ft)
1	-945 ft

Query Points

Point #	Query Point Name	(X,Y) Location	Number of Divisions
1	Pile Location	0, 6	Auto: 50
2	MSE Wall Face	0, 0	Auto: 50
3	Differential Settlement Edge PL	-76.8, 6	Auto: 50
4	Differential Settlement Edge MSEWF	-76.8, 0	Auto: 50
5	Differential Settlement Midpoint PL	-39.8, 6	Auto: 50
6	Differential Settlement Midpoint MSEWF	-39.8, 0	Auto: 50

Query Lines

Line #	Query Line Name	Start Location	End Location	Horizontal Divisions	Vertical Divisions
1	Pile Location Differential Settlement	-76.8, 6	76.8, 6	154	Auto: 50
2	MSE Wall Face Differential Settlement	-76.8, 0	76.8, 0	154	Auto: 50

Time Points

Point #	(X,Y) Location	Depth	Goal Type	Goal	Time Until Goal
1	0, 6	-943 ft	Degree of Consolidation	80%	73.9285 d
2	0, 6	-943 ft	Degree of Consolidation	90%	128.553 d
3	0, 6	-943 ft	Degree of Consolidation	95%	191.843 d
4	0, 0	-943 ft	Degree of Consolidation	80%	79.376 d
5	0, 0	-943 ft	Degree of Consolidation	90%	136.15 d
6	0, 0	-943 ft	Degree of Consolidation	95%	201.133 d
7	0, 6	-943 ft	Total Settlement	4 in	98.0858 d

APPENDIX H

Subgrade Stabilization Analysis

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Bulletin GB1

BRO-32-4.16
110478

Subgrade Analysis: Mt. Orab SR 32 Interchange

Stantec

Prepared By: Eric M. Kistner, PE
Date prepared: Friday, March 12, 2021

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513-479-7723
Eric.Kistner@stantec.com

NO. OF BORINGS: 44

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-060-0-20	Bruce Lunsford Way	420+50	0		Dietrich D-50	87	945.1	947.3	2.2 F
2	B-061-0-20	Bruce Lunsford Way	423+50	1	Rt.	Dietrich D-50	87	945.5	943.8	1.7 C
3	B-062-0-20	Bruce Lunsford Way	427+00	2	Rt.	Dietrich D-50	87	946.0	945.6	0.4 C
4	B-063-0-20	Bruce Lunsford Way	430+07	2	Rt.	Dietrich D-50	87	947.4	947.1	0.3 C
5	B-037-0-20	Homan Way	303+68	0		Dietrich D-50	87	938.3	938.2	0.1 C
6	B-039-0-20	Homan Way	311+25	0		Dietrich D-50	87	936.6	939.8	3.2 F
7	B-040-0-20	Homan Way	315+15	10	Lt.	Dietrich D-50	87	940.5	941.8	1.3 F
8	B-041-0-20	Homan Way	318+95	20	Lt.	Dietrich D-50	87	942.1	943.7	1.6 F
9	B-042-0-20	Homan Way	322+75	10	Lt.	Dietrich D-50	87	942.1	944.0	1.9 F
10	B-043-0-20	Homan Way	326+55	10	Lt.	Dietrich D-50	87	941.5	942.5	1.0 F
11	B-044-0-20	Homan Way	330+34	15	Lt.	Dietrich D-50	87	941.3	944.4	3.1 F
12	B-045-0-20	Homan Way	334+15	15	Lt.	Dietrich D-50	87	942.1	943.3	1.2 F
13	B-046-0-20	Homan Way	337+96	20	Lt.	Dietrich D-50	87	943.0	944.7	1.7 F
14	B-047-0-20	Homan Way	341+75	20	Lt.	Dietrich D-50	87	943.1	945.9	2.8 F
15	B-048-0-20	Homan Way	345+55	0		Dietrich D-50	87	943.9	945.5	1.6 F
16	B-049-0-20	Homan Way	349+35	0		Dietrich D-50	87	946.4	947.4	1.0 F
17	B-050-0-20	Homan Way	353+15	0		Dietrich D-50	87	946.4	948.8	2.4 F
18	B-054-0-20	Homan Way	356+95	0		Dietrich D-51	87	947.2	948.2	1.0 F
19	B-055-0-20	Homan Way	360+75	0		Dietrich D-52	87	944.7	946.7	2.0 F
20	B-056-0-20	Homan Way	364+25	0		Dietrich D-53	87	945.2	945.3	0.1 F
21	B-010-0-20	SR 32	169+90	65	Lt.	Dietrich D-50	87	946.7	946.7	0.0
22	B-012-0-20	SR 32	174+03	69	Lt.	Dietrich D-50	87	945.4	945.4	0.0
23	B-014-0-20	Ramp NW	500+00	1	Rt.	Dietrich D-50	87	945.4	945.4	0.0
24	B-016-0-20	Ramp NW	503+00	1	Rt.	Dietrich D-50	87	943.0	945.6	2.6 F
25	B-018-0-20	Ramp NW	507+00	1	Rt.	Dietrich D-50	87	944.5	951.6	7.1 F
26	B-024-0-20	Ramp NE	606+00	15	Lt.	Dietrich D-50	87	948.0	953.2	5.2 F
27	B-026-0-20	Ramp NE	611+06	17	Lt.	Dietrich D-50	87	948.5	950.3	1.8 F
28	B-028-0-20	Ramp NE	613+56	4	Lt.	Dietrich D-50	87	949.8	949.2	0.6 C
29	B-030-0-20	Ramp NE	617+06	1	Rt.	Dietrich D-50	87	950.2	949.1	1.1 C
30	B-011-0-20	Ramp SW	700+00	1	Rt.	Dietrich D-50	87	946.0	945.4	0.6 C
31	B-013-0-20	Ramp SW	704+00	1	Rt.	Dietrich D-50	87	946.4	945.9	0.5 C
32	B-015-0-20	Ramp SW	707+50	1	Rt.	Dietrich D-50	87	943.2	946.4	3.2 F
33	B-017-0-20	Ramp SW	712+00	2	Rt.	Dietrich D-50	87	943.7	952.9	9.2 F
34	B-023-0-20	Ramp SE	806+00	1	Rt.	Dietrich D-50	87	948.0	953.0	5.0 F
35	B-025-0-20	Ramp SE	810+50	1	Rt.	Dietrich D-50	87	946.3	950.4	4.1 F
36	B-027-0-20	Ramp SE	812+50	1	Rt.	Dietrich D-50	87	947.9	949.7	1.8 F
37	B-029-0-20	SR 32	206+72	68	Rt.	Dietrich D-50	87	950.1	950.1	0.0
38	B-031-0-20	SR 32	213+03	73	Rt.	Dietrich D-50	87	947.9	947.9	0.0
39	B-009-0-20	Bodman Road	24+56	17	Rt.	Dietrich D-50	87	941.2	940.6	0.6 C
40	B-051-0-20	Mercy Boulevard	53+00	0		Dietrich D-50	87	946.7	946.6	0.1 C
41	B-053-0-20	Mercy Boulevard	58+01	10	Rt.	Dietrich D-50	87	945.8	945.0	0.8 C
42	B-052-0-20	Shaw Drive	22+02	18	Lt.	Dietrich D-50	87	946.9	946.0	0.9 C
43	B-032-0-20	Brooks Malott Road	14+02	29	Lt.	Dietrich D-50	87	942.8	944.8	2.0 F
44	B-035-0-20	Brooks Malott Road	20+75	41	Lt.	Dietrich D-50	87	946.8	946.2	0.6 C

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.5 1/18/2019

#	Boring	Sample	Sample Depth From	Sample Depth To	Subgrade Depth From	Subgrade Depth To	Standard Penetration N_{60}	Standard Penetration N_{60L}	HP (tsf)	Physical Characteristics LL	PL	PI	% Silt	% Clay	P200	Moisture M_C	Moisture M_{OPT}	Ohio DOT Class	GI	Sulfate Content (ppm)	Problem Unsuitable	Problem Unstable	Excavate and Replace (Item 204) Unsuitable	Excavate and Replace (Item 204) Unstable	Recommendation (Enter depth in inches)
1	B	1	1.0	2.5	3.2	4.7	6		1.25	58	23	35	34	47	81	26	20	A-7-6	20						Bruce Lunsford Way
	060-0	2	3.5	5.0	5.7	7.2	14		2.25	58	23	35	34	47	81	30	20	A-7-6							
	20	3	6.0	7.5	8.2	9.7	16		2	58	23	35	34	47	81	21	20	A-7-6							
		4	8.5	10.0	10.7	12.2	22	6	4.5	25	15	10	34	22	56	13	10	A-4a							
2	B	1	1.0	2.5	-0.7	0.8	7		1.5	66	21	45	31	50	81	23	18	A-7-6	20	100	High LL	HP & Mc		15''	Bruce Lunsford Way
	061-0	2	3.5	5.0	1.8	3.3	10		1.75	66	21	45	31	50	81	27	18	A-7-6	20		High LL	HP & Mc	40''		
	20	3	6.0	7.5	4.3	5.8	14		2	56	18	38	33	48	81	19	18	A-7-6	19						
		4	8.5	10.0	6.8	8.3	12	7		56	18	38	33	48	81	19	18	A-7-6							
3	B	1	1.0	2.5	0.6	2.1	4		1.25	55	22	33	39	50	89	28	19	A-7-6	19			HP & Mc		24''	Bruce Lunsford Way
	062-0	2	3.5	5.0	3.1	4.6	12		2.25	55	22	33	39	50	89	24	19	A-7-6	19						
	20	3	6.0	7.5	5.6	7.1	13		1.5	45	19	26	34	41	75	22	18	A-7-6							
		4	8.5	10.0	8.1	9.6	13	4	1.5	45	19	26	34	41	75	21	18	A-7-6							
4	B	1	1.0	2.5	0.7	2.2	4		1	54	23	31	30	45	75	26	20	A-7-6	19	100		HP & Mc		24''	Bruce Lunsford Way
	063-0	2	3.5	5.0	3.2	4.7	13		2	54	23	31	30	45	75	24	20	A-7-6	19						
	20	3	6.0	7.5	5.7	7.2	13		2	55	26	29	34	41	75	21	23	A-7-6							
		4	8.5	10.0	8.2	9.7	17	4	2.25	55	26	29	34	41	75	21	23	A-7-6							
5	B	1	1.0	2.5	0.9	2.4	6			29	17	12	41	33	74	18	14	A-6a	9			N_{60} & Mc		18''	Homan Way
	037-0	2	3.5	5.0	3.4	4.9	7		1	29	17	12	41	33	74	28	14	A-6a	9						
	20	3	6.0	7.5	5.9	7.4	12		2.5	25	15	10	35	26	61	23	10	A-4a							
		4	8.5	10.0	8.4	9.9	54	6	4.5	25	15	10	35	26	61	9	10	A-4a							
6	B	1	1.0	2.5	4.2	5.7	7		2.5	29	16	13	36	25	61	23	14	A-6a	6	378					Homan Way
	039-0	2	3.5	5.0	6.7	8.2	30		2.5	29	16	13	36	25	61	17	14	A-6a							
	20	3	6.0	7.5	9.2	10.7	84		4.5	27	17	10	37	23	60	8	12	A-4a							
		4	8.5	10.0	11.7	13.2	93	7	4.5	27	17	10	37	23	60	9	12	A-4a							
7	B	1	1.0	2.5	2.3	3.8	9		2	45	20	25	37	40	77	23	18	A-7-6	15	238					Homan Way
	040-0	2	3.5	5.0	4.8	6.3	16		2	45	20	25	37	40	77	22	18	A-7-6	15						
	20	3	6.0	7.5	7.3	8.8	41		4	27	15	12	34	25	59	11	14	A-6a							
		4	8.5	10.0	9.8	11.3	69	9	4.5	27	15	12	34	25	59	12	14	A-6a							
8	B	1	1.0	2.5	2.6	4.1	9		1.5	47	18	29	35	46	81	21	18	A-7-6	17	213					Homan Way
	041-0	2	3.5	5.0	5.1	6.6	9		2	47	18	29	35	46	81	25	18	A-7-6							
	20	3	6.0	7.5	7.6	9.1	16		3	48	25	23	30	44	74	19	22	A-7-6							
		4	8.5	10.0	10.1	11.6	50	9	4.5	48	25	23	30	44	74	11	20	A-4a							
9	B	1	1.0	2.5	2.9	4.4	6		0.5	50	20	30	31	46	77	26	18	A-7-6	18	100					Homan Way
	042-0	2	3.5	5.0	5.4	6.9	9		2.5	50	20	30	31	46	77	20	18	A-7-6							
	20	3	6.0	7.5	7.9	9.4	23		3.5	50	20	30	31	46	77	21	18	A-7-6							

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.5 1/18/2019

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
		4	8.5	10.0	10.4	11.9	75	6	4.5	25	14	11	30	25	55	9	14	A-6a							
10	B	1	1.0	2.5	2.0	3.5	7		2.5	60	21	39	29	52	81	23	18	A-7-6	20	202		N_{60} & Mc			**Homan Way**
	043-0	2	3.5	5.0	4.5	6.0	23		1.25	60	21	39	29	52	81	29	18	A-7-6	20						
	20	3	6.0	7.5	7.0	8.5	13		1.75	38	24	14	30	35	65	18	19	A-6a							
		4	8.5	10.0	9.5	11.0	61	7	4.5							10	10	A-4a							
11	B	1	1.0	2.5	4.1	5.6	6		1.5	55	20	35	28	46	74	25	18	A-7-6	19	367					**Homan Way**
	044-0	2	3.5	5.0	6.6	8.1	12		1.5	55	20	35	28	46	74	22	18	A-7-6							
	20	3	6.0	7.5	9.1	10.6	12		1.25	26	15	11	23	18	41	24	14	A-6a							
		4	8.5	10.0	11.6	13.1	62	6	4	26	15	11	23	18	41	8	10	A-4a							
12	B	1	1.0	2.5	2.2	3.7	9		1	53	31	22	28	49	77	22		A-7-5	15	167					**Homan Way**
	045-0	2	3.5	5.0	4.7	6.2	10		0.75	53	31	22	28	49	77	31		A-7-5	15						
	20	3	6.0	7.5	7.2	8.7	6			38	20	18	26	40	66	22	16	A-6b							
		4	8.5	10.0	9.7	11.2	13	9	1.25	38	20	18	26	40	66	23	16	A-6b							
13	B	1	1.0	2.5	2.7	4.2	7		2.25	51	17	34	31	47	78	26	18	A-7-6	18	238					**Homan Way**
	046-0	2	3.5	5.0	5.2	6.7	10		1	51	17	34	31	47	78	24	18	A-7-6							
	20	3	6.0	7.5	7.7	9.2	12		2.25	51	17	34	31	47	78	23	18	A-7-6							
		4	8.5	10.0	10.2	11.7	27	7	4.5	29	16	13	34	25	59	15	14	A-6a							
14	B	1	1.0	2.5	3.8	5.3	6		1.25	51	19	32	24	42	66	24	18	A-7-6	16	133					**Homan Way**
	047-0	2	3.5	5.0	6.3	7.8	12		1	51	19	32	24	42	66	25	18	A-7-6							
	20	3	6.0	7.5	8.8	10.3	12		2	41	22	19	30	32	62	20	19	A-7-6							
		4	8.5	10.0	11.3	12.8	9	6		41	22	19	30	32	62	24	19	A-7-6							
15	B	1	1.0	2.5	2.6	4.1	4		1.5	57	24	33	34	52	86	10	21	A-7-6	19	100					**Homan Way**
	048-0	2	3.5	5.0	5.1	6.6	10		4	57	24	33	34	52	86	23	21	A-7-6							
	20	3	6.0	7.5	7.6	9.1	13		3.5	44	20	24	32	45	77	21	18	A-7-6							
		4	8.5	10.0	10.1	11.6	14	4	3.5	44	20	24	32	45	77	20	18	A-7-6							
16	B	1	1.0	2.5	2.0	3.5	6		2.5	28	17	11	54	30	84	20	14	A-6a	8			N_{60} & Mc			**Homan Way**
	049-0	2	3.5	5.0	4.5	6.0	12		3.5	42	19	23	31	38	69	21	18	A-7-6	12	290					
	20	3	6.0	7.5	7.0	8.5	14		3	42	19	23	31	38	69	23	18	A-7-6							
		4	8.5	10.0	9.5	11.0	19	6	3.5	42	19	23	31	38	69	19	18	A-7-6							
17	B	1	1.0	2.5	3.4	4.9	4		2.5	49	22	27	40	45	85	24	19	A-7-6	17	100					**Homan Way**
	050-0	2	3.5	5.0	5.9	7.4	10		3.5	49	22	27	40	45	85	25	19	A-7-6							
	20	3	6.0	7.5	8.4	9.9	12		4	49	22	27	40	45	85	22	19	A-7-6							
		4	8.5	10.0	10.9	12.4	10	4	1.5	36	19	17	40	36	76	28	16	A-6b							
18	B	1	1.0	2.5	2.0	3.5	4		1.5	46	17	29	40	40	80	22	18	A-7-6	17	100		HP & Mc			**Homan Way**
	054-0	2	3.5	5.0	4.5	6.0	12		3	46	17	29	40	40	80	24	18	A-7-6	17						

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
	20	3	6.0	7.5	7.0	8.5	16		4.5	43	20	23	32	40	72	17	18	A-7-6							
		4	8.5	10.0	9.5	11.0	55	4	4.5	43	20	23	32	40	72	11	18	A-7-6							
19	B	1	1.0	2.5	3.0	4.5	3		2	38	18	20	48	38	86	28	16	A-6b	12						**Homan Way**
	055-0	2	3.5	5.0	5.5	7.0	7		3	46	17	29	30	45	75	23	18	A-7-6		830					
	20	3	6.0	7.5	8.0	9.5	12		3.5	46	17	29	30	45	75	24	18	A-7-6							
		4	8.5	10.0	10.5	12.0	13	3	4.5	46	17	29	30	45	75	24	18	A-7-6							
20	B	1	1.0	2.5	1.1	2.6	7		3	51	24	27	40	46	86	27	21	A-7-6	17	100		N_{60} & Mc			**Homan Way**
	056-0	2	3.5	5.0	3.6	5.1	12		3	51	24	27	40	46	86	28	21	A-7-6	17						
	20	3	6.0	7.5	6.1	7.6	7		3.5	53	24	29	31	52	83	24	21	A-7-6							
		4	8.5	10.0	8.6	10.1	14	7	3	53	24	29	31	52	83	23	21	A-7-6							
21	B	1	0.0	1.5	0.0	1.5	27			56	18	38	56	27	83	10	14	A-6a	10	844					**Ramp NW**
	010-0	2	1.5	3.0	1.5	3.0	20			56	18	38	56	27	83	14	14	A-6a	10						
	20	3	3.0	4.5	3.0	4.5	9		1.5	47	24	23	47	41	88	24	19	A-6a	10						
		4	4.5	6.0	4.5	6.0	10	9	2	47	24	23	47	41	88	20	19	A-6a	10						
22	B	1	0.0	1.5	0.0	1.5	7		1	46	23	23	46	41	87	17	20	A-7-6	14			HP		15"	**Ramp NW**
	012-0	2	1.5	3.0	1.5	3.0	10		3	46	23	23	46	41	87	23	20	A-7-6	14	100		N_{60} & Mc			
	20	3	3.0	4.5	3.0	4.5	10		2	29	18	11	52	33	85	17	14	A-6a	8						
		4	4.5	6.0	4.5	6.0	6	6	1	29	18	11	52	33	85	30	14	A-6a	8						
23	B	1	0.0	1.5	0.0	1.5	20			29	17	12	48	32	80	14	14	A-6a	9						**Ramp NW**
	014-0	2	1.5	3.0	1.5	3.0	10		1.5	29	17	12	48	32	80	18	14	A-6a	9	100		HP & Mc			
	20	3	3.0	4.5	3.0	4.5	12		1	29	17	12	48	32	80	24	14	A-6a	9						
		4	4.5	6.0	4.5	6.0	12	10	1.5	52	20	32	39	43	82	21	18	A-7-6	18						
24	B	1	1.0	2.5	3.6	5.1	4		0.5	38	20	18	46	40	86	30	16	A-6b	11	3302					**Ramp NW**
	016-0	2	3.5	5.0	6.1	7.6	13		1.5	38	20	18	46	40	86	25	16	A-6b							
	20	3	6.0	7.5	8.6	10.1	13		2	49	25	24	31	51	82	22	22	A-7-6							
		4	8.5	10.0	11.1	12.6	77	4	4.5	49	25	24	31	51	82	9	22	A-7-6							
26	B	1	1.0	2.5	6.2	7.7	6		3	32	19	13	58	26	84	23	14	A-6a							
	024-0	2	3.5	5.0	8.7	10.2	13		3	32	19	13	58	26	84	24	14	A-6a							
	20	3	6.0	7.5	11.2	12.7	12		4	37	20	17	36	38	74	19	16	A-6b							
		4	8.5	10.0	13.7	15.2	67		4.5	37	20	17	36	38	74	10									
27	B	1	1.0	2.5	2.8	4.3	4		3.5	58	23	35	28	54	82	24	20	A-7-6	20						**Ramp NE**
	026-0	2	3.5	5.0	5.3	6.8	10		1.5	58	23	35	28	54	82	28	20	A-7-6							
	20	3	6.0	7.5	7.8	9.3	14		1.5	55	26	29	32	49	81	20	23	A-7-6							
		4	8.5	10.0	10.3	11.8	46	4	4.5	55	26	29	32	49	81	10	21	A-4a							
28	B	1	0.0	1.5	-0.6	0.9	17		4	26	16	10	54	26	80	15	11	A-4b	8	100	A-4b	Mc			**Ramp NE**

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.5 1/18/2019

#	Boring	Sample	Sample Depth From	Sample Depth To	Subgrade Depth From	Subgrade Depth To	Standard Penetration N_{60}	Standard Penetration N_{60L}	HP (tsf)	LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Ohio DOT Class	GI	Sulfate Content (ppm)	Problem Unsuitable	Problem Unstable	Excavate and Replace (Item 204) Unsuitable	Excavate and Replace (Item 204) Unstable	Recommendation (Enter depth in inches)
	028-0	2	1.5	3.0	0.9	2.4	20		4.5	26	16	10	54	26	80	16	11	A-4b	8		A-4b	Mc	29"		
	20	3	3.0	4.5	2.4	3.9	10		2	38	18	20	50	37	87	20	16	A-6b	12						
		4	4.5	6.0	3.9	5.4	13	10	1	38	18	20	50	37	87	19	16	A-6b	12						
29	B	1	0.0	1.5	-1.1	0.4	14		4.5	35	16	19	34	34	68	13	16	A-6b	10						Ramp NE
	030-0	2	1.5	3.0	0.4	1.9	16		2	29	17	12	52	32	84	18	14	A-6a	9	1273		Mc			
	20	3	3.0	4.5	1.9	3.4	12		3	29	17	12	52	32	84	18	14	A-6a	9			N_{60} & Mc			
		4	4.5	6.0	3.4	4.9	13	12	3.5	29	17	12	54	32	86	22	14	A-6a	9						
30	B	1	0.0	1.5	-0.6	0.9	14			33	16	17	41	37	78	10	16	A-6b	11						Ramp SW
	011-0	2	1.5	3.0	0.9	2.4	6		1	48	28	20	40	53	93	23	23	A-6b	14	1020		HP		18"	
	20	3	3.0	4.5	2.4	3.9	7		2	48	28	20	40	53	93	22	23	A-6b	14						
		4	4.5	6.0	3.9	5.4	7	6	0.5	48	28	20	40	53	93	24	25	A-7-6	14						
31	B	1	0.0	1.5	-0.5	1.0	12		3	31	19	12	41	31	72	13	14	A-6a	8	100					Ramp SW
	013-0	2	1.5	3.0	1.0	2.5	14		2	31	19	12	41	31	72	15	14	A-6a	8						
	20	3	3.0	4.5	2.5	4.0	14			27	20	7	55	30	85	17	15	A-4b	8						
		4	4.5	6.0	4.0	5.5	14	12	1.5	27	20	7	55	30	85	16	15	A-4b	8						
32	B	1	1.0	2.5	4.2	5.7	6		4.5	46	23	23	36	46	82	22	20	A-7-6	14	295					Ramp SW
	015-0	2	3.5	5.0	6.7	8.2	16		4.5	46	23	23	36	46	82	21	20	A-7-6							
	20	3	6.0	7.5	9.2	10.7	16		3	54	21	33	25	48	73	24	18	A-7-6							
		4	8.5	10.0	11.7	13.2	41	6	4.5	54	21	33	25	48	73	11	18	A-7-6							
34	B	1	1.0	2.5	6.0	7.5	9		1.5	50	21	29	37	44	81	19	18	A-7-6							Ramp SE
	023-0	2	3.5	5.0	8.5	10.0	9		3	50	21	29	37	44	81	21	18	A-7-6							
	20	3	6.0	7.5	11.0	12.5	35		4.5	50	21	29	37	44	81	15	18	A-7-6							
		4	8.5	10.0	13.5	15.0	67	9	4.5	26	14	12	26	14	40	10	14	A-6a							
35	B	1	1.0	2.5	5.1	6.6	9		1.5	51	28	23	27	49	76	25	25	A-7-6		130					Ramp SE
	025-0	2	3.5	5.0	7.6	9.1	17		2	51	28	23	27	49	76	18	25	A-7-6							
	20	3	6.0	7.5	10.1	11.6	41		4.5	28	17	11	32	27	59	12	14	A-6a							
		4	8.5	10.0	12.6	14.1	78	9	4.5	28	17	11	32	27	59	8	14	A-6a							
36	B	1	0.0	1.5	1.8	3.3	12			25	17	8	54	27	81	15	12	A-4b	8	100	A-4b	N_{60} & Mc	40"		Ramp SE
	027-0	2	1.5	3.0	3.3	4.8	7		1	25	17	8	54	27	81	19	12	A-4b	8						
	20	3	3.0	4.5	4.8	6.3	12		2	31	19	12	51	33	84	19	14	A-6a	9						
		4	4.5	6.0	6.3	7.8	12	7	2.5	31	19	12	51	33	84	29	16	A-6b							
37	B	1	0.0	1.5	0.0	1.5	13		4	30	18	12	58	28	86	15	14	A-6a	9	100					Ramp SE
	029-0	2	1.5	3.0	1.5	3.0	9		2	30	18	12	58	28	86	20	14	A-6a	9			N_{60} & Mc			
	20	3	3.0	4.5	3.0	4.5	10		2.25	30	18	12	58	28	86	19	14	A-6a	9						
		4	4.5	6.0	4.5	6.0	7	7	0	40	24	16	45	41	86	31	19	A-6b	10						

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.5 1/18/2019

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
38	B	1	0.0	1.5	0.0	1.5	23		4.5	34	18	16	43	35	78	11	16	A-6b	10	100					**Ramp SE**
	031-0	2	1.5	3.0	1.5	3.0	10		1.5	34	18	16	43	35	78	16	16	A-6b	10			HP			
	20	3	3.0	4.5	3.0	4.5	20		2	34	18	16	43	35	78	16	16	A-6b	10						
		4	4.5	6.0	4.5	6.0	10	10	1	34	18	16	43	35	78	30	16	A-6b	10						
39	B	1	0.0	1.5	-0.6	0.9	9			40	25	15	44	21	65	17	20	A-6a	8			N_{60}		**12"**	**Bodman Road**
	009-0	2	1.5	3.0	0.9	2.4	3		0.5	47	18	29	37	46	83	29	18	A-7-6	17	453		HP & Mc		**33"**	
	20	3	3.0	4.5	2.4	3.9	7		0.5	47	18	29	37	46	83	22	18	A-7-6	17						
		4	4.5	6.0	3.9	5.4	10	3	3	47	18	29	37	46	83	22	18	A-7-6	17						
40	B	1	1.0	2.5	0.9	2.4	3		1	50	21	29	45	43	88	25	18	A-7-6	18			HP & Mc		**33"**	**Mercy Blvd.**
	051-0	2	3.5	5.0	3.4	4.9	14		4.5	40	18	22	35	38	73	22	16	A-6b	12	100					
	20	3	6.0	7.5	5.9	7.4	13		3	40	18	22	35	38	73	21	16	A-6b							
		4	8.5	10.0	8.4	9.9	27	3	4.5	40	18	22	35	38	73	19	16	A-6b							
41	B	1	1.0	2.5	0.2	1.7	9		1	41	24	17	40	40	80	24	21	A-7-6	11	424		HP & Mc		**12"**	**Mercy Blvd.**
	053-0	2	3.5	5.0	2.7	4.2	12		1.5	41	24	17	40	40	80	22	21	A-7-6	11						
	20	3	6.0	7.5	5.2	6.7	14		1	41	24	17	40	40	80	19	21	A-7-6							
		4	8.5	10.0	7.7	9.2	16	9	1	25	17	8	39	20	59	14	12	A-4a							
42	B	1	1.0	2.5	0.1	1.6	9		1.5	39	24	15	31	38	69	16	19	A-6a	9	518		HP		**12"**	**Shaw Drive**
	052-0	2	3.5	5.0	2.6	4.1	12		2	39	24	15	31	38	69	17	19	A-6a	9						
	20	3	6.0	7.5	5.1	6.6	16		3.5	39	24	15	31	38	69	22	19	A-6a							
		4	8.5	10.0	7.6	9.1	52	9	4.5	21	15	6	35	20	55	12	10	A-4a							
43	B	1	0.0	1.5	2.0	3.5	13		3	38	17	21	48	37	85	18	16	A-6b	12	664					**Brooks-Mallott Rd.**
	032-0	2	1.5	3.0	3.5	5.0	9		1.5	38	17	21	48	37	85	20	16	A-6b	12						
	20	3	3.0	4.5	5.0	6.5	9		1.5	51	19	32	30	44	74	24	18	A-7-6	18						
		4	4.5	6.0	6.5	8.0	16	9	2	51	19	32	30	44	74	22	18	A-7-6							
44	B	1	0.0	1.5	-0.6	0.9	10		4	37	24	13	38	26	64	11	19	A-6a	7			N_{60}		**12"**	**Brooks-Mallott Rd.**
	035-0	2	1.5	3.0	0.9	2.4	13		2	37	24	13	38	26	64	21	19	A-6a	7	100					
	20	3	3.0	4.5	2.4	3.9	14		1.5	38	25	13	45	24	69	22	20	A-6a	8						
		4	4.5	6.0	3.9	5.4	6	6	1	38	25	13	45	24	69	26	20	A-6a	8						

Chemical Stabilization Options		
320	Rubblize & Roll	No
206	Cement Stabilization	No
	Lime Stabilization	Option
206	Depth	14"

Excavate and Replace Stabilization Options	
Global Geotextile Override(N60L): Average(HP):	 18" 0"
Global Geogrid Override(N60L): Average(HP):	 12" 0"

Design CBR	5

% Samples within 6 feet of subgrade			
$N_{60} \leq 5$	9%	HP ≤ 0.5	6%
$N_{60} < 12$	59%	0.5 < HP ≤ 1	15%
$12 \leq N_{60} < 15$	30%	1 < HP ≤ 2	40%
$N_{60} \geq 20$	7%	HP > 2	32%
M+	19%		
Rock	0%		
Unsuitable	5%		

Excavate and Replace at Surface	
Average	0"
Maximum	0"
Minimum	0"

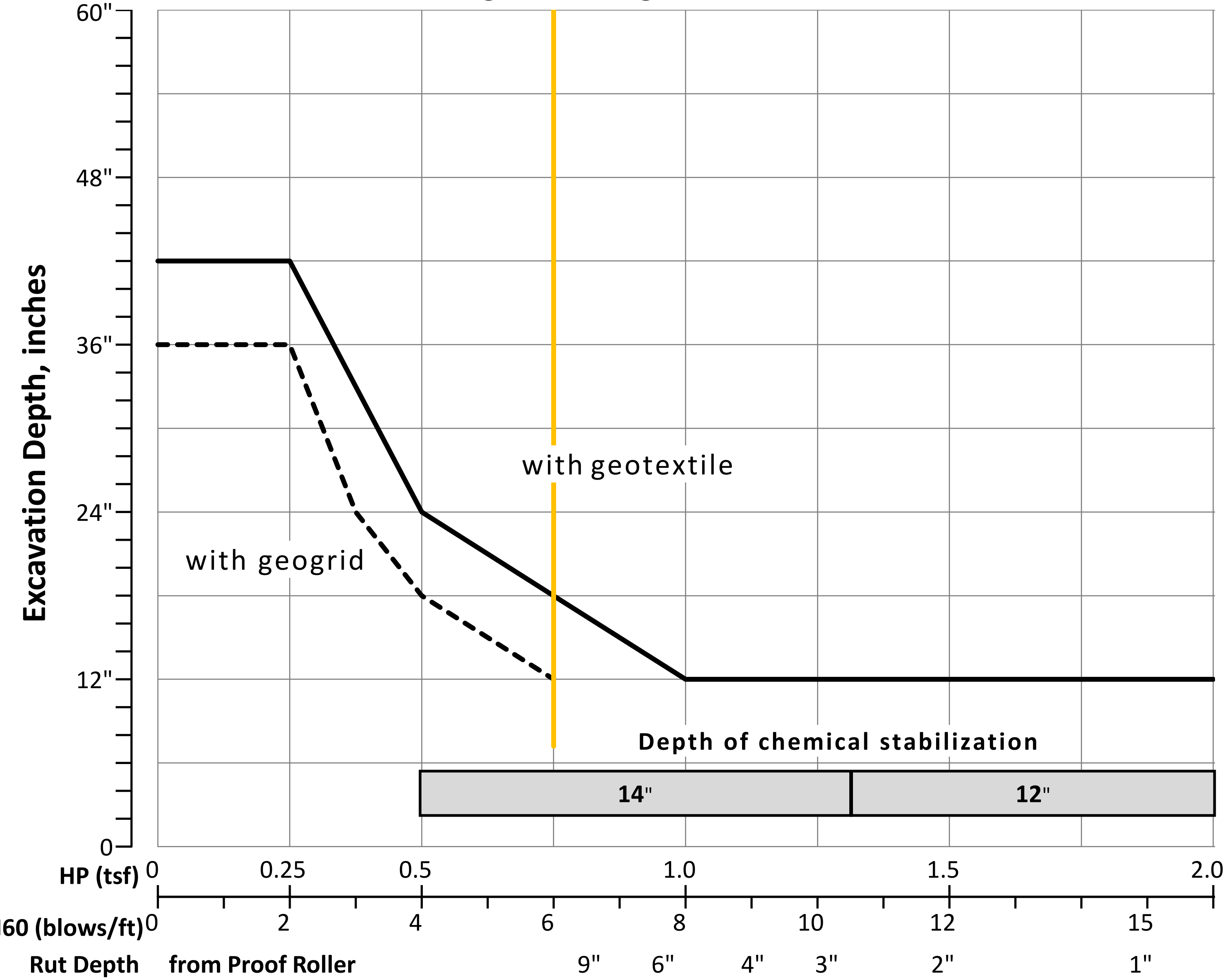
% Proposed Subgrade Surface	
Unstable & Unsuitable	62%
Unstable	52%
Unsuitable	10%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	17	7	2.51	42	20	22	38	39	76	20	17	13
Maximum	93	12	4.50	66	31	45	58	54	93	31	25	20
Minimum	3	3	0.00	21	14	6	23	14	40	8	10	6

Classification Counts by Sample

ODOT Class	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	0	0	0	0	0	0	11	6	0	42	24	2	82	0	0	167
Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	7%	4%	0%	25%	14%	1%	49%	0%	0%	100%
% Rock|Granular|Cohesive	0%	7%									93%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	0	4	0	18	8	1	19	0	0	50
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	8%	0%	36%	16%	2%	38%	0%	0%	100%

GB1 Figure B – Subgrade Stabilization



OVERRIDE TABLE

Calculated Average	New Values	Check to Override
2.51	0.50	☐ HP

Average HP

Average N_{60L}

GB1 Figure B – Subgrade Stabilization

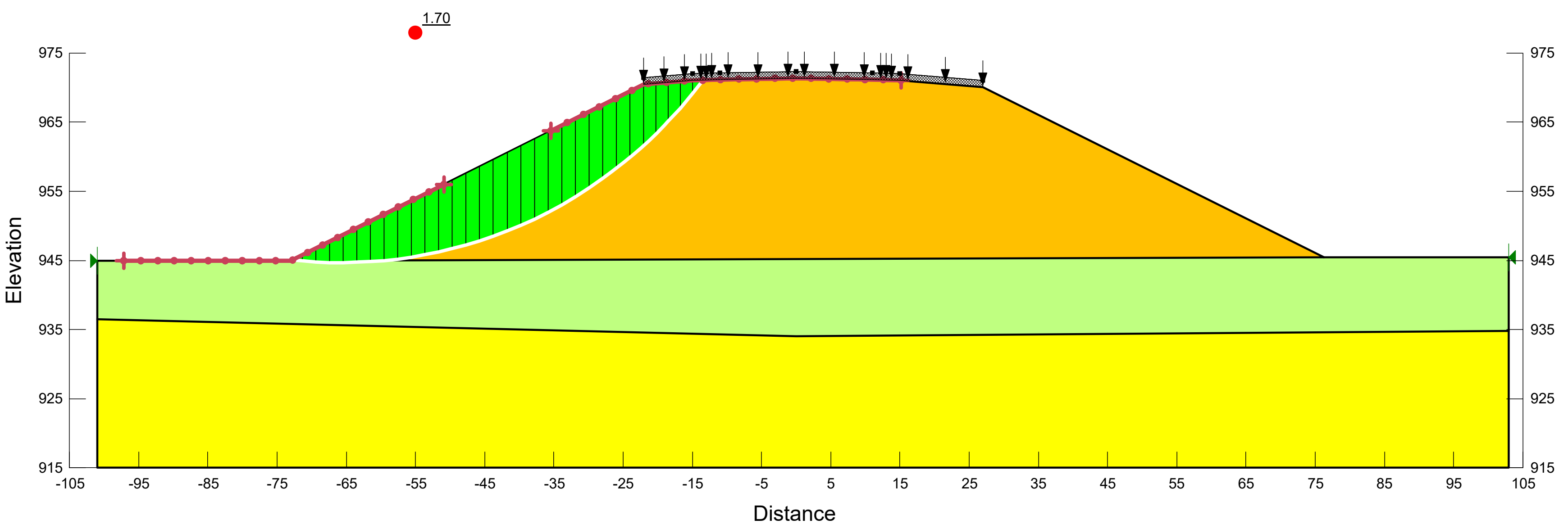
6.85	6.00	☑ N60L

Average N_{60L}

APPENDIX I

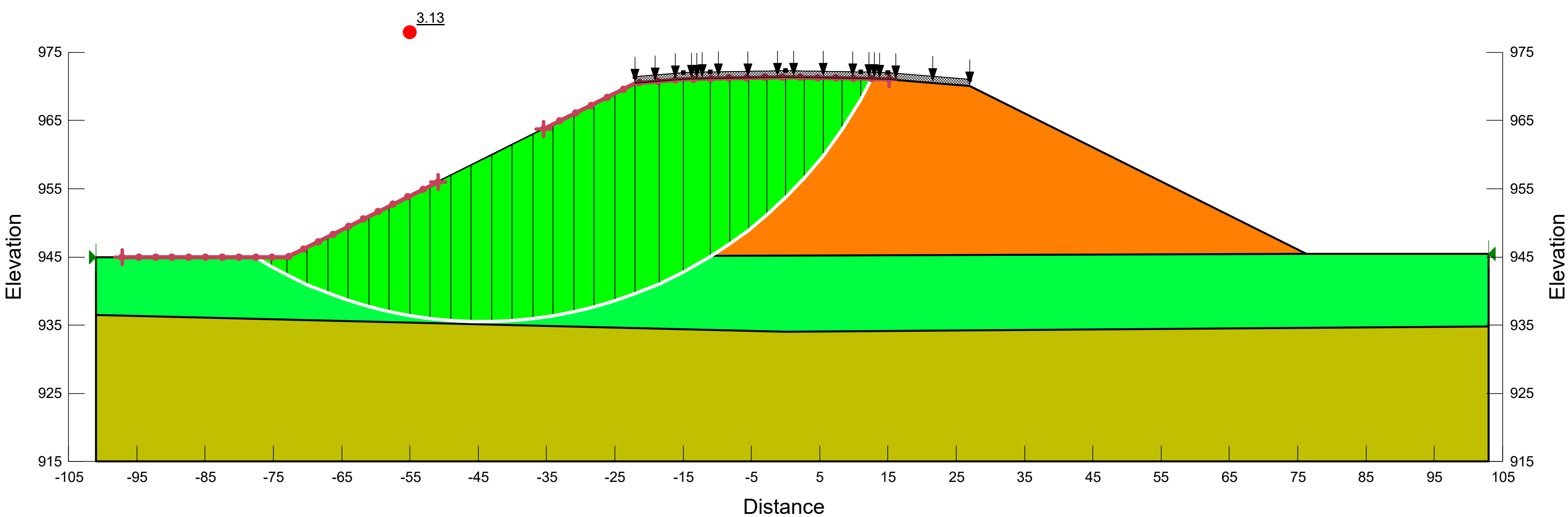
Embankment Stability Analyses

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Embankment Fill (drained)	125	200	26
	Glacial Till (drained)	130	400	32
	Weathered Glacial Till (drained)	125	150	28



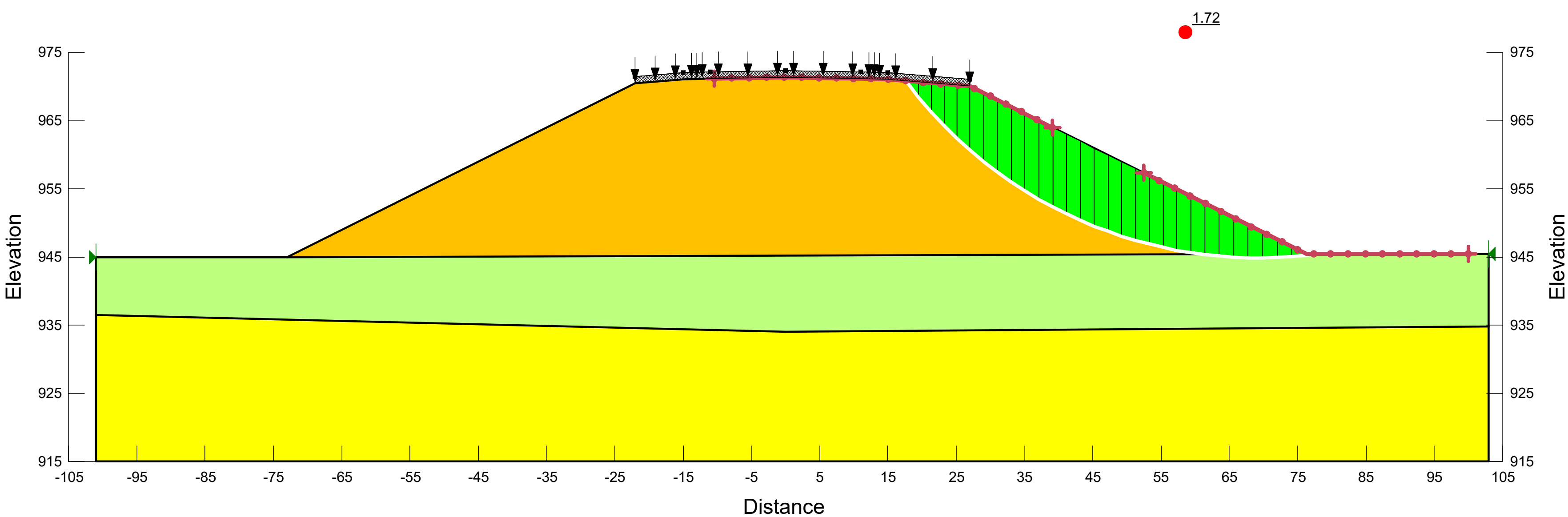
Slope Stability_left_drained	
BRO-32_415+00 Embankment Stability_1-18-2021.gsz	
03/02/2021	1:300

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Embankment Fill (undrained)	125	2,000	0
	Glacial Till (undrained)	130	12,000	0
	Weathered Glacial Till (undrained)	125	1,600	0



Slope Stability_left_undrained
BRO-32_415+00 Embankment Stability_1-18-2021.gsz
03/02/2021 1:300

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Embankment Fill (drained)	125	200	26
	Glacial Till (drained)	130	400	32
	Weathered Glacial Till (drained)	125	150	28

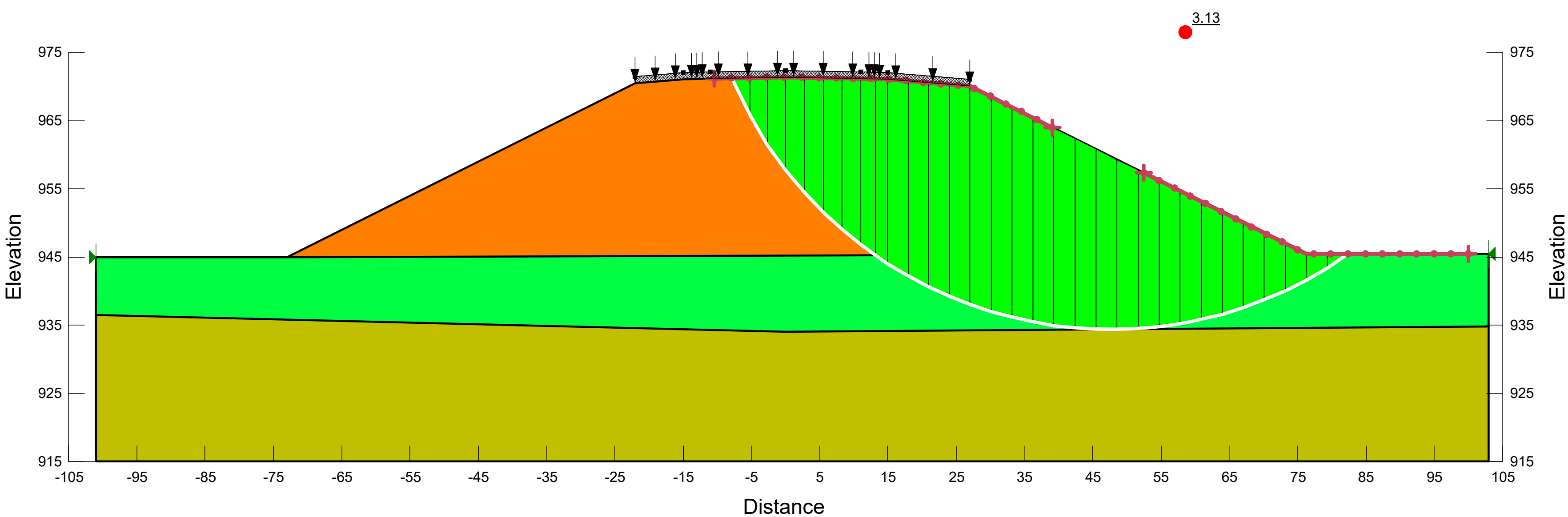


Slope Stability_right_drained

BRO-32_415+00 Embankment Stability_1-18-2021.gsz

03/02/2021 1:300

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Embankment Fill (undrained)	125	2,000	0
	Glacial Till (undrained)	130	12,000	0
	Weathered Glacial Till (undrained)	125	1,600	0



Slope Stability_right_undrained

BRO-32_415+00 Embankment Stability_1-18-2021.gsz

03/02/2021 1:300

APPENDIX J

Geotechnical Engineering Design Checklists

I. Geotechnical Design Checklists

Project:	**BRO-32-4.16**	**PDP Path:**	**3**
PID:	**110478**	**Review Stage:**	**2**

Checklist	Included in This Submission
II. Reconnaissance and Planning	✓
III. A. Centerline Cuts	
III. B. Embankments	✓
III. C. Subgrade	✓
IV. A. Foundations of Structures	✓
IV. B. Retaining Wall	
V. A. Landslide Remediation	
V. B. Rockfall Remediation	
V. C. Wetland or Peat Remediation	
V. D. Underground Mine Remediation	
V. E. Surface Mine Remediation	
V. F. Karst Remediation	
VI. A. Soil Profile	✓
VI. D. Geotechnical Reports	✓

II. Reconnaissance and Planning Checklist

C-R-S: BRO-32-4.16	PID: 110478	Reviewer: E. Kistner	Date: 1/20/2021

Reconnaissance		(Y/N/X)	Notes:
1	Based on Section 302.1 in the SGE, have the necessary plans been developed in the following areas prior to the commencement of the subsurface exploration reconnaissance:	Y	
	Roadway plans	✓	
	Structures plans	✓	
	Geohazards plans		
2	Have the resources listed in Section 302.2.1 of the SGE been reviewed as part of the office reconnaissance?	Y	
3	Have all the features listed in Section 302.3 of the SGE been observed and evaluated during the field reconnaissance?	Y	
4	If notable features were discovered in the field reconnaissance, were the GPS coordinates of these features recorded?	N	Features were marked on a site plan.

Planning - General		(Y/N/X)	Notes:
5	In planning the geotechnical exploration program for the project, have the specific geologic conditions, the proposed work, and historic subsurface exploration work been considered?	Y	
6	Has the ODOT Transportation Information Mapping System (TIMS) been accessed to find all available historic boring information and inventoried geohazards?	Y	
7	Have the borings been located to develop the maximum subsurface information while using a minimum number of borings, utilizing historic geotechnical explorations to the fullest extent possible?	Y	
8	Have the topography, geologic origin of materials, surface manifestation of soil conditions, and any other special design considerations been utilized in determining the spacing and depth of borings?	Y	
9	Have the borings been located so as to provide adequate overhead clearance for the equipment, clearance of underground utilities, minimize damage to private property, and minimize disruption of traffic, without compromising the quality of the exploration?	Y	

II. Reconnaissance and Planning Checklist

Planning - General		(Y/N/X)	Notes:
10	Have the scaled boring plans, showing all project and historic borings, and a schedule of borings in tabular format, been submitted to the District Geotechnical Engineer?	X	
	The schedule of borings should present the following information for each boring:		
a.	exploration identification number	X	
b.	location by station and offset	X	
c.	estimated amount of rock and soil, including the total for each for the entire program.	X	
Planning – Exploration Number		(Y/N/X)	Notes:
11	Have the coordinates, stations and offsets of all explorations (borings, probes, test pits, etc.) been identified?	Y	
12	Has each exploration been assigned a unique identification number, in the following format X-ZZZ-W-YY, as per Section 303.2 of the SGE?	Y	
13	When referring to historic explorations that did not use the identification scheme in 12 above, have the historic explorations been assigned identification numbers according to Section 303.2 of the SGE?	X	

II. Reconnaissance and Planning Checklist

Planning – Boring Types		(Y/N/X)	Notes:
14	Based on Sections 303.3 to 303.7.6 of the SGE, have the location, depth, and sampling requirements for the following boring types been determined for the project?		
	Check all boring types utilized for this project:		
	Existing Subgrades (Type A)	✓	
	Roadway Borings (Type B)	✓	
	Embankment Foundations (Type B1)	✓	
	Cut Sections (Type B2)		
	Sidehill Cut Sections (Type B3)		
	Sidehill Cut-Fill Sections (Type B4)		
	Sidehill Fill Sections on Unstable Slopes (Type B5)		
	Geohazard Borings (Type C)		
	Lakes, Ponds, and Low-Lying Areas (Type C1)		
	Peat Deposits, Compressible Soils, and Low Strength Soils (Type C2)		
	Uncontrolled Fills, Waste Pits, and Reclaimed Surface Mines (Type C3)		
	Underground Mines (C4)		
	Landslides (Type C5)		
	Rockfall (Type C6)		
	Karst (Type C7)		
	Proposed Underground Utilities (Type D)		
	Structure Borings (Type E)	✓	
	Bridges (Type E1)	✓	
	Culverts (Type E2 a,b,c)	✓	
	Retaining Walls (Type E3 a,b,c)		
	Noise Barrier (Type E4)		
	CCTV & High Mast Lighting Towers (Type E5)		
	Buildings and Salt Domes (Type E6)		

III.B. Embankments Checklist

C-R-S:	BRO-32-4.16	PID:	110478	Reviewer:	E. Kistner	Date:	1/20/2021

If you do not have an embankment on the project, you do not have to fill out this checklist.

Settlement		(Y/N/X)	Notes:
1	If soil conditions and project requirements warrant, have settlement issues been addressed? If not applicable (X), go to Question 14	Y	
2	Have consolidation properties of the foundation soils been determined?	Y	
	Check methods used:		
	laboratory consolidation tests	✓	
	empirical correlations with moisture content and Atterberg values	✓	
	other (describe other methods)		
3	Have calculations been performed to estimate the total expected embankment settlement and the time of consolidation? Indicate method used.	Y	
4	If differing foundation soil and/or loading conditions occur throughout the embankment area, have sufficient analyses been completed to evaluate consolidation at locations representative of the most critical conditions?	Y	
5	Have the total settlement and the time of consolidation analyses indicated acceptable values at all locations for the scope of the embankment work?	Y	
6	If total settlement or time of consolidation is unacceptable, have the stations and lateral extent of the problem areas been defined?	Y	
7	Has a method been chosen as a solution to the settlement issues?		
	Check the method(s) used:		
	waiting periods with monitoring	✓	
	drainage blanket and wick drains		
	surcharge (preloading)		
	removal and replacement of weak soil		
	lowering proposed grade / change alignment		
	lightweight fill		
	other (describe other methods)		

III.B. Embankments Checklist

Settlement		(Y/N/X)	Notes:
8	Based on accepted design practices, and where applicable, adhering to published guidelines and design recommendations from FHWA, have calculations been performed to evaluate the effectiveness of the chosen solution(s)?	Y	
9	Has an economic analysis been performed to evaluate the cost benefits of the recommended solution compared to others?	X	
10	Have all necessary notes, specifications, and details for the chosen solution been determined?	Y	
11	Have the need, locations, type, plan notes, and reading schedule for settlement platforms or cells been determined?	Y	
12	Have the effects of the predicted settlement and the chosen solution been determined and accounted for on the construction schedule?	Y	
13	Has the effect of any foundation soil consolidation (including differential settlement) been evaluated with regard to adjacent structures (e.g., bridges, buildings, culverts, utilities) which will also undergo settlement and be subject to stresses induced by the consolidation of the surrounding soil?	Y	

Stability		(Y/N/X)	Notes:
14	If soil conditions and project requirements warrant, have stability issues been addressed? If not applicable (X), go to Question 29	Y	
15	Has the total (short term) and effective (long term) shear strength of the foundation soils been determined?	Y	
	Check method used:		
	laboratory shear tests	✓	
	estimation from SPT or field tests	✓	
16	Have the values of shear strength for proposed embankment fill material, as determined from <u>Geotechnical Bulletin</u> 2 Special Benching and Sidehill Embankment Fills (GB2), been used in the stability analyses?	Y	

III.B. Embankments Checklist

Stability		(Y/N/X)	Notes:
17	Have calculations been performed to determine the F.S. for stability? Indicate which program and which analysis method (Spencer, Bishop, etc) was used.	Y	
18	Have the following F.S. been met or exceeded, as determined by the calculations, for the given stability conditions:	Y	
a.	1.30 for short term (undrained) condition		
b.	1.30 for long term (drained) condition		
c.	1.10 for rapid drawdown, flood condition		
d.	1.50 for embankment containing or supporting a structural element	Y	
19	When differing soil or loading conditions occur throughout the embankment area, have sufficient analyses been completed to evaluate the stability at locations representative of the most critical conditions?	Y	
20	If the F.S. was not met or exceeded, have the stations and lateral extent of the problem areas been defined?	X	
21	Has a method been chosen as a solution to the stability issues?		
	Check the method(s) used:		
	flattening slopes		
	counterberm		
	lightweight embankment		
	reinforced soil slope		
	soil nailing		
	drainage blanket and wick drains		
	removal of soft soil, adding shear key		
	reduced grade / change alignment		
	staged construction		
	controlled rate of fill placement		
	drilled shaft slope stabilization		
	other (describe other methods)		
22	Based on accepted design practices, and where applicable, adhering to published guidelines and design recommendations from FHWA, have calculations been performed to evaluate the effectiveness of the chosen solution(s)?	X	

III.B. Embankments Checklist

23	Has an economic analysis been performed to evaluate the cost benefits of the recommended solution compared to others?	X	
Stability		(Y/N/X)	Notes:
24	Have all necessary notes, specifications, and details for the chosen solution been determined?	Y	
25	Have the need, location, type, plan notes, and reading schedule for piezometers and inclinometers been determined?	Y	
26	If piezometers will be used, has the critical pressure value been determined and the appropriate information included in the plans?	X	
27	Have the effects of the stability solution been determined and accounted for on the construction schedule?	Y	
28	Has the effect of the stability solution been evaluated with regard to structures (e.g., bridges, buildings, culverts, utilities) which may be subject to unusual stresses or require special construction considerations?	Y	
Sidehill Fills		(Y/N/X)	Notes:
29	If soil conditions and project requirements warrant, have sidehill fill issues been addressed? If not applicable (X), go to Question 34	X	
30	In accordance with <u>Geotechnical Bulletin 2: Special Benching and Sidehill Embankment Fills (GB 2)</u>, have sidehill fills been evaluated to determine if special benching or shear keys are needed?		
31	In accordance with GB 2, if special benching or shear keys are required,		
	a. has Plan Note G109 from L&D3 been included in the General Notes?		
	b. have quantities for both excavation and embankment been calculated for the benched areas and added to the plan General Quantities?		
	c. have the special benching or shear keys been indicated on the appropriate cross sections?		
32	Have water bearing zones been identified and their impact addressed?		

III.B. Embankments Checklist

33	Have subsurface drainage controls been adequately addressed?		

III.B. Embankments Checklist

Special		(Y/N/X)	Notes:
34	Have all of the environmental factors, including wetlands, stream mitigation, and landfills, been considered and incorporated prior to design and analysis of embankment settlement and stability, including EPA or other government agencies' involvement, mitigation, or special design or construction considerations?	Y	
35	If an embankment is to be placed through standing water or over weak, wet soils (with or without a fabric separator), the fill should be placed by the method of end dumping to a given height above the standing water or until compaction is achievable over the soft soil. If end dumping is to be specified,	X	
a.	has the material type for the fill to be end dumped been specified?	X	
b.	has the need for a fabric separator or filter layer been determined?	X	
c.	has the height of fill to be end dumped been determined?	X	
d.	have all notes and specifications for end dumping been developed?	X	

III.C. Subgrade Checklist

C-R-S: BRO-32-4.16	PID: 110478	Reviewer: E. Kistner	Date: 1/20/2021

If you do not have any subgrade work on the project, you do not have to fill out this checklist.

Subgrade		(Y/N/X)	Notes:
1	Has the subsurface exploration adequately characterized the soil or rock according to Geotechnical Bulletin 1: Plan Subgrades (GB1)?	Y	
a.	Has each sample been visually classified and inspected for the presence of gypsum? Has a moisture content been performed on each sample?		
b.	Has mechanical classification (Plastic Limit (PL), Liquid Limit (LL), and gradation testing) been done on at least two samples from each boring within six feet of the proposed subgrade?		
c.	Has the sulfate content of at least one sample from each boring within 3 feet of the proposed subgrade been determined, per Supplement 1122, Determining Sulfate Content in Soils?		
d.	Has the sulfate content of all samples that exhibit gypsum crystals been determined?		
e.	Have A-2-5, A-4b, A-5, A-7-5, A-8a, or A-8b soils within the top 3 feet of the proposed subgrade been mechanically classified?		
2	If soils classified as A-2-5, A-4b, A-5, A-7-5, A-8a, or A-8b, or having a LL>65, are present at the proposed subgrade (soil profile), do the plans specify that these materials need to be removed and replaced or chemically stabilized?		A-4b & A-7-5 (LL>65)
a.	If these materials are to be removed and replaced, have the station limits, depth, and lateral limits for the planned removal been provided?		
3	If there is any rock, shale, or coal present at the proposed subgrade (C&MS 204.05), do the plans specify the removal of the material?		
a.	If removal of any rock, shale, or coal is required, have the station limits, depth, and lateral limits for the planned removal of the material at proposed subgrade been provided?		

III.C. Subgrade Checklist

Subgrade		(Y/N/X)	Notes:
4	In accordance with GB1, do the SPT (N_{60})/HP values and existing moisture contents for the proposed subgrade soils indicate the need for subgrade stabilization?	Y	
	a. If removal and replacement is applicable, has the detail of subgrade removal been shown on the plans, including depth of removal, station limits, lateral extent, replacement material, and plan notes (Item 204 - Subgrade Compaction and Proof Rolling)?	Y	
	b. If chemical stabilization is applicable, has the detail of this treatment been shown on the plans, including depth, percentage of chemical, station limits, lateral extent, and plan notes?	Y	
	Indicate type of chemcial stabilization specified:		
	cement stabilization		
	lime stabilization	✓	
5	If removal and replacement has been specified, do the plans include Plan Note G121 from L&D3?		
6	If drainage or groundwater is an issue with the proposed subgrade, has an appropriate drainage system (e.g., pipe, underdrains) been provided?	X	
7	Has an appropriate quantity of Proof Rolling (C&MS 204.06) and has Plan Note G111 from L&D3 been included in the plans?	Y	
8	Has a design CBR value been provided?	Y	

IV.A Foundations of Structures Checklist

C-R-S: BRO-32-4.16	PID: 110478	Reviewer: E. Kistner	Date: 8/14/2020

If you do not have such a foundation or structure on the project, you do not have to fill out this checklist.

Soil and Bedrock Strength Data		(Y/N/X)	Notes:
1	Has the shear strength of the foundation soils been determined?	Y	
	Check method used:		
	laboratory shear tests	✓	
	estimation from SPT or field tests	✓	
2	Have sufficient soil shear strength, consolidation, and other parameters been determined so that the required allowable loads for the foundation/structure can be designed?	Y	
3	Has the shear strength of the foundation bedrock been determined?	X	
	Check method used:		
	laboratory shear tests		
	other (describe other methods)		
Spread Footings		(Y/N/X)	Notes:
4	Are there spread footings on the project? If no, go to Question 11	Y	
5	Have the recommended bottom of footing elevation and reason for this recommendation been provided?	Y	
a.	Has the recommended bottom of footing elevation taken scour from streams or other water flow into account?	Y	
6	Were representative sections analyzed for the entire length of the structure for the following:	Y	
a.	factored bearing resistance?	Y	
b.	factored sliding resistance?	Y	
c.	eccentric load limitations (overturning)?	Y	
d.	predicted settlement?	Y	
e.	overall (global) stability?	Y	
7	Has the need for a shear key been evaluated?	X	
a.	If needed, have the details been included in the plans?	X	
8	If special conditions exist (e.g. geometry, sloping rock, varying soil conditions), was the bottom of footing “stepped” to accommodate them?	X	
9	Have the Service I and Maximum Strength Limit States for bearing pressure on soil or rock been provided?	Y	

IV.A Foundations of Structures Checklist

Spread Footings		(Y/N/X)	Notes:
10	If weak soil is present at the proposed foundation level, has the removal / treatment of this soil been developed and included in the plans?	X	
a.	Have the procedure and quantities related to this removal / treatment been included in the plans?	X	
Pile Structures		(Y/N/X)	Notes:
11	Are there piles on the project? If no, go to Question 17	Y	
12	Has an appropriate pile type been selected?		
	Check the type selected:		
	H-pile (driven)		
	H-pile (prebored)		
	Cast In-place Reinforced Concrete Pipe	✓	
	Micropile		
	Continuous Flight Auger (CFA)		
	other (describe other types)		
13	Have the estimated pile length or tip elevation and section (diameter) based on either the Ultimate Bearing Value (UBV) or the depth to top of bedrock been specified? Indicate method used.	Y	
14	If scour is predicted, has pile resistance in the scour zone been neglected?	✓	
15	Has a wave equation drivability analysis been performed as per BDM 305.4.1.2 to determine whether the pile can be driven to either the UBV, the pile tip elevation, or refusal on bedrock without overstressing the pile?	Y	
16	If required for design, have sufficient soil parameters been provided and calculations performed to evaluate the:	Y	
a.	Nominal unit tip resistance and maximum settlement of the piles?	Y	
b.	Nominal unit side resistance for each contributing soil layer and maximum deflection of the piles?	Y	
c.	Downdrag load on piles driven through new embankment or compressible soil layers, as per BDM 305.4.2.2?	Y	
d.	Potential for and impact of lateral squeeze from soft foundation soils?	X	

IV.A Foundations of Structures Checklist

	Pile Structures	(Y/N/X)	Notes:
17	If piles are to be driven to strong bedrock (Q_u >7.5 ksi) or through very dense granular soils or overburden containing boulders, have “pile points” been recommended in order to protect the tips of the steel piling, as per BDM 305.4.5.6?	X	
18	If subsurface obstacles exist, has preboring been recommended to avoid these obstructions?	X	
19	If piles will be driven through 15 feet or more of new embankment, has preboring been specified as per BDM 305.4.5.7?	N	Pile sleeves are planned for the MSE reinforced zone.

IV.A Foundations of Structures Checklist

Drilled Shafts		(Y/N/X)	Notes:
20	Are there drilled shafts on the project? If no, go to the next checklist.	N	
21	Have the drilled shaft diameter and embedment length been specified?		
22	Have the recommended drilled shaft diameter and embedment been developed based on the nominal unit side resistance and nominal unit tip resistance for vertical loading situations?		
23	For shafts undergoing lateral loading, have the following been determined:		
a.	total factored lateral shear?		
b.	total factored bending moment?		
c.	maximum deflection?		
d.	reinforcement design?		
24	If a bedrock socket is required, has a minimum rock socket length equal to 1.5 times the rock socket diameter been used, as per BDM 305.5.2?		
25	Generally, bedrock sockets are 6" smaller in diameter than the soil embedment section of the drilled shaft. Has this factor been accounted for in the drilled shaft design?		
26	If scour is predicted, has shaft resistance in the scour zone been neglected?		
27	Has the site been assessed for groundwater influence?		
a.	If yes, and if artesian flow is a potential concern, does the design address control of groundwater flow during construction?		
28	Have all the proper items been included in the plans for integrity testing?		
29	If special construction features (e.g., slurry, casing, load tests) are required, have all the proper items been included in the plans?		
30	If necessary, have wet construction methods been specified?		
General		(Y/N/X)	Notes:
31	Has the need for load testing of the foundations been evaluated?	Y	
a.	If needed, have details and plan notes for load testing been included in the plans?	Y	Dynamic pile testing is planned.

IV.B. Retaining Wall Checklist

C-R-S: BRO-32-4.16	**PID:** 110478	**Reviewer:** E. Kistner	**Date:** 3/12/2021
		PDP Path:	

If you do not have a retaining wall on the project, you do not have to fill out this checklist.

Soil Data and Preliminary Calculations		(Y/N/X)	Notes:
1	Has a justification study been performed to determine the necessity of a wall as opposed to ROW purchase or other project alternatives?		
2	Have the necessary soil strength parameters and unit weights been determined?		
	Check method used:		
	laboratory shear tests		
	estimation from SPT or field tests		
3	Has the groundwater elevation been determined?		
4	Have the proper loading conditions been determined?		
a.	If yes, check which loading conditions apply:		
	Backfill (Active Earth Pressure Loading):		
	Backfill (Apparent Earth Pressure (AEP) Loading for Ground Anchors):		
	Backfill (At-Rest Earth Pressure Loading):		
	Backfill (Flat, No Slope):		
	Backfill (Infinite Slope):		
	Backfill (Broken Back Slope):		
	Earth Surcharge:		
	Live Load Surcharge:		
	Other (describe):		
5	Have the correct Load Factors, Load Combinations, and Limit States been considered, per AASHTO LRFD 8th Ed. Articles 3.4.1, 10.5, and 11.5?		
6	Are earth pressure loads inclined at the soil-structure interaction friction angle, δ and has δ been determined per BDM 307.1.1?		
7	Have the correct Resistance Factors been considered, per AASHTO LRFD 8th Ed. Articles 10.5 and 11.5?		
8	If applicable, has the influence of groundwater been taken into account with regards to soil unit weights and active pressures?		
9	Has the Coulomb method been utilized to determine the lateral earth pressure?		

IV.B. Retaining Wall Checklist

Design		(Y/N/X)	Notes:
10	For preliminary wall design, have the design criteria and wall type selection process been followed as instructed in BDM 201.2.5?		
11	Was an economic analysis performed to evaluate the cost benefits of the chosen wall type compared to others?		
12	Were representative sections analyzed for the entire length of the retaining wall for the following:		
a.	bearing resistance?		
b.	sliding resistance?		
c.	limiting eccentricity and overturning resistance? Analyze moment equilibrium about toe for non-gravity cantilever walls.		
d.	total and differential settlement?		
e.	overall (global) stability?		
13	If poor foundation soils are present, has a solution been determined with respect to the following:		
a.	excessive settlement?		
b.	inadequate bearing resistance?		
c.	inadequate sliding resistance?		
d.	overall (global) instability?		
14	For non-proprietary walls, each wall type has design recommendations which need to be determined. For the wall type being evaluated, have the following design recommendations been determined by accepted design methods or, where applicable, FHWA design guidelines:		
a.	Rigid Gravity and Semigravity -- footing width and elevation, maximum factored Service and Strength Limit State bearing pressures, factored bearing resistance (BDM 307.1.5 & 307.2)		
b.	Drilled Shafts - diameter, spacing, embedment, arrangement and percent reinforcement, maximum moment and lateral shear, maximum deflection (see BDM 307.6)		
c.	Soldier Pile -pile size and type, drilled hole diameter, embedment, spacing, lagging design, facing, maximum moment and lateral shear, section modulus, maximum deflection		

IV.B. Retaining Wall Checklist

Design	(Y/N/X)	Notes:
d. Sheet Pile - pile size, embedment, maximum moment and lateral shear, section modulus, maximum deflection (BDM 307.7.1)		
e. Cellular - type, maximum factored Service and Strength Limit State bearing pressures, factored bearing resistance, fill material (BDM 307.7.2)		
f. Soil Anchor - load per anchor, number of rows, wale design, anchor inclination and minimum length, type of anchor, pile size, type, spacing, and embedment, maximum moment and lateral shear, section modulus, lagging design, facing (BDM 307.8)		
g. Soil Nail - nail size, spacing, inclination, and length, loading per nail, facing (BDM 307.9)		
15 Has the need for load testing of the retaining wall elements been evaluated?		
a. If needed, have details and plan notes for load testing been included in the plans?		
16 Proprietary wall designs require a special process for detail design, as outlined in BDM 307.3 and 307.4. Has this procedure been followed for this project?		
17 Temporary walls - have the same design requirements as permanent walls of the same type been followed, except the design service life is no more than three years (BDM 307.10)?		
18 The presence and quality of water behind the wall structure and in the backfill can be a major source of overloading and failure.		
a. Has the quality / chemistry of the groundwater been accounted for in the drainage system?		
b. Has an adequate drainage system been included in the detail wall design?		
c. If there is a water source behind the wall, has additional drainage been added to control the effect of this water source on the wall?		
19 Have the effects of the wall design and construction procedure been determined and accounted for on the construction schedule?		

IV.B. Retaining Wall Checklist

Design		(Y/N/X)	Notes:
20	Has the effect of the wall design and construction been evaluated with regard to structures (e.g., bridges, culverts, buildings, utilities), which may be subject to unusual stresses or require special design or construction considerations?		
Plans and Contract Documents		(Y/N/X)	Notes:
21	Have all the necessary notes, specifications, special provisions, and details for the construction of the wall system been included in the plans?		
22	Have the need, location, type, plan notes, and reading schedule for any instrumentation been determined and included in the plans?		
	Check the types of instrumentation specified:		
	settlement cells		
	settlement platforms		
	inclinometers		
	monitoring wells / piezometers		
	load cells		
	strain gages		
	other (describe other types)		

VI.A. Soil Profile Checklist

C-R-S: BRO-32-4.16	PID: 110478	Reviewer: E. Kistner	Date: 3/12/2021

General Presentation		(Y/N/X)	Notes:
1	Has an electronic copy of all geotechnical submissions been provided to the District Geotechnical Engineer (DGE)?	Y	
2	Have the cadd files been prepared using the appropriate version of the ODOT CADD standards?	Y	
3	Has the geotechnical specification (title and date) under which the work was performed been clearly identified on every submission (reports, plans, etc.)?	Y	
4	Has the first complete version of all documents being submitted been labeled as 'Draft'?	Y	
5	Subsequent to ODOT's review and approval, has the complete version of the revised documents being submitted been labeled as 'Final'?	X	
a.	Have the C-R-S, PID number, and product title been included in the folder name?	Y	
6	If the project includes structures, have all structure explorations been presented together under the same cover sheet? (Do not create separate Structure Foundation Exploration Sheets)	Y	
7	Has a scale of 1"=1' been used for cover sheets, laboratory test data sheets, and boring log sheets, if applicable?	Y	
8	Based on the project length, has the correct horizontal scale been used to plot the project data?	Y	
	Check scale used:		
	1" = 5', 10', 20', 25', 40', or 50' for projects 1500' or less (use largest scale appropriate to present entire plan on one sheet)		
	1" = 50' projects greater than 1500'	✓	
9	Has a scale of 1" = 10' been utilized for the vertical scale of the project data?	Y	
10	If the project includes structures, has the plan and profile view been shown at the same scale as the Site Plan for the proposed structure(s), when possible?	Y	

VI.A. Soil Profile Checklist

General Presentation		(Y/N/X)	Notes:
11	If the project includes culverts, have the plan and profile been presented along the flowline of the culvert?	Y	
12	Have the cross-sections been plotted at a scale of 1" = 10' (preferred) or 1" = 20' (for higher or wider slopes)?	Y	
Cover Sheet		(Y/N/X)	Notes:
13	Has the following general information been provided on the cover sheet:	Y	
a.	Brief description of the project, including the bridge number of each bridge involved in the plan set, if any?	Y	
b.	Brief description of historic geotechnical explorations referenced in this exploration? State if no historic records are available.	Y	
c.	Generalized information about the geology of the project area, including terrain, soil origin, bedrock types, and age?	Y	
d.	Brief presentation of geological and topographical information derived from the field reconnaissance? Include comments on structure and pavement conditions.	Y	
e.	Brief presentation of test boring and sampling methods? Include date of last calibration and drill rod energy ratio as a percent for the hammer systems used.	Y	
f.	Summary of general soil, bedrock, and groundwater conditions, including a generalized interpretation of findings?	Y	
g.	A statement of which version (date) of the SGE specification the exploration was performed in accordance with?	Y	
h.	Statement of where geotechnical reports are available for review?	Y	
i.	Initials of personnel and dates they performed field reconnaissance, subsurface exploration and preparation of the soil profile?	Y	

VI.A. Soil Profile Checklist

Cover Sheet		(Y/N/X)	Notes:
14	Has a Legend been provided?	Y	
15	Have the following items been included in the Legend:	Y	
a.	Symbols and usual descriptions for only the soil and bedrock types presented in the Soil Profile, as per the Soil and Rock Symbology Chart in Appendix D of the SGE?		
b.	All miscellaneous symbols and acronyms, used on any of the sheets, defined?	Y	
c.	The number of soil samples for each classification that were mechanically classified and visually described in the current exploration?	Y	
16	Has a Location Map, showing the beginning and end stations for the project, been shown on the cover sheet, sized per the L&D3 Manual?	Y	
17	Have the station limits for each plan and profile sheet for projects with multiple alignments, or greater than 1500’, been identified in a table?	Y	
18	Have the station limits for any cross section sheets been identified in the same table?	Y	
19	Has a list of any structures for which structure foundation explorations been performed been identified in the same table?	Y	
20	If sampling and testing for a scour analysis was performed, has this data been shown in tabular form?	Y	
21	Has a summary table of test data for all roadway and subgrade boring samples been shown?	Y	
22	If borings from previous subsurface explorations are being used, has that data been shown in a separate table?	Y	
23	In the summary table, has the data been displayed by roadway and subgrade boring in ascending stationing order for each roadway?	Y	
24	Have the centerline or baseline station, offset, and exploration identification number been provided for each boring presented in the table?	Y	

VI.A. Soil Profile Checklist

Cover Sheet	(Y/N/X)	Notes:
25 For each sample, has the following information been provided in the summary table:	Y	
a. Sample depth interval?	Y	
b. Sample number and type?	Y	
c. N_{60}?	Y	
d. Percent recovery?	Y	
e. Hand Penetrometer?	Y	
f. Percentage of aggregate, coarse sand, fine sand, silt, and clay size particles?	Y	
g. Liquid limit, plastic limit, plasticity index, and water content, all rounded to the nearest percent or whole number?	Y	
h. ODOT classification and Group Index?	Y	
i. Visual description of samples not mechanically classified, including water content, and estimated ODOT classification with 'Visual' in parentheses?	Y	
j. Sulfate Content test results?	Y	
26 Have all undisturbed test results been displayed in graphical format on the sheet prior to the plan and profile sheets?	Y	
Surface Data	(Y/N/X)	Notes:
27 Has the following information been shown on each roadway plan drawing:	Y	
a. Existing surface features described in Section 702.5.1?	Y	
b. Proposed construction items, as described in Section 702.5.2?	Y	
c. Project and historic boring locations, with appropriate exploration targets and exploration identification numbers?	Y	
d. Notes regarding observations not readily shown by drawings?	Y	
28 Have the existing ground surface contours been presented?	Y	
29 If cross sections are to be developed for stationing covered on a plan sheet, has an index for the appropriate cross section sheets been included on the plan sheet?	Y	

VI.A. Soil Profile Checklist

Subsurface Data		(Y/N/X)	Notes:
30	Has all the subsurface data been presented in the form of a profile along the centerline or baseline, and on cross sections where applicable?	Y	
31	Have the graphical boring logs been correctly shown, as follows:	Y	
a.	Location and depth of boring indicated by a heavy dashed vertical line?	Y	
b.	Exploration identification number above the boring?	Y	
c.	Logs indicate soil and bedrock layers with symbols 0.4” wide and centered on the heavy dashed vertical line where possible?	Y	
d.	Bedrock exposures with 0.4” wide symbols, but without a heavy dashed vertical line?	Y	
e.	Soil and bedrock symbols as per ODOT Soil and Rock Symbology chart (SGE - Appendix D)?	Y	
f.	Historical borings shown in same manner with the exploration identification number above the boring?	Y	
32	Have the proposed groundline and existing groundline been shown on the profile view, according to ODOT CADD standards?	Y	
33	Have the locations of the proposed structure foundation elements been shown on the profile view?	Y	
34	Have the offsets from centerline or baseline been indicated above the borings in the profile view?	Y	
35	Have borings located immediately adjacent to the centerline or baseline and considered representative of centerline or baseline subsurface conditions been referenced directly to the centerline or baseline?	Y	
36	Have offset borings in or near the same elevation interval of a centerline or baseline boring been plotted either on a cross section or immediately above or below the centerline boring in a box containing an elevation scale?	Y	

VI.A. Soil Profile Checklist

37	Have cross-sections been developed to show subsurface conditions disclosed by a series of borings drilled transverse to centerline or baseline?	Y	

VI.A. Soil Profile Checklist

Subsurface Data		(Y/N/X)	Notes:
38	Have the existing and proposed groundlines been displayed on cross section sheets according to ODOT CADD standards?	Y	
39	Have bedrock exposures shown on the cross sections been plotted along the contour of the cross section?	Y	
40	Has the following information been provided adjacent to the graphical logs or bedrock exposure:	Y	
a.	Thickness, to the nearest inch, of sod/topsoil or other shallow surface material written above the boring (with corresponding symbology at top of log)?	Y	
b.	Moisture content, to nearest whole percent, with the bottom of the text aligned with the bottom of the sample? Label this column as 'WC' at bottom of the boring.	Y	
c.	N_{60}, aligned with the bottom of sample? Label column as 'N_{60}' at bottom of boring.	Y	
d.	Free water indicated by a horizontal line with a 'w' attached, and water level at the end of drilling indicated by an open equilateral triangle, point down?	Y	
e.	Complete geologic description of each bedrock unit, including unit core loss, unit RQD, SDI, and compressive strength test results? (Do not present geologic descriptions for structure borings for which this information is presented on the boring logs as described in 703.3)	Y	
f.	Visual description of any uncontrolled fill or interval not adequately defined by a graphical symbol?	Y	
g.	Organic content with modifiers, per 603.5?	Y	
h.	Designate a plastic soil with moisture content equal to or greater than the liquid limit minus three with a 1/8" solid black circle adjacent to the moisture content?	Y	
i.	Designate a non-plastic soil with moisture content exceeding 25% or exceeding 19% but appearing wet initially, with a 1/8" open circle with a horizontal line through it adjacent to the moisture content?	Y	
j.	The reason for discontinuing a boring prior to reaching the planned depth indicated immediately below the boring?	Y	

VI.A. Soil Profile Checklist

Boring Logs		(Y/N/X)	Notes:
41	Have the boring logs of all structure borings, all geohazard borings, and any roadway borings drilled in the vicinity of the structures or geohazard been shown on the boring log sheets following the plan and profile sheets? (Create the logs in accordance with 703.3)	Y	
42	Have the boring logs been developed by integrating the driller's field logs, laboratory test data, and visual descriptions?	Y	
43	Has the following boring information been included in the heading of each boring log:	Y	
a.	Exploration identification number?	Y	
b.	Project designation (C-R-S) and PID?	Y	
c.	Structure File Number (if applicable) and project type.	Y	
d.	Centerline or baseline name, station, offset, and surface elevation?	Y	
e.	Coordinates?	Y	
f.	Method of drilling?	Y	
g.	Date started and date completed?	Y	
h.	Method and material (including quantity) used for backfilling or sealing, including type of instrumentation, if any?	Y	
i.	Date of last calibration and drill rod energy ratio (ER) in percent for the hammer system(s) used?	Y	
44	Has the following boring information been included in each boring log:	Y	
a.	A depth and elevation scale?	Y	
b.	Indication of stratum change?	Y	
c.	Description of material in each stratum?	Y	
d.	Depth of bottom of boring?	Y	
e.	Depth of boulders or cobbles, if encountered?	X	
f.	Caving depth?	X	
g.	Water level observations?	Y	
h.	Artesian water level and height of rise?	Y	
i.	Heaving sand?	Y	
j.	Cavities or other unusual conditions?	Y	
k.	Depth interval represented by sample?	Y	
l.	Sample number and type?	Y	
m.	Percent recovery for each sample?	Y	
n.	Measured blow counts for each 6 inches of drive for split spoon samples?	Y	
o.	N_{60} to the nearest whole number?	Y	

VI.A. Soil Profile Checklist

p. Hand penetrometer?	Y	

VI.A. Soil Profile Checklist

Boring Logs		(Y/N/X)	Notes:
q.	Particle-size analysis?	Y	
r.	Liquid limit, plastic limit, plasticity index?	Y	
s.	Water content?	Y	
t.	ODOT soil classifications, with "V" in parentheses for those samples that are not mechanically classified?	Y	
u.	Top of bedrock and bedrock descriptions?	Y	
v.	Run rock core percent recovery?	Y	
w.	Run RQD?	Y	
x.	Unit rock core percent recovery?	Y	
y.	Unit RQD?	Y	
z.	SDI, if applicable?	Y	
aa.	Rock compressive strength test results, if applicable?	Y	

VI.B. Geotechnical Reports

C-R-S: BRO-32-4.16	PID: 110478	Reviewer: E. Kistner	Date: 3/12/2021

General	(Y/N/X)	Notes:
1 Has an electronic copy of all geotechnical submissions been provided to the District Geotechnical Engineer (DGE)?	Y	
2 Has the first complete version of a geotechnical report being submitted been labeled as 'Draft'?	Y	
3 Subsequent to ODOT's review and approval, has the complete version of the revised geotechnical report being submitted been labeled 'Final'?	Y	
4 Has the boring data been submitted in a native format that is DIGGS (Data Interchange for Geotechnical and Geoenvironmental) compatable? gINT files may be used for this.	N	Will be submitted at a later time.
5 Does the report cover format follow ODOT's Brand and Identity Guidelines Report Standards found at http://www.dot.state.oh.us/brand/Pages/default.aspx ?	Y	
6 Have all geotechnical reports being submitted been titled correctly as prescribed in Section 705.1 of the SGE?	Y	
Report Body	(Y/N/X)	Notes:
7 Do all geotechnical reports being submitted contain the following:	Y	
a. an Executive Summary as described in Section 705.2 of the SGE?	Y	
b. an Introduction as described in Section 705.3 of the SGE?	Y	
c. a section titled "Geology and Observations of the Project," as described in Section 705.4 of the SGE?	Y	
d. a section titled "Exploration," as described in Section 705.5 of the SGE?	Y	
e. a section titled "Findings," as described in Section 705.6 of the SGE?	Y	
f. a section titled "Analyses and Recommendations," as described in Section 705.7 of the SGE?	Y	
Appendices	(Y/N/X)	Notes:
8 Do all geotechnical reports being submitted contain all applicable Appendices as described in Section 705.8 of the SGE?	Y	

VI.B. Geotechnical Reports

9	Do the Appendices present a site Boring Plan showing all boring locations as described in Section 705.8.1 of the SGE?	Y	

VI.B. Geotechnical Reports

Appendices		(Y/N/X)	Notes:
10	Do the Appendices include boring logs and color pictures of rock, if applicable, as described in Section 705.8.2 of the SGE?	Y	
11	Do the Appendices include reports of undisturbed test data as described in Section 705.8.3 of the SGE?	Y	
12	Do the Appendices include calculations in a logical format to support recommendations as described in Section 705.8.4 of the SGE?	Y	