STRUCTURE FOUNDATION EXPLORATION
MULTI-USE PATH BRIDGE OVER
WEST BRANCH ROCKY RIVER
MED-18-13.54
MEDINA COUNTY, OHIO
PID#: 92953

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NEAS PROJECT 15-0091

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EXECUTIVE SUMMARY

The Ohio Department of Transportation (ODOT) has proposed a project for improvements to State Route 18 (MED-18-13.54, PID 92953) in the City of Medina, Medina County, Ohio. The SR-18 roadway alignment is located in the Killbuck-Glaciated Pittsburgh Plateau physiographic region, which is part of the Glaciated Allegheny Plateaus. This area is characterized by ridges and flat uplands dissected by steep valleys. This topography is reflected in the steep valley of the West Branch Rocky River which crosses MED-18 midway at an elevation of about 910 feet (ft) as compared to the western and eastern ends of the alignment which rise to ~1,000 ft and 1,060, respectively. The alignment is underlain by till from 80 to 320 ft deep.

This report presents the results of structure foundation exploration for a multi-use path bridge over the West Branch Rocky River, part of the MED-18-13.54 Improvements to State Route 18 (SR-18) within the City of Medina, Ohio in Montville Township. The bridge will be single span, approximately ~130 feet (ft) long and will accommodate a 10-ft wide path.

The bridge is being designed using the Load and Resistance Factor Design (LRFD) method as set forth in the American Association of State Highway and Transportation Officials (AASHTO) Publication LRFD Bridge Design Specifications 7th Edition with 2015 Interim Revisions (AASHTO, 2015), and Ohio Department of Transportation's (ODOT's) Bridge Design Manual (2007, with revisions July 17, 2015).

Two, 61.5 ft deep borings were drilled to explore subsurface conditions for the bridge abutments. The borings encountered about 50 ft of what appears to be recent alluvium and glacial outwash and/or lake deposits. These materials are predominantly fine-grained silt and clay mixtures with occasional sand and gravel lenses. The natural soils are mantled by embankment fill that was observed to be 10-12 feet in thickness and consists mostly of fine-grained reworked glacial till. The consistency of the soils is fair overall with most of the materials below an assumed foundation elevation including both zones of stiff to very stiff material as well as soft to very soft or loose and very loose.

Based off the site plan provided by Northwest Consultants, Inc. for Bridge MED-18-1299 over West Branch Rocky River dated January 23, 2017, global (overall) stability analysis was performed at both abutment locations to evaluate the stability of the proposed embankment slopes. Based on our analyses, global stability is not anticipated to be a concern at the forward abutment of the proposed bridge replacement structure. However, safety factor of global stability obtained for current rear abutment design is smaller than the desired value of 1.3. Therefore, we recommend extend the rear abutment height with the footing bearing at the elevation of 910.1 ft to force the slide plane through stronger materials which thus improve the global stability. Deep foundation analyses were performed for the abutments based on developed soil profiles at the project boring locations. For the analyses, 12-inch closed-ended cast-in-place (CIP) friction pipe pile was considered at both abutment locations. Based off the email correspondence dated March 30, 2017, a maximum total factored load of 89.3 and 79.5 kips per each pile was assumed at the proposed rear and forward abutment locations, respectively. To obtain the required UBV (pile resistance) at each substructure location, estimated pile lengths are anticipated to 65 ft and 50 ft for the rear and forward abutments, respectively. However, because of soil disturbance caused during pile driving near the pile perimeter, the piles could potentially drive easily or “run” for extended depths and may not reach the required UBV during initial driving. Therefore, in order to minimize pile lengths, it may be necessary to drive the CIP piles to an target UBV estimated tip elevation and then allow for a “set-up” period to occur followed by re-striking the pile to determine if the required UBV was achieved. Analyses of pile drivability also were conducted for the considered pile types and soil profiles. Based on our analysis, using the contractor preferred Delmag D30 diesel hammer and a minimum wall thickness of 0.375 inches at both abutment locations, driveability issues are not anticipated assuming the referenced pile types and sizes are driven to the recommended depths.

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1. INTRODUCTION

1.1. General

NEAS, formerly Barr Engineering, Inc. (BEI), presents our Structure Foundation Exploration Report for the proposed construction of a multi-use path bridge over the West Branch Rocky River, part of the MED-18-13.54 Improvements to SR-18 within the City of Medina, Ohio in Montville Township. This report presents a summary of the encountered superficial and subsurface conditions and our recommendations for multi-use path bridge foundation design and construction in accordance with Load and Resistance Factor Design (LRFD) method as set forth in AASHTO's Publication LRFD Bridge Design Specifications, 7th Edition with 2015 interim revisions (BDS) (AASHTO, 2014) and ODOT's 2007 LRFD Bridge Design Manual (BDM) (ODOT, 2007).

The work was conducted in general accordance with Barr & Prevost Inc.'s (B&P)[1] proposal to GPD Group dated June 19, 2014 (revised June 23, 2014) and the provisions of ODOT's *Specifications for Geotechnical Explorations* (SGE) (ODOT, 2015).

The scope of work performed by NEAS as part of the referenced project included: a review of published geotechnical information; performing 2 test borings; laboratory testing of soil samples in accordance with the SGE; performing geotechnical engineering analysis to assess multi-use bridge design and construction considerations; and development of this summary report.

1.2. Proposed Construction

The bridge will be single span, approximately ~110 feet (ft) long and will accommodate a 12-ft wide path. It is assumed that the bridge deck elevation will be at approximately 926 ft. Deep foundations are planned by using 12 inches (in) cast-in-place (C.I.P.) pile.

2. GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1. Geology and Physiography

The bridge site is located in the Killbuck-Glaciated Pittsburgh Plateau physiographic region, which is part of the Glaciated Allegheny Plateaus (Brockman, 1998). This area is characterized by ridges and flat uplands dissected by steep valleys. This topography is reflected in the steep valley of the West Branch Rocky River which crosses SR-18 at an elevation of about 910 feet (ft) as compared to the western and eastern ends of SR-18 which rise to ~1,000 ft and 1,050, respectively.

The ODNR maps the surficial geology of the bridge site as 10 ft of alluvium over 260 ft of Wisconsinan-age till (unsorted mix of clay, silt, sand, gravel and boulders) over Mississippian-age sandstone and shale (ODNR, 2000).

[1] On October 19, 2014 Barr & Prevost Inc. (B&P) separated into two entities; Barr Engineering Inc. (BEI), the predecessor company to B&P, and Barr & Prevost, a JMT Division. BEI has retained the geotechnical exploration services for this project. On Novermber 23, 2016 BEI changed name to National Engineering & Architectural Services Inc.

2.2. Soils

Soils underlying the bridge have been mapped and rated by the Natural Resources Conservation Service (U.S. Department of Agriculture, 2015) as Ellsworth silt loam, 25 to 70% slopes very limited for shallow excavations due to slope and depth to the saturated zone.

2.3. Seismicity

Earthquake hazard analysis in this part of the country is dominated by proximity to the New Madrid Fault Zone (NMFZ) approximately 525 miles to the southwest. Possible future movements along this fault could generate earthquakes of magnitude (mag) 7.0-8.0 with a recurrence period of 500-1,500 years (USGS, 2008). The resulting ground motion would be experienced over a wide area, with the Medina area located within the possible zone of influence. In addition, earthquake epicenters of lesser mag (< ~ mag 5) occurred in Medina County (mag 3.0-2011-16 miles southwest) and in surrounding counties [(mag 3.8-Summit Co-1885), (mag 3.3-Cuyahoga Co-1955) and (3.3 Lorain Co-1899), which indicate other potential earthquake sources that are contributory to seismic risk (ODNR, 2014(1)).

2.4. Hydrology

SR-18 bridges the West Branch Rocky River at approximately Sta. 741+00 where the flow elevation is approximately 910 ft and likely represents the local groundwater elevation. The West Branch is within the 100-year flood zone; its base flood elevation at the bridge is 917 ft.

A ~3.0 acre Freshwater Emergent Wetland lies immediately north of the alignment at West Branch Rocky River.

2.5. Mining and Oil/Gas Production

No abandoned mines are noted on ODNR's Abandoned Underground Mine Locator in the immediate vicinity of the bridge site (ODNR, 2015(2)).

No oil or gas wells are noted within the immediate vicinity of the bridge site (ODNR, 2015(3)).

2.6. Site Reconnaissance

A site reconnaissance was conducted July 16, 2015; site conditions were noted and photographed during the visit. Land use to the north includes Lake Medina and a wooded area to the south.

A proposed multi-use path bridge is to be built over West Branch Rocky River south of SR-18 to carry non-vehicle travel; it is part of the new path proposed south of SR 18. The new concrete path will trend away from SR 18 just east of Summa Dr at Sta 737+69 (Photograph 1) then cross the river (Photograph 2) then trends back towards the roadway until it joins the path at Sta 743+33. South of the western end of the path is a marsh area that drains into West Branch Rocky River (see Photograph 1). The embankment is currently thickly covered in vegetation with a slope of approximately 2:1. Riprap overlays the both banks that the bridge will cross. The river is approximately 25' across and 2' deep near the proposed crossing. Drainage ditches both east and west of the river run along the proposed path alignment (Photograph 3). The western bank of the river, south of the proposed path, is showing signs of erosion.

Photograph 1: Proposed western end of path location and marsh area.

Photograph 2: View of West Branch Rocky River at the proposed path bridge site.

Photograph 3: Drainage ditches along proposed path.

3. GEOTECHNICAL EXPLORATION

3.1. Historical Boring Program

ODOT online FALCON Geotechnical Data Management System (GDMS) was queried for existing subsurface information for the bridge site (FALCON, 2014). Two soil borings (B-001-P-99 and B-002-P-99) were reviewed for this report (Table 1). A summary of the historical borings information (location, elevation, etc.) is provided in Table 1 below, the location is depicted on the Site Plan provided in Appendix A, and the historical boring logs are provided in Appendix B.

Table 1: Historical Borings Summary

Boring Number	Location (Sta/offset)	Elevation (NAVD 88) (ft)	Depth (ft)	Structure
B-001-P-99	740+50, 11.6' RT	926.5	90.0	Bridge
B-002-P-99	741+85, 15.0' LT	925.0	90.0	Bridge

3.2. Field Exploration Program

NEAS drilled and sampled 2 borings for this project on July 6, 2015, the locations of which are shown on Appendix A. A summary of the drilling information is presented below in Table 2.

Table 2: Borings Summary

Boring Number	Location (Sta/Offset)[2]	Latitude[1]	Longitude[1]	Elevation (NAVD 88) (ft)	Depth (ft)
B-020-0-14	140+30, 30' RT	41.137032	-81.822534	927.1	61.5
B-021-0-14	141+80, 31' RT	41.136970	-81.821995	924.7	61.5

Notes:
1. *As-drilled boring location and corresponding ground surface elevation was surveyed in the field by GPD Group.*
2. *Stationing in reference to centerline of PR S.R. 18.*

Drilling was accomplished using a CME 55 rig with 3.25" inside diameter hollow stem augers. The hammer energy ratio was 78.8 at its last calibration on 1/26/14.

Disturbed soil samples were obtained in accordance with the Standard Penetration Test (SPT) (AASHTO T206) and collected continuously for most of the borings. The borings were sampled continuously to 9 ft and 1.5 ft thereafter. Split spoon samples collected as part of the SPT were placed in sealed glass containers and transported to NEAS's geotechnical laboratory in Columbus, OH. Hand penetrometer (HP) tests were conducted on a majority of the cohesive samples prior to their removal from the sampler. Borings were abandoned using one/or a combination of the following: bentonite chips, cement and asphalt patch, as indicated on the Log of Borings (see Appendix B).

Field boring logs were maintained by the drill crew that included a description of the soils and rock encountered, SPT test results recorded as hammer blows per 6-inch increment of penetration, and HP test results. Groundwater related observations were recorded as appropriate.

3.3. Laboratory Testing Program

The laboratory testing program consisted primarily of classification testing and moisture content determinations. Data from the laboratory-testing program were incorporated onto the logs of borings (Appendix B). Soil samples are retained at the laboratory for 60 days following report submittal, after which time they will be discarded.

3.3.1. Classification Testing

Natural moisture content tests were performed on all soil samples. Representative soil samples were selected for index property (Atterberg Limits) and gradation testing for classification purposes. The results are presented on the log of the boring. Mechanical soil classification (Plastic Limit, Liquid Limit and gradation testing) was conducted on 46% of the recovered samples enabling identification and testing of all significant soil units.

Final classification of soil strata in accordance with AASHTO M-145 "Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes," as modified by ODOT "Classification of Soils" was made once laboratory test results became available. Samples that were not tested were classified visually on the basis of comparison to those that were.

3.3.2. Standard Penetration Test Results

Standard Penetration Tests (SPT) and split-barrel (commonly known as split-spoon) sampling of soils was performed in all borings using a calibrated auto-hammer. The resulting N-values must then be adjusted to account for the high efficiency of the hammer, compared to those used historically when many of the correlations of N-value with engineering properties of soils were developed. Manual hammers used in the past are considered to have been approximately 60% efficient and so the field measured N-values are adjusted by a factor equal to the calibrated efficiency/60. The resulting N_{60} values are shown on the logs of borings in Appendix B.

4. GEOTECHNICAL FINDINGS

The following description of the subsurface conditions is based on interpretation of the current field exploration, laboratory testing, and consideration of the geological history of the site.

4.1. Subsurface Conditions

The subsurface profile at the referenced site is generally consistent with the geological model for the project in regards to the materials encountered. The subsurface profile within the proposed project area consists of surficial materials comprised of existing pavement and granular base generally underlain by either cohesive and/or non-cohesive embankment fill soil.

4.1.1. Overburden Soil

The borings encountered about 50 ft of what appears to be glacially derived alluvium in the form outwash and/or lake deposits with zones of till observed infrequently. These materials are predominantly fine-grained silt and clay mixtures with occasional sand and gravel lenses. The natural soils are mantled by embankment fill that was observed to be 10 - 12 feet in thickness and consists mostly of fine grained reworked glacial till.

The consistency of the soils is fair overall with most of the materials below the assumed pile cap elevation including both zones of stiff to very stiff material as well as soft to very soft or loose and very loose. Low N_{60} values in the silty soils are frequently attributable to unbalanced hydrostatic heads in the soil and augers resulting in the potential for apparent strength reduction in susceptible silts and fine sands.

Soils at the elevation of about ~915 ft tend to be some of the poorest encountered and include silts that are sensitive to hydrostatic conditions and a thin stratum of soft clay with organics that could be a former ground surface.

4.1.2. Groundwater

Groundwater was encountered in both borings at elevations ~907 ft and 917 ft during drilling. The water table of West Branch Rocky River is at elevation ~906 ft, and the 100-year flood elevation (HW_{100}) is ~917.71 ft.

5. ANALYSIS AND RECOMMENDATIONS

We understand that the construction of a multi-use path bridge is planned over West Branch Rocky River, parallel to the existing SR-18 in Medina County, Ohio. The proposed bridge will be bearing on the assumed poor and saturated soils. Based on planned roadway grades and alignment, AASHTO's LRFD BDS dictates that the planned bridge embankment shall be designed for a live load surcharge of 250 pound per square foot (psf).

Based on the above information in addition to: 1) the soil characteristics gathered during the subsurface exploration (i.e., SPT results, laboratory test results, etc.); 2) the developed generalized soil profile at the proposed bridge location and other design assumptions presented in subsequent sections of this report; and, 3) the proposed multi-use path bridge site plans designed by Northwest Consultants, Inc, geotechnical analyses consisting of deep foundation design, global stability analysis, settlement analysis and seismic analysis were performed for the proposed multi-use path bridge.

The geotechnical engineering analyses were performed in accordance with ODOT's BDM (ODOT, 2007) and AASHTO's LRFD BDS (AASHTO, 2014). Based on the results of the analysis, it is our opinion that the subsurface conditions encountered are generally satisfactory and will provide adequate resistance assuming the proposed multi-use path bridge is constructed in accordance with the recommendations provided within this report, as well as all applicable standards and specifications (i.e. ODOT, manufacture, etc.) for soldier pile wall construction.

5.1. Soil Profile for Analysis

For analysis purposes, each boring log was reviewed and a generalized material profile was developed for analysis. At the rear abutment location, the soil profile was generalized on the basis of the boring B-020-0-14 and the historical boring B-001-P-99. The historical boring B-001-P-99 was utilized to generate the soil profile due to the soil conditions encountered above the end of boring (EOB) of the boring B-020-0-14 were relatively weak. At the forward location, the soil profile was generalized based on the boring B-021-0-14.

Utilizing the generalized soil profile, engineering properties for each soil strata was estimated based on their field (i.e., SPT N_{60} Values, hand penetrometer values, etc.) and laboratory (i.e., Atterberg Limits, grain size, etc.) test results using correlations provided in published engineering manuals, research reports and guidance documents. Engineering soil properties were estimated for each individual classified layer per boring location. Soil layers from both borings with similar behavior (i.e., cohesive or non-cohesive/granular) and characteristics (i.e., relative compactness/consistency, moisture content, etc.) were grouped into generalized soil units (i.e., Soil Types) and weighted average values of the estimated engineering soil properties were assigned to each Soil Type to develop a generalized soil profile for analysis. The summary of the generalized soil profile including designated Soil Types, elevations, average engineering soil properties per boring location are presented in Tables 3-4 below.

Table 3: Soil Profile and Estimated Engineering Properties (B-020-0-14 & B-001-P-99)

Multi-use Path Bridge: Rear Abutment, B-020-0-14 & B-001-P-99						
Soil Description	**Unit Weight(1) (pcf)**	**Moist Unit Weight(1) (pcf)**	**Saturated Unit Weight(1) (pcf)**	**Undrained Shear Strength(2) (psf)**	**Effective Cohesion(3) (psf)**	**Effective Friction Angle(3) (degrees)**
Silt and Clay Depth (927.1 ft - 924.1 ft)	112	112	122	2000	200	24
Silt and Clay Depth (924.1 ft - 917.6 ft)	108	108	118	950	100	22
Sandy Silt Depth (917.6 ft - 915.1 ft)	108	108	118	-	-	27
Silty Clay Depth (915.1 ft - 912.6 ft)	100	100	110	350	35	19
Silt and Clay Depth (912.6 ft - 910.1 ft)	105	105	115	600	75	21
Sandy Silt Depth (910.1 ft - 905.1 ft)	110	110	120	-	-	28
Gravel with Sand Depth (905.1 ft - 902.8 ft)	118	108	118	-	-	31
Sandy Silt Depth (902.8 ft - 897.6 ft)	118	108	118	1100	100	23
Silt and Clay Elevation (897.6 ft - 893.8 ft)	120	110	120	1600	150	23
Gravel with Sand Elevation (893.8 ft - 887.1 ft)	122	112	122	-	-	33
Silt Elevation (887.1 ft - 868.8 ft)	118	108	118	1000	100	23
Sandy Silt Elevation (868.8 ft - 858 ft)	128	118	128	4000	300	30
Silt and Clay Elevation (858 ft - 847.3 ft)	135	125	135	5850	400	32
Coarse and Fine Sand Elevation (847.3 ft - 836.5 ft)	90.6	122	132	-	-	37

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2.*

Table 4: Soil Profile and Estimated Engineering Properties (B-021-0-14)

Multi-use Path Bridge: Forward Abutment, B-021-0-14						
Soil Description	**Unit Weight(1) (pcf)**	**Moist Unit Weight(1) (pcf)**	**Saturated Unit Weight(1) (pcf)**	**Undrained Shear Strength(2) (psf)**	**Effective Cohesion(3) (psf)**	**Effective Friction Angle(3) (degrees)**
Gravel with Sand and Silt Elevation (924.7 ft - 920.2 ft)	115	115	125	-	-	37
Silt and Clay Elevation (920.2 ft - 912.7 ft)	108	108	118	850	100	22
Sandy Silt Elevation (912.7 ft - 905.2 ft)	108	108	118	-	-	27
Silt and Clay Elevation (905.2 ft - 902.7 ft)	120	110	120	1350	150	23
Sandy Silt Elevation (902.7 ft - 900.2 ft)	120	110	120	1350	150	24
Silt and Clay Elevation (900.2 ft - 895.2 ft)	120	110	120	1550	150	23
Silty Clay Elevation (895.2 ft - 892.7 ft)	120	110	120	1600	150	23
Coarse and Fine Sand Elevation (892.7 ft - 886.7 ft)	125	115	125	-	-	33
Sandy Silt Elevation (886.7 ft - 866.4 ft)	122	112	122	2450	200	26
Gravel with Sand Elevation (866.4 ft - 863.2 ft)	130	120	130	-	-	38

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2.*

5.2. Global Stability

For purposes of evaluating the stability of the proposed multi-use path bridge site, NEAS reviewed two cross-sections for rear abutment slope and forward abutment slope within the project limits that were interpreted to represent conditions that posed the greatest potential for slope instability. In general, cross-sections at the proposed bridge site were reviewed to determine if the section would represent a combination of existing subsurface conditions and planned site grading that would be most critical to slope stability (i.e., maximum embankment height measured from toe of slope to top of wall coping, proposed cut into existing embankment slopes, weak or thick soil layer, etc.).

For the two cross-sections, NEAS developed two corresponding representative cross-sectional models to use as the basis for global stability analyses. The models were developed from NEAS's interpretation of the available information which included: 1) The proposed bridge site plans prepared by Northwest Consultants, Inc.; 2) a live load surcharge of 240 psf, accounting for traffic induced loads; and, 3) test borings and laboratory data developed as part of this report. With respect to the soils' engineering properties, the provided Soil Profile and Estimated Engineering Properties presented in Section 5.1. of this report were used in our analyses.

The above referenced slope stability models were analyzed for long-term (Effective Stress) and short-term (Total Stress) slope stability utilizing the software entitled *Slide 7.0* by Rock Science, Inc. Specifically, the Bishop method and Janbu method were used to calculate a factor of safety (FOS) for circular slope failures. The FOS is the ratio of the resisting forces and the driving forces, with the desired safety factor being more than about 1.33 which equates to an AASHTO resistance factor less than 0.75 (per AASHTO's LRFD BDS the specified resistance factors are essentially the inverse of the FOS that should be targeted in slope stability programs). For this analysis, a resistance factor of 0.75 or lower is targeted as the slope does not contain or support a structural element.

5.2.1. Global Stability Analysis at Forward Abutment

Based on our slope stability analysis for the forward abutment slope at the referenced bridge site, the minimum slope stability safety factor is about 1.79 (0.56 resistance factor). The results of the analyses are summarized in Table 5. Based on the results of the analyses, it is our opinion that the subsurface conditions encountered at this location are generally satisfactory and the site can be considered to be stable for short-term and long-term condition. The graphical output of the slope stability program (cross-sectional model, calculated safety factor, and critical failure plane) is presented in Appendix C.

Table 5: Glabal Stability Analysis Summary for Forward Abutment

Description	Minimum Factor of Safety	Equivalent Resistance Factor	Status (OK/NG)
Short Term	3.32	0.30	OK
Long Term	1.79	0.56	OK

5.2.2. Global Stability Analysis at Rear Abutment

Based on our slope stability analysis for the rear abutment slope at the referenced bridge site, the minimum slope stability safety factor is about 1.26 (0.80 resistance factor) for the long-term soil strength conditions, which was below the desired value of 1.3. The results of the analyses are summarized in Table 6. Based on the results of the analyses, it is our opinion that some form of remediation or extension of the rear abutment through weak materials should be implemented within the referenced area to improve the global stability at rear abutment. Further slope stability analyses were performed and presented in Section 5.2.3 to evaluate possible solutions that could be considered to achieve a FOS greater than 1.3 at rear abutment. The graphical output of the slope stability program (cross-sectional model, calculated safety factor, and critical failure plane) is presented in Appendix C.

Table 6: Glabal Stability Analysis Summary for Original Rear Abutment Design

Description	Minimum Factor of Safety	Equivalent Resistance Factor	Status (OK/NG)
Short Term	2.01	0.50	OK
Long Term	1.26	0.80	NG

5.2.3. Recommendations for Improving Global Stability at Rear Abutment

The evaluated solutions to increase the slope stability FOS included: 1) excavate and replace of the weak materials encountered in B-020-0-14 between 910.6 ft and 917.6 ft; 2) extend the proposed rear abutment bottom to the depth at elevation of ~ 910.1 ft. Excavation and replacement of the weak materials would require a expensive temporary shoring to support 17 ft high side embankment at the bridge MED-18-1299. Extension the proposed through rear abutment will force the sliding plane deeper to stronger soil materials. Extension abutment option is more economical. To evaluate the extension option, the respective slope stability model was re-evaluated to confirm that the FOS under both short-term and long-term soil strength conditions will meet the desired minimum.

Based on our slope stability analyses, when the rear abutment footing extends to the elevation of ~910.1 ft, the short-term and long-term slope stability FOS for the cross-section exceeds the desired value of 1.3; therefore, the provided solution is considered feasible at the referenced location. The results of the analyses are summarized in Table 7. It is our opinion that the increase of rear abutment height with footing bearing at the elevation of ~910.1 ft will help improve the global stability and create a stable slope. The graphical output of the slope stability program (cross-sectional model, calculated safety factor, and critical failure plane) is presented in Appendix C.

Table 7: Global Stability Analysis Summary for Modified Rear Abutment Design

Description	Minimum Factor of Safety	Equivalent Resistance Factor	Status (OK/NG)
Short Term	2.01	0.50	OK
Long Term	1.32	0.76	OK

5.3. Settlement

To construct the embankments behind abutments, it will introduce about 8 ft high fill and 11 ft high fill for rear abutment and forward abutment, respectively. In order to estimate the maximum total and differential settlement that could result within the subsurface soils supporting the proposed bridge abutments, NEAS reviewed: 1) the proposed bridge Site Plan prepared by Northwest Consultants, Inc.; 2) Service Limit State loading conditions; and, 3) test borings and laboratory data developed as part of this report. Utilizing this information and the software entitled FoSSA 2.0 by ADAMA Engineering, Inc., two settlement models were developed and analyzed for both elastic (immediate) and consolidation (long term) settlement for rear abutment and forward abutment. The detailed reports are presented in Appendix D.

Based on our analysis the ground surface at the rear abutment is estimated to experience about 4.4 inches of immediate settlement and 0.6 inches of long term (consolidation) settlement from the induced loads associated with the 8-ft high embankment. The ground surface at the forward abutment is estimated to experience about 4.6 inches of immediate settlement and 0.8 inches long term (consolidation) settlement from the induced loads associated with the 11-ft high embankment. The immediate settlement is expected to take place during construction prior to bridge loading and is not anticipated to be a concern; however, it is anticipated that majority of the long term settlement will take place following abutment construction. Therefore, it is our opinion that measures will need to be taken to ensure the settlement does not negatively impact the structural integrity of the bridge (i.e., down drag induced loading of piles) or serviceability of the bridge abutment embankment (i.e., excessive total and differential settlement). Recommendations regarding these measures are included within subsequent sections of this report.

5.4. Deep Foundation Design

5.4.1. Pile Foundation Analysis

Design of foundation elements for the proposed new bridge has been based on bridge site plan and anticipating loads provided by Northwest Consultants, Inc. on March 30, 2017. Service loads, Strength I Limit State factored loads and Ultimate Bearing Values (UBV) are estimated as follows:

- Service Loads: 62.0 kips for Rear Abutment and 79.5 kips for Forward Abutment
- Total Factored Loads: 89.3 kips for Rear abutment and 79.5 kips for Forward Abutment
- UBV: 127.6 kips for Rear abutment and 113.6 kips for Forward Abutment

Based on our estimated engineering soil properties presented in Section 5.1 of this report, a pile analysis was performed using the computer program Driven. The Driven analyses results can be found in Appendix E.

5.4.2. Downdrag Load

To construct the embankments behind abutments, it will introduce about 8 ft high fill for rear abutment and 11 ft high fill for forward abutment, which creates the potential for compression of the soils underlying the abutments. Deep foundations may be subject to downdrag loads. These should be assumed to be imposed unless it can be determined with certainty that one of the following mitigative factors is in place:

- The embankments have been raised using low density fill that substantially reduces settlement and/or
- Monitoring has shown that settlement is complete.

The potential downdrag loads were computed using the neutral plan method (Goudrealt & Fellenius, 1994). The essence of the method lies in the idea that dragload forces and structure loads are resisted by the geotechnical resistance on the lower part of the pile such that there is a balance between the two. The point on the pile where the structure load plus dragload equals the geotechnical resistance is where the neutral plane is said to exist. At this point on the pile there is no movement of soil relative to the pile. (In the upper portion of the pile, the settling soil is trying to move down relative to the pile and at the bottom where the pile is being pushed down, the soil is trying to move up relative to the pile.) Whatever settlement is induced by surface loads at the neutral plane will, therefore, be the settlement experienced by the pile as a whole and should be considered. This movement actually represents the true 'downdrag'.

Pile failure at the strength limit state occurs only after the full geotechnical resistance of whole pile has been overcome. Conditions at abutments have been evaluated using this model.

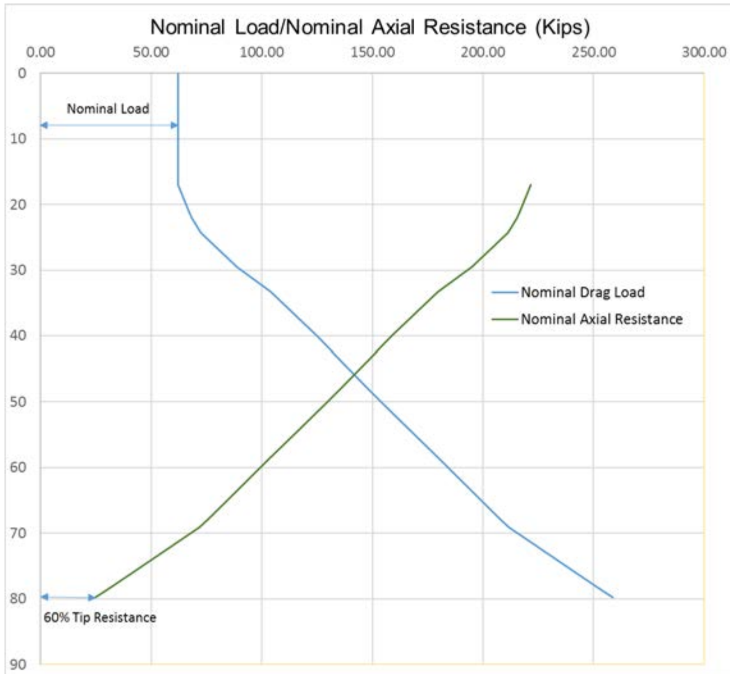
On one hand, the location of the neutral plane can be illusive and varies depending on the loading conditions and the pile length; on the other hand, the pile length also depends the amount of downdrag load (cumulative negative skin friction), which is determined by the location of the neutral plane. An iterative process involves first assuming a pile length and determining the corresponding neutral plane and the downdrag load. Then the pile length can be updated based on the estimated downdrag load and the axial loads.

The graphical construction for determining the neutral plane involves several steps:

(1) The nominal dead loads are plotted on the top horizontal axis and form the starting point for the plot of dead load plus friction drag load (DL + DD). DD is based on the nominal skin friction of the pile resistances computed from Driven 1.2 presented in Appendix E.
(2) The total capacity (side and 40 to 60% nominal tip resistance) computed from Driven 1.2 presented in Appendix E are then used to plot the cumulative resistance from the bottom of the pile upwards, starting on the horizontal axis corresponding to the nominal toe resistance for that pile.
(3) Where the two curves intersect represents the neutral plane location.

The analysis produces the depth to the neutral plane and the compressive load (unfactored) in the pile at this point, as shown in the example below (Figure 1).

Figure 1: Graphical Neutral Plane Analysis



The pertinent results of this analysis are summarized in Table 8. A capacity to demand ratio (CDR) value of greater than 1.0 is needed not to exceed maximum ultimate bearing value. The results indicate that at both abutments the required UBVs of 12 in CIP piles are smaller than the specified ODOT's maximum UBV and that the foundation design should be satisfactory for both abutments.

Table 8: Neutral Plane Analysis Results

Factored Design Load (DL) (kips)	Nominal Dragload (DD) (kips)	DD Load Factor	Factored Dragload (kips)	Total Factored Load (kips)	Resistance Factor	Ultimate Bearing Value(kips)	Maximum Ultimate Bearing Value(kips)	Capacity Demand Ratio
Rear Abutment, 12" CIP Pile								
89.3	87.5	1.4	122.5	211.8	0.7	302.6	330	1.09
Forward Abutment, 12" CIP Pile								
79.5	55.6	1.4	77.9	157.4	0.7	224.8	330	1.47

5.4.3. Deep Foundation Design

Based on the required axial loads for the pile at each substructure from Northwest Consultants, Inc. provided on March 30, 2017 and the estimated downdrag loads, the estimated geotechnical pile length can be determined at each substructure. It should be noted that the bottom of pile cap elevation at rear abutment location 910.1 ft is used on estimating pile length on the basis of NEAS's recommendations in Section 5.2.3. The *Driven* analysis results can be found in Appendix E.

For the purposes of this report and our analysis the term 'geotechnical pile length' has been assumed to represent the length of pile from bottom of pile cap (pile cap bearing elevation) to the depth at which the required Ultimate Bearing Value (UBV) is obtained. The UBV is determined in accordance with Section 202.2.3.2.b of the BDM in which the given total factored load for the pile at each substructure is divided by the appropriate driven pile resistance factor. The piles for the referenced project are to be installed according to CMS 507 and CMS 523 and as such, a driven pile resistance factor of 0.7 was used in our analysis.

Pile lengths based on: 1) the "Estimated Length" and "Order Length" definitions and formulas presented in Section 303.4.2 "Pile Foundations" of the BDM, are shown in Table 9. The piles will be supported from about elevations given in Table 9 at the bottom of footing. The calculated 'estimated' length assumes penetration through one foot embedment in the pile cap and rounding up to the nearest 5 ft.

Table 9: Estimated Pile Lengths

Pile Type	Bottom of Pile Cap Elevation(1) (ft)	Factored Axial Load (kips)	Factored Downdrag Load (kips)	Ultimate Bearing Value (kips)	Geotechnical Pile Length(1) (ft)	Estimated Pile Length(2) (ft)	Order Length(3) (ft)
Multi-use Path Bridge: Rear Abutment, B-020-0-14 & B-001-P-99							
12" CIP pile	910.1	89.3	122.5	302.6	63	65	70
Multi-use Path Bridge: Forward Abutment, B-021-0-14							
12" CIP pile	914.3	79.5	77.9	224.8	47	50	55

Notes:

1. *The length of pile from bottom of pile cap (pile cap bearing elevation) to the depth at which the required UBV is obtained.*
2. *The estimated length asuumes penetration one foot embedment in the pile cap and rounding up to the nearest 5 ft.*
3. *Based on definitions and formulas presented in Section 303.4.2 of the 2004 BDM.*

5.4.4. Pile Drivability

NEAS's pile drivability evaluation estimated a Delmag D30 diesel hammer to determine if the piles would be overstressed at any time during pile installation. The results of the evaluation indicated that none of the piles would be overstressed during the pile installation process prior to reaching the pile maximum UBV based on a minimum wall thickness calculated in accordance with Section 507.03 "Cast-in-Place Reinforced Concrete Piles" of the CMS and the computer program GRLWEAP developed by GRL Engineers, Inc. Using the assumed UBVs noted above (Section 5.1.1.) the minimum wall thickness of 12-inch CIP piles was calculated to be 0.34 and 0.25 inches for rear abutment and forward abutment, respectively. In GRLWEAP analysis, the wall thickness of 12-inch CIP piles is chosen as 0.375 inches for both rear and forward abutments, respectively. GRLWEAP results for each substructure location can be found in Appendix E.

Pile driveability is highly reliant upon the specific equipment used in construction. Therefore, it is recommended that the contractor should provide an analysis to demonstrate that the equipment planned for use is capable of performing without over-stressing the piles.

5.4.5. Deep Foundation Recommendations

We recommend that a driven pile foundation be sued for support on this bridge, utilizing 12-inch CIP piles used at abutment locations, driven to a maximum UBV of 303 kips and 225 kips at the rear and forward abutments, respectively. The 12-in CIP piles should be ASTM A 252 Grade 2 with a minimum wall thickness of 0.375 inches. When installed in accordance with Sections 507 and 523 of ODOT's CMS, 12-inch CIP piles driven to the indicated UBV may be used to support a total factored load (single pile) of 89 kips and 80 kips for the rear and forward abutments, respectively. However, because of soil disturbance caused during pile driving (development of high pore water pressure) near the pile perimeter, the pile could potentially drive easily or "run" for extended depths. As a result of this occurrence, initial driving may not reach the required UBV and it may be necessary to: 1) drive the friction pile to a target UBV estimated tip elevation; 2) allow a minimum "set-up" period of 7 days; and, 3) re-strike the driven pile to determine if the required UBV was achieved during "set-up". It is our opinion that if piles do not obtain the indicated Ultimate Bearing Values during driving, pile should be driven to the substructures' target UBV estimated tip elevation (where pile re-strike is recommended to occur following the set-up period) which ranges from 647 to 667 ft amsl depending on the substructure.

Target UBV estimated tip elevations and pile lengths based on: 1) our Pile Foundation Analysis (presented in Section 5.4.1); and, 2) the "Estimated Length" and "Order Length" definitions and formulas presented in Section 303.4.2 "Pile Foundations" of the BDM, are presented in Table 9 above.

6. QUALIFICATIONS

This investigation was performed in accordance with accepted geotechnical engineering practice for the purpose of characterizing the subsurface conditions at the site of Multi-use Path Bridge Over West Branch Rocky River for the MED-18-13.54 project. This report has been prepared for GPD Group, ODOT and their design consultants to be used solely in evaluating the soils underlying the bridge site and presenting geotechnical engineering recommendations specific to this project. The assessment of general site environmental conditions or the presence of pollutants in the soil, rock and groundwater of the site was beyond the scope of this geotechnical exploration. Our recommendations are based on the results of our field explorations, laboratory tests results from representative soil samples, and geotechnical engineering analyses. The results of the field explorations and laboratory tests, which form the basis of our recommendations, are presented in the appendices as noted. This report does not reflect any variations that may occur between the borings or elsewhere on the site, or variations whose nature and extent may not become evident until a later stage of construction. In the event that any changes in the nature, design or location of the proposed bridge is made, the conclusions and recommendations contained in this report should not be considered valid until they are reviewed, and have been modified or verified in writing by a geotechnical engineer.

It has been a pleasure to be of service to Northwest Consultants, Inc. in performing this geotechnical exploration for the MED-18-13.54 project. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

Zhao (Lizzy) Mankoci, Ph.D., EIT
Staff Engineer

Chunmei (Melinda) He, Ph.D. P.E.
Geotechnical Engineer

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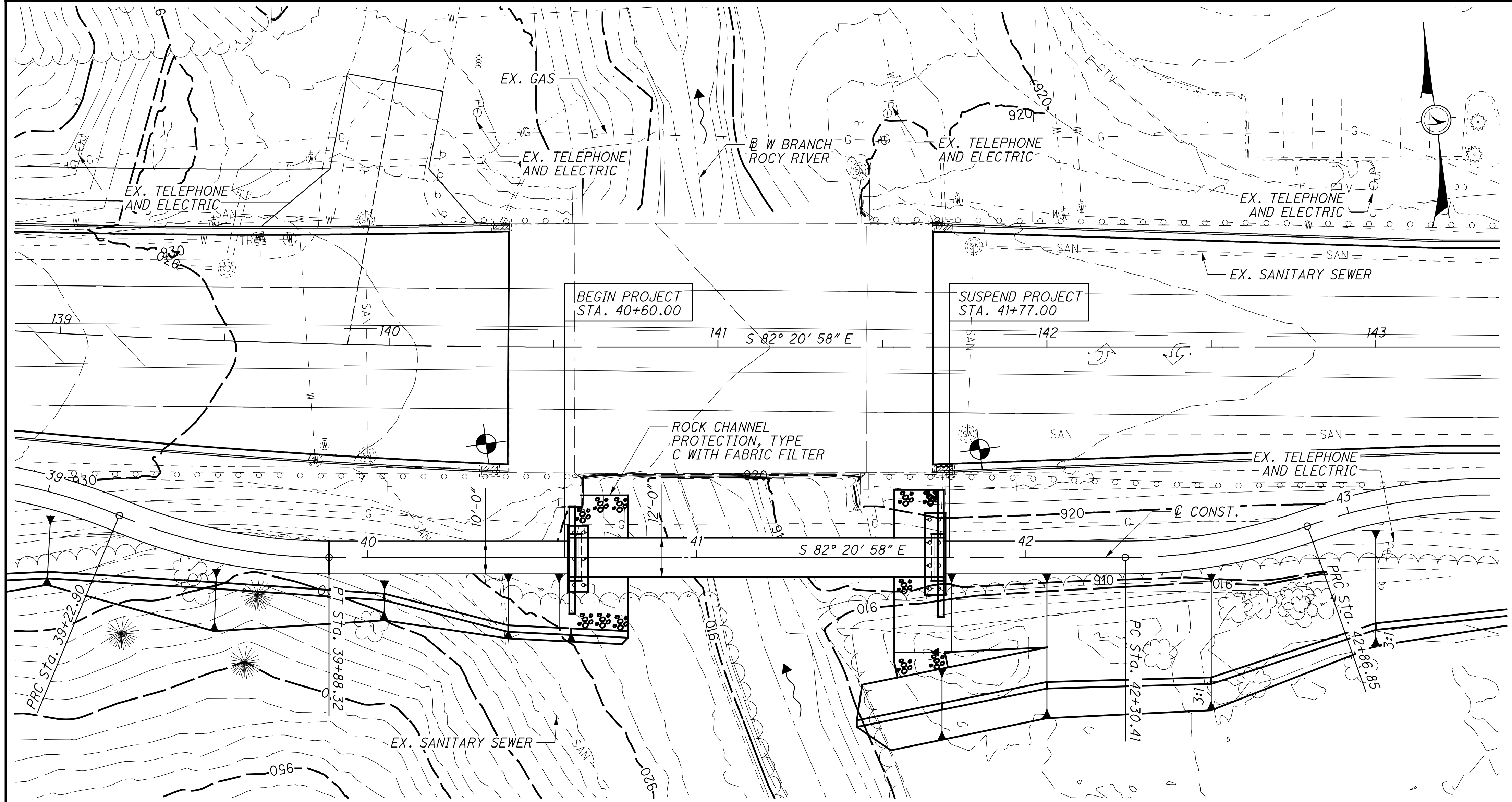
APPENDIX A

SITE PLAN AND
SOIL BORING LOCATIONS PLAN



PLAN

BENCHMARK DATA

BM #1 STA. 141+44.60 ELEV. 924.893 OFFSET 40.30', LT

FOR ADDITIONAL BENCHMARK INFORMATION. SEE ROADWAY PLAN SHEET

NOTES

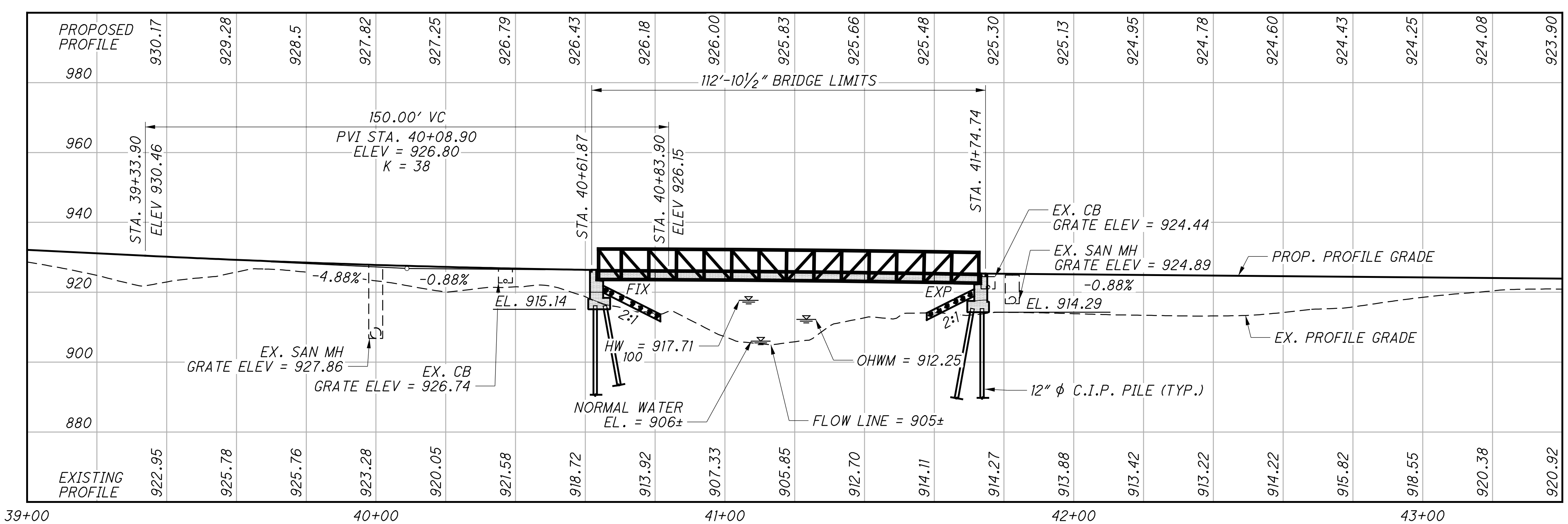
ALL SLOPES ARE 2:1 UNLESS OTHERWISE SHOWN.
EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.

LEGEND

BORING LOCATION

HYDRAULIC DATA

DRAINAGE AREA = 21.1 SQ. MILES
Q (100) = 2358 CFS (FIS) V (100) = 6.39 FT/S
STRUCTURE CLEARS THE 100 YEAR DESIGN HW BY 1.29 FEET.



PROFILE ALONG ℄ CONSTRUCTION

PROPOSED STRUCTURE

TYPE: SINGLE SPAN PREFABRICATED PEDESTRIAN TRUSS BRIDGE WITH REINFORCED CONCRETE ABUTMENTS ON FRICTION PILES

SPAN: 110'-0" ℄ BRG. TO ℄ BRG.
ROADWAY: 12'-0" F/F RAILING
LOADING: 90 PSF PEDESTRIAN LOAD OR H15 TRUCK
SKEW: 0°00'00"
APPROACH SLABS: NONE
ALIGNMENT: TANGENT
CROWN: 0.016
COORDINATES: LATITUDE 41.136956
LONGITUDE -81.822274

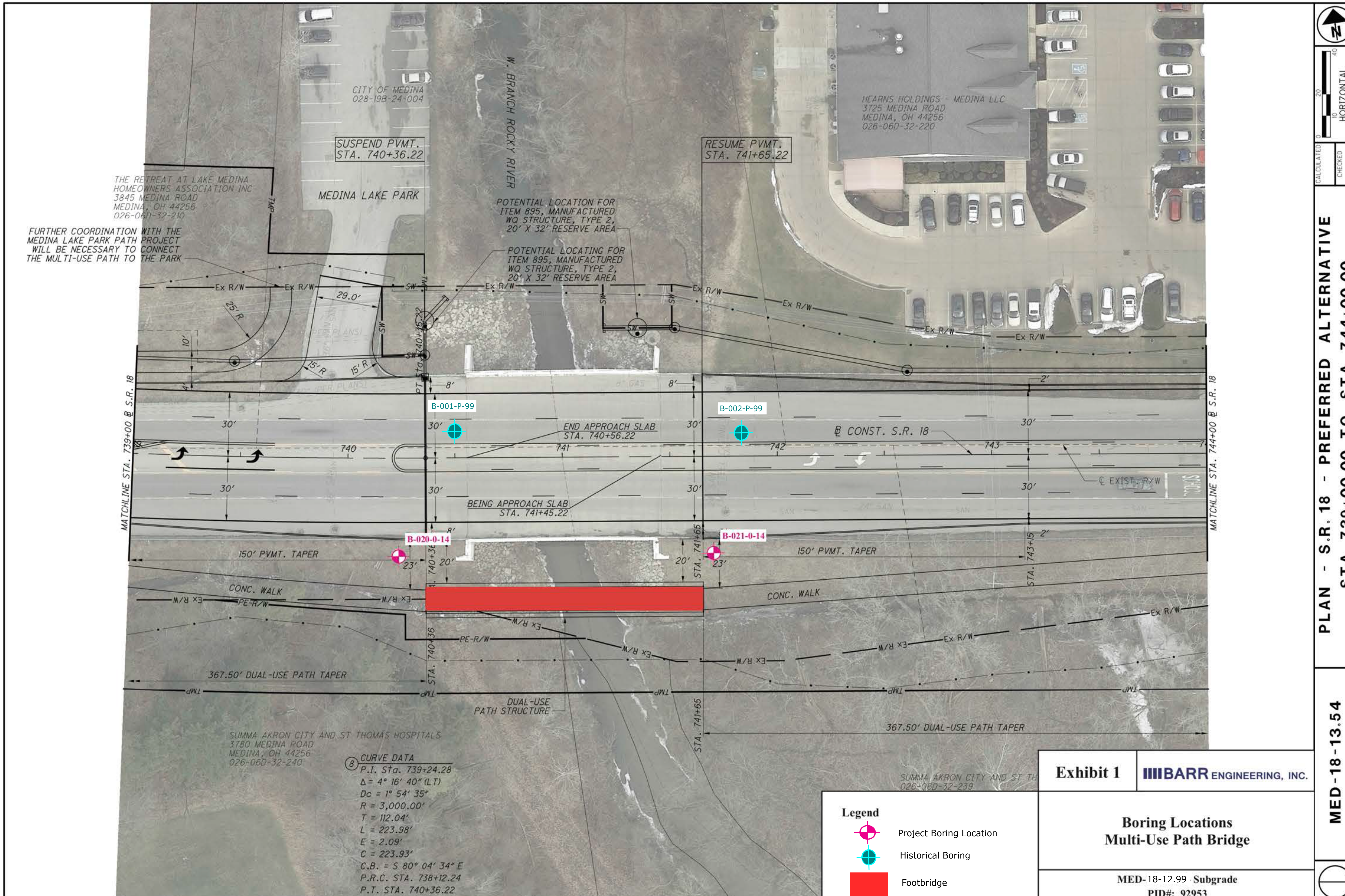
DESIGN AGENCY
NORTHWEST CONSULTANTS, INC.
3220 CENTRAL PARK WEST
TOLEDO, OHIO 43617
PHONE:(419) 841-4704 FAX:(419) 841-2979

REVIEWED JBD DATE 1-23-2017
STRUCTURE FILE NUMBER TBD
DRAWN BSM REVISED —
DESIGNED BSM CHECKED KJJ

STA. ______
STA. ______

SITE PLAN
BRIDGE NO. MED-18-1299
S.R. 18 OVER WEST BRANCH ROCKY RIVER

MED-18-12.99
PID No. 92953


PLAN - S.R. 18 - PREFERRED ALTERNATIVE
STA. 739+00.00 TO STA. 744+00.00
MED-18-13.54
HORIZONTAL SCALE IN FEET
0 10 20 40
CALCULATED
CHECKED
W. BRANCH ROCKY RIVER
CITY OF MEDINA 028-19B-24-004
SUSPEND PVMT. STA. 740+36.22
RESUME PVMT. STA. 741+65.22
MEDINA LAKE PARK
HEARNS HOLDINGS - MEDINA LLC 3725 MEDINA ROAD MEDINA, OH 44256 026-06D-32-220
THE RETREAT AT LAKE MEDINA HOMEOWNERS ASSOCIATION INC 3845 MEDINA ROAD MEDINA, OH 44256 026-06D-32-210
FURTHER COORDINATION WITH THE MEDINA LAKE PARK PATH PROJECT WILL BE NECESSARY TO CONNECT THE MULTI-USE PATH TO THE PARK
POTENTIAL LOCATION FOR ITEM 895, MANUFACTURED WQ STRUCTURE, TYPE 2, 20' X 32' RESERVE AREA
POTENTIAL LOCATING FOR ITEM 895, MANUFACTURED WQ STRUCTURE, TYPE 2, 20' X 32' RESERVE AREA
Ex R/W
29.0'
25' R
15' R
10'
8'
2'
B-001-P-99
B-002-P-99
B-020-0-14
B-021-0-14
30'
END APPROACH SLAB STA. 740+56.22
BEING APPROACH SLAB STA. 741+45.22
℄ CONST. S.R. 18
℄ EXIST. R/W
740
741
742
743
MATCHLINE STA. 739+00 ℄ S.R. 18
MATCHLINE STA. 744+00 ℄ S.R. 18
150' PVMT. TAPER
23'
20'
CONC. WALK
PE-R/W
STA. 740+36
STA. 741+65
STA. 743+15
367.50' DUAL-USE PATH TAPER
DUAL-USE PATH STRUCTURE
TMP
SUMMA AKRON CITY AND ST THOMAS HOSPITALS 3780 MEDINA ROAD MEDINA, OH 44256 026-06D-32-240
SUMMA AKRON CITY AND ST TH 026-06D-32-239
CURVE DATA
P.I. Sta. 739+24.28
Δ = 4° 16' 40" (LT)
Dc = 1° 54' 35"
R = 3,000.00'
T = 112.04'
L = 223.98'
E = 2.09'
C = 223.93'
C.B. = S 80° 04' 34" E
P.R.C. STA. 738+12.24
P.T. STA. 740+36.22
Legend
Project Boring Location
Historical Boring
Footbridge
Exhibit 1
BARR ENGINEERING, INC.
Boring Locations
Multi-Use Path Bridge
MED-18-12.99 · Subgrade
PID#: 92953

APPENDIX B

SOIL BORING LOGS

NEAS Inc.
National Engineering & Architectural Services Inc.

LEGEND

DESCRIPTION	ODOT CLASSIFICATION
Gravel and/or Stone Fragments	A-1-a
Gravel and/or Stone Fragments with Sand	A-1-b
Fine Sand	A-3
Coarse and Fine Sand	A-3a
Gravel and/or Stone Fragments with Sand and Silt	A-2-4 A-2-5
Gravel and/or Stone Fragments with Sand, Silt and Clay	A-2-6 A-2-7
Sandy Silt	A-4a
Silt	A-4b
Elastic Silt and Clay	A-5
Silt and Clay	A-6a
Silty Clay	A-6b
Elastic Clay	A-7-5
Clay	A-7-6
Organic Silt	A-8a
Organic Clay	A-8b

DESCRIPTION	ODOT CLASSIFICATION
Shale	Visual
Weathered Shale	Visual
Sandstone	Visual

GRADATION (%)

GR Gravel
CS Coarse Sand
MS Medium Sand
FS Fine Sand
SI Silt
CL Clay (<5 micron)

SAMPLER SYMBOLS

Shelby Tube

Rock Core

Split Spoon Sample (SS)

* Indicates a Sample Taken Within 3 ft of Proposed Grade

ABBREVIATIONS

LL	LIQUID LIMIT (%)	HP	HAND PENETROMETER
PI	PLASTIC INDEX (%0	PID	PHOTOIONIZATION DETECTOR
WC	MOISTURE CONTENT (%)	UC	UNCONFINED COMPRESSION
SPT	STANDARD PENETRATION TEST	ppm	PARTS PER MILLION
NP	NON PLASTIC	w	WATER FIRST ENCOUNTERED
-200	PERCENT PASSING NO. 200 SIEVE	▼	WATER LEVEL UPON COMPLETION
N_{60}	ADJUSTED SPT RESULT	WOH	WEIGHT OF HAMMER
EOB	END OF BORING		

MATERIAL CLASSIFIED BY VISUAL INSPECTION

Sod and Topsoil
Pavement or Base
Concrete

Uncontrolled Fill (Describe)

Bouldery Zone

Peat, S-Sedimentary W-Woody F-Fibrous L-Loamy & etc

PROJECT: MED-18-12.99	DRILLING FIRM / OPERATOR: BARR / J.HODGES	DRILL RIG: CME 55	STATION / OFFSET: 140+30, 30 RT	EXPLORATION ID B-020-0-14
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: BARR / D.LYON	HAMMER: CME AUTOMATIC	ALIGNMENT: SR-18	
PID: 92953 BR ID: MED-18-1403	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/26/14	ELEVATION: 927.1 (MSL), EOB: 61.5 ft.	PAGE 1 OF 2
START: 7/6/15 END: 7/6/15	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78.8	COORD: 41.137032, -81.822534	

MATERIAL DESCRIPTION AND NOTES	ELEV. 927.1
14", **ASPHALT**	925.9
12", **GRANULAR BASE**	924.9
HARD, GRAYISH BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP **(FILL)**	924.1
HARD, GRAY AND BROWN, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, DAMP TO MOIST **(FILL)** @4.5'; SS-3 TO SS-5 CHANGE TO MEDIUM STIFF TO VERY STIFF	917.6
SOFT, DARK GRAY, **SANDY SILT**, TRACE CLAY, CONTAINS DECAYED VEGETATION, WET	915.1
STIFF TO VERY STIFF, GRAY MOTTLED WITH BROWN, **SILTY CLAY**, LITTLE SAND, MOIST	912.6
VERY SOFT TO SOFT, BLACK MOTTLED WITH BROWN, **SILT AND CLAY**, TRACE SAND, SLIGHTLY ORGANIC, CONTAINS DECAYED VEGETATION, WET	910.1
VERY SOFT TO VERY STIFF, DARK GRAY MOTTLED WITH BROWN, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, CONTAINS DECAYED VEGETATION, WET	905.1
VERY LOOSE, GRAY, **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, MOIST	902.8
MEDIUM STIFF TO VERY STIFF, GRAY TO GRAYISH BROWN, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, CONTAINS FEW SILT LENSES, DAMP TO MOIST	897.6

DEPTHS: 1 – 29 (groundwater W at 11.5'; ▼ at 13.0')

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
6 5 7	16	61	SS-1	4.5+	5	9	17	37	32	31	17	14	14	A-6a (8)
4 3 5	11	72	SS-2	4.5+	1	5	15	43	36	33	19	14	19	A-6a (10)
2 2 2	5	33	SS-3	1.0 - 3.5	-	-	-	-	-	-	-	-	25	A-6a (V)
2 3 2	7	22	SS-4	0.75 - 2.2	-	-	-	-	-	-	-	-	17	A-6a (V)
2 3 3	8	89	SS-5	0.75 - 2.5	-	-	-	-	-	-	-	-	19	A-6a (V)
WOH 1 2	4	100	SS-6	0.25 - 0.5	-	-	-	-	-	-	-	-	27	A-4a (V)
2 1 1	3	100	SS-7	1.0 - 2.5	0	6	12	38	44	33	16	17	22	A-6b (11)
WOH 2 2	5	100	SS-8	0.2 - 0.5	0	0	4	58	38	37	23	14	35	A-6a (10)
WOH 3 3	8	100	SS-9	1.2 - 2.2	1	4	23	44	28	NP	NP	NP	34	A-4a (7)
3 1 4	7	78	SS-10	0.2 - 0.75	-	-	-	-	-	-	-	-	34	A-4a (V)
2 2 2	5	11	SS-11	-	-	-	-	-	-	-	-	-	18	A-1-b (V)
3 2 2	5	83	SS-12	0.5 - 1.9	5	11	19	48	17	20	16	4	17	A-4a (6)
4 5 5	13	94	SS-13	1.0 - 3.0	-	-	-	-	-	-	-	-	16	A-4a (V)

NOTES: GROUNDWATER ENCOUNTERED AT 11.5' DURING DRILLING, 13.0' UPON COMPLETION. CAVE DEPTH 31.7'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED .5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PID: 92953	BR ID: MED-18-1403	PROJECT: MED-18-12.99	STATION / OFFSET: 140+29.75, 30.0 RT	START: 7/6/15	END: 7/6/15	PG 2 OF 2	B-020-0-14

MATERIAL DESCRIPTION AND NOTES	ELEV. 897.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
VERY STIFF TO HARD, GRAYISH BROWN, **SILT AND CLAY**, SOME SAND, TRACE GRAVEL, DAMP *(continued from above)*		31	4 4 6	13	83	SS-14	2.5 - 4.5+	-	-	-	-	-	-	-	-	14	A-6a (V)	
	893.8	32, 33																
LOOSE, GRAY, **GRAVEL WITH SAND**, LITTLE SAND, LITTLE SILT, TRACE CLAY, WET		34, 35, 36	2 2 5	9	56	SS-15	-	21	38	23	14	4	NP	NP	NP	15	A-1-b (0)	
	890.1																	
GRAYISH BROWN, **COARSE AND FINE SAND**, LITTLE SILT, LITTLE GRAVEL, TRACE CLAY	887.1	37, 38, 39																
VERY SOFT TO STIFF, GRAY, **SILT**, "AND" CLAY, TRACE SAND, MOIST TO WET @40.1'; 8' OF HEAVE		40, 41	WOH 1 2	4	100	SS-16	0.2 - 1.0	-	-	-	-	-	-	-	-	25	A-4b (V)	
		42, 43, 44, 45, 46	4 4 6	13	100	SS-17	0.5 - 1.5	0	1	2	51	46	29	19	10	23	A-4b (8)	
		47, 48, 49, 50, 51	1 2 4	8	100	SS-18	0.75 - 1.7	-	-	-	-	-	-	-	-	20	A-4b (V)	
@55.0'; SS-19 BECOMES LOOSE, LITTLE CLAY		52, 53, 54, 55, 56	1 2 3	7	100	SS-19	0.25 - 0.75	0	1	2	82	15	NP	NP	NP	26	A-4b (8)	
	868.8	57, 58																
VERY STIFF TO HARD, GRAYISH BROWN, **SANDY SILT**, LITTLE GRAVEL, LITTLE CLAY, DAMP	865.6	59, 60, 61 EOB	6 10 14	32	111	SS-20	2.0 - 4.5+	-	-	-	-	-	-	-	-	11	A-4a (V)	

NOTES: GROUNDWATER ENCOUNTERED AT 11.5' DURING DRILLING, 13.0' UPON COMPLETION. CAVE DEPTH 31.7'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED .5 BAG ASPHALT PATCH; SHOVELED SOIL CUTTINGS

PROJECT: MED-18-12.99	DRILLING FIRM / OPERATOR: BARR / J.HODGES	DRILL RIG: CME 55	STATION / OFFSET: 141+80, 31 RT
TYPE: BRIDGE	SAMPLING FIRM / LOGGER: BARR / D.LYON	HAMMER: CME AUTOMATIC	ALIGNMENT: SR-18
PID: 92953 BR ID: MED-18-1403	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 1/26/14	ELEVATION: 924.7 (MSL), EOB: 61.5 ft.
START: 7/6/15 END: 7/6/15	SAMPLING METHOD: SPT	ENERGY RATIO (%): 78.8	COORD: 41.136970, -81.821995

EXPLORATION ID B-021-0-14

MATERIAL DESCRIPTION AND NOTES	ELEV. 924.7
12", **ASPHALT**	923.7
9", **GRANULAR BASE**	922.9
MEDIUM DENSE, BROWN, **GRAVEL WITH SAND AND SILT**, LITTLE CLAY, CONTAINS CONCRETE AND BRICK FRAGMENTS, DAMP **(FILL)**	920.2
MEDIUM STIFF TO STIFF, BROWN, GRAY, AND DARK GRAY, **SILT AND CLAY**, SOME SAND, LITTLE TO SOME GRAVEL, CONTAINS CONCRETE, BRICK, AND LIMESTONE FRAGMENTS, DAMP TO MOIST **(FILL)**	912.7
SOFT TO STIFF, GRAY BECOMING DARK GRAY, **SANDY SILT**, LITTLE CLAY, SS-7 CONTAINS FEW SAND LENSES, MOIST @15.0'; SS-8 CONTAINS MANY DECAYED ROOTS @17.0'; SS-9 CONTAINS FEW SAND LENSES	905.2
STIFF TO VERY STIFF, GRAYISH BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, MOIST	902.7
VERY STIFF, GRAYISH BROWN, **SANDY SILT**, "AND" CLAY, TRACE GRAVEL, DAMP	900.2
MEDIUM STIFF TO VERY STIFF, GRAYISH BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST	895.2

DEPTHS: 1–29 ft (water level ▼ at 18 ft; W at 20 ft)

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
5 4 12	21	67	SS-1	-	-	-	-	-	-	-	-	-	14	A-2-4 (V)
5 6 4	13	56	SS-2	-	41	17	13	17	12	22	15	7	9	A-2-4 (0)
2 3 3	8	50	SS-3	1.0 - 2.0	22	14	14	27	23	31	18	13	15	A-6a (4)
2 1 3	5	56	SS-4	0.5 - 1.0	-	-	-	-	-	-	-	-	20	A-6a (V)
WOH 2 3	7	50	SS-5	0.9 - 1.75	-	-	-	-	-	-	-	-	20	A-6a (V)
2 2 4	8	78	SS-6	1.0 - 2.0	-	-	-	-	-	-	-	-	19	A-6a (V)
3 3 3	8	100	SS-7	1.7 - 2.0	0	1	46	37	16	NP	NP	NP	21	A-4a (4)
WOH WOH 2	3	100	SS-8	0.25 - 0.6	-	-	-	-	-	-	-	-	30	A-4a (V)
2 1 2	4	100	SS-9	0.7 - 1.0	-	-	-	-	-	-	-	-	29	A-4a (V)
4 3 5	11	89	SS-10	1.5 - 3.5	3	7	13	39	38	28	16	12	17	A-6a (9)
3 3 5	11	94	SS-11	2.0 - 3.1	2	8	13	41	36	26	16	10	15	A-4a (8)
3 4 7	14	89	SS-12	1.2 - 2.2	1	7	12	37	43	28	17	11	18	A-6a (8)
2 3 5	11	100	SS-13	0.75 - 1.5	-	-	-	-	-	-	-	-	17	A-6a (V)

BACK FILL

NOTES: GROUNDWATER ENCOUNTERED AT 20.0' DURING DRILLING, 18.0' UPON COMPLETION. CAVE DEPTH 39.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SOIL CUTTINGS

PID: 92953 | BR ID: MED-18-1403 | PROJECT: MED-18-12.99 | STATION / OFFSET: 141+79.56, 31.0 RT | START: 7/6/15 | END: 7/6/15 | | B-021-0-14

MATERIAL DESCRIPTION AND NOTES	ELEV. 894.7	DEPTHS
MEDIUM STIFF TO STIFF, GRAYISH BROWN, **SILTY CLAY**, TRACE SAND, WET *(continued from above)*	892.7	31–32
MEDIUM DENSE, GRAY, **COARSE AND FINE SAND**, LITTLE GRAVEL, LITTLE SILT, TRACE CLAY, WET	886.7	32–38
MEDIUM STIFF TO HARD, GRAYISH BROWN, **SANDY SILT**, SOME TO "AND" CLAY, TRACE GRAVEL, DAMP TO MOIST	866.4	38–58
DENSE, GRAY AND BROWN, **GRAVEL WITH SAND**, TRACE SILT, TRACE CLAY, WET	863.2	58–61 (EOB)

SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GR	CS	FS	SI	CL	LL	PL	PI	WC	ODOT CLASS (GI)
3 5 5	13	100	SS-14	0.9 - 1.25	-	-	-	-	-	-	-	-	32	A-6b (V)
7 8 8	21	100	SS-15	-	14	33	34	14	5	NP	NP	NP	14	A-3a (0)
4 3 7	13	100	SS-16	-	-	-	-	-	-	-	-	-	17	A-3a (V)
9 3 4	9	39	SS-17	1.2 - 2.25	1	5	4	46	44	29	20	9	21	A-4a (8)
3 4 5	12	100	SS-18	0.5 - 1.75	-	-	-	-	-	-	-	-	26	A-4a (V)
5 7 12	25	100	SS-19	3.0 - 4.5+	10	9	17	43	21	20	15	5	12	A-4a (6)
7 12 13	33	100	SS-20	2.2 - 4.5	-	-	-	-	-	-	-	-	12	A-4a (V)
20 17 12	38	100	SS-21	-	32	28	18	16	6	NP	NP	NP	12	A-1-b (0)

BACK FILL

NOTES: GROUNDWATER ENCOUNTERED AT 20.0' DURING DRILLING, 18.0' UPON COMPLETION. CAVE DEPTH 39.0'.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; SOIL CUTTINGS

B-001-P-99

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory
LOG OF BORING

Date Started 8/9/99 Sampler: Type SS Dia. 2.0" Water Elev. 913.0ft Project: Replacement of Bridge No. MED-18-1403
Date Completed 8/11/99 Casing: Length Dia. 3.25" Project No.: 99081
Location: Medina County, Ohio
Boring No. B-1 Station & Offset 740+50, 11.6' Rt. Surface Elev. 926.5ft

Elev. (ft)	Depth (ft)	Std. Pen./RQD	Rec. (ft)	Loss (ft)	Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
926.5	0														
925.9					ASPHALT										
925.5					RED BRICK										
924.7					CONCRETE SLAB										
					Stiff to soft, brown SANDY SILT, some clay, trace gravel, trace rock fragments, moist (fill).										
		1 - 4 - 7				1	--	--	--	--	--	--	--	17	VISUAL
		1 - 2 - 2				2	--	--	--	--	--	--	--	25	VISUAL
		1 - 2 - 2			Note: Trace organics from 16.0 to 20.0 feet.	3	--	--	--	--	--	--	--	35	VISUAL
		WOH - 2 - 2				4	--	--	--	--	--	--	--	32	VISUAL
906.0		1 - 3 - 6			Loose, brown GRAVEL AND ROCK FRAGMENTS WITH SAND AND SILT, trace clay, wet.	5	41	13	15	--	31 *	--	--	14	A-2-4
904.5		1 - 4 - 6			Stiff, brown SANDY SILT, some clay, trace gravel, trace rock fragments, moist.	6	3	6	9	46	36	--	--	20	A-4a
902.5		3 - 10 - 10			Medium dense, brown GRAVEL AND ROCK FRAGMENTS WITH SAND AND SILT, trace clay, wet.	7	35	18	12	--	35 *	--	--	19	A-2-4
900.5					Very stiff, gray SILT AND CLAY, little to trace sand, trace rock fragments, moist.										
		5 - 9 - 11				8	--	--	--	--	--	--	--	16	VISUAL
		6 - 10 - 12				9	--	--	--	--	--	--	--	18	VISUAL
		7 - 7 - 11				10	--	--	--	--	--	--	--	22	VISUAL
891.5					Note: Heaving sand and gravel at approximately 36.0 feet. Sand raised 2.5 feet in augers. No spoon recovery at 36.0 feet.										
890.5		7 - 8 - 12			Medium dense, light gray GRAVEL AND ROCK FRAGMENTS WITH SAND, trace silt, wet.	11	--	--	--	--	--	--	--	--	VISUAL
887.5		7 - 5 - 5			Stiff, gray SILT, "and" clay, trace sand, moist.	12	--	--	--	--	--	--	--	15	VISUAL
		3 - 5 - 5				13	--	--	--	--	--	--	--	24	VISUAL
		2 - 4 - 5				14	--	--	--	--	--	--	--	26	VISUAL
873.0		5 - 6 - 7			Stiff to hard, gray SANDY SILT, some clay, trace to little gravel and rock fragments, moist	15	--	--	--	--	--	--	--	17	VISUAL
		7 - 10 - 11				16	--	--	--	--	--	--	--	10	VISUAL
		12 - 19 - 25				17	--	--	--	--	--	--	--	10	VISUAL
858.0		15 - 15 - 15			Very stiff to hard, gray SILT AND CLAY, little sand, trace gravel trace rock fragments, wet.	18	--	--	--	--	--	--	--	16	VISUAL
		12 - 16 - 21				19	--	--	--	--	--	--	--	15	VISUAL
849.5					Note: Heaving sand and gravel at approximately 79.0 feet. Sand raised 7.0 feet in augers.										
847.3		14 - 17 - 22			Dense, gray COARSE AND FINE SAND, little silt, trace clay, wet.	20	--	--	--	--	--	--	--	14	VISUAL
		15 - 18 - 21				21	--	--	--	--	--	--	--	13	VISUAL
		14 - 17 - 25				22	--	--	--	--	--	--	--	11	VISUAL
836.5	90				TERMINATION DEPTH = 90.0 FEET										

Particle Sizes: Agg => 2.00mm, Coarse Sand = 2.00-0.42mm, Fine Sand = 0.42-0.074mm, Silt = 0.074-0.005mm, Clay =< 0.005mm. * Indicates Silt and Clay Combined

B-002-P-99

State of Ohio
Department of Transportation
Division of Highways
Testing Laboratory
LOG OF BORING

Date Started 8/5/99 Sampler: Type SS Dia. 2.0" Water Elev. 907.5ft
Date Completed 8/9/99 Casing: Length Dia. 3.25"

Project: Replacement of Bridge No. MED-18-1403
Project No.: 99081
Location: Medina County, Ohio

Boring No. B-2 Station & Offset 741+85, 15.0' Lt. Surface Elev. 925.0ft

Elev. (ft)	Depth (ft)	Std. Pen./RQD	Rec. (ft)	Loss (ft)	Description	Sample No.	% Agg	% C.S.	% F.S.	% Silt	% Clay	L.L.	P.I.	W.C.	ODOT Class
925.0	0														
924.5					ASPHALT										
924.1					RED BRICK										
923.0					CONCRETE SLAB										
					Soft, brown and gray SANDY SILT, some clay, trace gravel, trace rock fragments, moist (fill).										
		1 - 2 - 2				1	--	--	--	--	--	--	--	20	VISUAL
		1 - 1 - 2				2	--	--	--	--	--	--	--	21	VISUAL
		2 - 2 - 2				3	--	--	--	--	--	--	--	23	VISUAL
908.0					Stiff, brown to gray SILT AND CLAY, little to trace sand, trace rock fragments, moist.										
		1 - 5 - 7				4	6	5	10	--	79 *	28	11	16	A-6a
		2 - 4 - 7				5	--	--	--	--	--	--	--	19	VISUAL
		2 - 5 - 7				6	--	--	--	--	--	--	--	19	VISUAL
		3 - 5 - 7				7	--	--	--	--	--	--	--	20	VISUAL
		3 - 5 - 7			Note: Heaving sand and gravel at approximately 33.5 feet. Sand raised 3.5 feet in augers.	8	--	--	--	--	--	--	--	30	VISUAL
891.5		3 - 4 - 7			Medium dense, light gray GRAVEL AND ROCK FRAGMENTS WITH SAND, trace silt, wet	9	5	50	42	--	4 *	--	--	23	A-1-b
890.0		3 - 5 - 7				10	--	--	--	--	--	--	--	19	VISUAL
886.5		7 - 8 - 15			Stiff to very stiff, gray SILT, "and" clay, trace sand, moist.	11	--	--	--	--	--	--	--	20	VISUAL
		4 - 4 - 5				12	--	--	--	--	--	--	--	26	VISUAL
		5 - 8 - 9				13	--	--	--	--	--	--	--	25	VISUAL
871.5		5 - 10 - 13			Very stiff, gray SANDY SILT, some clay, trace gravel, trace rock fragments, moist.	14	--	--	--	--	--	--	--	14	VISUAL
		6 - 12 - 16				15	--	--	--	--	--	--	--	13	VISUAL
		7 - 10 - 12				16	--	--	--	--	--	--	--	18	VISUAL
856.5		5 - 7 - 8			Stiff to very stiff, gray SILT AND CLAY, trace sand, moist.	17	--	--	--	--	--	--	--	27	VISUAL
		8 - 9 - 8				18	--	--	--	--	--	--	--	25	VISUAL
848.0															
846.5		6 - 7 - 8			Stiff to very stiff, gray SANDY SILT, "and" clay, moist	19	--	--	--	--	--	--	--	25	VISUAL
		8 - 9 - 8				20	0	0	1	45	54	28	9	24	A-4a
		3 - 7 - 8				21	--	--	--	--	--	--	--	23	VISUAL
835.0	90				TERMINATION DEPTH = 90.0 FEET										

Particle Sizes: Agg => 2.00mm, Coarse Sand = 2.00-0.42mm, Fine Sand = 0.42-0.074mm, Silt = 0.074-0.005mm, Clay =< 0.005mm. * Indicates Silt and Clay Combined

4/4 MED-18-14.00

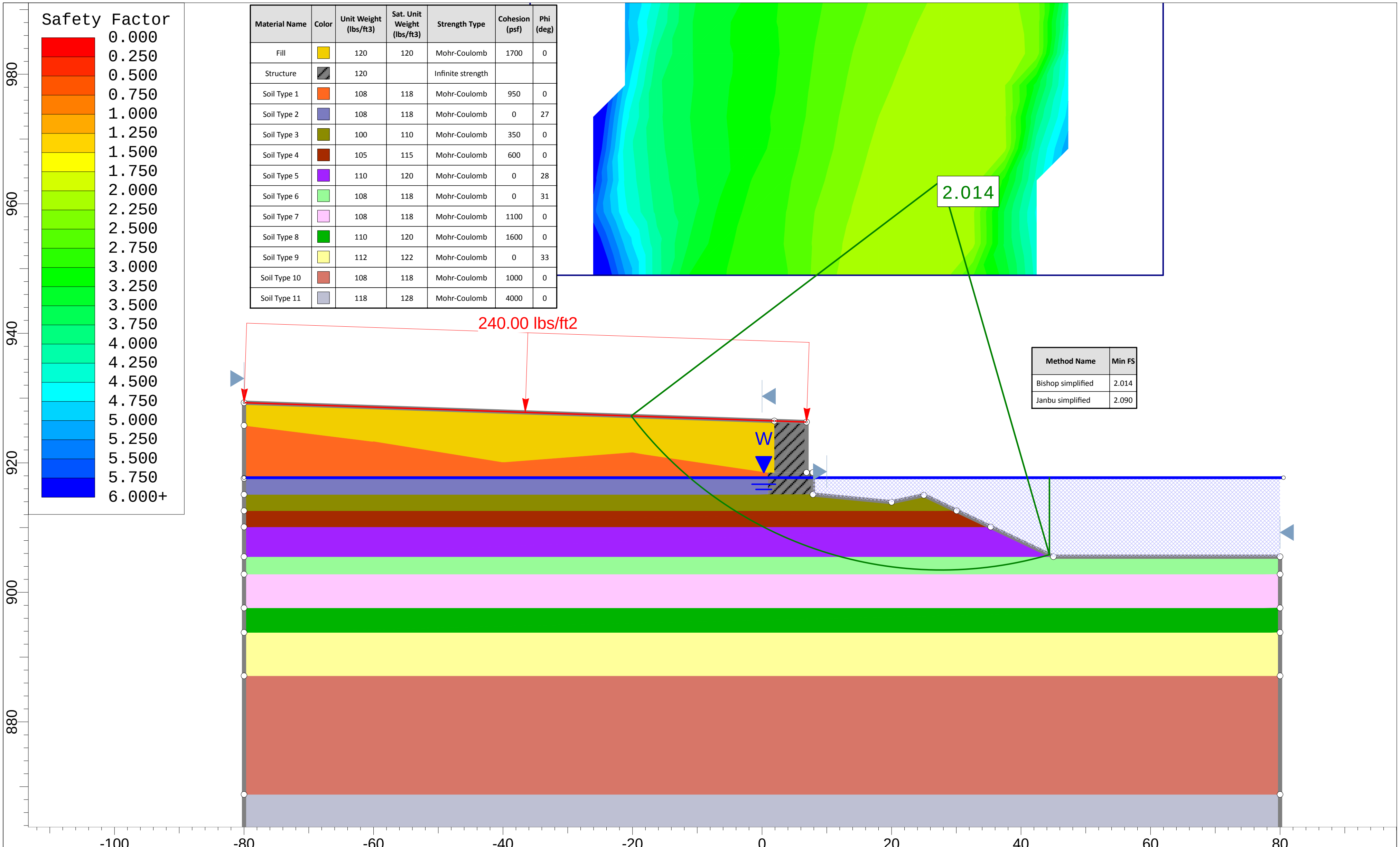
STRUCTURE FOUNDATION INVESTIGATION
BRIDGE NO. MED-18-1403 OVER WEST BRANCH OF ROCKY RIVER

DRAWN BM REVIEWED SS DATE 12/22/00 CALCULATED WIN CHECKED SSS

PRIME ENGINEERING & ARCHITECTURE, INC. COLUMBUS: (614) 457-2100 AKRON: (330) 666-5432

APPENDIX C

GLOBAL STABILITY ANALYSIS

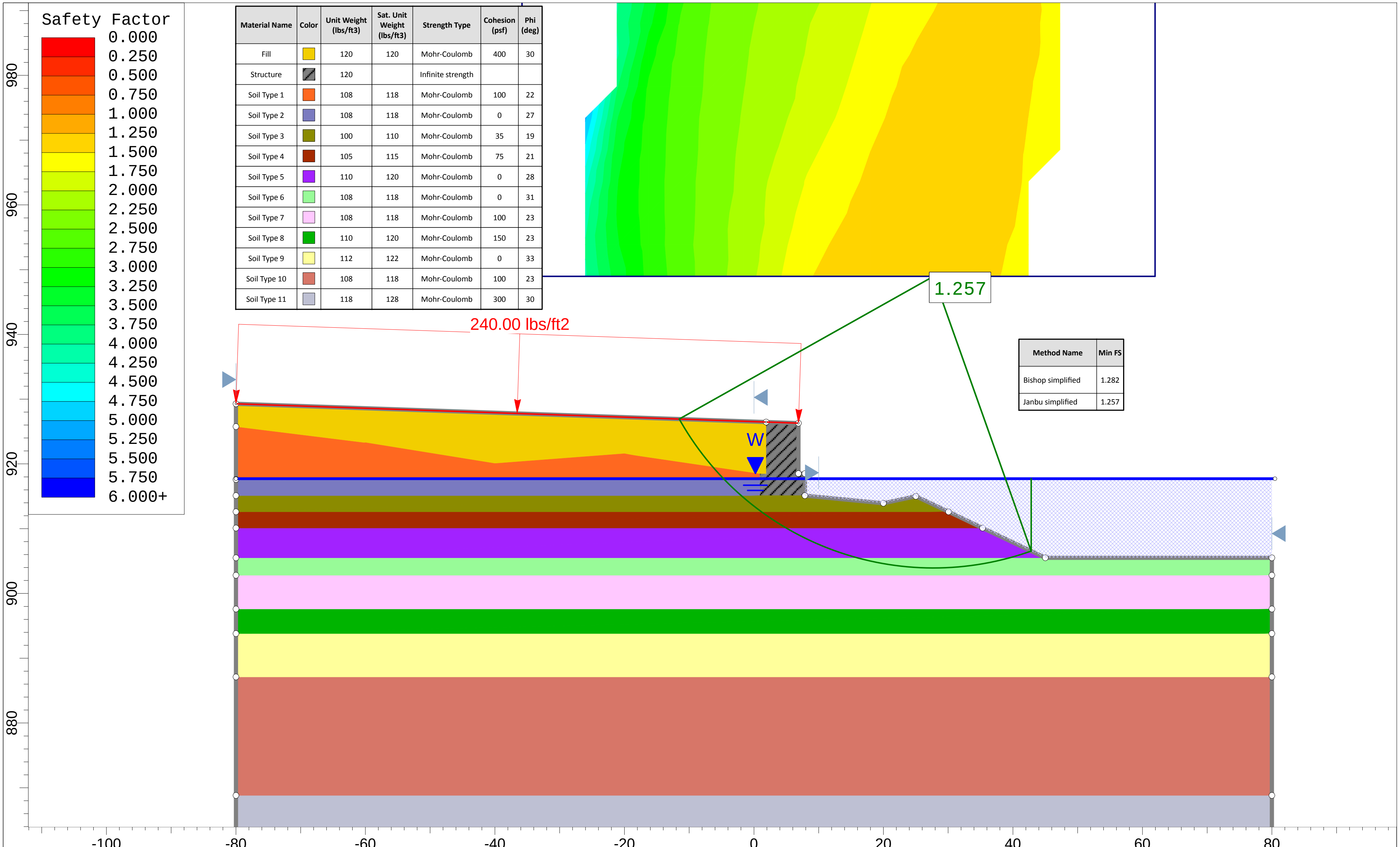


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		120	120	Mohr-Coulomb	1700	0
Structure		120		Infinite strength		
Soil Type 1		108	118	Mohr-Coulomb	950	0
Soil Type 2		108	118	Mohr-Coulomb	0	27
Soil Type 3		100	110	Mohr-Coulomb	350	0
Soil Type 4		105	115	Mohr-Coulomb	600	0
Soil Type 5		110	120	Mohr-Coulomb	0	28
Soil Type 6		108	118	Mohr-Coulomb	0	31
Soil Type 7		108	118	Mohr-Coulomb	1100	0
Soil Type 8		110	120	Mohr-Coulomb	1600	0
Soil Type 9		112	122	Mohr-Coulomb	0	33
Soil Type 10		108	118	Mohr-Coulomb	1000	0
Soil Type 11		118	128	Mohr-Coulomb	4000	0

Method Name	Min FS
Bishop simplified	2.014
Janbu simplified	2.090

SLIDEINTERPRET 7.022

Project	MED-18-12.99 Multipath Bridge		
Analysis Description	Rear Abutment-Total-Circular-B-020		
Drawn By	ZM	*Scale* 1:246	*Company*
Date	3/30/2017, 9:56:22 AM	*File Name*	MED-18-MultiPathBridge-RearAbut-Total-B-020-Terrain.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		120	120	Mohr-Coulomb	400	30
Structure		120		Infinite strength		
Soil Type 1		108	118	Mohr-Coulomb	100	22
Soil Type 2		108	118	Mohr-Coulomb	0	27
Soil Type 3		100	110	Mohr-Coulomb	35	19
Soil Type 4		105	115	Mohr-Coulomb	75	21
Soil Type 5		110	120	Mohr-Coulomb	0	28
Soil Type 6		108	118	Mohr-Coulomb	0	31
Soil Type 7		108	118	Mohr-Coulomb	100	23
Soil Type 8		110	120	Mohr-Coulomb	150	23
Soil Type 9		112	122	Mohr-Coulomb	0	33
Soil Type 10		108	118	Mohr-Coulomb	100	23
Soil Type 11		118	128	Mohr-Coulomb	300	30

Method Name	Min FS
Bishop simplified	1.282
Janbu simplified	1.257

rocscience

SLIDEINTERPRET 7.022

Project	MED-18-12.99 Multipath Bridge
Analysis Description	Rear Abutment-Effective-Circular-B-020
Drawn By	ZM
Scale	1:246
Company	
Date	3/30/2017, 9:56:22 AM
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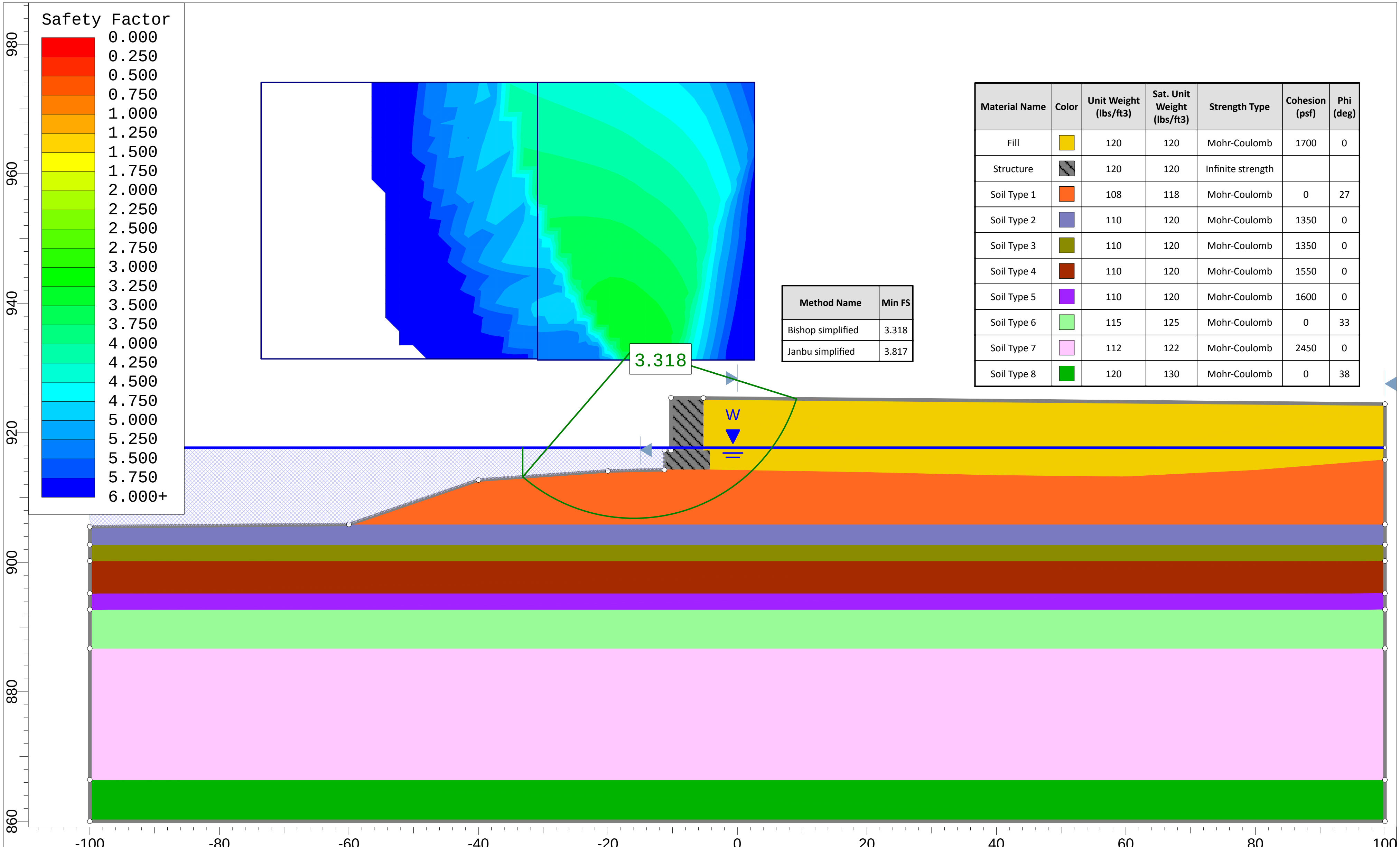

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		120	120	Mohr-Coulomb	1700	0
Structure		120	120	Infinite strength		
Soil Type 1		108	118	Mohr-Coulomb	0	27
Soil Type 2		110	120	Mohr-Coulomb	1350	0
Soil Type 3		110	120	Mohr-Coulomb	1350	0
Soil Type 4		110	120	Mohr-Coulomb	1550	0
Soil Type 5		110	120	Mohr-Coulomb	1600	0
Soil Type 6		115	125	Mohr-Coulomb	0	33
Soil Type 7		112	122	Mohr-Coulomb	2450	0
Soil Type 8		120	130	Mohr-Coulomb	0	38

Method Name	Min FS
Bishop simplified	3.318
Janbu simplified	3.817

rocscience

SLIDEINTERPRET 7.022

Project	MED-18-12.99 Multipath Bridge
Analysis Description	Forward Abutment-Total-Circular
Drawn By	ZM
Scale	1:246
Company	
Date	3/31/2017, 9:56:22 AM
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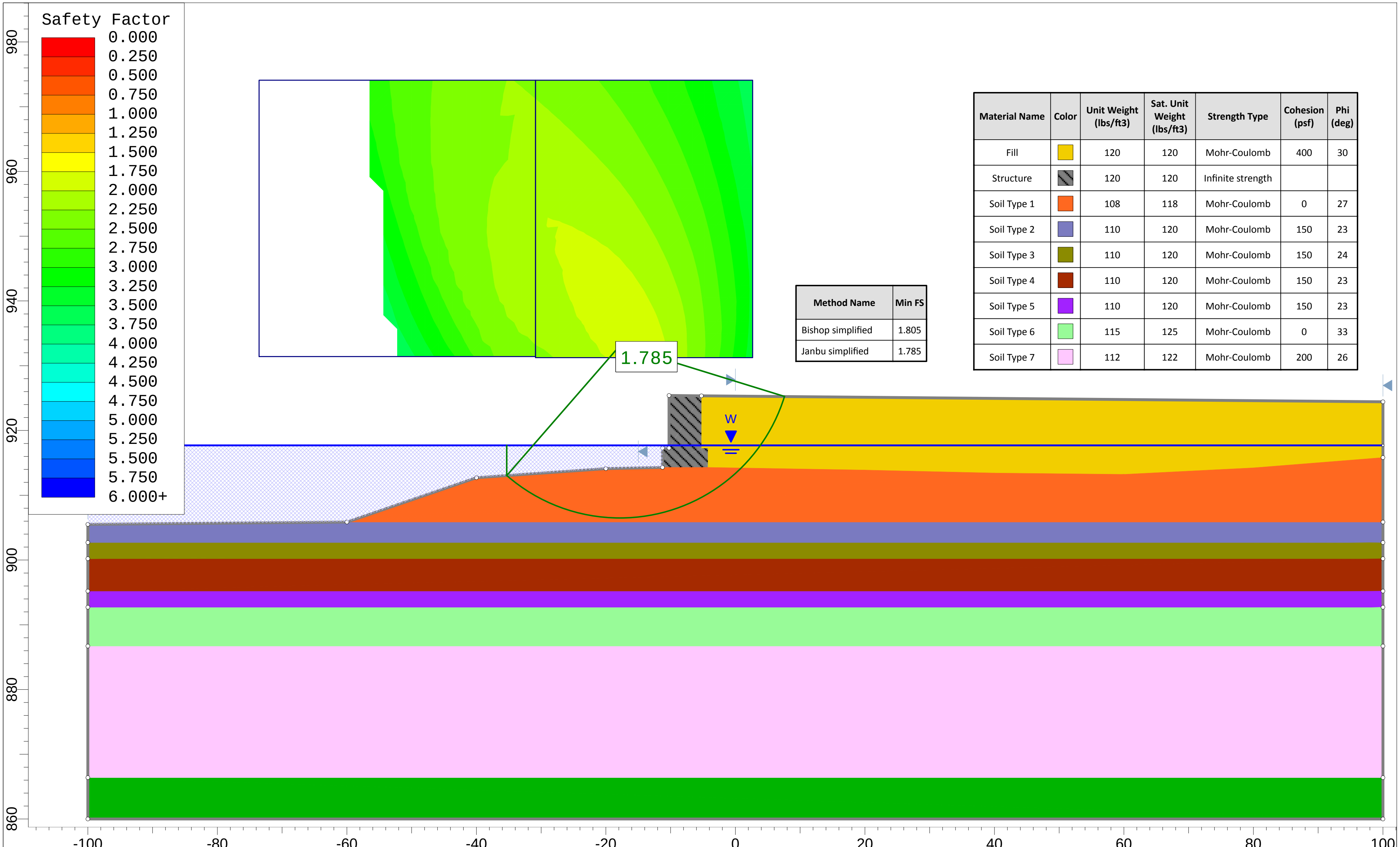

Method Name	Min FS
Bishop simplified	1.805
Janbu simplified	1.785

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		120	120	Mohr-Coulomb	400	30
Structure		120	120	Infinite strength		
Soil Type 1		108	118	Mohr-Coulomb	0	27
Soil Type 2		110	120	Mohr-Coulomb	150	23
Soil Type 3		110	120	Mohr-Coulomb	150	24
Soil Type 4		110	120	Mohr-Coulomb	150	23
Soil Type 5		110	120	Mohr-Coulomb	150	23
Soil Type 6		115	125	Mohr-Coulomb	0	33
Soil Type 7		112	122	Mohr-Coulomb	200	26

rocscience

SLIDEINTERPRET 7.022

Project	MED-18-12.99 Multipath Bridge
Analysis Description	Forward Abutment-Effective-Circular
Drawn By	ZM
Scale	1:246
Company	
Date	3/23/2017, 9:56:22 AM
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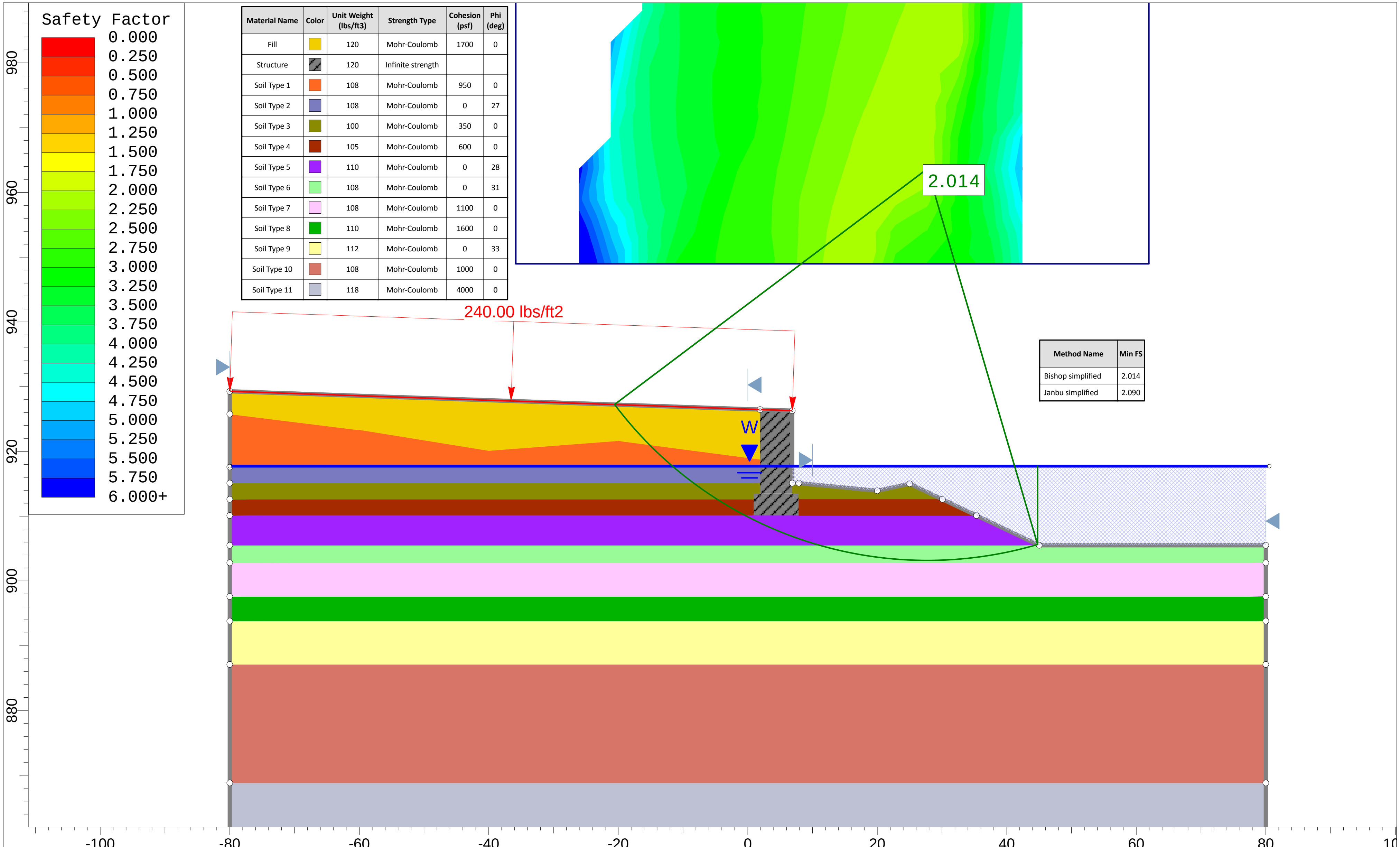
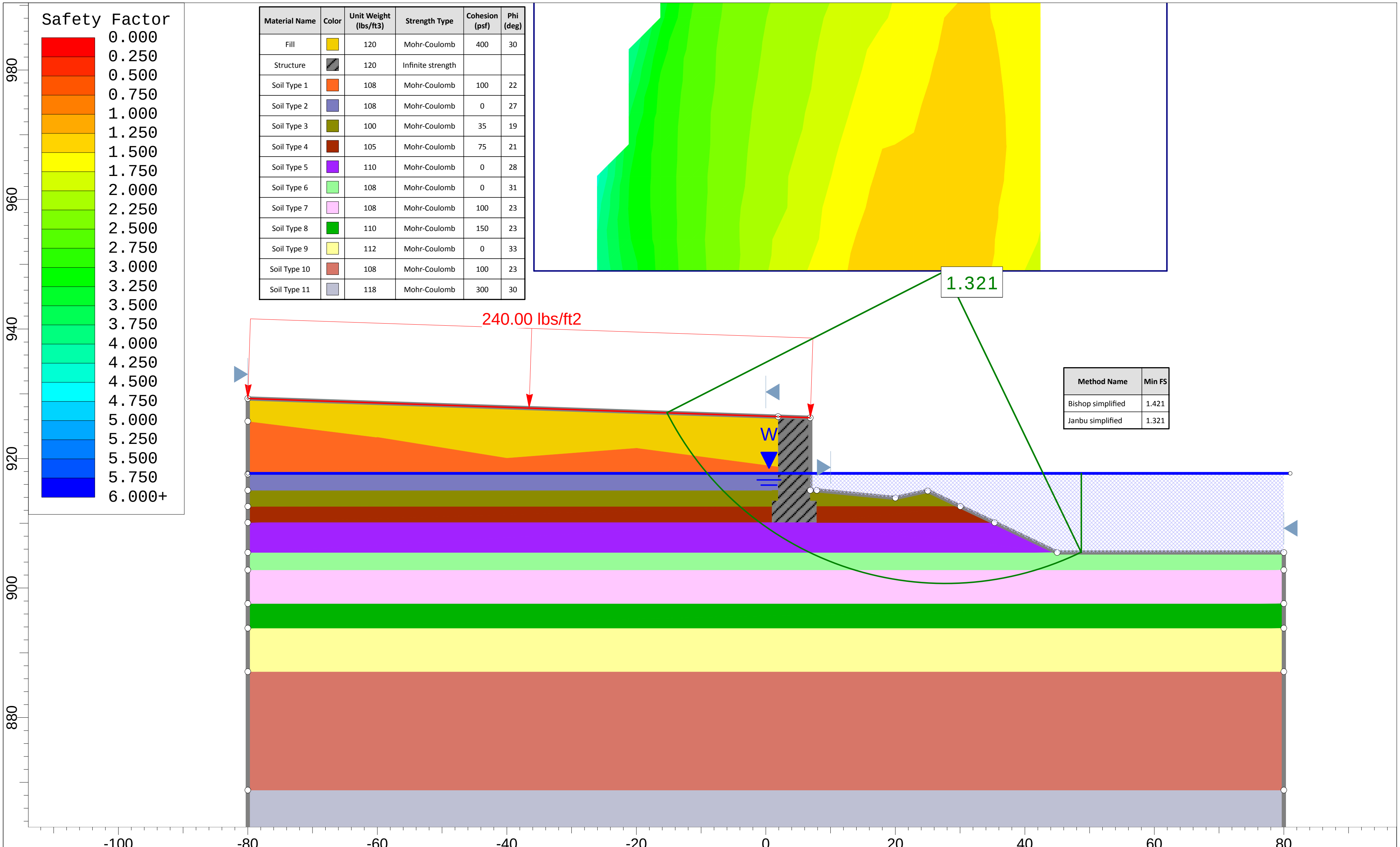


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		120	Mohr-Coulomb	1700	0
Structure		120	Infinite strength		
Soil Type 1		108	Mohr-Coulomb	950	0
Soil Type 2		108	Mohr-Coulomb	0	27
Soil Type 3		100	Mohr-Coulomb	350	0
Soil Type 4		105	Mohr-Coulomb	600	0
Soil Type 5		110	Mohr-Coulomb	0	28
Soil Type 6		108	Mohr-Coulomb	0	31
Soil Type 7		108	Mohr-Coulomb	1100	0
Soil Type 8		110	Mohr-Coulomb	1600	0
Soil Type 9		112	Mohr-Coulomb	0	33
Soil Type 10		108	Mohr-Coulomb	1000	0
Soil Type 11		118	Mohr-Coulomb	4000	0

Method Name	Min FS
Bishop simplified	2.014
Janbu simplified	2.090

Project	MED-18-12.99 Multipath Bridge
Analysis Description	Rear Abutment-Total-Circular-B-020
Drawn By	ZM
Scale	1:246
Company	
Date	4/06/2017, 9:56:22 AM
File Name	ED-18-MultiPathBridge-RearAbut-Total-B-020-Terrain-LengthenAbut.sli

SLIDEINTERPRET 7.022



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		120	Mohr-Coulomb	400	30
Structure		120	Infinite strength		
Soil Type 1		108	Mohr-Coulomb	100	22
Soil Type 2		108	Mohr-Coulomb	0	27
Soil Type 3		100	Mohr-Coulomb	35	19
Soil Type 4		105	Mohr-Coulomb	75	21
Soil Type 5		110	Mohr-Coulomb	0	28
Soil Type 6		108	Mohr-Coulomb	0	31
Soil Type 7		108	Mohr-Coulomb	100	23
Soil Type 8		110	Mohr-Coulomb	150	23
Soil Type 9		112	Mohr-Coulomb	0	33
Soil Type 10		108	Mohr-Coulomb	100	23
Soil Type 11		118	Mohr-Coulomb	300	30

Method Name	Min FS
Bishop simplified	1.421
Janbu simplified	1.321

SLIDEINTERPRET 7.022

Project	MED-18-12.99 Multipath Bridge		
Analysis Description	Rear Abutment-Effective-Circular-B-020		
Drawn By ZM	*Scale* 1:246	*Company*	
Date 4/06/2017, 9:56:22 AM	*File Name* 5-18-MultiPathBridge-RearAbut-Effective-B-020-Terrain-LengthenAbut.s		

APPENDIX D

SETTLEMENT ANALYSIS

MED-18-12.99

PROJECT IDENTIFICATION

Title: MED-18-12.99
Project Number: -
Client: GPD Group
Designer: ZM
Station Number:

Description:
Rear Abutment B-020

Company's information:

Name: NEAS, Inc.
Street: 2800 Corporate Exchange Drive
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Original file path and name: F:\MED\929 ..... ysis_bridge\Fossa\MED-18-B-020_Addbottomelayer.2ST
Original date and time of creating this file: March 28, 2017

GEOMETRY: Analysis of a 3D-Approximate geometry

INPUT DATA -- FOUNDATION LAYERS -- 12 layers

	Wet Unit Weight, γ [lb/ft³]	Poisson's Ratio μ	Description of Soil
1	118.00	0.40	SILT AND CLAY, A-6a
2	118.00	0.30	Soft, SANDY SILT, A-4a
3	110.00	0.40	Stiff to verys stiff, Silty Clay, A-6b
4	115.00	0.40	Very soft wo soft, SILT AND CLAY, A-6a
5	120.00	0.30	Very soft to very stiff, SANDY SILT, A-4a
6	118.00	0.25	Very loose, Gravel and Sand, A-1-b
7	118.00	0.30	Medium stiff to very stiff, SANDY SILT, A-4a
8	120.00	0.40	Very stiff to hard, SILT AND CLAY, A-6a
9	122.00	0.30	Loose, GRAVEL WITH SAND, A-1-b
10	118.00	0.30	Very soft to stiff, SILT AND CLAY, A-4b
11	128.00	0.30	Very stiff to hard, SANDY SILT, A-4a
12	130.00	0.30	Granular Soil

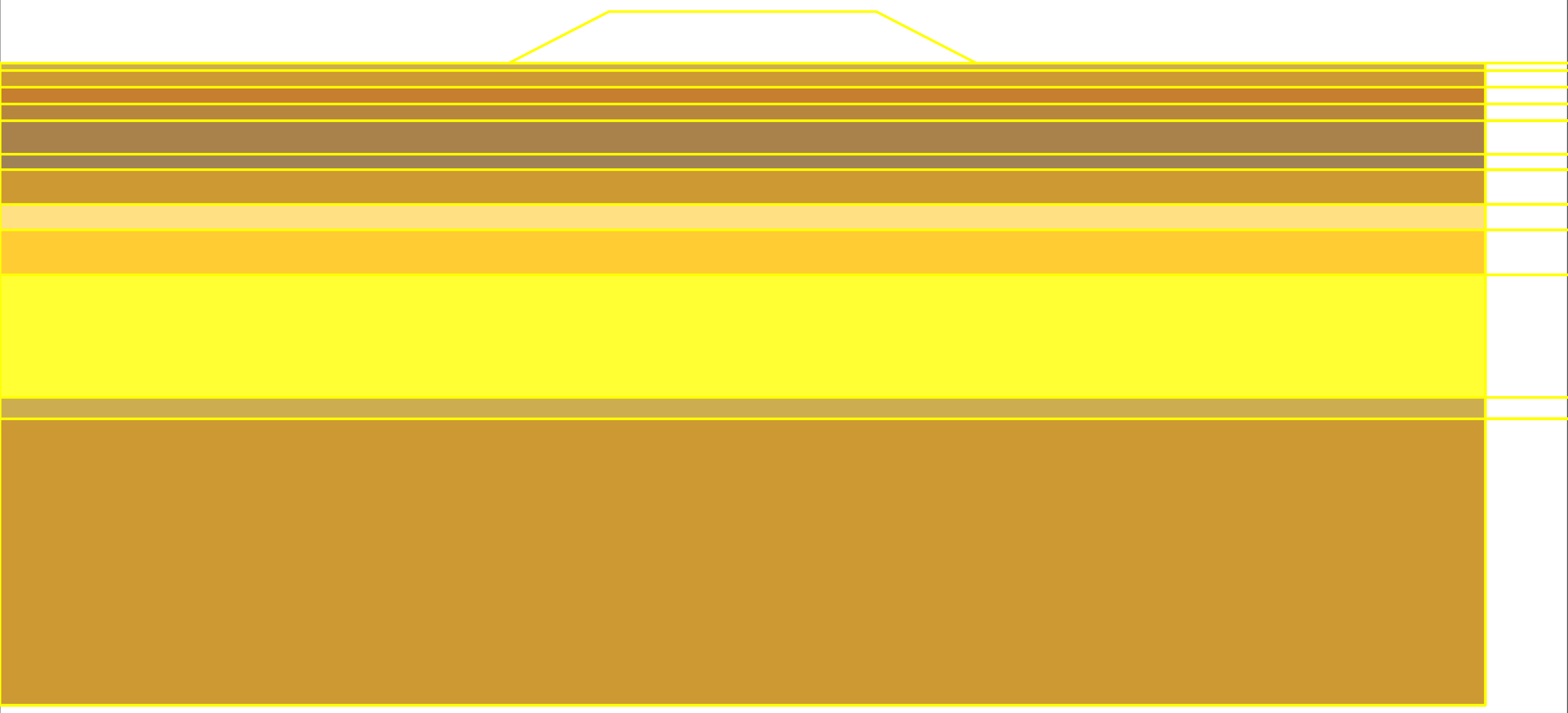
INPUT DATA -- EMBANKMENT LAYERS -- 1 layers

	Wet Unit Weight, γ [lb/ft³]	Description of Soil
1	120.00	

INPUT DATA OF WATER

Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]
1	0.00	906.00
2	200.00	906.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION -- $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc	Cr	e0	Cv [ft ²/day]	Drains at :
1	Yes	111.00	0.10	0.01	0.52	0.2000	Top & Bot.
2	No	N/A	N/A	N/A	N/A	N/A	N/A
3	Yes	7.00	0.10	0.01	0.63	0.2000	Top & Bot.
4	Yes	7.40	0.12	0.01	0.71	0.2000	Top & Bot.
5	No	N/A	N/A	N/A	N/A	N/A	N/A
6	No	N/A	N/A	N/A	N/A	N/A	N/A
7	Yes	3.30	0.12	0.01	0.65	0.2000	Top & Bot.
8	Yes	5.20	0.14	0.02	0.65	0.2000	Top & Bot.
9	No	N/A	N/A	N/A	N/A	N/A	N/A
10	Yes	3.60	0.15	0.02	0.70	0.2000	Top & Bot.
11	Yes	3.70	0.14	0.02	0.63	0.2800	Top
12	No	N/A	N/A	N/A	N/A	N/A	N/A

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	-35.00	0.00	1	289120	0.4000	-0.0000	918.70	918.61	0.09
			2	37980	0.3000	-0.0011			
			3	91560	0.4000	-0.0016			
			4	174750	0.4000	-0.0006			
			5	59830	0.3000	0.0052			
			6	94350	0.2500	0.0035			
			7	72580	0.3000	0.0099			
			8	432800	0.4000	0.0011			
			9	152930	0.3000	0.0090			
			10	64500	0.3000	0.0664			
			11	258000	0.3000	0.0031			
			12	9999999999	0.3000	0.0000			
2	-28.00	0.00	1	289120	0.4000	0.0007	918.70	918.51	0.19
			2	37980	0.3000	0.0170			
			3	91560	0.4000	0.0046			
			4	174750	0.4000	0.0026			
			5	59830	0.3000	0.0243			
			6	94350	0.2500	0.0091			
			7	72580	0.3000	0.0222			
			8	432800	0.4000	0.0023			
			9	152930	0.3000	0.0145			
			10	64500	0.3000	0.0908			
			11	258000	0.3000	0.0039			
			12	9999999999	0.3000	0.0000			
3	-21.00	0.00	1	289120	0.4000	0.0014	918.70	918.41	0.29
			2	37980	0.3000	0.0361			
			3	91560	0.4000	0.0114			
			4	174750	0.4000	0.0060			
			5	59830	0.3000	0.0446			
			6	94350	0.2500	0.0148			
			7	72580	0.3000	0.0349			
			8	432800	0.4000	0.0036			
			9	152930	0.3000	0.0201			
			10	64500	0.3000	0.1147			
			11	258000	0.3000	0.0046			
			12	9999999999	0.3000	0.0000			
4	-14.00	0.00	1	289120	0.4000	0.0015	918.70	918.36	0.34
			2	37980	0.3000	0.0379			
			3	91560	0.4000	0.0123			
			4	174750	0.4000	0.0069			
			5	59830	0.3000	0.0540			
			6	94350	0.2500	0.0182			
			7	72580	0.3000	0.0433			
			8	432800	0.4000	0.0046			
			9	152930	0.3000	0.0245			
			10	64500	0.3000	0.1343			
			11	258000	0.3000	0.0052			
			12	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
5	-7.00	0.00	1	289120	0.4000	0.0015	918.70	918.34	0.36
			2	37980	0.3000	0.0372			
			3	91560	0.4000	0.0117			
			4	174750	0.4000	0.0067			
			5	59830	0.3000	0.0559			
			6	94350	0.2500	0.0195			
			7	72580	0.3000	0.0471			
			8	432800	0.4000	0.0051			
			9	152930	0.3000	0.0271			
			10	64500	0.3000	0.1469			
			11	258000	0.3000	0.0056			
			12	9999999999	0.3000	0.0000			
6	0.00	0.00	1	289120	0.4000	0.0015	918.70	918.33	0.37
			2	37980	0.3000	0.0370			
			3	91560	0.4000	0.0115			
			4	174750	0.4000	0.0066			
			5	59830	0.3000	0.0561			
			6	94350	0.2500	0.0197			
			7	72580	0.3000	0.0481			
			8	432800	0.4000	0.0052			
			9	152930	0.3000	0.0280			
			10	64500	0.3000	0.1514			
			11	258000	0.3000	0.0058			
			12	9999999999	0.3000	0.0000			
7	7.00	0.00	1	289120	0.4000	0.0015	918.70	918.34	0.36
			2	37980	0.3000	0.0372			
			3	91560	0.4000	0.0117			
			4	174750	0.4000	0.0067			
			5	59830	0.3000	0.0559			
			6	94350	0.2500	0.0195			
			7	72580	0.3000	0.0471			
			8	432800	0.4000	0.0051			
			9	152930	0.3000	0.0272			
			10	64500	0.3000	0.1475			
			11	258000	0.3000	0.0057			
			12	9999999999	0.3000	0.0000			
8	14.00	0.00	1	289120	0.4000	0.0015	918.70	918.36	0.34
			2	37980	0.3000	0.0379			
			3	91560	0.4000	0.0123			
			4	174750	0.4000	0.0069			
			5	59830	0.3000	0.0540			
			6	94350	0.2500	0.0183			
			7	72580	0.3000	0.0434			
			8	432800	0.4000	0.0046			
			9	152930	0.3000	0.0246			
			10	64500	0.3000	0.1353			
			11	258000	0.3000	0.0053			
			12	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
9	21.00	0.00	1	289120	0.4000	0.0014	918.70	918.41	0.29
			2	37980	0.3000	0.0360			
			3	91560	0.4000	0.0114			
			4	174750	0.4000	0.0060			
			5	59830	0.3000	0.0446			
			6	94350	0.2500	0.0148			
			7	72580	0.3000	0.0350			
			8	432800	0.4000	0.0036			
			9	152930	0.3000	0.0203			
			10	64500	0.3000	0.1160			
			11	258000	0.3000	0.0047			
			12	9999999999	0.3000	0.0000			
10	28.00	0.00	1	289120	0.4000	0.0007	918.70	918.51	0.19
			2	37980	0.3000	0.0170			
			3	91560	0.4000	0.0046			
			4	174750	0.4000	0.0026			
			5	59830	0.3000	0.0243			
			6	94350	0.2500	0.0091			
			7	72580	0.3000	0.0223			
			8	432800	0.4000	0.0024			
			9	152930	0.3000	0.0147			
			10	64500	0.3000	0.0923			
			11	258000	0.3000	0.0039			
			12	9999999999	0.3000	0.0000			
11	35.00	0.00	1	289120	0.4000	-0.0000	918.70	918.60	0.10
			2	37980	0.3000	-0.0012			
			3	91560	0.4000	-0.0016			
			4	174750	0.4000	-0.0006			
			5	59830	0.3000	0.0052			
			6	94350	0.2500	0.0036			
			7	72580	0.3000	0.0100			
			8	432800	0.4000	0.0011			
			9	152930	0.3000	0.0091			
			10	64500	0.3000	0.0680			
			11	258000	0.3000	0.0032			
			12	9999999999	0.3000	0.0000			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	-35.00	0.00	918.70	0.02	918.68
2	-28.00	0.00	918.70	0.03	918.67
3	-21.00	0.00	918.70	0.04	918.66
4	-14.00	0.00	918.70	0.05	918.65
5	-7.00	0.00	918.70	0.05	918.65
6	0.00	0.00	918.70	0.05	918.65
7	7.00	0.00	918.70	0.05	918.65
8	14.00	0.00	918.70	0.05	918.65
9	21.00	0.00	918.70	0.04	918.66
10	28.00	0.00	918.70	0.03	918.67
11	35.00	0.00	918.70	0.02	918.68

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	0.00	918.70	SILT AND CLAY, A-6a
	2	200.00	918.70	
2	1	0.00	917.60	Soft, SANDY SILT, A-4a
	2	200.00	917.60	
3	1	0.00	915.10	Stiff to verys stiff, Silty Clay, A-6b
	2	200.00	915.10	
4	1	0.00	912.60	Very soft wo soft, SILT AND CLAY, A-6a
	2	200.00	912.60	
5	1	0.00	910.10	Very soft to very stiff, SANDY SILT, A-4a
	2	200.00	910.10	
6	1	0.00	905.10	Very loose, Gravel and Sand, A-1-b
	2	200.00	905.10	
7	1	0.00	902.80	Medium stiff to very stiff, SANDY SILT, A-4a
	2	200.00	902.80	
8	1	0.00	897.60	Very stiff to hard, SILT AND CLAY, A-6a
	2	200.00	897.60	
9	1	0.00	893.80	Loose, GRAVEL WITH SAND, A-1-b
	2	200.00	893.80	
10	1	0.00	887.10	Very soft to stiff, SILT AND CLAY, A-4b
	2	200.00	887.10	
11	1	0.00	868.80	Very stiff to hard, SANDY SILT, A-4a
	2	200.00	868.80	
12	1	0.00	865.60	Granular Soil
	2	200.00	865.60	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	D E S C R I P T I O N
1	X1 = -35.00 [ft]	1	-20.00	926.40	
	X2 = 35.00 [ft]	2	20.00	926.40	

MED-18-12.99

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PROJECT IDENTIFICATION

Title: MED-18-12.99
Project Number: -
Client: GPD Group
Designer: ZM
Station Number:

Description:
Forward Abutment B-021

Company's information:

Name: NEAS, Inc.
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Telephone #: (614)7014-0299
Fax #:
E-Mail:

Original file path and name: F:\MED\929 ..... ED-18-13.54\analysis_bridge\Fossa\MED-18-B-021.2ST
Original date and time of creating this file: March 28, 2017

GEOMETRY: Analysis of a 3D-Approximate geometry

INPUT DATA -- FOUNDATION LAYERS -- 9 layers

	Wet Unit Weight, γ [lb/ft³]	Poisson's Ratio μ	Description of Soil
1	118.00	0.40	Medium stiff to stiff, Silt and Clay, A-6a
2	118.00	0.30	Soft to Stiff, SANDY SILT, A-4a
3	120.00	0.40	Stiff to very stiff, SILT AND CLAY, A-6a
4	120.00	0.30	Very stiff, SANDY SILT, A-4a
5	120.00	0.40	Medium stiff to very stiff, SILT AND CLAY, A-6a
6	120.00	0.40	Medium stiff to stiff, SILTY CLAY, A-6b
7	125.00	0.30	COARSE AND FINE SAND, A-3a
8	122.00	0.30	Medium stiff to hard, SANDY SILT, A-4a
9	130.00	0.30	Gravel WITH SAND, A-1-b

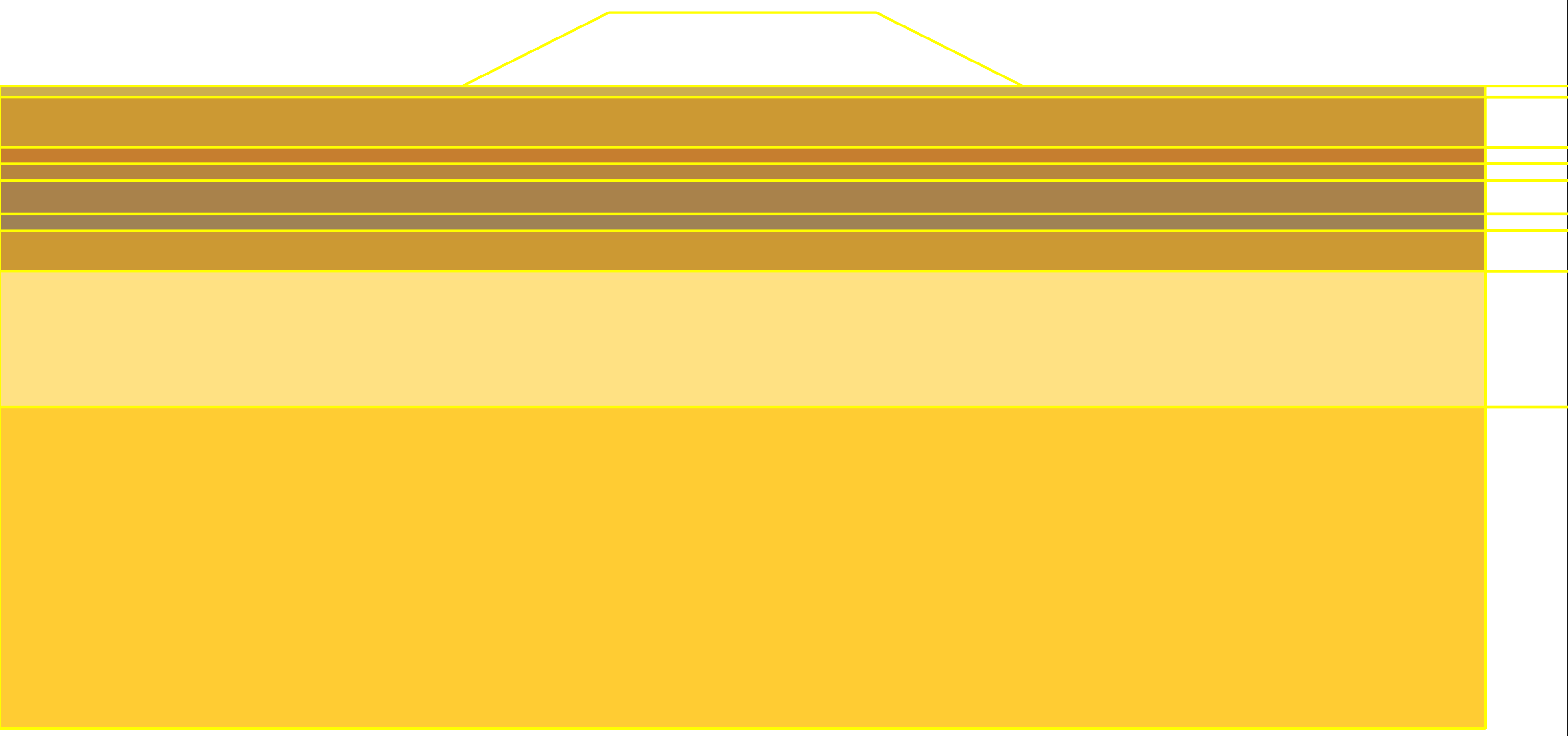
INPUT DATA -- EMBANKMENT LAYERS -- 1 layers

	Wet Unit Weight, γ [lb/ft³]	Description of Soil
1	120.00	

INPUT DATA OF WATER

Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]
1	0.00	906.00
2	200.00	906.00

DRAWING OF SPECIFIED GEOMETRY



INPUT DATA FOR CONSOLIDATION –– $\alpha = 1/2$

Layer #	Underging Consolidation [Yes/No]	OCR = Pc / Po	Cc	Cr	e0	Cv [ft ²/day]	Drains at :
1	Yes	72.80	0.10	0.01	0.52	0.2000	Top & Bot.
2	No	N/A	N/A	N/A	N/A	N/A	N/A
3	Yes	12.00	0.11	0.01	0.61	0.2000	Top & Bot.
4	Yes	10.70	0.11	0.01	0.61	0.2000	Top & Bot.
5	Yes	10.40	0.12	0.01	0.62	0.2000	Top & Bot.
6	Yes	9.40	0.12	0.01	0.62	0.2000	Top & Bot.
7	No	N/A	N/A	N/A	N/A	N/A	N/A
8	Yes	8.90	0.14	0.02	0.63	0.2000	Top & Bot.
9	No	N/A	N/A	N/A	N/A	N/A	N/A

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
1	-42.00	0.00	1	257928	0.4000	-0.0001	914.30	914.24	0.06
			2	42520	0.3000	-0.0031			
			3	366170	0.4000	-0.0003			
			4	88704	0.3000	0.0016			
			5	416160	0.4000	0.0003			
			6	432800	0.4000	0.0004			
			7	294920	0.3000	0.0039			
			8	105290	0.3000	0.0516			
			9	555640	0.3000	0.0037			
2	-33.60	0.00	1	257928	0.4000	0.0012	914.30	914.14	0.16
			2	42520	0.3000	0.0499			
			3	366170	0.4000	0.0014			
			4	88704	0.3000	0.0094			
			5	416160	0.4000	0.0031			
			6	432800	0.4000	0.0017			
			7	294920	0.3000	0.0082			
			8	105290	0.3000	0.0809			
			9	555640	0.3000	0.0049			
3	-25.20	0.00	1	257928	0.4000	0.0023	914.30	914.02	0.28
			2	42520	0.3000	0.1106			
			3	366170	0.4000	0.0036			
			4	88704	0.3000	0.0189			
			5	416160	0.4000	0.0065			
			6	432800	0.4000	0.0031			
			7	294920	0.3000	0.0131			
			8	105290	0.3000	0.1117			
			9	555640	0.3000	0.0062			
4	-16.80	0.00	1	257928	0.4000	0.0030	914.30	913.95	0.35
			2	42520	0.3000	0.1462			
			3	366170	0.4000	0.0048			
			4	88704	0.3000	0.0251			
			5	416160	0.4000	0.0088			
			6	432800	0.4000	0.0042			
			7	294920	0.3000	0.0169			
			8	105290	0.3000	0.1376			
			9	555640	0.3000	0.0073			
5	-8.40	0.00	1	257928	0.4000	0.0029	914.30	913.92	0.38
			2	42520	0.3000	0.1451			
			3	366170	0.4000	0.0050			
			4	88704	0.3000	0.0268			
			5	416160	0.4000	0.0096			
			6	432800	0.4000	0.0047			
			7	294920	0.3000	0.0189			
			8	105290	0.3000	0.1540			
			9	555640	0.3000	0.0080			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
6	0.00	0.00	1	257928	0.4000	0.0029	914.30	913.92	0.38
			2	42520	0.3000	0.1441			
			3	366170	0.4000	0.0049			
			4	88704	0.3000	0.0270			
			5	416160	0.4000	0.0098			
			6	432800	0.4000	0.0048			
			7	294920	0.3000	0.0196			
			8	105290	0.3000	0.1596			
			9	555640	0.3000	0.0083			
7	8.40	0.00	1	257928	0.4000	0.0029	914.30	913.92	0.38
			2	42520	0.3000	0.1451			
			3	366170	0.4000	0.0050			
			4	88704	0.3000	0.0268			
			5	416160	0.4000	0.0096			
			6	432800	0.4000	0.0047			
			7	294920	0.3000	0.0190			
			8	105290	0.3000	0.1545			
			9	555640	0.3000	0.0081			
8	16.80	0.00	1	257928	0.4000	0.0030	914.30	913.94	0.36
			2	42520	0.3000	0.1462			
			3	366170	0.4000	0.0048			
			4	88704	0.3000	0.0251			
			5	416160	0.4000	0.0088			
			6	432800	0.4000	0.0042			
			7	294920	0.3000	0.0169			
			8	105290	0.3000	0.1386			
			9	555640	0.3000	0.0074			
9	25.20	0.00	1	257928	0.4000	0.0023	914.30	914.02	0.28
			2	42520	0.3000	0.1106			
			3	366170	0.4000	0.0036			
			4	88704	0.3000	0.0190			
			5	416160	0.4000	0.0065			
			6	432800	0.4000	0.0031			
			7	294920	0.3000	0.0132			
			8	105290	0.3000	0.1131			
			9	555640	0.3000	0.0063			
10	33.60	0.00	1	257928	0.4000	0.0012	914.30	914.14	0.16
			2	42520	0.3000	0.0499			
			3	366170	0.4000	0.0014			
			4	88704	0.3000	0.0094			
			5	416160	0.4000	0.0031			
			6	432800	0.4000	0.0017			
			7	294920	0.3000	0.0083			
			8	105290	0.3000	0.0824			
			9	555640	0.3000	0.0051			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

IMMEDIATE SETTLEMENT, Si

Node #	Settlement along section: X [ft.]	Y [ft.]	Layer (k)	Young's Modulus, E [lb/ft ²]	Poisson's Ratio, μ	Settlement of each layer, Si(k) [ft.]	Initial Z [ft.]	Final Z * [ft.]	Total Settlement Sum of Si(k), [ft.]
11	42.00	0.00	1	257928	0.4000	-0.0001	914.30	914.24	0.06
			2	42520	0.3000	-0.0032			
			3	366170	0.4000	-0.0003			
			4	88704	0.3000	0.0016			
			5	416160	0.4000	0.0003			
			6	432800	0.4000	0.0004			
			7	294920	0.3000	0.0040			
			8	105290	0.3000	0.0530			
			9	555640	0.3000	0.0038			

*Note: Final Z is calculated assuming only 'Immediate Settlement' exists.

ULTIMATE SETTLEMENT, Sc

Node #	X [ft.]	Y [ft.]	Original Z [ft.]	Settlement Sc [ft.]	Final Z * [ft.]
1	-42.00	0.00	914.30	0.02	914.28
2	-33.60	0.00	914.30	0.04	914.26
3	-25.20	0.00	914.30	0.05	914.25
4	-16.80	0.00	914.30	0.06	914.24
5	-8.40	0.00	914.30	0.07	914.23
6	0.00	0.00	914.30	0.07	914.23
7	8.40	0.00	914.30	0.07	914.23
8	16.80	0.00	914.30	0.06	914.24
9	25.20	0.00	914.30	0.05	914.25
10	33.60	0.00	914.30	0.04	914.26
11	42.00	0.00	914.30	0.02	914.28

*Note: Final Z is calculated assuming only 'Ultimate Settlement' exists.

TABULATED GEOMETRY: INPUT OF FOUNDATION SOILS

Found. Soil #	Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	DESCRIPTION
1	1	0.00	914.30	Medium stiff to stiff, Silt and Clay, A-6a
	2	200.00	914.30	
2	1	0.00	912.70	Soft to Stiff, SANDY SILT, A-4a
	2	200.00	912.70	
3	1	0.00	905.20	Stiff to very stiff, SILT AND CLAY, A-6a
	2	200.00	905.20	
4	1	0.00	902.70	Very stiff, SANDY SILT, A-4a
	2	200.00	902.70	
5	1	0.00	900.20	Medium stiff to very stiff, SILT AND CLAY, A-6a
	2	200.00	900.20	
6	1	0.00	895.20	Medium stiff to stiff, SILTY CLAY, A-6b
	2	200.00	895.20	
7	1	0.00	892.70	COARSE AND FINE SAND, A-3a
	2	200.00	892.70	
8	1	0.00	886.70	Medium stiff to hard, SANDY SILT, A-4a
	2	200.00	886.70	
9	1	0.00	866.40	Gravel WITH SAND, A-1-b
	2	200.00	866.40	

TABULATED GEOMETRY: INPUT OF EMBANKMENT SOILS

Embank. Soil #		Point #	Coordinates (X, Z) : (X) [ft.]	(Z) [ft.]	D E S C R I P T I O N
1	X1 = -42.00 [ft]	1	-20.00	925.30	
	X2 = 42.00 [ft]	2	20.00	925.30	

APPENDIX E

DEEP FOUNDATION ANALYSIS

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\PROGRA~1\DRIVEN\MED-18~1\MEDB20P1.DVN
Project Name: MED-18-12.99 Project Date: 03/29/2017
Project Client: GPD/ODOT
Computed By: ZM
Project Manager: CH

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 17.00 ft
Diameter of Pile: 12.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	21.10 ft
	- Driving/Restrike	21.10 ft
	- Ultimate:	9.40 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesive	3.00 ft	33.00%	122.00 pcf	2000.00 psf	T-80 Same
2	Cohesive	6.50 ft	33.00%	118.00 pcf	950.00 psf	T-80 Same
3	Cohesionless	2.50 ft	17.00%	118.00 pcf	27.0/27.0	Nordlund
4	Cohesive	2.50 ft	33.00%	110.00 pcf	350.00 psf	T-80 Same
5	Cohesive	2.50 ft	33.00%	115.00 pcf	600.00 psf	T-80 Same
6	Cohesionless	5.00 ft	17.00%	120.00 pcf	28.0/28.0	Nordlund
7	Cohesionless	2.30 ft	0.00%	118.00 pcf	31.0/31.0	Nordlund
8	Cohesive	5.20 ft	17.00%	118.00 pcf	1100.00 psf	T-80 Same
9	Cohesive	3.80 ft	33.00%	120.00 pcf	1600.00 psf	T-80 Same
10	Cohesionless	6.70 ft	0.00%	122.00 pcf	33.0/33.0	Nordlund
11	Cohesive	18.30 ft	33.00%	118.00 pcf	1000.00 psf	T-80 Same
12	Cohesive	10.80 ft	17.00%	128.00 pcf	4000.00 psf	T-80 Same
13	Cohesive	10.70 ft	33.00%	135.00 pcf	5850.00 psf	T-80 Same
14	Cohesionless	10.80 ft	0.00%	132.00 pcf	37.0/37.0	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.49 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.51 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
11.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
12.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
14.49 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
14.51 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
16.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
16.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
17.00 ft	Cohesionless	582.11 psf	0.00	N/A	0.00 Kips
17.01 ft	Cohesionless	1991.10 psf	16.46	N/A	0.01 Kips
21.09 ft	Cohesionless	2235.90 psf	16.46	N/A	6.77 Kips
21.11 ft	Cohesionless	2482.79 psf	16.46	N/A	6.81 Kips
21.99 ft	Cohesionless	2508.13 psf	16.46	N/A	8.44 Kips
22.01 ft	Cohesionless	2534.62 psf	18.23	N/A	8.49 Kips
24.29 ft	Cohesionless	2598.00 psf	18.23	N/A	14.22 Kips
24.31 ft	Cohesive	N/A	N/A	997.39 psf	14.28 Kips
29.49 ft	Cohesive	N/A	N/A	997.39 psf	30.51 Kips
29.51 ft	Cohesive	N/A	N/A	1287.72 psf	30.58 Kips
33.29 ft	Cohesive	N/A	N/A	1287.72 psf	45.88 Kips
33.31 ft	Cohesionless	3170.52 psf	19.41	N/A	45.95 Kips
39.99 ft	Cohesionless	3369.58 psf	19.41	N/A	72.51 Kips
40.01 ft	Cohesive	N/A	N/A	923.00 psf	72.58 Kips
49.01 ft	Cohesive	N/A	N/A	923.00 psf	98.68 Kips
58.01 ft	Cohesive	N/A	N/A	943.56 psf	125.94 Kips
58.29 ft	Cohesive	N/A	N/A	944.28 psf	126.81 Kips
58.31 ft	Cohesive	N/A	N/A	952.00 psf	126.87 Kips
67.31 ft	Cohesive	N/A	N/A	952.00 psf	153.79 Kips
69.09 ft	Cohesive	N/A	N/A	960.09 psf	159.38 Kips
69.11 ft	Cohesive	N/A	N/A	1392.30 psf	159.46 Kips
78.11 ft	Cohesive	N/A	N/A	1392.30 psf	198.83 Kips
79.79 ft	Cohesive	N/A	N/A	1400.51 psf	206.45 Kips
79.81 ft	Cohesionless	6072.67 psf	21.76	N/A	206.61 Kips
88.81 ft	Cohesionless	6385.87 psf	21.76	N/A	311.06 Kips
90.59 ft	Cohesionless	6447.81 psf	21.76	N/A	332.93 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.49 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.51 ft	Cohesionless	0.00 psf	19.80	10.46 Kips	0.00 Kips
11.99 ft	Cohesionless	0.00 psf	19.80	10.46 Kips	0.00 Kips
12.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
14.49 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
14.51 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
16.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
16.99 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
17.00 ft	Cohesionless	1990.50 psf	0.00	4.24 Kips	4.24 Kips
17.01 ft	Cohesionless	1991.70 psf	22.80	10.46 Kips	10.46 Kips
21.09 ft	Cohesionless	2481.30 psf	22.80	10.46 Kips	10.46 Kips
21.11 ft	Cohesionless	2483.08 psf	22.80	10.46 Kips	10.46 Kips
21.99 ft	Cohesionless	2533.76 psf	22.80	10.46 Kips	10.46 Kips
22.01 ft	Cohesionless	2534.90 psf	35.20	16.23 Kips	16.23 Kips
24.29 ft	Cohesionless	2661.66 psf	35.20	16.23 Kips	16.23 Kips
24.31 ft	Cohesive	N/A	N/A	N/A	7.78 Kips
29.49 ft	Cohesive	N/A	N/A	N/A	7.78 Kips
29.51 ft	Cohesive	N/A	N/A	N/A	11.31 Kips
33.29 ft	Cohesive	N/A	N/A	N/A	11.31 Kips
33.31 ft	Cohesionless	3170.82 psf	47.20	39.27 Kips	39.27 Kips
39.99 ft	Cohesionless	3568.94 psf	47.20	39.27 Kips	39.27 Kips
40.01 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
49.01 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
58.01 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
58.29 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
58.31 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
67.31 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
69.09 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
69.11 ft	Cohesive	N/A	N/A	N/A	41.35 Kips
78.11 ft	Cohesive	N/A	N/A	N/A	41.35 Kips
79.79 ft	Cohesive	N/A	N/A	N/A	41.35 Kips
79.81 ft	Cohesionless	6073.02 psf	91.20	161.82 Kips	161.82 Kips
88.81 ft	Cohesionless	6699.42 psf	91.20	161.82 Kips	161.82 Kips
90.59 ft	Cohesionless	6823.30 psf	91.20	161.82 Kips	161.82 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.49 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.51 ft	0.00 Kips	0.00 Kips	0.00 Kips
11.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
12.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
14.49 ft	0.00 Kips	0.00 Kips	0.00 Kips
14.51 ft	0.00 Kips	0.00 Kips	0.00 Kips
16.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
16.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
17.00 ft	0.00 Kips	4.24 Kips	4.24 Kips
17.01 ft	0.01 Kips	10.46 Kips	10.48 Kips
21.09 ft	6.77 Kips	10.46 Kips	17.23 Kips
21.11 ft	6.81 Kips	10.46 Kips	17.27 Kips
21.99 ft	8.44 Kips	10.46 Kips	18.91 Kips
22.01 ft	8.49 Kips	16.23 Kips	24.72 Kips
24.29 ft	14.22 Kips	16.23 Kips	30.45 Kips
24.31 ft	14.28 Kips	7.78 Kips	22.06 Kips
29.49 ft	30.51 Kips	7.78 Kips	38.29 Kips
29.51 ft	30.58 Kips	11.31 Kips	41.89 Kips
33.29 ft	45.88 Kips	11.31 Kips	57.19 Kips
33.31 ft	45.95 Kips	39.27 Kips	85.22 Kips
39.99 ft	72.51 Kips	39.27 Kips	111.78 Kips
40.01 ft	72.58 Kips	7.07 Kips	79.65 Kips
49.01 ft	98.68 Kips	7.07 Kips	105.75 Kips
58.01 ft	125.94 Kips	7.07 Kips	133.01 Kips
58.29 ft	126.81 Kips	7.07 Kips	133.88 Kips
58.31 ft	126.87 Kips	28.27 Kips	155.14 Kips
67.31 ft	153.79 Kips	28.27 Kips	182.06 Kips
69.09 ft	159.38 Kips	28.27 Kips	187.66 Kips
69.11 ft	159.46 Kips	41.35 Kips	200.81 Kips
78.11 ft	198.83 Kips	41.35 Kips	240.18 Kips
79.79 ft	206.45 Kips	41.35 Kips	247.80 Kips
79.81 ft	206.61 Kips	161.82 Kips	368.43 Kips
88.81 ft	311.06 Kips	161.82 Kips	472.88 Kips
90.59 ft	332.93 Kips	161.82 Kips	494.75 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.49 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.51 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
11.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
12.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
14.49 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
14.51 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
16.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
16.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
17.00 ft	Cohesionless	582.11 psf	0.00	N/A	0.00 Kips
17.01 ft	Cohesionless	1991.10 psf	16.46	N/A	0.01 Kips
21.09 ft	Cohesionless	2235.90 psf	16.46	N/A	5.62 Kips
21.11 ft	Cohesionless	2482.79 psf	16.46	N/A	5.65 Kips
21.99 ft	Cohesionless	2508.13 psf	16.46	N/A	7.01 Kips
22.01 ft	Cohesionless	2534.62 psf	18.23	N/A	7.05 Kips
24.29 ft	Cohesionless	2598.00 psf	18.23	N/A	12.79 Kips
24.31 ft	Cohesive	N/A	N/A	997.39 psf	12.84 Kips
29.49 ft	Cohesive	N/A	N/A	997.39 psf	26.31 Kips
29.51 ft	Cohesive	N/A	N/A	1287.72 psf	26.36 Kips
33.29 ft	Cohesive	N/A	N/A	1287.72 psf	36.60 Kips
33.31 ft	Cohesionless	3170.52 psf	19.41	N/A	36.68 Kips
39.99 ft	Cohesionless	3369.58 psf	19.41	N/A	63.23 Kips
40.01 ft	Cohesive	N/A	N/A	923.00 psf	63.28 Kips
49.01 ft	Cohesive	N/A	N/A	923.00 psf	80.77 Kips
58.01 ft	Cohesive	N/A	N/A	943.56 psf	99.03 Kips
58.29 ft	Cohesive	N/A	N/A	944.28 psf	99.62 Kips
58.31 ft	Cohesive	N/A	N/A	952.00 psf	99.67 Kips
67.31 ft	Cohesive	N/A	N/A	952.00 psf	122.01 Kips
69.09 ft	Cohesive	N/A	N/A	960.09 psf	126.65 Kips
69.11 ft	Cohesive	N/A	N/A	1392.30 psf	126.70 Kips
78.11 ft	Cohesive	N/A	N/A	1392.30 psf	153.08 Kips
79.79 ft	Cohesive	N/A	N/A	1400.51 psf	158.19 Kips
79.81 ft	Cohesionless	6072.67 psf	21.76	N/A	158.35 Kips
88.81 ft	Cohesionless	6385.87 psf	21.76	N/A	262.79 Kips
90.59 ft	Cohesionless	6447.81 psf	21.76	N/A	284.66 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.49 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.51 ft	Cohesionless	0.00 psf	19.80	10.46 Kips	0.00 Kips
11.99 ft	Cohesionless	0.00 psf	19.80	10.46 Kips	0.00 Kips
12.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
14.49 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
14.51 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
16.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
16.99 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
17.00 ft	Cohesionless	1990.50 psf	0.00	4.24 Kips	4.24 Kips
17.01 ft	Cohesionless	1991.70 psf	22.80	10.46 Kips	10.46 Kips
21.09 ft	Cohesionless	2481.30 psf	22.80	10.46 Kips	10.46 Kips
21.11 ft	Cohesionless	2483.08 psf	22.80	10.46 Kips	10.46 Kips
21.99 ft	Cohesionless	2533.76 psf	22.80	10.46 Kips	10.46 Kips
22.01 ft	Cohesionless	2534.90 psf	35.20	16.23 Kips	16.23 Kips
24.29 ft	Cohesionless	2661.66 psf	35.20	16.23 Kips	16.23 Kips
24.31 ft	Cohesive	N/A	N/A	N/A	7.78 Kips
29.49 ft	Cohesive	N/A	N/A	N/A	7.78 Kips
29.51 ft	Cohesive	N/A	N/A	N/A	11.31 Kips
33.29 ft	Cohesive	N/A	N/A	N/A	11.31 Kips
33.31 ft	Cohesionless	3170.82 psf	47.20	39.27 Kips	39.27 Kips
39.99 ft	Cohesionless	3568.94 psf	47.20	39.27 Kips	39.27 Kips
40.01 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
49.01 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
58.01 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
58.29 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
58.31 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
67.31 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
69.09 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
69.11 ft	Cohesive	N/A	N/A	N/A	41.35 Kips
78.11 ft	Cohesive	N/A	N/A	N/A	41.35 Kips
79.79 ft	Cohesive	N/A	N/A	N/A	41.35 Kips
79.81 ft	Cohesionless	6073.02 psf	91.20	161.82 Kips	161.82 Kips
88.81 ft	Cohesionless	6699.42 psf	91.20	161.82 Kips	161.82 Kips
90.59 ft	Cohesionless	6823.30 psf	91.20	161.82 Kips	161.82 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.49 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.51 ft	0.00 Kips	0.00 Kips	0.00 Kips
11.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
12.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
14.49 ft	0.00 Kips	0.00 Kips	0.00 Kips
14.51 ft	0.00 Kips	0.00 Kips	0.00 Kips
16.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
16.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
17.00 ft	0.00 Kips	4.24 Kips	4.24 Kips
17.01 ft	0.01 Kips	10.46 Kips	10.47 Kips
21.09 ft	5.62 Kips	10.46 Kips	16.08 Kips
21.11 ft	5.65 Kips	10.46 Kips	16.11 Kips
21.99 ft	7.01 Kips	10.46 Kips	17.47 Kips
22.01 ft	7.05 Kips	16.23 Kips	23.28 Kips
24.29 ft	12.79 Kips	16.23 Kips	29.02 Kips
24.31 ft	12.84 Kips	7.78 Kips	20.61 Kips
29.49 ft	26.31 Kips	7.78 Kips	34.08 Kips
29.51 ft	26.36 Kips	11.31 Kips	37.67 Kips
33.29 ft	36.60 Kips	11.31 Kips	47.91 Kips
33.31 ft	36.68 Kips	39.27 Kips	75.95 Kips
39.99 ft	63.23 Kips	39.27 Kips	102.50 Kips
40.01 ft	63.28 Kips	7.07 Kips	70.35 Kips
49.01 ft	80.77 Kips	7.07 Kips	87.84 Kips
58.01 ft	99.03 Kips	7.07 Kips	106.10 Kips
58.29 ft	99.62 Kips	7.07 Kips	106.68 Kips
58.31 ft	99.67 Kips	28.27 Kips	127.94 Kips
67.31 ft	122.01 Kips	28.27 Kips	150.28 Kips
69.09 ft	126.65 Kips	28.27 Kips	154.93 Kips
69.11 ft	126.70 Kips	41.35 Kips	168.06 Kips
78.11 ft	153.08 Kips	41.35 Kips	194.43 Kips
79.79 ft	158.19 Kips	41.35 Kips	199.54 Kips
79.81 ft	158.35 Kips	161.82 Kips	320.17 Kips
88.81 ft	262.79 Kips	161.82 Kips	424.62 Kips
90.59 ft	284.66 Kips	161.82 Kips	446.49 Kips

ULTIMATE - SKIN FRICTION

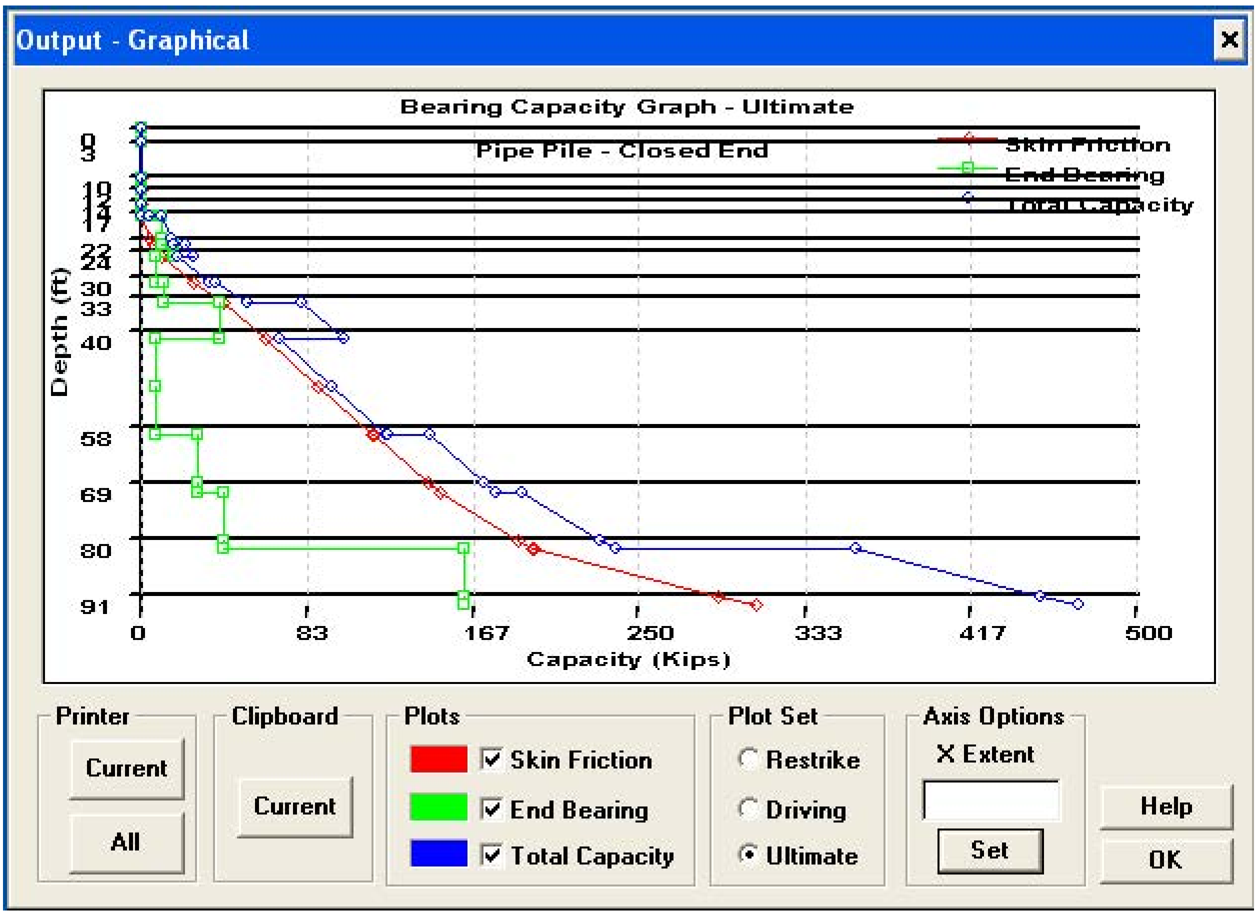
Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.49 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
9.51 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
11.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
12.01 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
14.49 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
14.51 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
16.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
16.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
17.00 ft	Cohesionless	582.11 psf	0.00	N/A	0.00 Kips
17.01 ft	Cohesionless	1516.55 psf	16.46	N/A	0.01 Kips
21.09 ft	Cohesionless	1634.05 psf	16.46	N/A	4.95 Kips
21.11 ft	Cohesionless	1752.71 psf	16.46	N/A	4.98 Kips
21.99 ft	Cohesionless	1778.05 psf	16.46	N/A	6.14 Kips
22.01 ft	Cohesionless	1804.54 psf	18.23	N/A	6.17 Kips
24.29 ft	Cohesionless	1867.92 psf	18.23	N/A	10.29 Kips
24.31 ft	Cohesive	N/A	N/A	997.39 psf	10.34 Kips
29.49 ft	Cohesive	N/A	N/A	997.39 psf	26.57 Kips
29.51 ft	Cohesive	N/A	N/A	1287.72 psf	26.64 Kips
33.29 ft	Cohesive	N/A	N/A	1287.72 psf	41.93 Kips
33.31 ft	Cohesionless	2440.44 psf	19.41	N/A	42.00 Kips
39.99 ft	Cohesionless	2639.50 psf	19.41	N/A	62.81 Kips
40.01 ft	Cohesive	N/A	N/A	923.00 psf	62.87 Kips
49.01 ft	Cohesive	N/A	N/A	923.00 psf	88.97 Kips
58.01 ft	Cohesive	N/A	N/A	943.56 psf	116.23 Kips
58.29 ft	Cohesive	N/A	N/A	944.28 psf	117.10 Kips
58.31 ft	Cohesive	N/A	N/A	952.00 psf	117.16 Kips
67.31 ft	Cohesive	N/A	N/A	952.00 psf	144.08 Kips
69.09 ft	Cohesive	N/A	N/A	960.09 psf	149.67 Kips
69.11 ft	Cohesive	N/A	N/A	1392.30 psf	149.75 Kips
78.11 ft	Cohesive	N/A	N/A	1392.30 psf	189.12 Kips
79.79 ft	Cohesive	N/A	N/A	1400.51 psf	196.74 Kips
79.81 ft	Cohesionless	5342.59 psf	21.76	N/A	196.89 Kips
88.81 ft	Cohesionless	5655.79 psf	21.76	N/A	289.39 Kips
90.59 ft	Cohesionless	5717.73 psf	21.76	N/A	308.90 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
2.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
3.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.49 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
9.51 ft	Cohesionless	0.00 psf	19.80	10.46 Kips	0.00 Kips
11.99 ft	Cohesionless	0.00 psf	19.80	10.46 Kips	0.00 Kips
12.01 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
14.49 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
14.51 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
16.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
16.99 ft	Cohesionless	0.00 psf	0.00	0.00 Kips	0.00 Kips
17.00 ft	Cohesionless	1516.26 psf	0.00	4.24 Kips	4.24 Kips
17.01 ft	Cohesionless	1516.84 psf	22.80	10.46 Kips	10.46 Kips
21.09 ft	Cohesionless	1751.84 psf	22.80	10.46 Kips	10.46 Kips
21.11 ft	Cohesionless	1753.00 psf	22.80	10.46 Kips	10.46 Kips
21.99 ft	Cohesionless	1803.68 psf	22.80	10.46 Kips	10.46 Kips
22.01 ft	Cohesionless	1804.82 psf	35.20	16.23 Kips	16.23 Kips
24.29 ft	Cohesionless	1931.58 psf	35.20	16.23 Kips	16.23 Kips
24.31 ft	Cohesive	N/A	N/A	N/A	7.78 Kips
29.49 ft	Cohesive	N/A	N/A	N/A	7.78 Kips
29.51 ft	Cohesive	N/A	N/A	N/A	11.31 Kips
33.29 ft	Cohesive	N/A	N/A	N/A	11.31 Kips
33.31 ft	Cohesionless	2440.74 psf	47.20	39.27 Kips	39.27 Kips
39.99 ft	Cohesionless	2838.86 psf	47.20	39.27 Kips	39.27 Kips
40.01 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
49.01 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
58.01 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
58.29 ft	Cohesive	N/A	N/A	N/A	7.07 Kips
58.31 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
67.31 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
69.09 ft	Cohesive	N/A	N/A	N/A	28.27 Kips
69.11 ft	Cohesive	N/A	N/A	N/A	41.35 Kips
78.11 ft	Cohesive	N/A	N/A	N/A	41.35 Kips
79.79 ft	Cohesive	N/A	N/A	N/A	41.35 Kips
79.81 ft	Cohesionless	5342.94 psf	91.20	161.82 Kips	161.82 Kips
88.81 ft	Cohesionless	5969.34 psf	91.20	161.82 Kips	161.82 Kips
90.59 ft	Cohesionless	6093.22 psf	91.20	161.82 Kips	161.82 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
2.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.49 ft	0.00 Kips	0.00 Kips	0.00 Kips
9.51 ft	0.00 Kips	0.00 Kips	0.00 Kips
11.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
12.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
14.49 ft	0.00 Kips	0.00 Kips	0.00 Kips
14.51 ft	0.00 Kips	0.00 Kips	0.00 Kips
16.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
16.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
17.00 ft	0.00 Kips	4.24 Kips	4.24 Kips
17.01 ft	0.01 Kips	10.46 Kips	10.47 Kips
21.09 ft	4.95 Kips	10.46 Kips	15.41 Kips
21.11 ft	4.98 Kips	10.46 Kips	15.44 Kips
21.99 ft	6.14 Kips	10.46 Kips	16.60 Kips
22.01 ft	6.17 Kips	16.23 Kips	22.40 Kips
24.29 ft	10.29 Kips	16.23 Kips	26.52 Kips
24.31 ft	10.34 Kips	7.78 Kips	18.12 Kips
29.49 ft	26.57 Kips	7.78 Kips	34.35 Kips
29.51 ft	26.64 Kips	11.31 Kips	37.95 Kips
33.29 ft	41.93 Kips	11.31 Kips	53.24 Kips
33.31 ft	42.00 Kips	39.27 Kips	81.27 Kips
39.99 ft	62.81 Kips	39.27 Kips	102.08 Kips
40.01 ft	62.87 Kips	7.07 Kips	69.94 Kips
49.01 ft	88.97 Kips	7.07 Kips	96.03 Kips
58.01 ft	116.23 Kips	7.07 Kips	123.29 Kips
58.29 ft	117.10 Kips	7.07 Kips	124.17 Kips
58.31 ft	117.16 Kips	28.27 Kips	145.43 Kips
67.31 ft	144.08 Kips	28.27 Kips	172.35 Kips
69.09 ft	149.67 Kips	28.27 Kips	177.95 Kips
69.11 ft	149.75 Kips	41.35 Kips	191.10 Kips
78.11 ft	189.12 Kips	41.35 Kips	230.47 Kips
79.79 ft	196.74 Kips	41.35 Kips	238.09 Kips
79.81 ft	196.89 Kips	161.82 Kips	358.71 Kips
88.81 ft	289.39 Kips	161.82 Kips	451.21 Kips
90.59 ft	308.90 Kips	161.82 Kips	470.72 Kips



DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: C:\PROGRA~1\DRIVEN\MED-18~1\MEDB021.DVN
Project Name: MED-18-12.99 Project Date: 03/29/2017
Project Client: GPD/ODOT
Computed By: ZM
Project Manager: CH

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 11.00 ft
Diameter of Pile: 12.00 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	18.70 ft
	- Driving/Restrike	18.70 ft
	- Ultimate:	7.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	4.50 ft	0.00%	125.00 pcf	37.0/37.0	Nordlund
2	Cohesive	7.50 ft	33.00%	118.00 pcf	850.00 psf	T-80 Same
3	Cohesionless	7.50 ft	17.00%	118.00 pcf	27.0/27.0	Nordlund
4	Cohesive	2.50 ft	33.00%	120.00 pcf	1350.00 psf	T-80 Same
5	Cohesive	2.50 ft	17.00%	120.00 pcf	1350.00 psf	T-80 Same
6	Cohesive	5.00 ft	33.00%	120.00 pcf	1550.00 psf	T-80 Same
7	Cohesive	2.50 ft	33.00%	120.00 pcf	1600.00 psf	T-80 Same
8	Cohesionless	6.00 ft	0.00%	125.00 pcf	33.0/33.0	Nordlund
9	Cohesive	20.30 ft	17.00%	122.00 pcf	2450.00 psf	T-80 Same
10	Cohesionless	3.20 ft	0.00%	130.00 pcf	38.0/38.0	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.49 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.51 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
10.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
11.00 ft	Cohesive	N/A	N/A	802.64 psf	0.00 Kips
11.99 ft	Cohesive	N/A	N/A	802.64 psf	2.50 Kips
12.01 ft	Cohesionless	1448.09 psf	15.88	N/A	2.53 Kips
18.69 ft	Cohesionless	1842.21 psf	15.88	N/A	10.91 Kips
18.71 ft	Cohesionless	2238.38 psf	15.88	N/A	10.94 Kips
19.49 ft	Cohesionless	2260.06 psf	15.88	N/A	12.14 Kips
19.51 ft	Cohesive	N/A	N/A	1166.25 psf	12.20 Kips
21.99 ft	Cohesive	N/A	N/A	1166.25 psf	21.28 Kips
22.01 ft	Cohesive	N/A	N/A	1166.25 psf	21.35 Kips
24.49 ft	Cohesive	N/A	N/A	1166.25 psf	30.44 Kips
24.51 ft	Cohesive	N/A	N/A	1266.04 psf	30.52 Kips
29.49 ft	Cohesive	N/A	N/A	1266.04 psf	50.33 Kips
29.51 ft	Cohesive	N/A	N/A	1287.72 psf	50.41 Kips
31.99 ft	Cohesive	N/A	N/A	1287.72 psf	60.44 Kips
32.01 ft	Cohesionless	3002.89 psf	19.41	N/A	60.51 Kips
37.99 ft	Cohesionless	3190.07 psf	19.41	N/A	83.02 Kips
38.01 ft	Cohesive	N/A	N/A	1134.71 psf	83.10 Kips
47.01 ft	Cohesive	N/A	N/A	1134.71 psf	115.18 Kips
56.01 ft	Cohesive	N/A	N/A	1303.23 psf	156.80 Kips
58.29 ft	Cohesive	N/A	N/A	1351.19 psf	169.19 Kips
58.31 ft	Cohesionless	4588.40 psf	22.35	N/A	169.34 Kips
61.49 ft	Cohesionless	4695.88 psf	22.35	N/A	199.66 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	91.20	161.82 Kips	0.00 Kips
4.49 ft	Cohesionless	0.00 psf	91.20	161.82 Kips	0.00 Kips
4.51 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
10.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
11.00 ft	Cohesive	N/A	N/A	N/A	6.01 Kips
11.99 ft	Cohesive	N/A	N/A	N/A	6.01 Kips
12.01 ft	Cohesionless	1448.68 psf	19.80	10.46 Kips	10.46 Kips
18.69 ft	Cohesionless	2236.92 psf	19.80	10.46 Kips	10.46 Kips
18.71 ft	Cohesionless	2238.66 psf	19.80	10.46 Kips	10.46 Kips
19.49 ft	Cohesionless	2282.02 psf	19.80	10.46 Kips	10.46 Kips
19.51 ft	Cohesive	N/A	N/A	N/A	9.54 Kips
21.99 ft	Cohesive	N/A	N/A	N/A	9.54 Kips
22.01 ft	Cohesive	N/A	N/A	N/A	9.54 Kips
24.49 ft	Cohesive	N/A	N/A	N/A	9.54 Kips
24.51 ft	Cohesive	N/A	N/A	N/A	10.96 Kips
29.49 ft	Cohesive	N/A	N/A	N/A	10.96 Kips
29.51 ft	Cohesive	N/A	N/A	N/A	11.31 Kips
31.99 ft	Cohesive	N/A	N/A	N/A	11.31 Kips
32.01 ft	Cohesionless	3003.21 psf	47.20	39.27 Kips	39.27 Kips
37.99 ft	Cohesionless	3377.55 psf	47.20	39.27 Kips	39.27 Kips
38.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
47.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
56.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
58.29 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
58.31 ft	Cohesionless	4588.74 psf	110.40	210.96 Kips	210.96 Kips
61.49 ft	Cohesionless	4803.70 psf	110.40	210.96 Kips	210.96 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.49 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.51 ft	0.00 Kips	0.00 Kips	0.00 Kips
10.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
11.00 ft	0.00 Kips	6.01 Kips	6.01 Kips
11.99 ft	2.50 Kips	6.01 Kips	8.50 Kips
12.01 ft	2.53 Kips	10.46 Kips	12.99 Kips
18.69 ft	10.91 Kips	10.46 Kips	21.37 Kips
18.71 ft	10.94 Kips	10.46 Kips	21.40 Kips
19.49 ft	12.14 Kips	10.46 Kips	22.60 Kips
19.51 ft	12.20 Kips	9.54 Kips	21.74 Kips
21.99 ft	21.28 Kips	9.54 Kips	30.82 Kips
22.01 ft	21.35 Kips	9.54 Kips	30.90 Kips
24.49 ft	30.44 Kips	9.54 Kips	39.98 Kips
24.51 ft	30.52 Kips	10.96 Kips	41.47 Kips
29.49 ft	50.33 Kips	10.96 Kips	61.28 Kips
29.51 ft	50.41 Kips	11.31 Kips	61.71 Kips
31.99 ft	60.44 Kips	11.31 Kips	71.75 Kips
32.01 ft	60.51 Kips	39.27 Kips	99.78 Kips
37.99 ft	83.02 Kips	39.27 Kips	122.29 Kips
38.01 ft	83.10 Kips	17.32 Kips	100.41 Kips
47.01 ft	115.18 Kips	17.32 Kips	132.50 Kips
56.01 ft	156.80 Kips	17.32 Kips	174.11 Kips
58.29 ft	169.19 Kips	17.32 Kips	186.51 Kips
58.31 ft	169.34 Kips	210.96 Kips	380.30 Kips
61.49 ft	199.66 Kips	210.96 Kips	410.62 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.49 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.51 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
10.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
11.00 ft	Cohesive	N/A	N/A	802.64 psf	0.00 Kips
11.99 ft	Cohesive	N/A	N/A	802.64 psf	1.67 Kips
12.01 ft	Cohesionless	1448.09 psf	15.88	N/A	1.70 Kips
18.69 ft	Cohesionless	1842.21 psf	15.88	N/A	8.66 Kips
18.71 ft	Cohesionless	2238.38 psf	15.88	N/A	8.68 Kips
19.49 ft	Cohesionless	2260.06 psf	15.88	N/A	9.68 Kips
19.51 ft	Cohesive	N/A	N/A	1166.25 psf	9.71 Kips
21.99 ft	Cohesive	N/A	N/A	1166.25 psf	15.80 Kips
22.01 ft	Cohesive	N/A	N/A	1166.25 psf	15.86 Kips
24.49 ft	Cohesive	N/A	N/A	1166.25 psf	23.40 Kips
24.51 ft	Cohesive	N/A	N/A	1266.04 psf	23.46 Kips
29.49 ft	Cohesive	N/A	N/A	1266.04 psf	36.73 Kips
29.51 ft	Cohesive	N/A	N/A	1287.72 psf	36.78 Kips
31.99 ft	Cohesive	N/A	N/A	1287.72 psf	43.50 Kips
32.01 ft	Cohesionless	3002.89 psf	19.41	N/A	43.58 Kips
37.99 ft	Cohesionless	3190.07 psf	19.41	N/A	66.08 Kips
38.01 ft	Cohesive	N/A	N/A	1134.71 psf	66.15 Kips
47.01 ft	Cohesive	N/A	N/A	1134.71 psf	92.78 Kips
56.01 ft	Cohesive	N/A	N/A	1303.23 psf	127.32 Kips
58.29 ft	Cohesive	N/A	N/A	1351.19 psf	137.60 Kips
58.31 ft	Cohesionless	4588.40 psf	22.35	N/A	137.75 Kips
61.49 ft	Cohesionless	4695.88 psf	22.35	N/A	168.08 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	91.20	161.82 Kips	0.00 Kips
4.49 ft	Cohesionless	0.00 psf	91.20	161.82 Kips	0.00 Kips
4.51 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
10.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
11.00 ft	Cohesive	N/A	N/A	N/A	6.01 Kips
11.99 ft	Cohesive	N/A	N/A	N/A	6.01 Kips
12.01 ft	Cohesionless	1448.68 psf	19.80	10.46 Kips	10.46 Kips
18.69 ft	Cohesionless	2236.92 psf	19.80	10.46 Kips	10.46 Kips
18.71 ft	Cohesionless	2238.66 psf	19.80	10.46 Kips	10.46 Kips
19.49 ft	Cohesionless	2282.02 psf	19.80	10.46 Kips	10.46 Kips
19.51 ft	Cohesive	N/A	N/A	N/A	9.54 Kips
21.99 ft	Cohesive	N/A	N/A	N/A	9.54 Kips
22.01 ft	Cohesive	N/A	N/A	N/A	9.54 Kips
24.49 ft	Cohesive	N/A	N/A	N/A	9.54 Kips
24.51 ft	Cohesive	N/A	N/A	N/A	10.96 Kips
29.49 ft	Cohesive	N/A	N/A	N/A	10.96 Kips
29.51 ft	Cohesive	N/A	N/A	N/A	11.31 Kips
31.99 ft	Cohesive	N/A	N/A	N/A	11.31 Kips
32.01 ft	Cohesionless	3003.21 psf	47.20	39.27 Kips	39.27 Kips
37.99 ft	Cohesionless	3377.55 psf	47.20	39.27 Kips	39.27 Kips
38.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
47.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
56.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
58.29 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
58.31 ft	Cohesionless	4588.74 psf	110.40	210.96 Kips	210.96 Kips
61.49 ft	Cohesionless	4803.70 psf	110.40	210.96 Kips	210.96 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.49 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.51 ft	0.00 Kips	0.00 Kips	0.00 Kips
10.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
11.00 ft	0.00 Kips	6.01 Kips	6.01 Kips
11.99 ft	1.67 Kips	6.01 Kips	7.68 Kips
12.01 ft	1.70 Kips	10.46 Kips	12.16 Kips
18.69 ft	8.66 Kips	10.46 Kips	19.12 Kips
18.71 ft	8.68 Kips	10.46 Kips	19.14 Kips
19.49 ft	9.68 Kips	10.46 Kips	20.14 Kips
19.51 ft	9.71 Kips	9.54 Kips	19.26 Kips
21.99 ft	15.80 Kips	9.54 Kips	25.34 Kips
22.01 ft	15.86 Kips	9.54 Kips	25.41 Kips
24.49 ft	23.40 Kips	9.54 Kips	32.95 Kips
24.51 ft	23.46 Kips	10.96 Kips	34.41 Kips
29.49 ft	36.73 Kips	10.96 Kips	47.68 Kips
29.51 ft	36.78 Kips	11.31 Kips	48.09 Kips
31.99 ft	43.50 Kips	11.31 Kips	54.81 Kips
32.01 ft	43.58 Kips	39.27 Kips	82.85 Kips
37.99 ft	66.08 Kips	39.27 Kips	105.35 Kips
38.01 ft	66.15 Kips	17.32 Kips	83.46 Kips
47.01 ft	92.78 Kips	17.32 Kips	110.09 Kips
56.01 ft	127.32 Kips	17.32 Kips	144.64 Kips
58.29 ft	137.60 Kips	17.32 Kips	154.92 Kips
58.31 ft	137.75 Kips	210.96 Kips	348.71 Kips
61.49 ft	168.08 Kips	210.96 Kips	379.04 Kips

ULTIMATE - SKIN FRICTION

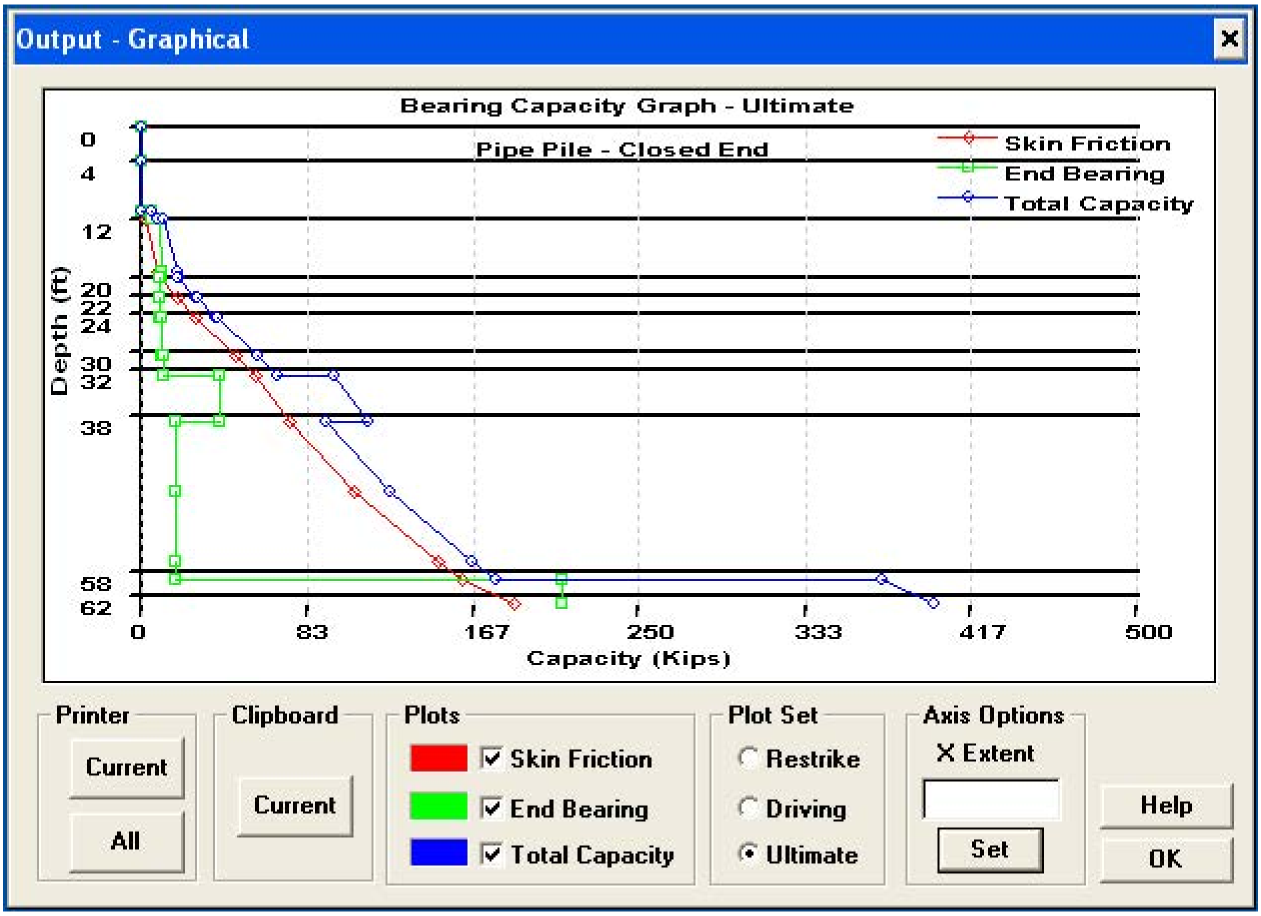
Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.49 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.51 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
10.99 ft	Cohesive	N/A	N/A	0.00 psf	0.00 Kips
11.00 ft	Cohesive	N/A	N/A	802.64 psf	0.00 Kips
11.99 ft	Cohesive	N/A	N/A	802.64 psf	2.50 Kips
12.01 ft	Cohesionless	1135.78 psf	15.88	N/A	2.53 Kips
18.69 ft	Cohesionless	1321.48 psf	15.88	N/A	8.54 Kips
18.71 ft	Cohesionless	1508.30 psf	15.88	N/A	8.56 Kips
19.49 ft	Cohesionless	1529.98 psf	15.88	N/A	9.37 Kips
19.51 ft	Cohesive	N/A	N/A	1166.25 psf	9.42 Kips
21.99 ft	Cohesive	N/A	N/A	1166.25 psf	18.51 Kips
22.01 ft	Cohesive	N/A	N/A	1166.25 psf	18.58 Kips
24.49 ft	Cohesive	N/A	N/A	1166.25 psf	27.67 Kips
24.51 ft	Cohesive	N/A	N/A	1266.04 psf	27.74 Kips
29.49 ft	Cohesive	N/A	N/A	1266.04 psf	47.55 Kips
29.51 ft	Cohesive	N/A	N/A	1287.72 psf	47.63 Kips
31.99 ft	Cohesive	N/A	N/A	1287.72 psf	57.66 Kips
32.01 ft	Cohesionless	2272.81 psf	19.41	N/A	57.73 Kips
37.99 ft	Cohesionless	2459.99 psf	19.41	N/A	75.09 Kips
38.01 ft	Cohesive	N/A	N/A	1134.71 psf	75.15 Kips
47.01 ft	Cohesive	N/A	N/A	1134.71 psf	107.24 Kips
56.01 ft	Cohesive	N/A	N/A	1303.23 psf	148.85 Kips
58.29 ft	Cohesive	N/A	N/A	1351.19 psf	161.25 Kips
58.31 ft	Cohesionless	3858.32 psf	22.35	N/A	161.38 Kips
61.49 ft	Cohesionless	3965.80 psf	22.35	N/A	186.99 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	91.20	161.82 Kips	0.00 Kips
4.49 ft	Cohesionless	0.00 psf	91.20	161.82 Kips	0.00 Kips
4.51 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
10.99 ft	Cohesive	N/A	N/A	N/A	0.00 Kips
11.00 ft	Cohesive	N/A	N/A	N/A	6.01 Kips
11.99 ft	Cohesive	N/A	N/A	N/A	6.01 Kips
12.01 ft	Cohesionless	1136.06 psf	19.80	10.46 Kips	9.08 Kips
18.69 ft	Cohesionless	1507.46 psf	19.80	10.46 Kips	10.46 Kips
18.71 ft	Cohesionless	1508.58 psf	19.80	10.46 Kips	10.46 Kips
19.49 ft	Cohesionless	1551.94 psf	19.80	10.46 Kips	10.46 Kips
19.51 ft	Cohesive	N/A	N/A	N/A	9.54 Kips
21.99 ft	Cohesive	N/A	N/A	N/A	9.54 Kips
22.01 ft	Cohesive	N/A	N/A	N/A	9.54 Kips
24.49 ft	Cohesive	N/A	N/A	N/A	9.54 Kips
24.51 ft	Cohesive	N/A	N/A	N/A	10.96 Kips
29.49 ft	Cohesive	N/A	N/A	N/A	10.96 Kips
29.51 ft	Cohesive	N/A	N/A	N/A	11.31 Kips
31.99 ft	Cohesive	N/A	N/A	N/A	11.31 Kips
32.01 ft	Cohesionless	2273.13 psf	47.20	39.27 Kips	39.27 Kips
37.99 ft	Cohesionless	2647.47 psf	47.20	39.27 Kips	39.27 Kips
38.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
47.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
56.01 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
58.29 ft	Cohesive	N/A	N/A	N/A	17.32 Kips
58.31 ft	Cohesionless	3858.66 psf	110.40	210.96 Kips	210.96 Kips
61.49 ft	Cohesionless	4073.62 psf	110.40	210.96 Kips	210.96 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.49 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.51 ft	0.00 Kips	0.00 Kips	0.00 Kips
10.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
11.00 ft	0.00 Kips	6.01 Kips	6.01 Kips
11.99 ft	2.50 Kips	6.01 Kips	8.50 Kips
12.01 ft	2.53 Kips	9.08 Kips	11.61 Kips
18.69 ft	8.54 Kips	10.46 Kips	19.00 Kips
18.71 ft	8.56 Kips	10.46 Kips	19.02 Kips
19.49 ft	9.37 Kips	10.46 Kips	19.84 Kips
19.51 ft	9.42 Kips	9.54 Kips	18.96 Kips
21.99 ft	18.51 Kips	9.54 Kips	28.05 Kips
22.01 ft	18.58 Kips	9.54 Kips	28.12 Kips
24.49 ft	27.67 Kips	9.54 Kips	37.21 Kips
24.51 ft	27.74 Kips	10.96 Kips	38.70 Kips
29.49 ft	47.55 Kips	10.96 Kips	58.51 Kips
29.51 ft	47.63 Kips	11.31 Kips	58.94 Kips
31.99 ft	57.66 Kips	11.31 Kips	68.97 Kips
32.01 ft	57.73 Kips	39.27 Kips	97.00 Kips
37.99 ft	75.09 Kips	39.27 Kips	114.36 Kips
38.01 ft	75.15 Kips	17.32 Kips	92.47 Kips
47.01 ft	107.24 Kips	17.32 Kips	124.55 Kips
56.01 ft	148.85 Kips	17.32 Kips	166.17 Kips
58.29 ft	161.25 Kips	17.32 Kips	178.56 Kips
58.31 ft	161.38 Kips	210.96 Kips	372.34 Kips
61.49 ft	186.99 Kips	210.96 Kips	397.95 Kips



Rear Abutment 12" CIP Pile
B-020-0-14 &B-001-P-99

Barr & Prevost
MED-18-12.99 : 03/29/2017 : ZM

Apr 07 2017
GRLWEAP(TM) Version 2005

Gain/Loss 1 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	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
3.0	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
6.2	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
9.5	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
9.5	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
10.8	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
12.0	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
12.0	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
13.2	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
14.5	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
14.5	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
15.8	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
17.0	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
17.0	10.5	0.0	10.5	-1.0	0.000	0.000	0.00	0.0
19.5	14.4	4.0	10.5	-1.0	0.000	0.000	0.00	0.0
22.0	18.9	8.4	10.5	1.4	11.631	-1.039	2.85	30.9
22.0	24.8	8.5	16.2	1.5	13.181	-1.604	3.02	34.4
23.1	27.6	11.3	16.2	1.6	13.443	-1.624	3.07	34.5
24.3	30.4	14.2	16.2	1.6	13.698	-1.526	3.12	34.5
24.3	22.1	14.3	7.8	1.4	12.352	-1.803	2.91	31.1
26.9	30.2	22.4	7.8	1.7	13.779	-1.374	3.14	34.6
29.5	38.3	30.5	7.8	2.1	15.827	-0.709	3.34	34.3
29.5	41.9	30.6	11.3	2.4	16.341	-0.412	3.38	33.4
31.4	49.6	38.2	11.3	3.0	17.920	0.000	3.59	32.3
33.3	57.2	45.8	11.3	3.7	18.918	0.000	3.71	31.1
33.3	85.3	46.0	39.3	6.0	21.766	0.000	4.07	28.9
36.7	98.1	58.9	39.3	6.8	22.566	0.000	4.22	28.8
40.0	111.8	72.5	39.3	7.6	23.166	-0.108	4.33	28.5
40.0	79.7	72.6	7.1	4.9	21.024	0.000	3.91	29.8
49.2	106.2	99.1	7.1	7.5	23.193	0.000	4.34	28.3
58.3	133.0	125.9	7.1	10.5	24.833	-1.672	4.67	27.2
58.3	154.3	126.0	28.3	12.3	25.470	-1.014	4.84	27.1
63.7	170.4	142.1	28.3	14.0	25.940	-1.130	4.99	26.8
69.1	186.5	158.2	28.3	15.8	26.854	-0.704	5.12	26.7
69.1	199.7	158.4	41.3	17.1	27.139	-1.462	5.21	27.1
74.4	223.0	181.7	41.3	20.1	28.991	-2.205	5.44	27.5
79.8	246.4	205.0	41.3	24.2	30.399	-2.346	5.59	27.5
79.8	367.1	205.3	161.8	65.2	33.515	-4.075	6.28	30.7
85.2	428.1	266.3	161.8	155.8	33.403	-3.417	6.48	31.0
90.6	493.2	331.4	161.8	9999.0	33.009	-2.421	6.54	30.7

Refusal occurred; no driving time output possible

Gain/Loss 1 at Shaft and Toe 1.000 / 1.000 (Continued)

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
85.2	428.1	266.3	161.8	155.8	33.403	-3.417	6.48	31.0
90.6	493.2	331.4	161.8	9999.0	33.009	-2.421	6.54	30.7

Refusal occurred; no driving time output possible

Rear Abutment 12" CIP Pile
B-020-0-14 &B-001-P-99

Barr & Prevost

Apr 07 2017

MED-18-12.99 : 03/29/2017 : ZM

Gain/Loss 1 at Shaft and Toe 1.000 / 1.000

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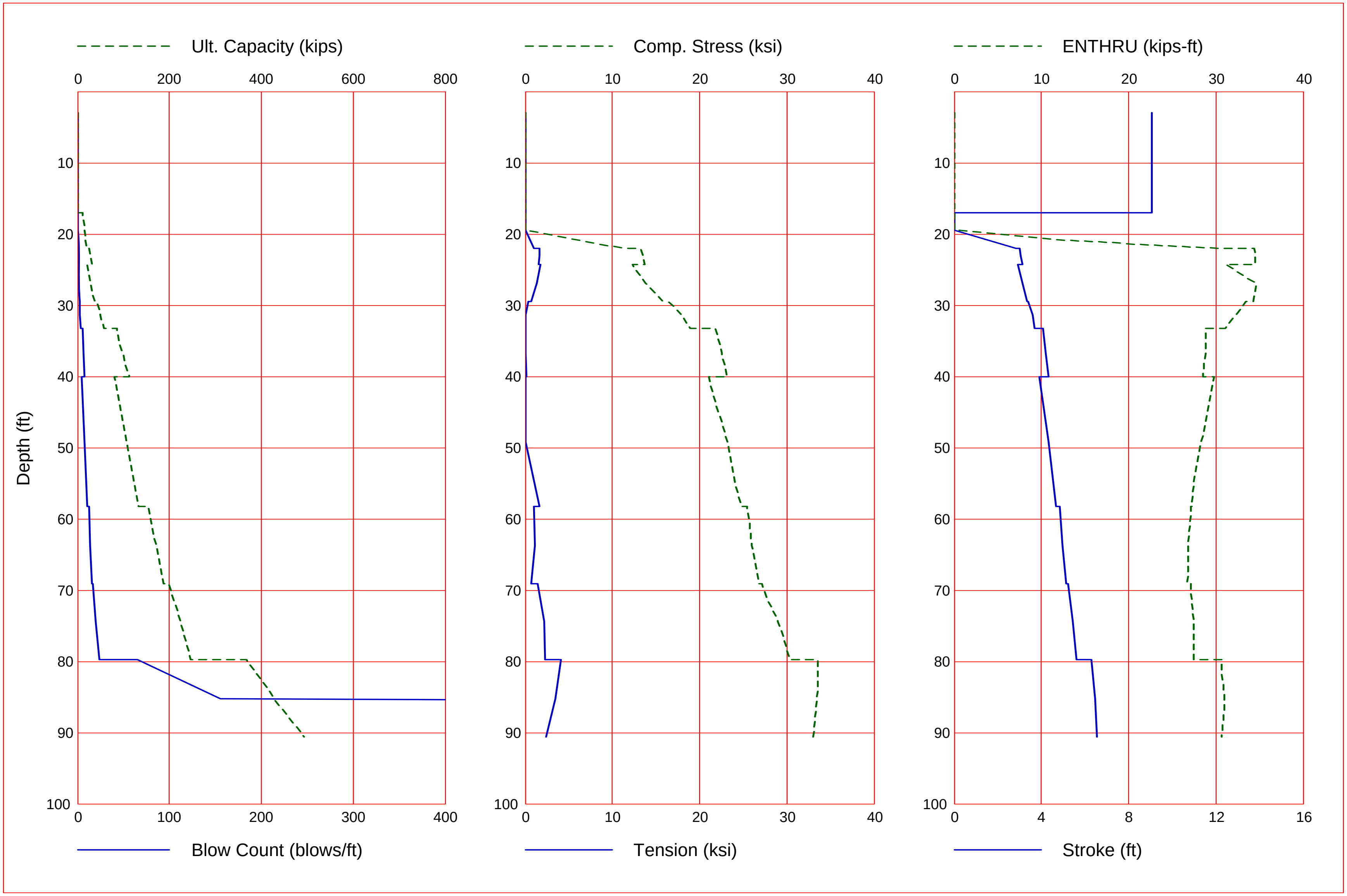

Forward Abutment 12" CIP Pile
B-021-0-14

Barr & Prevost
MED-18-12.99 : 03/29/2017 : ZM

Apr 07 2017
GRLWEAP(TM) Version 2005

Gain/Loss 1 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
4.5	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
4.5	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
8.2	0.0	0.0	0.0	0.0	0.000	0.000	9.05	0.0
12.0	8.5	2.5	6.0	-1.0	0.000	0.000	0.00	0.0
12.0	13.0	2.6	10.5	-1.0	0.000	0.000	0.00	0.0
15.8	17.3	6.8	10.5	-1.0	0.000	0.000	0.00	0.0
19.5	22.6	12.1	10.5	-1.0	0.000	0.000	0.00	0.0
19.5	21.8	12.3	9.5	-1.0	0.000	0.000	0.00	0.0
20.8	26.3	16.8	9.5	1.5	12.307	0.000	2.91	35.3
22.0	30.8	21.3	9.5	1.8	13.327	0.000	3.04	35.5
22.0	30.9	21.4	9.5	1.8	13.423	0.000	3.07	35.8
23.2	35.5	25.9	9.5	2.1	14.348	0.000	3.19	34.8
24.5	40.0	30.4	9.5	2.5	15.696	0.000	3.32	33.7
24.5	41.5	30.6	11.0	2.6	15.891	0.000	3.32	33.2
27.0	51.4	40.4	11.0	3.4	18.194	0.000	3.60	32.0
29.5	61.3	50.3	11.0	4.3	19.788	0.000	3.76	30.4
29.5	61.8	50.5	11.3	4.4	19.824	0.000	3.76	30.3
30.8	66.8	55.4	11.3	4.9	20.629	0.000	3.87	29.9
32.0	71.7	60.4	11.3	5.3	20.967	0.000	3.95	29.5
32.0	99.8	60.6	39.3	7.7	22.847	-0.748	4.32	27.9
35.0	110.7	71.5	39.3	8.4	23.698	-0.946	4.47	27.9
38.0	122.3	83.0	39.3	9.2	23.947	-1.073	4.53	27.4
38.0	100.5	83.2	17.3	7.2	22.905	-0.781	4.30	28.4
48.2	136.6	119.3	17.3	11.3	26.151	-0.624	4.79	26.6
58.3	176.5	159.2	17.3	16.2	29.755	0.000	5.22	25.4
58.3	370.4	159.4	211.0	49.3	37.598	-2.283	6.48	29.4
59.9	385.1	174.1	211.0	55.3	37.658	-2.110	6.53	29.3
61.5	400.5	189.6	211.0	62.3	37.548	-1.968	6.60	29.5

Total Continuous Driving Time 10.00 minutes; Total Number of Blows 497

Forward Abutment 12" CIP Pile
B-021-0-14

Barr & Prevost

Apr 07 2017

MED-18-12.99 : 03/29/2017 : ZM

Gain/Loss 1 at Shaft and Toe 1.000 / 1.000

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