GOLDER
MEMBER OF WSP

REPORT

Supplemental Geotechnical Design Report Part I

I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22)

FREEPORT, MAINE

MAINEDOT WIN 021726.00

Submitted to:

Ms. Laura Krusinski, PE
Senior Geotechnical Engineer
Maine Department of Transportation
Bridge Division
16 State House Station
Augusta, Maine 04333-0016

Submitted by:

Golder Associates Inc.
670 North Commercial Street, Suite 103
Manchester, NH 03101
+1 603 668-0880
Project No. 21450910

August 20, 2021

Table of Contents

TABLES

SHEETS

APPENDICES

1.0 INTRODUCTION

This Supplemental Geotechnical Design Report (SGDR) Part I summarizes the results of Golder Associates Inc.'s, a member of WSP, (Golder's) supplemental geotechnical design recommendations for the replacement of the Mallet Drive Bridge #5721 over I-295 in Freeport, Maine at Exit 22 (formerly Approach Road, see Sheet 1 for the location). This is the first of two supplemental reports associated with the geotechnical design at the site, and specifically pertains to the geotechnical design of the bridge abutments, foundations, and embankments.

Our design calculations and references are made in conjunction with the HNTB 60% Design Plans[1] and HNTB 98% Design Plans[2]. Golder had previously submitted the Preliminary Geotechnical Design Report (PGDR)[3] on December 21, 2020 which summarized our field activities, field and laboratory data collection, subsurface interpretations, and preliminary geotechnical design for the bridge foundations and embankments. The PGDR[3] serves as the basis for this report. Our work presented herein was completed in accordance with Golder's proposed scope of work[4] for supplemental geotechnical design and Golder's General Consultant Agreement (GCA) dated June 15, 2020.

Golder's supplemental geotechnical design work is being completed in two stages, and each stage will be documented in a separate report as follows:

- Part I pertains to the supplemental geotechnical subsurface investigation and supplemental design of the bridge abutments, their foundations, and the approach embankments. The supplemental subsurface investigation refined the bedrock profile parallel to the centerline of the proposed abutment locations, updated estimated settlement at the abutments due to the embankment loading, revised the abutment pile analysis, and reanalyzed global stability for both static and pseudo-static loading conditions at both abutments. This effort is the subject of this report.
- Part II pertains to geotechnical foundation designs and recommendations for traffic mast arms and light standards and luminaires within the project development area. This will be the subject of a separate report[5].

1.1 Project Background

The existing Mallet Drive Bridge (formerly Approach Road) at I-295 Exit 22 was originally constructed in 1957. The bridge will be replaced with a two span integral abutment bridge that will increase bridge clearance over I-295 to the 16 foot minimum standard. The proposed abutments will be moved away from I-295 back into the existing embankment, and will be lengthened to the south of the present Mallet Drive centerline to accommodate widening of Mallet Drive. These alignment modifications will impact approach embankment configurations and loadings.

Golder's PGDR details the historical geotechnical investigation findings and Golder's geotechnical subsurface investigation that included in-situ and laboratory testing; presents recommended geotechnical parameters for

---

1 HNTB, May 7, 2021, Freeport, Cumberland County, Approach Road Bridge over Interstate 295 and Signalized Intersections Exit 20 Interchange: 60% Plans, Filename: Freeport 20021726_Exit 2022_60pctPLANS.pdf.

2 HNTB, July 30, 2021, Freeport, Cumberland County, Merrill Road Bridge over Interstate 295 and Signalized Intersections Exit 20 Interchange: 98% Plans, Filename: Exit_20_98%25%20Plans.pdf.

3 Golder Associates, Inc., December 21, 2020, Preliminary Geotechnical Design Report, I-295 Mallet Drive Bridge Replacement #5721 (Exit 22), Freeport, Maine, MaineDOT WIN 021726.00.

4 Golder Associates, Inc., April 9, 2021, Proposal for Phase II Supplemental Geotechnical Design and Analysis: I-295 Mallet Drive Bridge Replacement #5721 (Exit 21), Freeport, Maine, MaineDOT WIN 021726.00.

5 Golder Associates, Inc., August 20, 2021, Supplemental Geotechnical Design Report Part II, I-295 Mallet Drive Bridge Replacement #5721 (Exit 22), Freeport, Maine, MaineDOT WIN 021726.00.

design and construction; and provides preliminary geotechnical designs for the bridge foundations and approach embankments. The PGDR describes shallow and sloping bedrock encountered at the abutment locations and recommends additional probes to establish the bedrock surface along the proposed abutment centerline. The PGDR additionally recommends abutment pile design, downdrag mitigation strategies for the piles, and engineering analysis and design be performed during final design after the bedrock elevations at the proposed abutment centerlines, specifically Abutment No. 2 with shallow bedrock, are better defined. These recommendations are the basis for the supplemental geotechnical analyses provided in this report.

1.2 Scope of Geotechnical Work

In accordance with the scope of work described in our proposal dated April 9, 2021 and referenced in our Project Contract with MaineDOT dated April 22, 2021, Golder performed the following work for the SGDR Part I:

- Planned, coordinated, and monitored a rock probe field program to establish the bedrock profile along the centerline of proposed Abutment No. 1 and Abutment No. 2, which were identified in the PGDR as having shallow sloping bedrock that may have implications for pile design.
- Performed a three-dimensional settlement analysis to better estimate and then mitigate downdrag loading on the abutment piles
- Updated the abutment pile analysis including the geotechnical, structural, and driving resistance with the revised downdrag and structural loads using the updated abutment locations from the HNTB Design Plans (60%[1] and 98%[2]) and pile lengths based on bedrock elevations from Golder's Interpretive Subsurface Profile (Sheet 5) and Interpretive Subsurface Cross Section (Sheet 6).
- Update the global stability analyses for both static and pseudo-static loading conditions longitudinal to the abutments and transverse to the Mallet Drive centerline at the approach embankments based on the HNTB Design Plans (60%[1] and 98%[2]). These analyses include recommendations for changes to proposed geometries and fills to achieve a factor of safety of 1.5 or greater for the abutment static stability analyses.

2.0 GEOLOGIC SETTING

2.1 Regional Surficial Geology

The proposed bridge replacement site is located in southern-central Maine within the Seaboard Lowland Section of the New England Physiographic Province.[6] Regional surficial geologic mapping indicates the surficial soils consist of Holocene (Recent) wetland/saltwater marsh deposits overlying Pleistocene Presumpscot Formation fine grained sediments, which overlie Pleistocene glacial till deposits. The wetland/saltwater marsh deposits consist of peat, clay, silt, and sand deposited in low-lying areas adjacent to tidal inlets, tidal channels, and tidal flats. The Presumpscot Formation consists of fine-grained marine mud (silt and clay with local sandy beds and lenses), locally with marine fossils and dropstones, deposited in deeper, quieter water during marine submergence of the coastal lowland. The till consists of a light to dark gray, heterogeneous, non-sorted to poorly sorted mixture of clay, silt, sand, pebbles, cobbles, and boulders, rarely stratified and deposited directly by glacial ice. The till consists of two varieties: a basal (or lodgment) till, fine grained and very dense; and an overlying ablation (or melt-

[6] Fenneman, N.M., and Johnson, D.W., 1946. Physiographic Divisions of the Conterminous U.S., U.S. Geological Survey, 1 sheet, scale 1:7,000,000.

out) till, coarser grained, stony, and relatively loose.[7,8,9] Regional mapping indicates the overburden thickness ranges between 5 feet and 200 feet below ground surface in the Yarmouth-Freeport area.[10]

2.2 Regional Bedrock Geology

Regional bedrock geologic mapping indicates the bedrock beneath the site consists of the Silurian-Ordovician Vassalboro Group, undifferentiated, previously mapped as the Hutchins Corner Formation.[11,12,13] The lithology consists of light to medium gray, fine- to medium-grained, plagioclase-quartz-biotite granofels and gneiss, interlayered with subordinate amounts of greenish gray, fine-grained, calc-silicate granofels or medium gray, medium-grained biotite schist. Layer thickness ranges from 1 to 4 inches, and pegmatite lenses, boudins and sills are common. This formation is interpreted to have been initially deposited as sediments within a marine basin, which subsequently underwent diagenesis to form sedimentary rocks. This formation was then metamorphosed by heat and pressure under miles of younger rocks, forming a layered foliation, and then underwent ductile deformation by several tectonic events dating back to at least Devonian time starting with the Acadian orogeny. This compressional stress created additional foliation textures (low greenschist to upper amphibolite facies), and at least three-fold sets. This in turn was followed by post-metamorphic brittle deformation forming numerous northeast trending thrust faults and joints, with the emplacement of non-metamorphosed discordant pegmatite dikes and layer diabase dikes during the Mesozoic Era.[10,11] Within the Yarmouth-Freeport area, metamorphic compositional layering within the Vassalboro Group strikes northeast-southwest, and dips gently to the southeast.

3.0 SUBSURFACE INVESTIGATIONS

3.1 Preliminary Geotechnical Investigation

Golder performed the preliminary geotechnical subsurface investigation as described in in the PGDR[2]. The subsurface investigation included 6 (six) borings (BB-FMD-101 through -106) with two borings each near the proposed abutment locations and pier location. For each abutment location, one boring was performed in the westbound lane of Mallet Drive and one boring was performed south of the existing embankment to provide information for the proposed bridge shift to the south. For the pier location, one boring was performed in the westbound lane of Mallet Drive and one boring was performed eastbound lane of Mallet Drive. These borings were performed in existing fills from the original roadway embankment construction through the in situ glaciomarine and sand and gravel layers to bedrock. Each boring had 10 feet of rock core drilled as well. The locations of these 100-series borings (BB-FMD-1XX) are shown on Sheet 3 of this report. Refer to the PGDR[2] for the methods used, boring logs, and interpretive subsurface stratigraphy. Historical and 100-series borings (BB-FMD-1XX) from the preliminary geotechnical investigation form the basis of the Interpretive Subsurface Profile

---

7 Retelle, M.J., 1999. Surficial Geology of the Yarmouth Quadrangle, Maine. Maine Geological Survey, Open-File No. 99-105, 1 sheet, scale 1:24,000.

8 Retelle, M.J., 1999. Surficial Geology of the Yarmouth 7.5-minute Quadrangle, Cumberland County, Maine. Maine Geological Survey Open-File 99-136, 8 p.

9 Prescott, G.C., Jr., 1977. Ground-Water Favorability and Surficial Geology of the Windham-Freeport Area, Maine. U.S. Geological Survey, Hydrologic Investigations Atlas HA-564, 1 sheet, scale 1:62,500.

10 Tolman, S.S., 2010. Overburden Thickness in the Portland 30x60-minute Quadrangle, Maine. Maine Geological Survey, Open-File No. 10-65, 1 sheet, scale 1:125,000.

11 Berry, H.N., IV, and Hussey, A.M., II, 1998. Bedrock Geology of the Portland 1:100,000 Quadrangle, Maine and New Hampshire. Maine Geological Survey, Open-File No. 98-1, 1 sheet, scale 1:100,000.

12 Hussey, A.M., II, 1985. The Bedrock Geology of the Bath and Portland 2° Map Sheets, Maine. Maine Geological Survey, Open-File No. 85-87, 82 p., 2 sheets, scale 1:250,000.

13 West, D.P., Jr. and Hussey, A.M., II, 2017. Bedrock Geology of the Yarmouth Quadrangle, Maine. Maine Geological Survey, Open-File No. 17-11, 1 sheet, scale 1:24,000.

shown in Sheet 5 and Interpretive Subsurface Cross Section shown in Sheet 6 of this report. Boring location, elevation, and bedrock depth for the BB-FMD-100 series borings are summarized in Table 1, and boring logs for these borings are provided in Appendix A.

3.2 Supplemental Investigations

A supplemental boring program was performed at the site to collect geotechnical soil data for the traffic mast arms and light standards and luminaires within the project development area. A detailed description of the boring program field activities, field and laboratory data collection, and subsurface interpretations will be provided in Golder's Supplemental Geotechnical Report Part II[5]. However, some boring data (BB-FMD-205 and -208) are used in definition of the bedrock surface and reinterpretation of the soil layering at proposed Abutment No. 2 and have been integrated into the abutment pile design and embankment stability analyses. Sheet 2 through Sheet 4 show the locations of the 200-series supplemental borings (BB-FMD-2XX) with respect to existing and proposed site features. Boring location, elevation, and bedrock depth for the BB-FMD-200 series borings shown in Sheet 5 and Sheet 6 (a subset of the full BB-FMD-200 series) are summarized in Table 1, and boring logs for these borings are provided in Appendix A.

3.3 Supplemental Rock Probes

Golder completed an exploration program to better define the shallow bedrock surface at the proposed location of Abutment No. 1 and Abutment No. 2. This allowed us to improve our estimate of pile length and design and provide recommendations appropriate for shallow piles on sloping bedrock at this location. A single rock probe was attempted at Abutment No. 1 (RP-FMD-204); however, bedrock was not reached after 33 feet, and probing was suspended after the compressed air pressure was lost to the formation. Three rock probes were successfully completed at Abutment No. 2 (RP-FMD-209, -210, and -211, shown on Sheet 3).

Maine Drilling and Blasting, Inc. (MD&B) of Gardiner, Maine performed the four (4) bedrock probes between June 9 and June 22, 2021 using an Atlas Copco D7 track-mounted rig, air-track methods, and a 3-inch diameter core bit. A Golder field engineer monitored drilling activities and logged the depth at which bedrock was encountered. The as-drilled rock probe locations were surveyed by MaineDOT following completion of the drilling program. Rock probe location coordinates and ground surface elevations are summarized in Table 1 along with nearby rock, and rock probe locations (RP-FMD-2XX) with respect to existing and proposed site features are illustrated in Sheet 3.

4.0 INTERPRETIVE SUBSURFACE PROFILE AND CROSS SECTION

Sheet 5 presents Golder's updated Interpretive Subsurface Profile A-A' along the proposed centerline of Mallet Drive between Station 29+54 and Station 32+54. Rock probes indicate that the bedrock surface is shallower at the location of proposed Abutment No. 2 by approximately four (4) feet over the original analysis. Additionally, the stratigraphy has been updated based on findings from borings BB-FMD-208 and BB-FMD-205 near Abutment No. 2.

Sheet 6 presents Golder's Interpretive Subsurface Cross Section B-B' that illustrates the bedrock depth aligned with the centerline of Abutment No. 2. Interpretive Subsurface Cross Section B-B' was developed to evaluate the impact of possible sloping and shallow bedrock surface on stability of the approach embankment and the pile design and were used for these analyses.

5.0 GEOTECHNICAL ANALYSES

Golder used the geotechnical data collected reported in the PGDR to develop design parameters for the major design elements of the proposed bridge and embankment features. Additionally, we used the proposed geometry, elevations, and stations for the proposed bridge abutments and piles and approach embankments from the HNTB 60% Design Plans[1] and 98% Design Plans[2] in the subsequent analyses.

5.1 Stability Analyses

Stability was evaluated for the proposed approach embankment transverse to the Mallet Drive centerline at Station 29+75 nearest proposed Abutment No. 1 and longitudinal to the proposed abutments along the proposed Mallet Drive centerline. Golder performed the analyses using the proposed geometry and materials from the HNTB 60% Design Plans[1]. Upon review of the HNTB 98% Design Plans[2], we found no significant changes to the locations, geometry, or elevation of the abutments or the geometry or elevations of the approach embankments, and thus our original analyses based on the HNTB 60% Design Plans[1] are appropriate, and were therefore not updated.

Analyses were performed using the two-dimensional limit equilibrium modeling software *Slide2* by Rocscience[14]. Analyses were performed for post-construction static and pseudo-static seismic load conditions transverse to the roadway centerline for both the southern and northern embankment slopes associated with the Abutment No. 1 approach embankment and longitudinal to the face of both Abutment No. 1 and Abutment No. 2. These analyses incorporated material design parameters estimated from SPT N_{60} values. As outlined in the Maine Bridge Design Guide Section 5.9.2, minimum allowable design factors of safety (FS) of 1.3 and 1.5 for static conditions were used in assessing satisfactory transverse embankment geometries and longitudinal abutment geometries, respectively, for the given subsurface conditions. While the Maine Bridge Design Guide Section 5.9.2 provides for a minimum allowable design factors of safety (FS) of 1.0 for pseudo-static seismic conditions, our analysis was based on FHWA (2011)[15] for both the transverse embankments and longitudinal abutment geometries, which requires a minimum FS of 1.1. Our pseudo-static seismic analysis based on FHWA (2011) uses half of the peak ground displacement value provided in the Golder's PGDR[2] or 0.064, assumes an allowable displacement of 1 inch to 2 inches, and evaluates the minimum acceptable FS of 1.1. The cross-sections were analyzed using the Spencer and Bishop simplified methods with an auto refine search for circular surfaces, along with the Spencer method and a Cuckoo search with surface altering optimization for noncircular surfaces. The noncircular surfaces were determined to govern the potential failure surfaces. Refer to the full methodology of the analysis, calculations, and locations of critical slip surfaces in Appendix B.

For all locations, we analyzed the lowest factor of safety for two cases: 1) the lowest factor of safety for a deep-seated failure surface below the roadway through the in situ soils and including the native glaciomarine soil where present, and 2) the lowest factor of safety potential failure surface for the overall slope geometry. Results are summarized in Table 5-1 for both static conditions and pseudo-static seismic conditions for the transverse embankment geometry. Results are summarized in Table 5-2 for both static and pseudo-static seismic conditions for the longitudinal abutment geometries. Longitudinal abutment geometries did not include the proposed piles to bedrock, as Golder does not recommend the piles be relied upon to provide stability of the abutment slopes.

[14] Rocscience Slide Software Package Version 9.005, build date May 6, 2020

[15] FHWA. 2011. Geotechnical Engineering Circular No. 3 - LRFD Seismic Analysis and Design of Transportation Geotechnical Features and Structural Foundations Reference Manual, Publication No. FHWA-NHI-11-032

For the transverse embankment geometries based on the HNTB 60% Design Plans[1], surfaces extending below the road and through the in situ soil soils, including through the glaciomarine deposit when present, yield a lower bound FS of 1.51 under static conditions and 1.29 under pseudo-static seismic conditions. These factors of safety meet required design FS values for both static and pseudo-static seismic conditions. For the transverse embankment geometries, overall potential failure surfaces that are limited to the existing and proposed fills yield a lower bound FS of 1.27 under static conditions and 1.09 under pseudo-static seismic conditions. For this scenario, the FS under static conditions does not meet the required value of 1.3 for each of the slopes analyzed, and does not meet the required value of 1.1 for pseudo-static seismic conditions for two of the slopes analyzed.

Table 5-1: Factors of Safety for Static Conditions and Pseudo-Static Seismic Conditions for the Abutment No. 1 Approach Embankment

Condition	Location	Slope	Lowest Factor of Safety[1] (Spencer Method)	
			Non-Circular Failure Surface in Proposed Fill	Non-Circular Deep-Seated Failure Surface Below the Roadway
Static	Abutment No. 1 Embankment (Station 29+75)	North	1.32	2.09
		South	1.27	1.51
Pseudo-Static Seismic	Abutment No. 1 Embankment (Station 29+75)	North	1.14	1.81
		South	1.09	1.29

1 - Minimum factors of safety are 1.3 for static analyses and 1.1 for pseudo-static seismic analyses.

The potential failure surfaces that do not meet FS ≥ 1.3 under static conditions or FS ≥ 1.1 under pseudo-static seismic conditions are shallow and contained entirely within the new embankment fill indicating potential surficial sloughing failure for the transverse embankment. The embankment fill modeled was standard granular borrow with material properties of 125 pounds per cubic foot (pcf) unit weight and 32° friction angle as provided in the MaineDOT Bridge Design Guide[16]. The model geometry is also based on HNTB's proposed 2 Horizontal to 1 Vertical (2H:1V) slope along the entire embankment, which does not account for shallower slopes that may be constructed as per MaineDOT Standard Specifications. While the modeled embankment slope angle of 26.5° is less than angle of internal friction of the embankment fill material (32°), the fill angle of internal friction is not great enough to result in a FS ≥ 1.3. The factor of safety for these potential surficial failure areas can likely be increased if the slope has an established protective vegetation or riprap layer, by increasing the required compactive effort for placed fill, decreasing the embankment slope angle, or using an embankment fill material with greater frictional resistance (i.e., angle of internal friction) such as Gravel Borrow with a design angle of internal friction of 36°.

For the longitudinal abutment geometries based on the HNTB 60% Design Plans[1], surfaces extending below the road and through the in situ soil soils, including through the glaciomarine deposit when present, yield a lower bound FS of 2.27 under static conditions and 1.80 under pseudo-static seismic conditions. These factors of safety

[16] Guertin Elkerton & Associates for Maine Department of Transportation. Bridge Design Guide. Dated August 2003 with 2018 updates.

meet required design FS values. For the longitudinal abutment geometries, overall potential failure surfaces that are limited to the existing and proposed fills yield a lower bound FS of 1.42 under static conditions and 1.24 under pseudo-static seismic conditions. For this scenario, the FS under static conditions does not meet the required FS ≥ 1.5 for potential failure surfaces that pass below Abutment No. 2 in the proposed and existing fills, however, does meet the required FS > 1.1 for pseudo-static seismic conditions.

Table 5-2: Factors of Safety for Static Conditions and Pseudo-Static Seismic Conditions for the Longitudinal Section Through the Abutments as Designed.

Condition	Location	Lowest Factor of Safety[1] (Spencer Method)	
		Non-Circular Failure Surface in Fill	Non-Circular Deep-Seated Failure Surface Below the Roadway[2]
Static	Abutment No. 1	1.56	2.27
	Abutment No. 2	1.42	N/A
Pseudo-Static Seismic	Abutment No. 1	1.36	1.80
	Abutment No. 2	1.24	N/A

1. Minimum factors of safety are 1.5 for static analyses and 1.1 for pseudo-static seismic analyses.
2. N/A indicates there is not a separate deep-seated failure because of the shallow bedrock depth.

Golder revisited the analysis for the longitudinal abutment stability to improve the factor of safety to 1.5 or greater at Abutment No. 2 by altering the fill materials and placement area around the abutment and within the slope in front of the abutment while maintaining the overall slope geometry at the Mallet Drive centerline. The recommended fill changes included:

- A larger volume of rock borrow at the toe of the abutment face slope than proposed, which extends 3.5 feet in depth and 8 feet in width at the toe of the slope and has a 1.75H:1V backslope between the rock borrow and in situ fill materials;
- Use of gravel borrow as the fill materials below around the proposed, rather than granular borrow as proposed; and
- Use of a greater volume of gravel borrow in the slope and around the abutment, which extends 4 feet below the base of the abutment, has a horizontal surface forward of the abutment to the back of the rock borrow and a backslope of 1.5H:1V behind the abutment to the roadway.

The geometry for these recommended changes is illustrated in Appendix B (specifically Figure B.2). Results are summarized in Table 5-3 for both static and pseudo-static seismic conditions for the longitudinal analysis of Golder's proposed fill scenario at Abutment No. 2 to improve the factor of safety.

For Golder's recommended fill scenario to approve longitudinal abutment stability at Abutment No. 2, the potential failure surface limited to the existing and proposed fills yield a lower bound FS of 1.51 under static conditions and 1.31 under pseudo-static seismic conditions. For these scenarios, the FS under static conditions meets the required FS ≥ 1.5 for potential failure surfaces and required FS > 1.1 for pseudo-static conditions. Golder

reviewed the HNTB 98% Design Plans[2] and found that our recommended changes in fill type and geometry longitudinal to the abutments were not included. We expect these changes will be included in the HNTB 100% Design Plans.

Table 5-3: Factors of Safety for Static Conditions and Pseudo-Static Seismic Conditions for the Longitudinal Section Through the Abutments with Recommended Changes to Fills to Meet Required Factors of Safety.

Condition	Location	Lowest Factor of Safety[1] (Spencer Method)	
		Non-Circular Failure Surface in Fill	Non-Circular Deep Seated Failure Surface Below the Roadway[2]
Static	Abutment No. 2	1.51	N/A
Pseudo-Static Seismic	Abutment No. 2	1.31	N/A

1. Minimum factors of safety are 1.5 for static analyses and 1.1 for pseudo-static seismic analyses.
2. N/A indicates there is not a separate deep-seated failure because of the shallow bedrock depth.

5.2 Settlement

Golder evaluated the anticipated total and differential settlement expected at the bridge abutments and at the approach embankments from the proposed improvements using the Rocscience's three-dimensional settlement analysis software *Settle3*[17]. The *Settle3* model incorporates features from the HNTB 60% Design Plans[1] between proposed Mallet Drive Station 27+90 and Station 34+10, and includes loading from the fill materials placed between the abutment and I-295, approach embankments, and roadway. Upon review of the HNTB 98% Design Plans[2], we found no significant changes in the geometry or elevations of the approach embankments, and thus our original analyses based on the HNTB 60% Design Plans[1] are appropriate, and were therefore not updated.

The subsurface stratigraphy was developed based on Interpretive Subsurface Profile A-A' (Sheet 5). Cohesionless soil layers (i.e., proposed fills, existing fill, and sand and gravel) were modeled to have immediate settlement only. The material properties were estimated from the SPT N_{60} values provided in boring logs presented in the Golder PGDR. The cohesive glaciomarine layer was modeled to have consolidation settlement only, immediate settlement and secondary compression was not considered. Due to the stiffness of the glaciomarine clay layer, undisturbed sampling for consolidation testing during the preliminary geotechnical investigation was unsuccessful. Thus, Golder used our knowledge of the Presumpscot Formation soil properties from southern coastal Maine and engineering judgement to estimate compressibility and coefficient of consolidation parameters used in the analysis. Refer to the full methodology and basis of analysis, material properties, and model development in Appendix C.

We evaluated total settlement below the proposed ground surface for the proposed approach embankment at Abutment No. 1 along a transverse cross-section at both Station 29+75 where the stability analyses were performed. We also evaluated total settlement below Abutment No. 1 and Abutment No. 2. The settlement values

[17] Rocscience, Inc. *Settle3* Software Package Version 5.001, build date December 19, 2020.

presented in Table 5-4 include estimated consolidation settlement after 5 years, the time period after which 95% consolidation settlement was estimated to occur. The settlement for the base of each abutment is provided to illustrate the settlement of the soil around the abutment piles used in the analysis of downdrag loading.

Table 5-4: Estimated Settlement for Abutment and Approach Embankment Locations

Location	Estimated Total Settlement	Estimated Settlement along the Base of the Abutment
Approach Embankment Station 29+75	max: 2.22 inches	N/A
Abutment No. 1	N/A	max: 1.22 inches min: 0.12 inches
Abutment No. 2	N/A	max: 0.56 inches min: ~0 inches

5.3 Proposed Bridge Abutment Lateral Earth Pressure

Per the HNTB 60% Design Plans[1] and HNTB 98% Design Plans[2], the proposed abutment dimensions are 89.5 feet wide skewed to the roadway alignment centerline, 10.6 feet tall, and 4.0 feet thick. HNTB also provided Golder with expected abutment movements of 0.8 inches of thermal expansion and 0.18 inches of girder rotation. Golder used these dimensions and abutment movements to analyze lateral earth pressure.

Both integral abutments should be designed to resist lateral earth pressures along the entire 10.6-foot-high abutment faces. Under longitudinal expansion, the abutments will be subject to passive earth pressure. Under longitudinal contraction, the abutments will be subject to active earth pressure. Per AASHTO (2020) Table C3.11.1-1, MassDOT (2020) LRFD Bridge Manual[18] Figure 3.10.8-1, the abutment height provided, the anticipated combined movement of 0.98 inches, we determined that the maximum wall rotation of 0.008 is less than 0.02 that MassDOT (2020) specifies is required to develop full passive earth pressure. Thus, the MassDOT (2020) LRFD Bridge Manual was used to determine the passive earth pressure coefficient, which is less than the maximum passive earth pressure coefficient identified in AASHTO (2020) when full passive pressures are engaged.

The Rankine earth pressure coefficient was used to determine active lateral earth pressure (assuming level backfill and no frictional interaction between the abutment wall and the backfill). Engineering parameters and calculated earth pressure coefficients for the backfill material are presented in Table 5-5.

Golder estimates that the resultant force generated from passive earth pressure, the governing scenario, is an unfactored load of 34,340 pounds per foot of abutment length and acts at elevations 156.5 feet at Abutment No. 1 and 160.2 feet at Abutment No. 2. These values assume the fill is free draining (i.e., no water pressure is allowed

[18] MassDOT LRFD Bridge Manual - Part 1, January 2020 Revision (https://www.mass.gov/doc/chapter-3-lrfd-bridge-design-guidelines/download)

to build up behind the abutment walls). Refer to the full methodology of the analysis, material properties, and calculations in Appendix D.

Table 5-5: Lateral Earth Pressure Coefficients

Abutment Earth Pressure Parameters	Value
Granular Backfill Unit Weight, γ (pcf)	125
Granular Backfill Friction Angle, ϕ (˚)	32
Passive Earth Pressure Coefficient, K_p	4.89
Active Earth Pressure Coefficient, K_a	0.31

5.4 Proposed Bridge Abutment Pile Foundations

The new bridge abutments are proposed to be founded on piles driven to the bedrock surface. To provide recommendations on pile design, we analyzed the pile design loads provided by HNTB[19], downdrag loading resulting from settlement of soil around the piles (from embankment loading), axial resistance, lateral loading and resistance, and driveability, as described in the subsections below. Refer to the full methodology of the analysis, material properties in Appendix E for Abutment No. 1 and Appendix F1 and Appendix F2 for Abutment No. 2 longer and shorter pile designs, respectively.

5.4.1 Pile Design Loading and Deflection

HNTB provided Golder with unfactored loads applied at the bottom of the abutment and the appropriate AASHTO LRFD load factors for the various load cases[19] for 60% design. Golder performed the pile design using the governing factored applied superstructure vertical dead and live load distributed to each of the 8 piles shown in the HNTB 60% Design Plans, resulting in a load of 402 kips per pile at both abutments. Following pile design, Golder reviewed the 98% design loads provided by HNTB. The Strength I factored vertical load for each abutment was 33 kips less than the 60% design load. The HNTB 98% Design Plans[2] increased the number of piles in from 8 in both abutments to 12 in Abutment No. 1 and 10 in Abutment No. 2. This resulted in a Strength I factored vertical load of 268 kips per pile at Abutment No. 1 and 322 kips per pile at Abutment No. 2 based on the 60% design loads. Rather than reperform pile design based on the lower load scenarios, we present the pile design in subsequent sections based on the Strength I factored vertical load of 402 kips per pile.

HNTB provided Golder with expected lateral movement[20] at each abutment that included a maximum thermal movement of 0.8 inches and horizontal movement due to girder rotation of 0.18 inches. These movements were incorporated into the lateral analysis of the abutment piles.

Golder analyzed HP 14x89 piles at the request of MaineDOT and HNTB for an abutment with a width of 89.5 feet. Per Interpretive Subsurface Profile A-A', Abutment No. 1 is expected to be supported by piles driven to bedrock

[19] HNTB calculation titled "Freeport Bridges_Loads_Bottom of Footing_flat.pdf", dated May 26, 2021.

[20] HNTB, May 7, 2021. Merrill Road Bridge 60% plans. Abutment 1 Reinforcement Sections Sheet 94 of 113. HNTB instructed Golder to use this information for Mallet Drive as well as Desert Road (WIN 023627.00)

with a length of 36.2 feet. Per Interpretive Subsurface Cross Section B-B', Abutment No. 2 is expected to be supported by piles within rock sockets with lengths of between 7.0 to 13.0 feet. We note that the MaineDOT Bridge Design Guide[15] indicates the shortest piles that shall be used are 10 feet in length. However, as will be discussed, we recommend a shorter pile as to minimize bending moments that would yield an unacceptable plastic hinge at the pile tip.

The following sections describe the downdrag analyses completed for abutment piles expected to be influenced by embankment settlement, axial resistance analyses, lateral response of the abutment piles due to thermal and rotational movements of the superstructure, and driveability analyses for the abutment piles.

5.4.2 Downdrag on Piles

In accordance with AASHTO LRFD Article 3.11.8, downdrag loads on piles can be assumed to be fully developed when settlement at the soils surrounding the piles is 0.4 inches or greater. The settlement analysis at Abutment No. 1 and Abutment No. 2 for the longer pile indicates downdrag loads will be imposed on the piles within the existing fill for both abutments and within the glaciomarine clay soil layer for Abutment No. 1. While settlements at the abutment pile locations are expected to vary along the length of the abutment, Golder calculated a maximum downdrag loading value for the pile nearest the southern edge of the abutments where settlement from approach embankment loading was greatest.

The software package APILE[21] was used to calculate shaft resistance contributing to downdrag loads along the length of the pile. Shaft resistance was modeled using the FHWA method for computation of unit load transfers and axial pile capacity to determine the shaft resistance. Specifically, the Nordlund/Thurman Method was used for side resistance in cohesionless soils and the Alpha method with a user-defined alpha value of 1.0 was used for cohesive soils.

Downdrag load was calculated in accordance with methods described in AASHTO LRFD Article 10.7.3.7. The factored maximum downdrag load at Abutment No. 1 for an HP 14x89 pile is 51 kips and 45 kips per pile for the Strength I and Service I load cases, respectively. The factored maximum downdrag load at Abutment No. 2 for the longer (13-foot) HP 14x89 pile is 42 kips and 39 kips per pile for the Strength I and Service I load cases, respectively. Downdrag load factors of 1.40 (Strength I) and 1.00 (Service I) were used for the glaciomarine soils based on the alpha Tomlinson Method in accordance with AASHTO LRFD Table 3.4.1-2. Downdrag load factors of 1.10 (Strength I) and 1.00 (Service I) were used for the existing fill soils based on the Oregon DOT Geotechnical Design Manual[22]. Downdrag load along the pile increases with depth, and we assume the maximum load occurs at the depth where the remaining settlement is below 0.4 inches.

5.4.3 Axial Pile Resistance

Golder analyzed the nominal structural and geotechnical pile resistance of HP 14x89 piles at Abutment No. 1 and No. 2 following the design procedures outlined in the MaineDOT Bridge Design Guide (2018) and AASHTO (2020). Since the piles will be driven to hard rock, the nominal resistance of the piles will be controlled by the structural limit state in accordance with AASHTO Article 10.7.3.2.3.

[21] Ensoft Inc. (2019). APile, Version 2019.9.6

[22] Oregon Department of Transportation, Geo-Environmental Section. Geotechnical Design Manual: Chapter 8 – Foundations, Version 2.1. Dated May 6, 2019.

The factored pile structural resistance, P_r, was calculated for the piles using the results of the LPILE analysis outlined in Section 7.6.4 and resistance factors of ϕ_c = 0.70 for combined axial and bending loading and ϕ_c = 0.50 for axial compression in the lower segment of the pile based on the potential for hard driving conditions.

As outlined in AASHTO Article 10.7.3.2.3, the nominal axial geotechnical resistance of piles driven to point bearing on hard rock should not exceed the nominal structural resistance values obtained from AASHTO Article 6.9.4.1 with a resistance factor ϕ_c, of 0.50, for severe driving conditions applied. As such, the controlling geotechnical pile resistance is equal to the structural resistance.

Drivability analyses were performed using GRLWEAP software[23] to determine the pile resistance that might be achieved at Abutment No. 1 and Abutment No. 2 considering available diesel hammers. Nominal drivability resistances were determined based on a maximum driving stress of 45 ksi and a limiting driving criterion of 15 bpi. The drivability resistances were calculated using the resistance factor, ϕ_{dyn}, of 0.65, for a single pile in axial compression when dynamic testing is performed as specified in AASHTO Table 10.5.5.2.3-1. Drivability controls and the recommended governing resistances for pile design are the resistances provided in the right column "Governing Axial Pile Resistance (kips)" in Table 5-6. The maximum applied factored axial pile loads should not exceed the governing factored axial pile resistances shown in Table 5-6.

Table 5-6: Summary of Strength Limit State Factored Axial Pile Resistance

Abutment	Structural Resistance ϕ_c = 0.50 (kips)	Controlling Geotechnical Resistance ϕ_c = 0.50 (kips)	Drivability Resistance[1,2] ϕ_{dyn} = 0.65 (kips)	Governing Axial Pile Resistance (kips)
Abutment No. 1	653	653	456	456
Abutment No. 2 (13-foot pile)	653	653	445	445
Abutment No. 2 (7-foot pile)	653	653	403	403

1. Factored axial load required to limit blow counts of between 3 bpi and 15 bpi while limiting the driving stresses to below 45 ksi.
2. Drivability resistance based on a Delmag D30 hammer. Refer to Appendix E and Appendix F for fuel setting recommendations.

5.4.4 Lateral Pile Response

Lateral response of the abutment piles was evaluated using LPile[24] analysis software. The input parameters were developed based on layer response models defined by the software, laboratory test results, correlations to soil properties determined from the field investigations, correlations to soil properties identified in the FB-MultiPier

[23] GRLWEAP Software Package Version 2010-8, Built November 28, 2018.

[24] Ensoft Inc. (2019). LPile, version 2019.11.03.

user manual[25], and standard properties provided in the MaineDOT Bridge Design Guide. The input parameters are summarized in Table 2 and Appendix E for Abutment No. 1, Table 3 and Appendix F1 for the longer pile analyzed at Abutment No. 2, and Table 4 and Appendix F2 for the shorter pile analyzed at Abutment No. 2. The piles were modeled for lateral response in the weak axis assuming factored pile loads, 0.98 inches of combined lateral movement from thermal bridge expansion and girder rotation, and an HP 14x89 pile size. This assumes an applied axial load including downdrag of 456 kips for a pile at Abutment No. 1, 445 kips for the longer pile at Abutment No. 2, and 403 kips for the shorter pile at Abutment No. 2. The pile head to abutment connection was assumed to be fixed.

For Abutment No. 1, Golder analyzed a pile length of 36.2 feet. For the HP 14x89 piles, the analysis indicates a maximum moment of 246 kip-feet in the piles occurs at the top of the pile under the Strength I load case and maximum lateral deflection of the pile cap of 0.98 inches with no lateral deflection at the pile tip.

For the Abutment No. 2 longer pile, Golder analyzed a pile length of 13.0 feet including a 2-foot depth rock socket having a diameter of 30 inches with pea gravel surrounding the pile seated directly on the bottom of the socket. The analysis indicates a maximum moment of 238 kip-feet occurs at the top of the pile under the Strength I load case and maximum lateral deflection of the pile cap of 0.98 inches. For the Abutment No. 2 shorter pile, Golder analyzed a pile length of 7.0 feet including a 2-foot depth rock socket having a diameter of 30 inches with pea gravel surrounding the pile seated directly on the bottom of the socket. The analysis indicates a maximum moment of 265 kip-feet occurs at the top of the pile under the Strength I load case and maximum lateral deflection of the pile cap of 0.98 inches. Results of the LPile first iteration analyses are summarized in Table 5-7. For both the 13 foot and 7 foot rock socketed piles analyzed at Abutment No. 2, fixity is not achieved, but the computed pile toe displacement is at or less than 1/8 inch (allowable based on our engineering judgement). The fixity check indicates there will be sufficient sliding resistance of the pile tip solely with the steel pile tip bearing against the bottom of the bedrock socket. The pile tips should be seated firmly onto the bedrock before casting the abutment. Recommendations for the socket construction and pile seating are provided in Section 6.0.

Table 5-7: LPile Lateral Analysis Results - First Iteration

Location	Axial Load Analyzed (kips)	Lateral Deflection[1] (in)	LPILE Moment at Pile Head (in-kips)	Plastic Hinge Moment (in-kips)	Plastic Hinge Forms
Abutment No. 1	456	0.98	2950	1693	Yes
Abutment No. 2 (13-foot pile)	445	0.98	2860	1729	Yes
Abutment No. 2 (7-foot pile)	403	0.98	3174	1885	Yes

1. From combined thermal effects and girder rotation as provided by HNTB[20]

[25] Bridge Software Institute. "FB-MultiPier Soil Parameter Table (US Customary Units)." Accessed on 4/10/2020. <https://bsi.ce.ufl.edu/downloads/files/MultiPier_Soil_Table.pdf>

Golder performed a sensitivity analysis on the depth of the rock socket for the Abutment No. 2 piles. Our goal was to evaluate the potential to achieve a minimum pile depth of 10 feet as specified in the MaineDOT Bridge Design Guide[15] where very shallow bedrock is encountered. We evaluated rock socket depths of 2 feet, 4 feet, and 6 feet. Results of the sensitivity analysis showed that a 2-foot length rock socket of 30-inches in diameter and pea stone fill in the annular space around the pile provides sufficient toe restraint to limit translation of the pile tip to a negligible amount (i.e., less than 1/8 inch). Furthermore, our analyses indicated that a rock socket that is greater in depth than 2 feet would fully restrain the tip, creating high bending moments associated with the abutment horizontal displacement and generate an unacceptable second plastic hinge at the bottom of the pile.

Since a plastic hinge forms at the top of the pile at both abutments, we assume that the pile head will enter plastic deformation. We then performed a second iteration using the same displacement and axial load conditions as the first iteration, but set the pile head moment equal to the plastic hinge moment predicted in the first iteration. Results of the LPile second iteration analyses are summarized in Table 5-8 and indicate that the demand ratio for combined bending is less than 1.0 in Segment 2, and therefore also shows that with the exception of the plastic hinge location, the pile remains within the elastic range over the remainder of its length and is stable against buckling. The results also indicate the nominal structural resistance in Segment 1 is sufficient to support the loads analyzed.

Table 5-8: LPile Lateral Analysis Results - Second Iteration

Location	Axial Load Analyzed (kips)	Lateral Deflection[1] (in)	Plastic Hinge Moment at Pile Head (in-kips)	Structural Resistance Demand Ratio, Segment 1[2]	Combined Axial and Bending Demand Ratio, Segment 2[3]	Computed Pile Toe Displacement (in)[4]
Abutment No. 1	456	0.98	1693	0.52	0.92	Fixity achieved
Abutment No. 2 (13-foot pile)	445	0.98	1729	0.51	0.76	0.002
Abutment No. 2 (7-foot pile)	403	0.98	1885	0.46	0.62	0.013

1. From combined thermal effects and girder rotation as provided by HNTB[20]
2. The ratio of the applied axial load (P_u) to the calculated compressive structural pile resistance in the upper portion of the pile ($P_{r.top}$) is recommended to be greater than 0.2 to avoid an unnecessarily large pile, as per the VTrans Integral Abutment Bridge Design Guidelines[26] Section 4.5.2.
3. The combined axial and bending demand ratio should be less than 1, as per AASHTO LRFD Article 6.9.2.2.1.
4. Fixity was not achieved for the Abutment No. 2 analyses; thus, the pile toe displacement should be limited to less than 1/8 inch, based on engineering judgement.

5.4.5 Pile Analysis Summary and Recommendations

We recommend the abutment piles be driven to, and seated on, bedrock and oriented with the weak axis parallel to the centerline of bearing. Drivability controls and should be the recommended governing resistances for pile

[26] Vermont Agency of Transportation (2008). Integral Abutment Bridge Design Guidelines. Accessed on 8/18/2021 <https://vtrans.vermont.gov/sites/aot/files/highway/documents/structures/SEI-08-004-1.pdf>

design. The recommended maximum factored loads for design of HP 14X89 piles at Abutments No. 1 and No. 2 including estimated downdrag loads, pile lengths, and pile orientation are provided in Table 5-9.

Table 5-9: Pile Analysis Summary.

Location	Recommended Nominal Pile Resistance (kips) [1]	Recommended Max. Factored Axial Load Per Pile (kips)	Estimated Factored Downdrag Load (kips)[2]	Estimated Pile Length (feet)	Proposed Rock Socket Length (feet)	Pile Orientation
Abutment No. 1	702	456	51	36.2	0	Weak
Abutment No. 2 (13-foot pile)	685	445	42	13.0	2.0	Weak
Abutment No. 2 (7-foot pile)	620	403	0	7.0	2.0	Weak

1. Using a resistance factor of 0.65 for driving criteria established by dynamic testing of one pile per abutment, but no less than 2% of the production piles.
2. Downdrag loads factored for Strength I.

5.5 Proposed Pier Foundation

Golder performed an analysis of the pier spread footing foundation as part of the preliminary geotechnical design. Our analyses and recommendations for use of a spread footing at the pier are provided in the PGDR[2].

6.0 CONSTRUCTION CONSIDERATIONS

All areas proposed for embankment fill placement or footing construction should be cleared, grubbed, and stripped of existing vegetation, pavement, and topsoil. During the grubbing and stripping process, unsuitable materials exposed at the subgrade level, such as wood, logs, tree stumps, organic silt, peat, soft clay, debris fill, or other materials that may compress, decay or collapse should be removed. Subgrade surfaces for embankments should be prepared in accordance with MaineDOT Standard Specifications and Standard Details, specifically Subsection 203.09 related to benching existing slopes before placement of fill materials.

Structural Fill materials and placement methods for abutment construction should meet the requirements of MaineDOT Standard Specifications, specifically Subsection 203.10 through Subsection 203.12.

If wet subgrade conditions are encountered in abutment and embankment fill areas, wet and disturbed subgrade material should be excavated and replaced with compacted Gravel Borrow, or an appropriate size stone which is enveloped with a geotextile (both as per MaineDOT Standard Specifications) to provide a firm base to allow proper compaction of overlying fills. If seepages persist over a broad subgrade area, provisions should be made to allow for positive drainage beneath and within the new abutments and embankment fills. Positive drainage could be provided by a layer of crushed stone wrapped in filter fabric that daylights beyond the new toe of slope.

Socketed Piles (Abutment No. 2): These piles should be installed in temporarily cased holes with a 30-inch-diameter socket drilled 2-feet into the top of bedrock. The annular space around the piles should be filled with a rounded 3/8-inch diameter pea stone to top of socket after the piles are placed into the socket. Excavation and

backfilling for the socketed piles should be completed in accordance with Special Provision 501 - Foundation Piles (Pre-Excavation for Piles) which is included in Appendix G.

Following installation and backfilling of the piles, the piles should be seated with a pile driving hammer. The purpose of the seating is to assure that the pile tip is in contact with the bedrock, in the event the pile is pulled up during the casing extraction. Care must be taken not to damage the piles nor to drive deeper into the bedrock. Piles should be fitted with standard prefabricated driving shoes meeting MaineDOT Standard Specification 501.048 and placed centered and plumb in the cased hole.

Driven Piles (Abutment No. 1 and Abutment No.2 following installation in sockets): We recommend implementing a field-verification program consisting of a wave equation analysis and dynamic testing with signal matching including the following. This is especially important for Abutment No. 1 driven piles where the actual pile lengths needed to develop the required axial resistance must be established:

- Prior to the beginning of pile driving, a wave equation analysis should be conducted on the contractor's proposed driving system for each abutment to ensure the hammer is capable of driving the piles to the required capacities without overstressing the piles to the required penetration depths and within a reasonable number of hammer blow counts, typically 3 blows per inch to 15 blows per inch at end of driving (EOD).
- Dynamic testing in accordance with MaineDOT specified procedures should be used to establish the driving criteria at the beginning of production pile driving. Two percent of the production piles or a minimum of one pile per substructure shall be subject to dynamic testing. We recommend the first production pile for each structure be tested during the initial drive and at the 24-hour (min.) restrike. Dynamic testing and field inspection should include verification of hammer stroke or bounce chamber pressures and hammer blows throughout the pile driving operations. To facilitate field inspection, the special provisions should include a requirement that the contractor provide the resident with a working Saximeter for the duration of pile testing and production pile driving. The Vermont Agency of Transportation provides the following details in Standard Specification 504.02(e)[27]:

  > Saximeter. The Contractor shall provide a Saximeter or equivalent device to assist the Inspector in collecting data to monitor the blow count (for all hammer types), the stroke (for open-end diesel hammers only), or the kinetic energy (if the hammer is equipped with proximity switches for measuring impact velocity). The Saximeter shall be completely charged and in sound working order prior to Agency use and shall be available for the duration of the pile driving operation. Pile driving operations shall not be conducted without the use of a Saximeter.
  >
  > The Saximeter shall perform the following functions:
  >
  > 1. Detect hammer blows automatically using sound recognition circuits, or manually with a keypad.
  > 2. Automatically count blows and determine the blows per minute (BPM) for all impact hammers.
  > 3. Calculate the stroke for open-end diesel hammers.

[27] Vermont Agency of Transportation (2018). Standard Specifications for Construction. Accessed on 8/18/2021 <https://outside.vermont.gov/agency/VTRANS/external/docs/construction/02ConstrServ/PreContract/2018SpecBook/2018%20Standard%20Specifications%20for%20Construction.pdf>

4. Store blow count, penetration, average stroke, or BPM data in memory.
5. Permit viewing of results on built-in screen.
6. Permit data transfer to PCs or printers.

For hammers equipped with proximity switches, the Saximeter shall be deployed to acquire hammer impact velocity data by communicating with a transmitter mounted on the hammer and use this information to calculate the hammer's kinetic energy.

The Saximeter shall operate on rechargeable batteries, with batteries and charger supplied by the Contractor.

- All piles should be driven to achieve bearing at the top of bedrock. We recommend that MaineDOT's typical refusal criteria of 10 blows per 0.5 inches be implemented to reduce structural damage to the piles. The piles should be fitted with standard prefabricated driving shoes meeting MaineDOT Standard Specification 501.048 to reduce potential for damaging the piles during driving and to engage the piles on sloping bedrock.
- The Engineer should review all dynamic pile testing results before the piles are cut off.
- Signal matching analysis of the dynamic test data using methods described by Rausche et al. (1972)[28] should be conducted to determine pile bearing resistance.

Our analyses are presently based on the embankment fills near the abutments being placed after the piles/abutment. This was done to account for the largest potential downdrag loading on the piles.

The excavation for the spread footing for the center pier needs to be done carefully to avoid over-excavation of the strongly foliated, slightly weathered bedrock with steeply dipping discontinuities parallel to the foliation (see PGDR[2] for more information on the bedrock at the proposed pier locations). The bedrock surface needs to be cleaned of soil with air or water pressure and the excavation dewatered sufficiently to allow the surface to be evaluated by the Engineer before casting the sub-footing concrete.

The bedrock surface elevations should be measured on a 4-foot maximum grid pattern to evaluate whether it is sloping steeper than 4 Horizontal to 1 Vertical (4H:1V). This information should be given to the design engineer to evaluate whether benching of the bedrock surface is necessary for sliding resistance purposes.

Since excavations along the existing I-295 embankment and for the piers will be adjacent to live traffic, limits on tolerable horizontal and vertical movement of the ground adjacent to the excavation should be provided in the construction documents and the contractor should be required to develop a monitoring plan for implementation prior to start of construction. Requirements for frequency of monitoring and minimum action levels should be outlined in the specification. Action levels would correspond to requiring increased attention to limiting further movements. Limiting movements acceptable to MaineDOT should also be specified requiring the contractor to suspend excavation until they submit an acceptable plan showing how further movements will be restricted.

7.0 REPORT AND EXPLORATION LIMITATIONS

This Supplemental Geotechnical Design Report was prepared for the exclusive use of MaineDOT and HNTB for specific application to the proposed Mallet Drive bridge replacement at I-295 Exit 22 in Freeport, Maine. We

[28] Rausche, F., F. Moses, and G. G. Goble. 1972. "Soil Resistance Predictions from Pile Dynamics," *Journal of the Soil Mechanics and Foundation Division*. American Society of Civil Engineers, Reston, VA, Vol. 98, No. SM9, pp. 917–937.

conducted our evaluations and compiled our recommendations in accordance with generally accepted soil and foundation engineering practices in this geographical area and under similar time and financial constraints. Golder makes no other warranty, either express or implied. If changes in the nature, design, or location of the proposed project are planned, Golder should be notified to review the appropriateness of our conclusions and recommendations, and to modify the recommendations as appropriate to reflect the changes in design. In addition, Golder should review the final plans and specifications to evaluate compliance with these recommendations.

Our analyses and recommendations are based, in part, on information obtained from the referenced subsurface explorations completed at the discrete locations described in the report. Variations in the nature and extent of subsurface conditions between explorations should be expected. Golder should be notified if conditions encountered during construction vary from those described in this report so that we may re-evaluate, and if necessary, revise the recommendations made in this report.

The professional services provided by Golder for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this report and have not been investigated or addressed.

Signature Page

Golder Associates Inc.

Melissa E. Landon, PhD, PE
Senior Project Engineer

Christopher C. Benda, PE
Practice Leader

MEL/CCB/RAW

https://golderassociates.sharepoint.com/sites/139982/project files/6 deliverables/sgdr part i 21450910/final/sgdr part 1 final - freeport bridge 5721 win 021726.00 - golder 21450910.docx

Tables

Table 1: Bedrock Depths from Rock Probes and Borings Nearby Abutments
Supplemental Geotechnical Design Report Part I
I-295 Mallet Drive Bridge Replacement #5721 (Exit 22)
Freeport, Maine
MaineDOT WIN 021726.00

Test Boring Designation[1]	As-Drilled Locations[2,3]		Existing Ground Surface Elevation[3] (ft)	Boring Depth[4] (ft)	Bedrock Elevation[4] (ft)	Bedrock Depth[4] (ft)	Nearby Feature
	Stationing	Offset (ft)					
BB-FMD-101	29+65.7	21.8 L	161.0	54.0	117.2	43.8	Abutment 1
BB-FMD-102	30+97.7	21.3 L	143.1	24.3	130.1	13.0	Pier
BB-FMD-103	32+22.2	23.3 L	166.2	29.5	147.2	19.0	Abutment 2
BB-FMD-104	32+47.7	94.9 R	144.6	16.3	138.3	6.3	Abutment 2
BB-FMD-105	30+99.6	4.1 R	142.5	19.3	133.2	9.3	Pier
BB-FMD-106	30+20.0	81.7 R	129.2	35.8	113.4	15.8	Abutment 1
BB-FMD-205	32+50.0	53.0 R	147.0	10.0	142.3	4.7	Abutment 2
BB-FMD-208	32+15.3	23.2 L	166.0	23.5	147.5	18.5	Abutment 2
RP-FMD-204	29+80.3	11.6 R	160.8	33.0	-	-[5]	Abutment 1
RP-FMD-209	32+16.1	13.6 L	166.4	16.0	150.4	16	Abutment 2
RP-FMD-210	32+18.3	1.2 L	166.7	15.0	151.7	15	Abutment 2
RP-FMD-211	32+21.5	9.6 R	166.2	15.5	150.7	15.5	Abutment 2

References

A. Golder Associates, Inc., December 21, 2020, Preliminary Geotechnical Design Report, I-295 Mallet Drive Bridge Replacement #5721 (Exit 22), Freeport, Maine, MaineDOT WIN 021726.00
B. Golder Associates, Inc., August 20, 2021, Supplemental Geotechnical Design Report Part II, I-295 Mallet Drive Bridge Replacement #5721 (Exit 22), Freeport, Maine, MaineDOT WIN 021726.00.

Notes:

1. Borings BB-FMD-10X were performed by New England Boring Contractors from December 15 to 17, 2019 as part of a preliminary design (Ref A). Borings BB-FMD-205 and BB-FDR-208 were performed by S.W. Cole on June 10, 2021 and June 2 to 3, 2021, respectively. Rock probes RP-FMD-2XX were performed by Maine Drilling and Blasting on June 9 and June 22, 2021.
2. All test boring (BB-FMD-XXX) and rock probe (RP-FMD-XXX) locations are illustrated in Sheet 2 through Sheet 4 entitled "Boring Location Plan".
3. As-drilled locations and elevations for BB-FMD-20X and RP-FMD-2XX are derived from survey files within the emails titled "FW Exit 20 and 22 Borings and Probes Freeport" received by Golder on June 11 and June 28, 2021 from MaineDOT and are provided in Ref. B. As-drilled locations and elevations for BB-FMD-10X are derived from the survey file received from MaineDOT on January 6, 2020 titled: "BOR12-18-19edit.csv".
4. Boring logs are provided in Appendix A.
5. Top of rock not reached due to rock probe rig mechanical limitations.

Prepared By: HTV
Checked By: BK
Reviewed By: CCB

Table 2: Summary of Soil Properties Used in LPile Analysis - Abutment No. 1
Supplemental Geotechnical Design Report Part I
I-295 Mallet Drive Bridge Replacement #5721 (Exit 22)
Freeport, Maine
MaineDOT WIN 021726.00

Stratigraphy		Depth Below Base of Abutment (ft)[1]	Layer Thickness (ft)	Lateral Model[6]	Effective Unit Weight (pcf)	Undrained Shear Strength (psf)[2]	ϕ (deg)[2]	Subgrade Modulus (pci)[3]	Major Principal Strain @ 50%[3]	UCS (psi)[2]
Existing Fill (above WT)	Layer 1	0.0 11.8	11.8	Sand (Reese)	125	-	33	165	-	-
Glaciomarine Silty Clay (above WT)	Layer 2	11.8 13.9	2.1	Stiff Clay w/ Free Water (Reese)	115	3500		500	0.005	-
Glaciomarine Silty Clay (below WT)	Layer 3	13.9 34.2	20.3	Stiff Clay w/o Free Water (Reese)	52.6	3500	-	-	0.005	-
Sand and Gravel	Layer 4	34.2 36.2	2.0	Sand (Reese)	62.6	-	36	100	-	-
Bedrock	Layer 5	36.2 50.0	13.8	Strong Rock (Vuggy Limestone)	106.6	-	-	-	-	12604

Notes:

1. Golder's Interpreted Subsurface Section A-A' (Sheet 5).
2. Golder geotechnical test boring logs (100-series: Appendix A, Preliminary Geotechnical Design Report, dated September 2020, 200-series: Appendix A, Supplemental Geotechnical Design Report Part 2).
3. Bridge Software Institute. “FB-MultiPier Soil Parameter Table (US Customary Units).” Accessed July 2020. <https://bsi.ce.ufl.edu/downloads/files/MultiPier_Soil_Table.pdf>
4. WT = water table
5. ft = feet, pcf = pounds per cubic foot, psf = pounds per square foot, deg = degrees, pci = pounds per cubic inch; psi = pounds per square inch
6. Layer names refer to the LPile lateral model type rather than the actual soil or rock encountered at site.

Prepared by: DAF
Checked by: KAR
Reviewed by: JEL

Table 3: Summary of Soil Properties Used in LPile Analysis - Abutment No. 2 (Longer Pile)
Supplemental Geotechnical Design Report Part I
I-295 Mallet Drive Bridge Replacement #5721 (Exit 22)
Freeport, Maine
MaineDOT WIN 021726.00

Stratigraphy		Depth Below Base of Abutment (ft)[1]	Layer Thickness (ft)	Lateral Model[6,7]	Effective Unit Weight (pcf)	Undrained Shear Strength (psf)[2]	ϕ (deg)[2]	Subgrade Modulus (pci)[3]	Major Principal Strain @ 50%[3]	UCS (psi)[2]
Proposed Fill (above WT)	Layer 1	0.0 9.5	9.5	Sand (Reese)	125	-	32	88	-	-
Existing Fill (above WT)	Layer 2	9.5 10.0	0.5	Sand (Reese)	125	-	33	165	-	-
Existing Fill (below WT)	Layer 3	10.0 11.0	1.0	Sand (Reese)	62.6	-	33	100	-	-
Bedrock	Layer 4	11.0 13.0	2.0	Strong Rock (Vuggy Limestone)	106.6	-	-	-	-	2486

Notes:

1. Golder's Interpreted Subsurface Section A-A' (Sheet 5).
2. Golder geotechnical test boring logs (100-series: Appendix A, Preliminary Geotechnical Design Report, dated September 2020, 200-series: Appendix A, Supplemental Geotechnical Design Report Part 2).
3. Bridge Software Institute. “FB-MultiPier Soil Parameter Table (US Customary Units).” Accessed July 2020. <https://bsi.ce.ufl.edu/downloads/files/MultiPier_Soil_Table.pdf>
4. WT = water table
5. ft = feet, pcf = pounds per cubic foot, psf = pounds per square foot, deg = degrees, pci = pounds per cubic inch; psi = pounds per square inch
6. Layer names refer to the LPile lateral model type rather than the actual soil or rock encountered at site.
7. The bottom two feet of the pile (within the rock socket) is modeled in LPile as a circular drilled shaft section with an H-pile insert. The material surrounding the drilled shaft exterior is modeled as "Strong Rock (Vuggy Limestone)"; the material in the annulus between the drilled shaft wall and the H-pile is modeled with a compressive strength of 50 psi to represent pea stone backfill.

Prepared by: DAF
Checked by: KAR
Reviewed by: JEL

Table 4: Summary of Soil Properties Used in LPile Analysis - Abutment No. 2 (Shorter Pile)
Supplemental Geotechnical Design Report Part I
I-295 Mallet Drive Bridge Replacement #5721 (Exit 22)
Freeport, Maine
MaineDOT WIN 021726.00

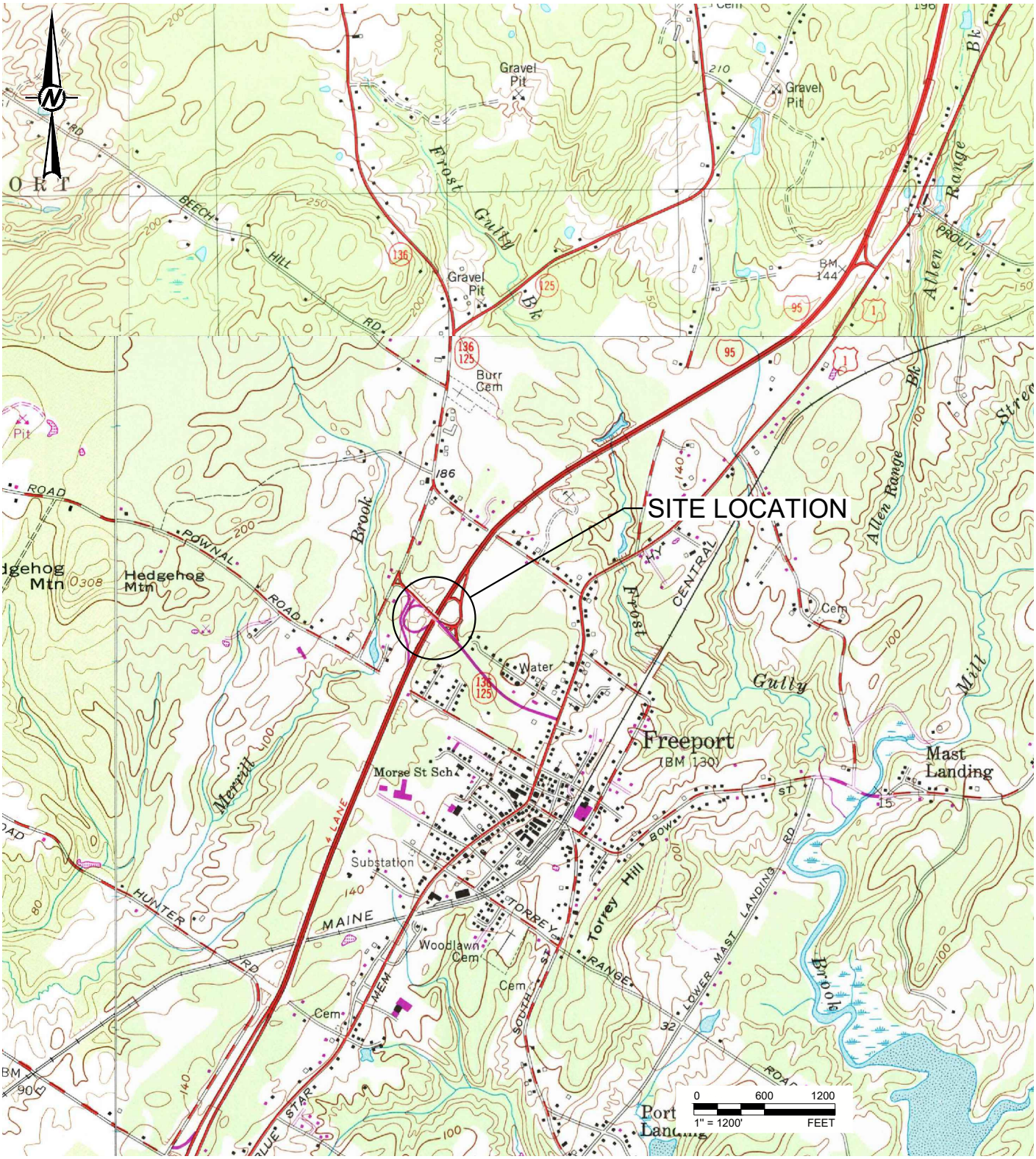
Stratigraphy		Depth Below Base of Abutment (ft)[1]	Layer Thickness (ft)	Lateral Model[6,7]	Effective Unit Weight (pcf)	Undrained Shear Strength (psf)[2]	ϕ (deg)[2]	Subgrade Modulus (pci)[3]	Major Principal Strain @ 50%[3]	UCS (psi)[2]
Existing Fill (above WT)	Layer 1	0.0 4.0	4.0	Sand (Reese)	125	-	33	165	-	-
Existing Fill (below WT)	Layer 2	4.0 5.0	1.0	Sand (Reese)	62.6	-	33	100	-	-
Bedrock	Layer 3	5.0 7.0	2.0	Strong Rock (Vuggy Limestone)	106.6	-	-	-	-	2486

Notes:

1. Golder's Interpreted Subsurface Section A-A' (Sheet 5).
2. Golder geotechnical test boring logs (100-series: Appendix A, Preliminary Geotechnical Design Report, dated September 2020, 200-series: Appendix A, Supplemental Geotechnical Design Report Part 2).
3. Bridge Software Institute. “FB-MultiPier Soil Parameter Table (US Customary Units).” Accessed July 2020. <https://bsi.ce.ufl.edu/downloads/files/MultiPier_Soil_Table.pdf>
4. WT = water table
5. ft = feet, pcf = pounds per cubic foot, psf = pounds per square foot, deg = degrees, pci = pounds per cubic inch; psi = pounds per square inch
6. Layer names refer to the LPile lateral model type rather than the actual soil or rock encountered at site.
7. The bottom two feet of the pile (within the rock socket) is modeled in LPile as a circular drilled shaft section with an H-pile insert. The material surrounding the drilled shaft exterior is modeled as "Strong Rock (Vuggy Limestone)"; the material in the annulus between the drilled shaft wall and the H-pile is modeled with a compressive strength of 50 psi to represent pea stone backfill.

Prepared by: DAF
Checked by: KAR
Reviewed by: JEL

Sheets



REFERENCE(S)

BASE MAP TAKEN FROM U.S.G.S. 7.5 MINUTE QUADRANGLE OF FREEPORT, MAINE DATED 1957

STATE OF MAINE
CHRISTOPHER C. BENDA
No. 15164
LICENSED
PROFESSIONAL ENGINEER

CLIENT

MAINE DEPARTMENT OF TRANSPORTATION
16 STATE HOUSE STATION
AUGUSTA, MAINE 04333

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2021-08-20
DESIGNED	MEL
PREPARED	AAZ
REVIEWED	MEL
APPROVED	CCB

PROJECT

I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22)
FREEPORT, MAINE
MAINEDOT WIN 021726.00

TITLE

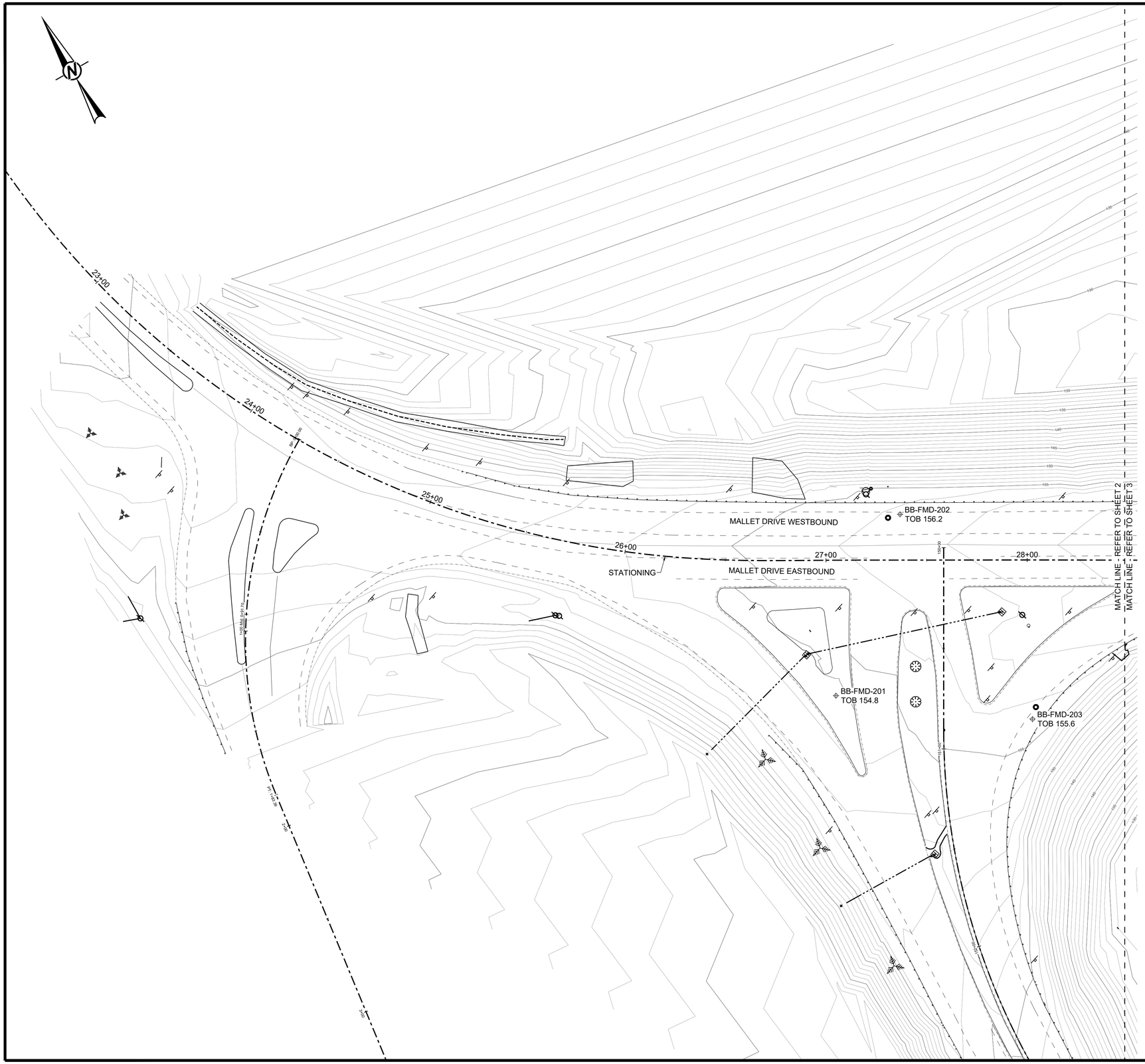
SITE LOCATION PLAN

PROJECT NO.	SUBTITLE	REV.	SHEET
21450910	A	0	1 OF 6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

1 in

0



LEGEND

◉	PROPOSED HIGH MAST LIGHTING (SEE SHEET 3)
○	PROPOSED MAST ARM FOUNDATION
⊕ BB-FDR-102 TOB 130.1	COMPLETED 100 SERIES BORINGS (SEE SHEET 3)
⊕ BB-FDR-202 TOB 156.2	COMPLETED 200 SERIES BORINGS
TOB XXX.X	ELEVATION OF TOP OF BORING

NOTE(S)

1. AS DRILLED BORING LOCATION PLAN FOR 100-SERIES BORINGS DERIVED FROM ELECTRONIC FILE NAME: "BOR12-18-19edit.csv" PROVIDED TO GOLDER BY MAINE DEPARTMENT OF TRANSPORTATION ON 01/06/2020. AS DRILLED BORING LOCATION PLAN FOR 200-SERIES BORINGS DERIVED FROM ELECTRONIC FILE NAME: "21726 Exit22 - 200 Series Borings Compiled" PROVIDED TO GOLDER BY MAINE DEPARTMENT OF TRANSPORTATION ON 06/24/2021.

REFERENCE(S)

1. BASEMAP ELEMENTS TAKEN FROM MAINE DOT IN FILE NAMED "3DTopo_2019-11-18.dgn" RECIEVED ON JANUARY 2, 2020.
2. SURVEY DATA PROVIDED TO GOLDER ON JANUARY 2, 2020 BY MAINE DOT IN FILE "FREEPORT 21726.00 SURVEY DATA 2019-11-18.zip".
3. PROPOSED STATIONING PROVIDED TO GOLDER BY HNTB FOR A SOUTHERN SHIFT OF THE BRIDGE.
4. LOCATIONS FOR MAST ARM FOUNDATIONS AND LIGHT STANDARD FOUNDATIONS DERIVED FROM ELECTRONIC FILE NAME: "Foundation Location Tables.pdf" PROVIDED BY HNTB ON JUNE 29, 2021.
5. GOLDER ASSOCIATES, INC., DECEMBER 21, 2020, PRELIMINARY GEOTECHNICAL DESIGN REPORT, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.
6. GOLDER ASSOCIATES, INC., AUGUST 20, 2021, SUPPLEMENTAL BRIDGE GEOTECHNICAL DESIGN REPORT Part I, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.
6. GOLDER ASSOCIATES, INC., AUGUST 20, 2021, SUPPLEMENTAL BRIDGE GEOTECHNICAL DESIGN REPORT Part II, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.
7. EXIT RAMP ALIGNMENTS PROVIDED TO GOLDER BY HNTB ON JULY 14, 2021.

0 25 50
1" = 25' FEET

GOLDER
MEMBER OF WSP

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

021726.00

WIN
021726.00

Bridge No. 5721

BRIDGE PLANS

STATE OF MAINE · CHRISTOPHER J. VONDRA · No. 15164 · LICENSED PROFESSIONAL ENGINEER

	BY	DATE
MEL	AAZ	2021-08-20
	AAZ	2021/08/20
SIGNATURE		
P.E. NUMBER		
DATE		

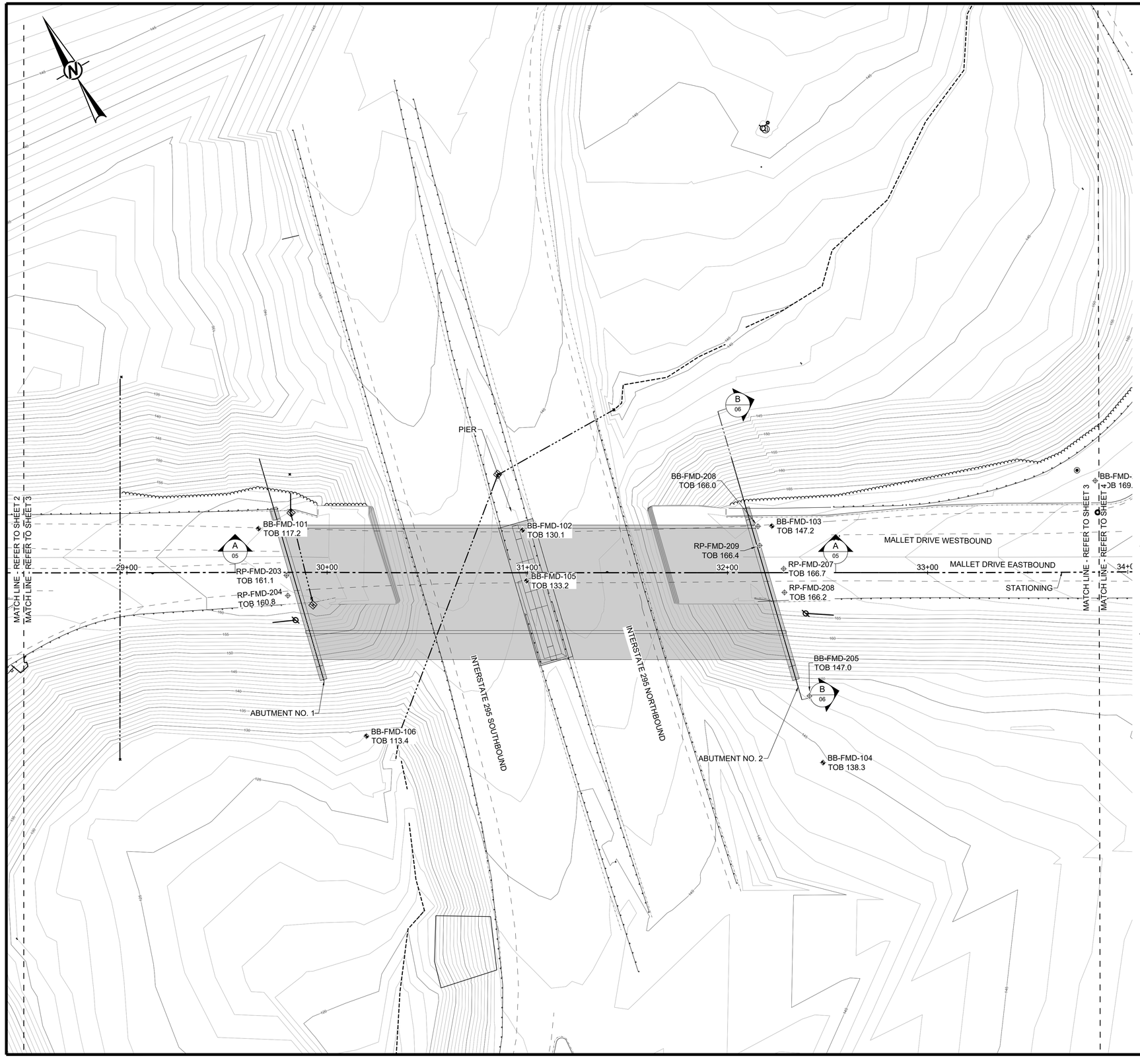
PROJ. MANAGER	MEL
DESIGN- DETAILED	MEL
CHECKED- REVIEWED	CDB
DESIGN2- DETAILED2	
DESIGN3- DETAILED3	
REVISIONS 1	
REVISIONS 2	
REVISIONS 3	
REVISIONS 4	
FIELD CHANGES	

APPROACH ROAD BRIDGE
INTERSTATE 295
FREEPORT CUMBERLAND

BORING LOCATION PLAN

SHEET NUMBER
2
OF 6

Filename: 21450910_0002_003.dwg Division: Username: Date:2021-07-02



LEGEND

RP-FDR-201	COMPLETED ROCK PROBES
	PROPOSED HIGH MAST LIGHTING
	PROPOSED MAST ARM FOUNDATION
BB-FDR-102 TOB 130.1	COMPLETED 100 SERIES BORINGS (SEE SHEET 3)
BB-FDR-202 TOB 156.2	COMPLETED 200 SERIES BORINGS
TOB XXX.X	ELEVATION OF TOP OF BORING OR ROCK PROBE

NOTE(S)

1. AS DRILLED BORING LOCATION PLAN FOR 100-SERIES BORINGS DERIVED FROM ELECTRONIC FILE NAME: "BOR12-18-19edit.csv" PROVIDED TO GOLDER BY MAINE DEPARTMENT OF TRANSPORTATION ON 01/06/2020. AS DRILLED BORING LOCATION PLAN FOR 200-SERIES BORINGS DERIVED FROM ELECTRONIC FILE NAME: "21726 Exit22 - 200 Series Borings Compiled" PROVIDED TO GOLDER BY MAINE DEPARTMENT OF TRANSPORTATION ON 06/24/2021.

REFERENCE(S)

1. BASEMAP ELEMENTS TAKEN FROM MAINE DOT IN FILE NAMED "3DTopo_2019-11-18.dgn" RECEIVED ON JANUARY 2, 2020.
2. SURVEY DATA PROVIDED TO GOLDER ON JANUARY 2, 2020 BY MAINE DOT IN FILE "FREEPORT 21726.00 SURVEY DATA 2019-11-18.zip".
3. PROPOSED STATIONING PROVIDED TO GOLDER BY HNTB FOR A SOUTHERN SHIFT OF THE BRIDGE.
4. LOCATIONS FOR MAST ARM FOUNDATIONS AND LIGHT STANDARD FOUNDATIONS DERIVED FROM ELECTRONIC FILE NAME: "Foundation Location Tables.pdf" PROVIDED BY HNTB ON JUNE 29, 2021.
5. GOLDER ASSOCIATES, INC., DECEMBER 21, 2020, PRELIMINARY GEOTECHNICAL DESIGN REPORT, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.
6. GOLDER ASSOCIATES, INC., AUGUST 20, 2021, SUPPLEMENTAL BRIDGE GEOTECHNICAL DESIGN REPORT Part I, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.
7. GOLDER ASSOCIATES, INC., AUGUST 20, 2021, SUPPLEMENTAL BRIDGE GEOTECHNICAL DESIGN REPORT Part II, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.
8. EXIT RAMP ALIGNMENTS PROVIDED TO GOLDER BY HNTB ON JULY 14, 2021.
9. DETAILS OF BRIDGE AND FOUNDATION ELEMENTS TAKEN FROM HNTB, APPROACH ROAD BRIDGE OVER INTERSTATE 295 AND SIGNALIZED INTERSECTIONS, EXIT 22 INTERCHANGE: 98% PS&E, DATED JULY 16, 2021.

0 25 50
1" = 25' FEET

GOLDER
MEMBER OF WSP

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

Ø21726.00

WIN
Ø21726.00

Bridge No. 5721

BRIDGE PLANS

STATE OF MAINE · CHRISTOPHER C. BONDA No. 15164 · LICENSED PROFESSIONAL ENGINEER

PROJ. MANAGER	MEL		
DESIGN-DETAILED	MEL	2021-08-20	
CHECKED-REVIEWED	CCB	2021/08/20	SIGNATURE
DESIGN2-DETAILED2			
DESIGN3-DETAILED3			P.E. NUMBER
REVISIONS 1	MEL	AAZ	
REVISIONS 2			
REVISIONS 3			DATE
REVISIONS 4			
FIELD CHANGES			

APPROACH ROAD BRIDGE
INTERSTATE 295
FREEPORT CUMBERLAND

BORING LOCATION PLAN

SHEET NUMBER
3
OF 6

Date:2021-07-02
Username:
Division:
Filename: 21450910_0002_003.dwg

LEGEND

◉	PROPOSED HIGH MAST LIGHTING
○	PROPOSED MAST ARM FOUNDATION
BB-FDR-102 TOB 130.1	COMPLETED 100 SERIES BORINGS (SEE SHEET 3)
BB-FDR-202 TOB 156.2	COMPLETED 200 SERIES BORINGS
TOB XXX.X	ELEVATION OF TOP OF BORING

NOTE(S)

1. AS DRILLED BORING LOCATION PLAN FOR 100-SERIES BORINGS DERIVED FROM ELECTRONIC FILE NAME: "BOR12-18-19edit.csv" PROVIDED TO GOLDER BY MAINE DEPARTMENT OF TRANSPORTATION ON 01/06/2020. AS DRILLED BORING LOCATION PLAN FOR 200-SERIES BORINGS DERIVED FROM ELECTRONIC FILE NAME: "21726 Exit22 - 200 Series Borings Compiled" PROVIDED TO GOLDER BY MAINE DEPARTMENT OF TRANSPORTATION ON 06/24/2021.

REFERENCE(S)

1. BASEMAP ELEMENTS TAKEN FROM MAINE DOT IN FILE NAMED "3DTopo_2019-11-18.dgn" RECEIVED ON JANUARY 2, 2020.
2. SURVEY DATA PROVIDED TO GOLDER ON JANUARY 2, 2020 BY MAINE DOT IN FILE "FREEPORT 21726.00 SURVEY DATA 2019-11-18.zip".
3. PROPOSED STATIONING PROVIDED TO GOLDER BY HNTB FOR A SOUTHERN SHIFT OF THE BRIDGE.
4. LOCATIONS FOR MAST ARM FOUNDATIONS AND LIGHT STANDARD FOUNDATIONS DERIVED FROM ELECTRONIC FILE NAME: "Foundation Location Tables.pdf" PROVIDED BY HNTB ON JUNE 29, 2021.
5. GOLDER ASSOCIATES, INC., DECEMBER 21, 2020, PRELIMINARY GEOTECHNICAL DESIGN REPORT, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.
6. GOLDER ASSOCIATES, INC., AUGUST 20, 2021, SUPPLEMENTAL BRIDGE GEOTECHNICAL DESIGN REPORT Part I, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.
7. GOLDER ASSOCIATES, INC., AUGUST 20, 2021, SUPPLEMENTAL BRIDGE GEOTECHNICAL DESIGN REPORT Part II, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.
8. EXIT RAMP ALIGNMENTS PROVIDED TO GOLDER BY HNTB ON JULY 14, 2021.

0 25 50
1" = 25' FEET

GOLDER
MEMBER OF WSP

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

021726.00

WIN
021726.00

Bridge No. 5721

BRIDGE PLANS

STATE OF MAINE · CHRISTOPHER J. PINKHAM · No. 15164 · LICENSED PROFESSIONAL ENGINEER

	BY	DATE
MEL	AAZ	2021-08-20
MEL	AAZ	2021/08/20

SIGNATURE

P.E. NUMBER

DATE

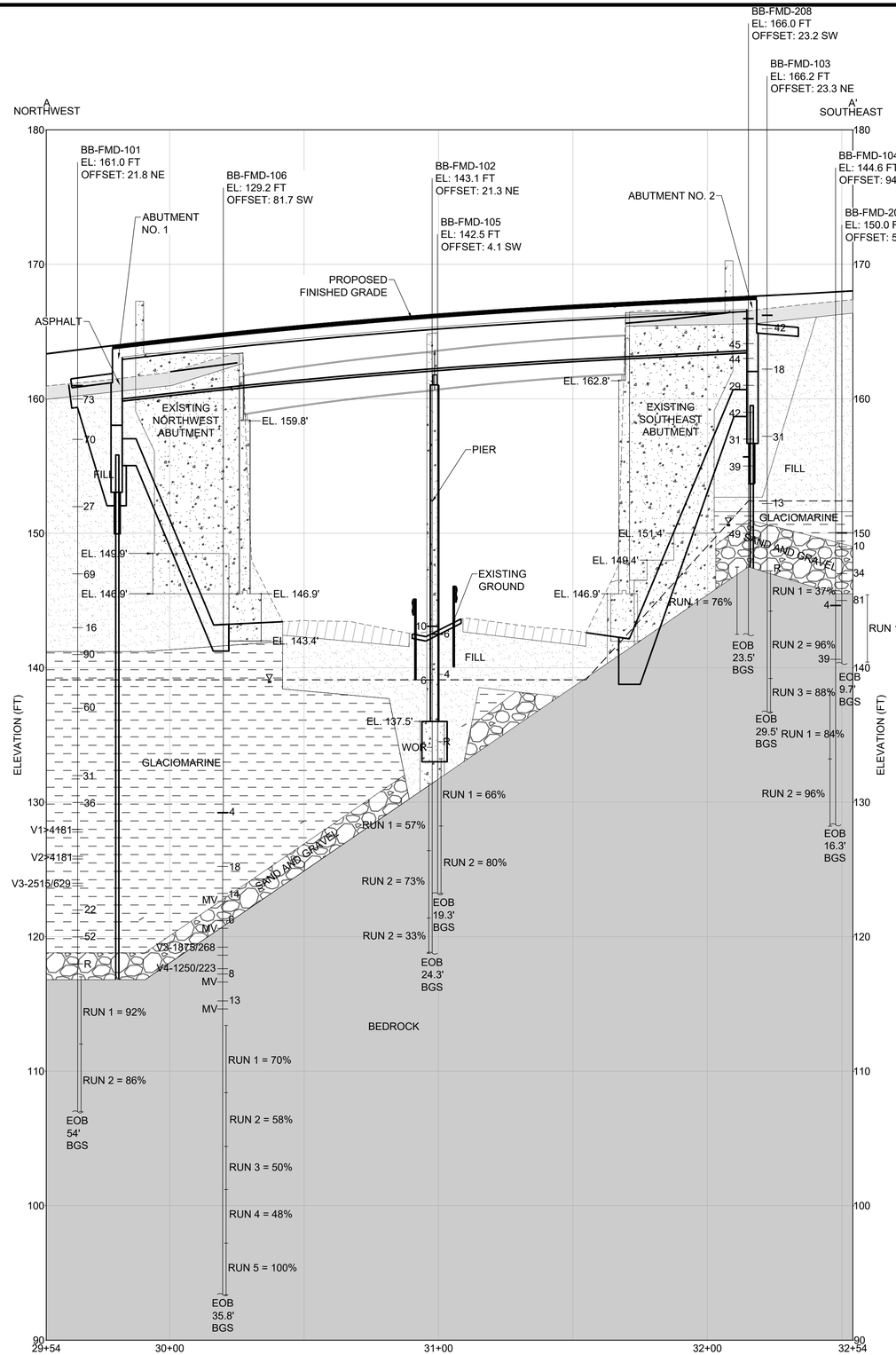
PROJ. MANAGER	MEL
DESIGN-DETAILED	MEL
CHECKED-REVIEWED	CCB
DESIGN2-DETAILED2	
DESIGN3-DETAILED3	
REVISIONS 1	
REVISIONS 2	
REVISIONS 3	
REVISIONS 4	
FIELD CHANGES	

APPROACH ROAD BRIDGE
INTERSTATE 295
FREEPORT CUMBERLAND

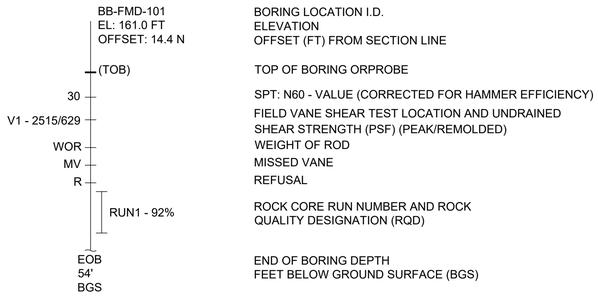
BORING LOCATION PLAN

SHEET NUMBER
4
OF 6

Filename: 21450910_0002_003.dwg Division: Username: Date:2021-07-02



LEGEND



NOTES:

1. AS DRILLED BORING LOCATION PLAN FOR 100-SERIES BORINGS DERIVED FROM ELECTRONIC FILE NAME: "BOR12-18-19edit.csv" PROVIDED TO GOLDER BY MAINE DEPARTMENT OF TRANSPORTATION ON 01/06/2020. AS DRILLED BORING LOCATION PLAN FOR 200-SERIES BORINGS DERIVED FROM ELECTRONIC FILE NAME: "21726 Exit22 - 200 Series Borings Compiled" PROVIDED TO GOLDER BY MAINE DEPARTMENT OF TRANSPORTATION ON 06/24/2021.
2. FOR DETAILED LITHOLOGIC DESCRIPTIONS SEE BORING LOGS IN NOTE 8, APPENDIX A (100-SERIES BORINGS) AND NOTE 9, APPENDIX A (200-SERIES BORINGS).
3. FOR COMPLETE LABORATORY DATA SEE LABORATORY REPORTS IN NOTE 8 (100-SERIES BORINGS) AND NOTE 9 (200-SERIES BORINGS).
4. GROUNDWATER SURFACE IS INTERPRETED FROM LOCALIZED SURFACE WATER LEVELS AND MEASUREMENTS TAKEN DURING THE SUBSURFACE EXPLORATION PROGRAMS. FOR DETAILS ON THE SUBSURFACE EXPLORATION PROGRAMS, SEE NOTE 8 (100-SERIES BORINGS) AND NOTE 9 (200-SERIES BORINGS).
5. THIS GENERALIZED SUBSURFACE PROFILE IS INTENDED TO CONVEY TRENDS IN SUBSURFACE CONDITIONS. THE BOUNDARIES BETWEEN STRATA ARE APPROXIMATE AND IDEALIZED AND HAVE BEEN DEVELOPED BASED ON INTERPRETATIONS OF WIDELY SPACED EXPLORATIONS. ACTUAL SOIL AND ROCK TRANSITIONS MAY VARY AND ARE PROBABLY MORE ERRATIC. FOR MORE SPECIFIC INFORMATION, REFER TO BORING LOGS IN NOTE 8, APPENDIX A (100-SERIES BORINGS) AND NOTE 9, APPENDIX A (200-SERIES BORINGS).
6. ABUTMENT AND PIER DETAILS INTERPRETED FROM ELECTRONIC FILE NAME "5721 FREEPORT 1956" PROVIDED TO GOLDER ON 8/22/2019 AND "Mallett Dr Profile1to1.dgn" PROVIDED TO GOLDER BY HNTB ON MAY 27, 2021.
7. FOR SOIL STRATA ANALYSIS THE ASPHALT LAYER AND ROADFILL LAYER ARE COMBINED FOR A LAYER THICKNESS OF FIVE FEET.
8. GOLDER ASSOCIATES, INC., DECEMBER 21, 2020, PRELIMINARY GEOTECHNICAL DESIGN REPORT, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.
9. GOLDER ASSOCIATES, INC., AUGUST 20, 2021, SUPPLEMENTAL BRIDGE GEOTECHNICAL DESIGN REPORT Part I, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.
10. GOLDER ASSOCIATES, INC., AUGUST 20, 2021, SUPPLEMENTAL BRIDGE GEOTECHNICAL DESIGN REPORT Part II, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.

0 5 10
1" = 5' FEET

0 25 50
1" = 25' FEET

GOLDER
MEMBER OF WSP

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

021726.00

WIN
021726.00

Bridge No. 5721

BRIDGE PLANS

STATE OF MAINE
CHRISTOPHER J. LACHER
No. 15164
REGISTERED PROFESSIONAL ENGINEER

PROJ. MANAGER	MEL		
DESIGN-DETAILED	MEL	AAZ	2021-08-20
CHECKED-REVIEWED	CCB	AAZ	2021/08/20
DESIGN2-DETAILED2			
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE

P.E. NUMBER

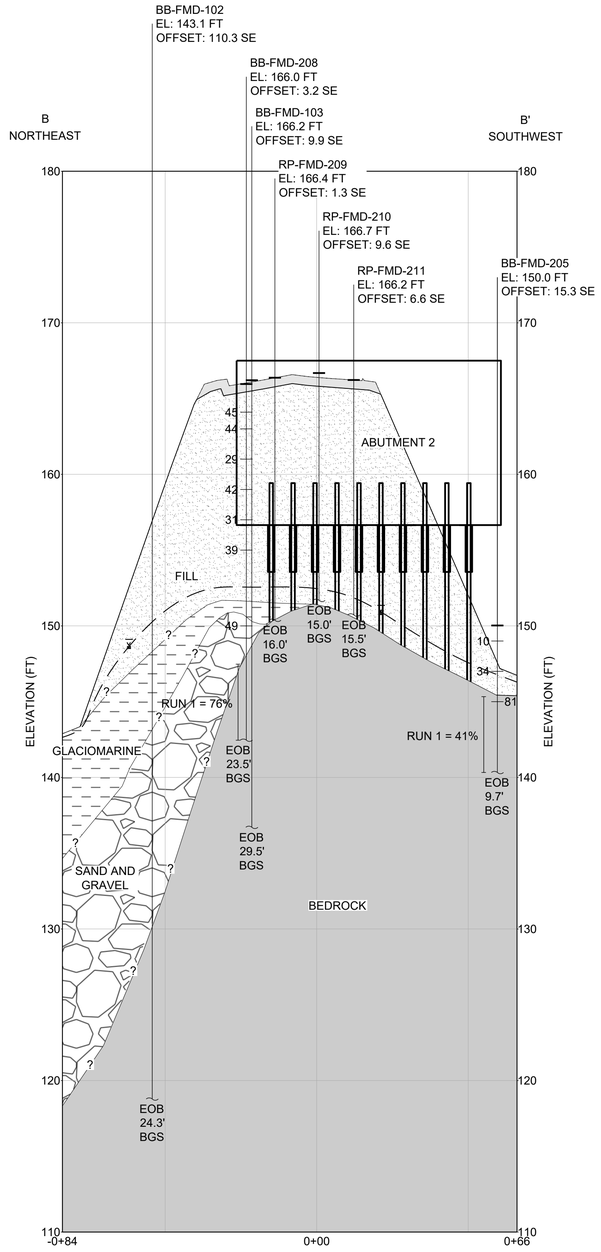
DATE

APPROACH ROAD BRIDGE
INTERSTATE 295
FREEPORT CUMBERLAND

INTERPRETIVE SUBSURFACE PROFILE A-A'

SHEET NUMBER
5
OF 6

Filename: 21450910_0002_004 Division: Username: Date:2021-07-02



LEGEND

RP-FMD-210 BB-FMD-101 EL: 161.0 FT OFFSET: 14.4 N	ROCK PROBE LOCATION I.D. BORING LOCATION I.D. ELEVATION OFFSET (FT) FROM SECTION LINE
(TOB)	TOP OF BORING OR PROBE
30	SPT: N60 - VALUE (CORRECTED FOR HAMMER EFFICIENCY)
V1 - 2515/629	FIELD VANE SHEAR TEST LOCATION AND UNDRAINED SHEAR STRENGTH (PSF) (PEAK/REMOLDED)
WOR	WEIGHT OF ROD
MV	MISSED VANE
R	REFUSAL
RUN1 - 92%	ROCK CORE RUN NUMBER AND ROCK QUALITY DESIGNATION (RQD)
EOB 54' BGS	END OF BORING OR ROCK PROBE DEPTH FEET BELOW GROUND SURFACE (BGS)

- ASPHALT
- PROPOSED ABUTMENT ELEMENTS
- BROWN TO GRAY, LOOSE TO MEDIUM DENSE, SILTY FINE TO COARSE SAND AND GRAVEL (FILL)
- GRAY, VERY SOFT TO VERY STIFF, LOW PLASTICITY SILTY CLAY (GLACIOMARINE)
- BROWN, MEDIUM DENSE TO VERY DENSE, FINE TO COARSE SAND, SOME SILT, TRACE GRAVEL (SAND AND GRAVEL)
- LIGHT GRAY, COARSE-GRAINED GNEISS, EXTREMELY STRONG, FRESH TO SLIGHTLY WEATHERED (BEDROCK)
- INTERPRETED GROUNDWATER SURFACE
- EXISTING GROUND SURFACE

NOTES:

1. AS DRILLED BORING LOCATION PLAN FOR 100-SERIES BORINGS DERIVED FROM ELECTRONIC FILE NAME: "BOR12-18-19edit.csv" PROVIDED TO GOLDER BY MAINE DEPARTMENT OF TRANSPORTATION ON 01/06/2020. AS DRILLED BORING LOCATION PLAN FOR 200-SERIES BORINGS DERIVED FROM ELECTRONIC FILE NAME: "21726 Exit22 - 200 Series Borings Compiled" PROVIDED TO GOLDER BY MAINE DEPARTMENT OF TRANSPORTATION ON 06/24/2021.
2. FOR DETAILED LITHOLOGIC DESCRIPTIONS SEE BORING LOGS IN NOTE 8, APPENDIX A (100-SERIES BORINGS) AND NOTE 9, APPENDIX A (200-SERIES BORINGS).
3. FOR COMPLETE LABORATORY DATA SEE LABORATORY REPORTS IN NOTE 8 (100-SERIES BORINGS) AND NOTE 9 (200-SERIES BORINGS).
4. GROUNDWATER SURFACE IS INTERPRETED FROM LOCALIZED SURFACE WATER LEVELS AND MEASUREMENTS TAKEN DURING THE SUBSURFACE EXPLORATION PROGRAMS. FOR DETAILS ON THE SUBSURFACE EXPLORATION PROGRAMS, SEE NOTE 8 (100-SERIES BORINGS) AND NOTE 9 (200-SERIES BORINGS).
5. THIS GENERALIZED SUBSURFACE PROFILE IS INTENDED TO CONVEY TRENDS IN SUBSURFACE CONDITIONS. THE BOUNDARIES BETWEEN STRATA ARE APPROXIMATE AND IDEALIZED AND HAVE BEEN DEVELOPED BASED ON INTERPRETATIONS OF WIDELY SPACED EXPLORATIONS. ACTUAL SOIL AND ROCK TRANSITIONS MAY VARY AND ARE PROBABLY MORE ERRATIC. FOR MORE SPECIFIC INFORMATION, REFER TO BORING LOGS IN NOTE 8, APPENDIX A (100-SERIES BORINGS) AND NOTE 9, APPENDIX A (200-SERIES BORINGS).
6. ABUTMENT AND PIER DETAILS INTERPRETED FROM ELECTRONIC FILE NAME "5721 FREEPORT 1956" PROVIDED TO GOLDER ON 8/22/2019 AND "Mallett Dr Profile1to1.dgn" PROVIDED TO GOLDER BY HNTB ON MAY 27, 2021.
7. FOR SOIL STRATA ANALYSIS THE ASPHALT LAYER AND ROADFILL LAYER ARE COMBINED FOR A LAYER THICKNESS OF FIVE FEET.
8. GOLDER ASSOCIATES, INC., DECEMBER 21, 2020, PRELIMINARY GEOTECHNICAL DESIGN REPORT, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.
9. GOLDER ASSOCIATES, INC., AUGUST 20, 2021, SUPPLEMENTAL BRIDGE GEOTECHNICAL DESIGN REPORT Part I, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.
10. GOLDER ASSOCIATES, INC., AUGUST 20, 2021, SUPPLEMENTAL BRIDGE GEOTECHNICAL DESIGN REPORT Part II, I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22), FREEPORT, MAINE, MAINEDOT WIN 021726.00.

VERTICAL SCALE 0 5 10 — 1" = 5' FEET

HORIZONTAL SCALE 0 25 50 — 1" = 25' FEET

GOLDER
MEMBER OF WSP

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

021726.00

WIN
021726.00

BRIDGE PLANS

Bridge No. 5721

STATE OF MAINE · CHRISTOPHER J. LOCKHART · No. 15164 · PROFESSIONAL ENGINEER

PROJ. MANAGER			
DESIGN-DETAILED	MEL	2021-08-20	
CHECKED-REVIEWED	KAR	2021/08/20	SIGNATURE
DESIGN2-DETAILED2	CCB		
DESIGN3-DETAILED3	AAZ		
REVISIONS 1	AAZ		P.E. NUMBER
REVISIONS 2			
REVISIONS 3			DATE
REVISIONS 4			
FIELD CHANGES			

APPROACH ROAD BRIDGE
INTERSTATE 295
FREEPORT CUMBERLAND

INTERPRETIVE SUBSURFACE
CROSS SECTION B-B'

SHEET NUMBER
6
OF 6

APPENDIX A

Boring Logs

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS (more than half of material is larger than No. 4 sieve size)	GRAVELS (more than half of coarse fraction is larger than No. 4 sieve size)	CLEAN GRAVELS (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly-graded gravels, gravel sand mixtures, little or no fines.
		GRAVEL WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.
			GC	Clayey gravels, gravel-sand-clay mixtures.
	SANDS (more than half of coarse fraction is smaller than No. 4 sieve size)	CLEAN SANDS (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly-graded sands, gravelly sand, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures.
FINE-GRAINED SOILS (more than half of material is smaller than No. 200 sieve size)	SILTS AND CLAYS (liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS (liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of medium to high plasticity, organic silts.
	HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.

Desired Soil Observations (in this order, if applicable):

Color (Munsell color chart)
Moisture (dry, damp, moist, wet)
Density/Consistency (from above right hand side)
Texture (fine, medium, coarse, etc.)
Name (sand, silty sand, clay, etc., including portions - trace, little, etc.)
Gradation (well-graded, poorly-graded, uniform, etc.)
Plasticity (non-plastic, slightly plastic, moderately plastic, highly plastic)
Structure (layering, fractures, cracks, etc.)
Bonding (well, moderately, loosely, etc.,)
Cementation (weak, moderate, or strong)
Geologic Origin (till, marine clay, alluvium, etc.)
Groundwater level

MODIFIED BURMISTER SYSTEM

Descriptive Term	Portion of Total (%)
trace	0 - 10
little	11 - 20
some	21 - 35
adjective (e.g. sandy, clayey)	36 - 50

TERMS DESCRIBING DENSITY/CONSISTENCY

Coarse-grained soils (more than half of material is larger than No. 200 sieve): Includes (1) clean gravels; (2) silty or clayey gravels; and (3) silty, clayey or gravelly sands. Density is rated according to standard penetration resistance (N-value).

Density of Cohesionless Soils	Standard Penetration Resistance N-Value (blows per foot)
Very loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

Fine-grained soils (more than half of material is smaller than No. 200 sieve): Includes (1) inorganic and organic silts and clays; (2) gravelly, sandy or silty clays; and (3) clayey silts. Consistency is rated according to undrained shear strength as indicated.

Consistency of Cohesive soils	SPT N-Value (blows per foot)	Approximate Undrained Shear Strength (psf)	Field Guidelines
Very Soft	WOH, WOR, WOP, <2	0 - 250	Fist easily penetrates
Soft	2 - 4	250 - 500	Thumb easily penetrates
Medium Stiff	5 - 8	500 - 1000	Thumb penetrates with moderate effort
Stiff	9 - 15	1000 - 2000	Indented by thumb with great effort
Very Stiff	16 - 30	2000 - 4000	Indented by thumbnail
Hard	>30	over 4000	Indented by thumbnail with difficulty

Rock Quality Designation (RQD):

RQD (%) = sum of the lengths of intact pieces of core* > 4 inches / length of core advance

*Minimum NQ rock core (1.88 in. OD of core)

Correlation of RQD to Rock Mass Quality

Rock Mass Quality	RQD (%)
Very Poor	≤25
Poor	26 - 50
Fair	51 - 75
Good	76 - 90
Excellent	91 - 100

Desired Rock Observations (in this order, if applicable):

Color (Munsell color chart)
Texture (aphanitic, fine-grained, etc.)
Rock Type (granite, schist, sandstone, etc.)
Hardness (very hard, hard, mod. hard, etc.)
Weathering (fresh, very slight, slight, moderate, mod. severe, severe, etc.)
Geologic discontinuities/jointing:
- -dip (horiz - 0-5 deg., low angle - 5-35 deg., mod. dipping - 35-55 deg., steep - 55-85 deg., vertical - 85-90 deg.)
- -spacing (very close - <2 inch, close - 2-12 inch, mod. close - 1-3 feet, wide - 3-10 feet, very wide >10 feet)
- -tightness (tight, open, or healed)
- -infilling (grain size, color, etc.)

Formation (Waterville, Ellsworth, Cape Elizabeth, etc.)
RQD and correlation to rock mass quality (very poor, poor, etc.)
ref: ASTM D6032 and AASHTO Standard Specification for Highway Bridges, 17th Ed. Table 4.4.8.1.2A
Recovery (inch/inch and percentage)
Rock Core Rate (X.X ft - Y.Y ft (min:sec))

Maine Department of Transportation
Geotechnical Section
Key to Soil and Rock Descriptions and Terms
Field Identification Information

Sample Container Labeling Requirements:

WIN
Bridge Name / Town
Boring Number
Sample Number
Sample Depth
Blow Counts
Sample Recovery
Date
Personnel Initials

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22)
Location: FREEPORT, MAINE

Boring No.: BB-FMD-101

WIN: 21726.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	161.0	**Auger ID/OD:**	4 in OD Solid Stem
Operator:	Brad Enos	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	Shiv Bhardwaj	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	12/16/19 (1:46), 12/17/19 (2:28)	**Drilling Method:**	Solid Stem Auger / Cased Wash	**Core Barrel:**	1-7/8 in - NQ
Boring Location:	N: 376042.7, E:1054596.1	**Casing ID/OD:**	4 in/4.5 in	**Water Level*:**	Not Recorded
Hammer Efficiency Factor: 0.896		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	160.6		Driller notes asphalt thickness of 5 in (ASPHALT). 0.4	
	1D	24/9	1.00 - 3.00	27/27/22/16	49	73				Brown, dry, very dense, fine to coarse SAND, well-graded (FILL).	
	2D	24/18	4.00 - 6.00	30/29/18/16	47	70				Brown, dry, very dense, gravelly fine to coarse SAND, trace silt, poorly-graded (FILL).	GTX #540011 Fines = 7.3% A-1-b (0), SP-SM
5											
	3D	24/14	9.00 - 11.00	7/9/9/8	18	27				Brown, dry, medium dense, fine to coarse SAND, trace coarse gravel, trace silt, well-graded (FILL).	WC = 6.0%
10											
							106				
							122				
							203				
	4D	24/10	14.00 - 16.00	17/23/23/19	46	69	56			Brown, moist, very dense, fine to coarse SAND, trace silt, well-graded (FILL).	
15							52				
							55				
							94	143.5		17.5	
	5D	24/12	18.00 - 20.00	13/6/5/6	11	16	51			Driller notes clay layer starting at 17. 5 ft bgs. 5DA, Top 5 in: Brown/grey, wet, very stiff, Silty CLAY, moderately plastic, (GLACIOMARINE). q_p = 4.0, 5.0 ksf. (Pocket Penetrometer), T_v = 200, 300 psf.	5DB: GTX #540010 WC = 17.8% Fines = 32.6% A-2-4 (0), SM
							33			5DB, Bottom 7 in: Brown, wet, medium dense, fine to coarse SAND, some silt clay, trace fine gravel, well-graded, non-plastic (GLACIOMARINE).	
20	6D	24/14	20.00 - 22.00	30/42/18/8	60	90	100			6DA, Top 12 in: Brown, wet, very dense, fine Gravelly fine to coarse SAND, trace silt, poorly-graded (GLACIOMARINE).	6DA: GTX #540009 Fines = 8.6% A-1-a (0), SP-SM
							76			6DB, Bottom 2 in: Brown/grey, wet, hard, CLAY, trace sand, moderately plastic, (GLACIOMARINE). q_p = 2.0 ksf (Pocket Penetrometer).	
							95				
							100				
25	7D	24/18	24.00 - 26.00	5/23/17/16	40	60	101			7DA: Grey, moist, very dense, SAND, some silt, trace gravel, poorly-	7DA: GTX #540003

Remarks:

1. Hammer Efficiency Factor provided by New England Boring Contractors and taken from "SPT Energy Submittal_Drill Rig No. NEBCD-24" by GZA GeoEnvironmental, dated 7/12/19. 2. As-drilled boring locations and ground surface elevations were provided by MaineDOT. 3. "-" Sample interval disturbed by vane test before sampling; blow counts not representative of undisturbed material.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22)
Location: FREEPORT, MAINE

Boring No.: BB-FMD-101
WIN: 21726.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	161.0	**Auger ID/OD:**	4 in OD Solid Stem
Operator:	Brad Enos	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	Shiv Bhardwaj	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	12/16/19 (1:46), 12/17/19 (2:28)	**Drilling Method:**	Solid Stem Auger / Cased Wash	**Core Barrel:**	1-7/8 in - NQ
Boring Location:	N: 376042.7, E:1054596.1	**Casing ID/OD:**	4 in/4.5 in	**Water Level*:**	Not Recorded
Hammer Efficiency Factor: 0.896		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample; MD = Unsuccessful Split Spoon Sample Attempt; U = Thin Wall Tube Sample; MU = Unsuccessful Thin Wall Tube Sample Attempt; V = Field Vane Shear Test, PP = Pocket Penetrometer; MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample; SSA = Solid Stem Auger; HSA = Hollow Stem Auger; RC = Roller Cone; WOH = Weight of 140 lb. Hammer; WOR/C = Weight of Rods or Casing; WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf); $S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf); q_p = Unconfined Compressive Strength (ksf); N-uncorrected = Raw Field SPT N-value; Hammer Efficiency Factor = Rig Specific Annual Calibration Value; N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency; N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf); WC = Water Content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25							87			graded (GLACIOMARINE).	WC = 14%
							89			7DB: Grey, moist, hard, CLAY, some fine to coarse sand, moderately plastic, (GLACIOMARINE). q_p = 8.0, 8.0 ksf (Pocket Penetrometer), T_v = 1100, 700, 900 psf.	Fines = 32.8% A-2-4 (0), SM
							74				
							123				
	8D	24/20	29.00 - 31.00	2/9/12/19	21	31	Open			8D: Grey, wet, hard, CLAY, some fine to coarse sand, moderately plastic (GLACIOMARINE). q_p = 10.0, 10.0 ksf (Pocket Penetrometer), T_v = 700, 800 psf.	
30											
	9D	24/14	31.00 - 33.00	12/12/12/14	24	36				9D: Grey, wet, hard, CLAY, some fine to coarse sand, moderately plastic (GLACIOMARINE). q_p = 2.0 2.0 ksf(Pocket Penetrometer), T_v = 1400 psf.	
	10D V1	24/24	33.00 - 35.00	4/6/7/8 ~~S_u > 4181 psf~~	-					10D: Wet, grey, hard, CLAY, some fine to coarse sand, moderately plastic (GLACIOMARINE). q_p = 6.0, 6.0 ksf (Pocket Penetrometer), T_v = 1000, 900, psf. 16x32 mm vane raw torque readings: V1: Reached 26.6 in-lbs without failure.	WC = 30.5%
35	11D V2	24/24	35.00 - 37.00	2/5/3/5 ~~S_u > 4181 psf~~	-					11D: Grey, wet, hard, CLAY, some fine to coarse sand, moderately plastic (GLACIOMARINE). q_p = 1.0 ksf (Pocket Penetrometer), T_v = 1000, 1100 psf. 16x32 mm vane raw torque readings: V2: Reached 26.6 in-lbs without failure.	
	12D V3	24/24	37.00 - 39.00	WOH(18")/3 ~~S_u=2515/629 psf~~	-					12D: Grey, wet, very stiff, CLAY, some fine to coarse sand, trace fine gravel, moderately plastic (GLACIOMARINE). q_p = 1.0 ksf (Pocket Penetrometer), T_v = 700, 300 psf. 16x32 mm vane raw torque readings: V3: 16/4 in-lbs	12D: GTX #539996 WC = 30% LL = 43 PL = 23 PI = 20 LI = 0.3 A-7-6, CL
	13D	24/21	39.00 - 41.00	2/4/11/22	15	22				13D: Grey, wet, very stiff, CLAY, some fine to coarse sand, moderately plastic (GLACIOMARINE). Failed 65x130 mm vane, would not push to 40.0 ft bgs.	13D: GTX #540002, 539995
40	MV			Would Not Push				120.0		41.0	
	14D	24/12	41.00 - 43.00	8/17/18/19	35	52				14D: Brown, wet, very dense, fine to coarse SAND, some silt, trace fine gravel, non-plastic (SAND AND GRAVEL).	WC = 32% Fines = 70.4% LL = 23 PL = 15 PI = 8 LI = 2.1 A-4 (3), CL
	15D	0/0	43.00 - 43.00	50(0")				117.2		No recovery; Refusal	14D: GTX #540008 Fines = 25.6% A-2-4 (0), SM
	R1	60/60	44.00 - 49.00	RQD = 92%			NX			43.8 Top of Bedrock at Elev. 117.2 ft. R1: Grey, coarse grained, strongly foliated, fresh (W1), very strong (R5), GNEISS; discontinuities steep angle (80°- 90°) and parallel to foliation, very close to moderately closely spaced (0.1 - 1.1 ft) [VASSALBORO FORMATION]. Rock Core Rate (min:sec): 44.0-45.0 ft (3:31) 45.0-46.0 ft (3:05) 46.0-47.0 ft (2:29)	
45											
	R2	60/60	49.00 - 54.00	RQD = 86%							q_p = 358 ksf
50											

Remarks:

1. Hammer Efficiency Factor provided by New England Boring Contractors and taken from "SPT Energy Submittal_Drill Rig No. NEBCD-24" by GZA GeoEnvironmental, dated 7/12/19. 2. As-drilled boring locations and ground surface elevations were provided by MaineDOT. 3. "-" Sample interval disturbed by vane test before sampling; blow counts not representative of undisturbed material.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22)
Location: FREEPORT, MAINE

Boring No.: BB-FMD-101
WIN: 21726.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	161.0	**Auger ID/OD:**	4 in OD Solid Stem
Operator:	Brad Enos	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	Shiv Bhardwaj	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	12/16/19 (1:46), 12/17/19 (2:28)	**Drilling Method:**	Solid Stem Auger / Cased Wash	**Core Barrel:**	1-7/8 in - NQ
Boring Location:	N: 376042.7, E:1054596.1	**Casing ID/OD:**	4 in/4.5 in	**Water Level*:**	Not Recorded
Hammer Efficiency Factor: 0.896		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140 lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50										47.0-48.0 ft (3:04) 48.0-49.0' ft (2:42) 100% Recovery R2: Grey, coarse grained, strongly foliated, fresh (W1), weak (R2), GNEISS; discontinuities steep angle (85° - 90°) and parallel to foliation, closely spaced (0.3 - 0.9 ft) [VASSALBORO FORMATION].	
								107.0		Rock Core Rate (min:sec): 49.0-50.0 ft (3:01) 50.0 -51.0 ft (2:26) 51.0 -52.0 ft (2:38) 52.0 -53.0 ft (3:35) 53.0 -54.0 ft (1:39) 100% Recovery	
55										54.0 **Bottom of Exploration at 54.0 feet below ground surface.** Boring backfilled with bentonite grout to 3 ft bgs, gravel from 3 ft bgs to 0.5 ft bgs, and cold patch asphalt to road surface.	
60											
65											
70											
75											

Remarks:

1. Hammer Efficiency Factor provided by New England Boring Contractors and taken from "SPT Energy Submittal_Drill Rig No. NEBCD-24" by GZA GeoEnvironmental, dated 7/12/19. 2. As-drilled boring locations and ground surface elevations were provided by MaineDOT. 3. "-" Sample interval disturbed by vane test before sampling; blow counts not representative of undisturbed material.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22)
Location: FREEPORT, MAINE

Boring No.: BB-FMD-102
WIN: 21726.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	143.1	**Auger ID/OD:**	N/A
Operator:	Brad Enos	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	Shiv Bhardwaj	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	12/17/19 (2:55), 12/19/19 (0:21)	**Drilling Method:**	Cased Wash	**Core Barrel:**	1-7/8 in - NQ
Boring Location:	N: 375943.7, E: 1054683.2	**Casing ID/OD:**	4 in/4.5 in	**Water Level*:**	6.91 ft on 12/18/19 at 21:23
Hammer Efficiency Factor: 0.896		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/10	0.00 - 2.00	2/4/3/2	7	10	Open			Brown, dry, loose, fine to coarse SAND, well-graded (FILL).	
	2D	24/4	4.00 - 6.00	3/3/1(12")	4	6	3			Brown, wet, loose, Silty fine SAND, well-graded (FILL).	WC = 15.6%
5							8				
							8				
							43				
							31				
	3D	24/3	9.00 - 11.00	WOR(24")	- -		15			Brown, wet, very loose, fine to coarse SAND, trace fine gravel, well-graded (FILL).	
10							14				
							20				
							144				
							Open	130.1		13.0	
	R1	27.6/24	14.00 - 16.30	RQD = 57%			NQ			Top of Bedrock at Elev. 130.1 ft. R1: Grey, coarse grained, strongly foliated, slightly weathered (W2), strong (R4), GNEISS; discontinuities steep angle (75°) and parallel to foliation, closely spaced (0.1 - 0.6 ft) [VASSALBORO FORMATION]. Rock Core Rate (min:sec): 14.0-15.0 ft (3:32) 15.0-16.0 ft (2:40) 16.0-16.3 ft (1:43) 87% Recovery	GTX #311186 q_p = 1495 ksf
15											
	R2	48/42	16.30 - 20.30	RQD = 73%							
20	R3	48/39	20.30 - 24.30	RQD = 33%						R2: Grey, coarse grained, strongly foliated, slightly weathered (W2), very strong (R5), GNEISS; discontinuities moderately dipping to steep (45° - 85°) and parallel to foliation, close to moderately closely spaced (0.1 - 0.6 ft) [VASSALBORO FORMATION]. Rock Core Rate (min:sec): 16.3-17.3 ft (2:10) 17.3-18.3 ft (2:14) 18.3-19.3 ft (2:29) 19.3-20.3 ft (3:01)	
25								118.8			

Remarks:

1. Hammer Efficiency Factor provided by New England Boring Contractors and taken from "SPT Energy Submittal_Drill Rig No. NEBCD-24" by GZA GeoEnvironmental, dated 7/12/19. 2. As-drilled boring locations and ground surface elevations were provided by MaineDOT.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22)
Location: FREEPORT, MAINE

Boring No.: BB-FMD-102
WIN: 21726.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	143.1	**Auger ID/OD:**	N/A
Operator:	Brad Enos	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	Shiv Bhardwaj	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	12/17/19 (2:55), 12/19/19 (0:21)	**Drilling Method:**	Cased Wash	**Core Barrel:**	1-7/8 in - NQ
Boring Location:	N: 375943.7, E: 1054683.2	**Casing ID/OD:**	4 in/4.5 in	**Water Level*:**	6.91 ft on 12/18/19 at 21:23
Hammer Efficiency Factor: 0.896		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140 lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25										88% Recovery R3: Grey, coarse grained, strongly foliated, moderately weathered (W3), very strong (R5), GNEISS; discontinuities steep dipping to vertical (75° - 90°) and parallel to foliation, close to moderately closely spaced (0.1 - 0.6 ft) [VASSALBORO FORMATION]. Rock Core Rate (min:sec): 20.3-21.3 ft (3:02) 21.3-22.3 ft (1:46) 22.3-23.3 ft (1:36) 23.3-24.3 ft (2:46) 83% Recovery	
30										24.3 **Bottom of Exploration at 24.3 feet below ground surface.** Boring backfilled with bentonite grout to ground surface.	
35											
40											
45											
50											

Remarks:

1. Hammer Efficiency Factor provided by New England Boring Contractors and taken from "SPT Energy Submittal_Drill Rig No. NEBCD-24" by GZA GeoEnvironmental, dated 7/12/19. 2. As-drilled boring locations and ground surface elevations were provided by MaineDOT.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22)
Location: FREEPORT, MAINE

Boring No.: BB-FMD-103

WIN: 21726.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	166.2	**Auger ID/OD:**	4 in OD Solid Stem
Operator:	Brad Enos	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	Shiv Bhardwaj	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	12/15/19 (21:25), 12/16/19 (1:36)	**Drilling Method:**	Solid Stem Auger / Cased Wash	**Core Barrel:**	1-7/8 in - NQ
Boring Location:	N: 375852.0, E: 1054767.6	**Casing ID/OD:**	4 in/4.5 in	**Water Level*:**	Not Recorded
Hammer Efficiency Factor: 0.896		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	165.6		Driller notes asphalt thickness of 7 in (ASPHALT).	
										0.6	
	1D	24/15	1.00 - 3.00	16/13/15/13	28	42				Brown, dry, dense, fine to coarse SAND, trace fine gravel, well-graded (FILL).	
	2D	24/18	4.00 - 6.00	5/6/6/9	12	18				Brown, dry, medium dense, fine to coarse SAND, trace fine gravel, trace clay, well-graded (FILL).	WC = 3.0%
5											
	3D	24/19	9.00 - 11.00	4/12/9/6	21	31	87			Brown, dry, dense, fine to coarse SAND, trace fine gravel, trace clay, well-graded, non-plastic (FILL).	
10							58				
							73				
							230				
							56			Brown fine to coarse sand in wash from 0.6-13.5 ft bgs.	
	4D	24/12	14.00 - 16.00	6/5/4/6	9	13	59	151.6		4DB, Top 7 in: Brown, moist, medium dense, fine to coarse SAND, little fine gravel, little clay, well-graded (FILL).	4DB: GTX #540004 Fines = 11.4% A-1-b (0), SW-SM
15							37			14.6	
							208			4DA, Bottom 5 in: Brown, moist, stiff, fine to coarse Sandy CLAY, well-graded, moderately plastic (GLACIOMARINE). q_p = 5.0, 5.0 ksf (Pocket Penetrometer), T_v = 400, 400 psf	4DA: GTX #540001 WC = 26% LL = 34 PL = 18 PI = 16 LI = 0.5 A-6, CL
							147			Blocks of clay in wash water from 14-19 ft bgs.	
							OPEN				
	R1	36/35	19.00 - 22.00	RQD = 37%			NQ	147.2		19.0	
20	5D	0/0	19.00 - 19.00	50(0")						Top of Bedrock at Elev. 147.2 ft.	
										R1: Blue/grey, coarse grained, strongly foliated, slightly weathered (W2), very strong (R5), GNEISS; discontinuities low angle (5°-35°) and parallel to foliation, very closely spaced [VASSALBORO FORMATION].	
	R2	60/59	22.00 - 27.00	RQD = 96%						Rock Core Rate (min:sec): 19.0-20.0 ft (3:40) 20.0-21.0 ft (1:58) 21.0-22.0 ft (2:46) 97% Recovery	
25											

Remarks:

1. Hammer Efficiency Factor provided by New England Boring Contractors and taken from "SPT Energy Submittal_Drill Rig No. NEBCD-24" by GZA GeoEnvironmental, dated 7/12/19. 2. As-drilled boring locations and ground surface elevations were provided by MaineDOT.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22)
Location: FREEPORT, MAINE

Boring No.: BB-FMD-103
WIN: 21726.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	166.2	**Auger ID/OD:**	4 in OD Solid Stem
Operator:	Brad Enos	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	Shiv Bhardwaj	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	12/15/19 (21:25), 12/16/19 (1:36)	**Drilling Method:**	Solid Stem Auger / Cased Wash	**Core Barrel:**	1-7/8 in - NQ
Boring Location:	N: 375852.0, E: 1054767.6	**Casing ID/OD:**	4 in/4.5 in	**Water Level*:**	Not Recorded
Hammer Efficiency Factor: 0.896		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140 lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25										R2: Blue/grey, coarse grained, strongly foliated, slightly weathered (W2), very strong (R5), GNEISS; discontinuities steep angle (75°-90°) and parallel to foliation, closely spaced (0.2 - 2.0 ft) [VASSALBORO FORMATION].	
										Rock Core Rate (min:sec):	
	R3	30/26.5	27.00 - 29.50	RQD = 88%						22.0-23.0 ft (3:11)	
										23.0-24.0 ft (2:14)	
										24.0-25.0 ft (2:21)	
								136.7		25.0-26.0 ft (2:16)	
30										26.0-27.0 ft (2:43)	
										98% Recovery	
										R3: Blue/grey, coarse grained, strongly foliated, fresh (W1), very strong (R5), GNEISS; no discontinuities [VASSALBORO FORMATION].	
										Rock Core Rate (min:sec):	
35										27.0-28.0 ft (2:06)	
										28.0-29.5 ft (2:10)	
										88% Recovery	
										29.5	
										Bottom of Exploration at 29.5 feet below ground surface.	
										Boring backfilled with bentonite grout to 0.5 ft bgs with cuttings and cold patch asphalt to road surface.	
40											
45											
50											

Remarks:

1. Hammer Efficiency Factor provided by New England Boring Contractors and taken from "SPT Energy Submittal_Drill Rig No. NEBCD-24" by GZA GeoEnvironmental, dated 7/12/19. 2. As-drilled boring locations and ground surface elevations were provided by MaineDOT.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22)
Location: FREEPORT, MAINE

Boring No.: BB-FMD-104

WIN: 21726.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	144.6	**Auger ID/OD:**	4 in OD Solid Stem
Operator:	Brad Enos	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	Shiv Bhardwaj	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	12/23/19 (7:54), 12/23/19 (9:16)	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	1-7/8 in - NQ
Boring Location:	N: 375754.3, E:1054696.2	**Casing ID/OD:**	3 in/3.5 in	**Water Level*:**	4.5 ft on 12/23/19 at 8:07
Hammer Efficiency Factor:	0.842	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/6.5	0.00 - 2.00	1/1/2/2	3	4	SSA			Brown, moist, soft, SILT, trace coarse gravel, trace organics, non-plastic (TOPSOIL).	
								142.6		2.0	
								140.4		2DC, Top 2 in: Brown, moist, hard, CLAY, trace silt, slightly plastic (GLACIOMARINE).	
5	2D	24/24	4.00 - 6.00	4/16/12/22	28	39				4.2	2DA/B: GTX #540005 Fines = 47.7% A-4 (0), SM
	R1	60/59	6.30 - 11.30	RQD = 84%			NQ	138.3		2DA and 2DB, Bottom 22 in: Brown, moist, dense, Silty fine to medium SAND, trace fine gravel, poorly-graded (SAND AND GRAVEL).	
										6.3	q_p = 2127 ksf
										Top of Bedrock at Elev. 138.3 ft. R1: Blue/grey, coarse grained, strongly foliated, fresh (W1), strong (R4), GNEISS; discontinuities vertical angle (85°-90°) and parallel to foliation, very closely to moderately closely spaced (0.1 - 2.4 ft) [VASSALBORO FORMATION]. Rock Core Rate (min:sec): 6.3-7.3 ft (2:49) 7.3-8.3 ft (2:24) 8.3-9.3 ft (2:45) 9.3-10.3 ft (3.15) 10.3-11.3 ft (3.02) 98% Recovery	
10	R2	60/60	11.30 - 16.30	RQD = 96%							
										R2: Blue/grey, coarse grained, strongly foliated, fresh (W1), very strong (R5), GNEISS; discontinuities steep angle (80°-85°) and parallel to foliation, closely to moderately closely spaced (0. 2 - 1.3 ft) [VASSALBORO FORMATION]. Rock Core Rate (min:sec): 11.3-12.3 ft (3:29) 12.3-13.3 ft (2:59) 13.3-14.3 ft (2:16) 14.3-15.3 ft(2:14) 15.3-16.3 ft (2:41) 100% Recovery	
15								128.3		16.3	
20										**Bottom of Exploration at 16.3 feet below ground surface.** Boring backfilled with soil cuttings and bentonite chips to ground surface.	
25											

Remarks:

1. Hammer Efficiency Factor provided by New England Boring Contractors and taken from "SPT Energy Submittal_Drill Rig No. 23" by GZA GeoEnvironmental, dated 7/12/19. 2. As-drilled boring locations and ground surface elevations were provided by MaineDOT.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22)
Location: FREEPORT, MAINE

Boring No.: BB-FMD-105
WIN: 21726.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	142.5	**Auger ID/OD:**	N/A
Operator:	Brad Enos	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	Shiv Bhardwaj	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	12/19/19 (0:52), 12/19/19 (4:15)	**Drilling Method:**	Cased Wash	**Core Barrel:**	1-7/8 in - NQ
Boring Location:	N: 375925.3, E: 1054665.6	**Casing ID/OD:**	4 in/4.5 in	**Water Level*:**	3.41 ft on 12/19/19 at 4:00
Hammer Efficiency Factor: 0.896		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_V = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/7	0.00 - 2.00	1/2/2/1	4	6	7			Brown, dry, loose, fine to coarse SAND, some silt, trace fine gravel, well-graded (FILL).	
							10				
							15				
	2D	24/4	3.00 - 5.00	2/2/1(12")	3	4	2			Brown, wet, very loose, fine to coarse SAND, some silt, trace fine gravel, well-graded (FILL).	GTX #540012 Fines = 21.2% A-2-4 (0), SM
							9				
5							7				
							12				
							19				
	3D	16/4	8.00 - 9.33	1/1/50(4")	- -					Brown, wet, very dense, fine to coarse SAND, some silt, well-graded (FILL).	
	R1	60/60	9.30 - 14.30	RQD = 66%			NQ	133.2		9.3 Top of Bedrock Elev. 133.2 ft. R1: Grey, coarse grained, strongly foliated, fresh (W1), very strong (R5), GNEISS; discontinuities steep angle (55°-85°) and parallel to foliation, closely spaced (0.1 - 0.8') [VASSALBORO FORMATION]. Rock Core Rate (min:sec): 9.3-10.3 ft (3:34) 10.3-11.3 ft (3:08) 11.3 12.3 ft (3:07) 12.3-13.3 ft (2:37) 13.3-14.3 ft (3:05) 100% Recovery	
10											
	R2	60/60	14.30 - 19.30	RQD = 80%						R2: Grey, coarse grained, strongly foliated, fresh (W1), very strong (R5), GNEISS; discontinuities steep angle (50°-85°) and parallel to foliation, very closely to closely spaced (0.1 - 1 ft) [VASSALBORO FORMATION].	
15											
								123.2		Rock Core Rate (min:sec): 14.3-15.3 ft (1:56) 15.3-16.3 ft (1:57) 16.3 17.3 ft (1:57) 17.3-18.3 ft(1.53) 18.3-19.3 ft (2.17) 100% Recovery 19.3 **Bottom of Exploration at 19.3 feet below ground surface.** Boring backfilled with gravel to ground surface.	
20											
25											

Remarks:

1. Hammer Efficiency Factor provided by New England Boring Contractors and taken from "SPT Energy Submittal_Drill Rig No. NEBCD-24" by GZA GeoEnvironmental, dated 7/12/19. 2. As-drilled boring locations and ground surface elevations were provided by MaineDOT.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22)
Location: FREEPORT, MAINE

Boring No.: BB-FMD-106

WIN: 21726.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	129.2	**Auger ID/OD:**	4 in OD Solid Stem
Operator:	Brad Enos	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	Shiv Bhardwaj	**Rig Type:**	SIMCO 2400	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	12/23/19 (10:35); 12/23/19 (16:51)	**Drilling Method:**	Solid Stem Auger / Cased Wash	**Core Barrel:**	1-7/8 in - NQ
Boring Location:	N: 375933.5, E: 1054554.5	**Casing ID/OD:**	3 in/3.5 in	**Water Level*:**	3.1 ft on 12/23/2019 at 16:30
Hammer Efficiency Factor: 0.600		**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/12	0.00 - 2.00	1/2/2/2	4	4	SSA	127.2		Brown, moist, soft, SILT, some fine sand, little organics, non-plastic (TOPSOIL). 2.0	
5	2D	24/24	4.00 - 6.00	5/8/10/12	18	18				2D: Grey, dry, very stiff, CLAY, moderately plastic (GLACIOMARINE). q_p = 8.5 ksf (Pocket Penetrometer), T_v = 800, 1000, 1000 psf	GTX #540006 WC = 26.1% Fines = 99.5%
	3D	24/19	6.00 - 8.00	6/7/7/8	14	14	25			3D: Grey, wet, stiff, CLAY, moderately plastic (GLACIOMARINE). q_p = 5.0, 5.0 ksf (Pocket Penetrometer), T_v = 900, 1000 psf. Failed 55x110 mm vane, would not push to 7.0 ft bgs.	
	MV			Would Not Push			19				
	4D	24/7.5	8.00 - 10.00	2/3/3/2	6	6	20			4D: Grey, wet, medium stiff, CLAY, trace sand, moderately plastic (GLACIOMARINE). q_p = 2.0 2.0 ksf (Pocket Penetrometer), T_v = 300, 700 psf. Failed 55x110 mm vane, would not push to 9.0 ft bgs	4D: GTX #540007, 539999 WC = 31% Fines = 97.4% LL = 45 PL = 21 PI = 24 LI = 0.4 A-7-6 (26), CL
10	MV			Would Not Push			24				
	5D	24/24	10.00 - 12.00	2/1(12")/2	-		Open			5D: Grey, wet, stiff, CLAY, moderately plastic (GLACIOMARINE). q_p = 1.0 ksf (Pocket Penetrometer), T_v = 500, 500 psf.	
	V3			S_u=1875/268psf						55x110 mm vane raw torque readings: V3: 42/6 ft-lbs V4: 28/5 ft-lbs	
	V4			S_u=1250/223psf							
	6D	24/5	12.00 - 14.00	1/3/5/5	8	8				6D: Grey, wet, medium stiff, CLAY, moderately plastic (GLACIOMARINE). q_p < 1.0 ksf (Pocket Penetrometer), T_v = 200 psf. Failed 55x110 mm vane, would not push to 13.0 ft bgs	6D: GTX #540000 WC = 33% LL = 38 PL = 19 PI = 19 LI = 0.7 A-6, CL
	MV			Would Not Push				115.2		14.0	
15	7D	22/15	14.00 - 15.83	WOR(5"),1(1")/5/8/50(4")	13	13				7DB, Top 7 in: Brown, wet, medium dense, Silty fine to coarse SAND, well-graded (SAND AND GRAVEL). 7DA, Bottom 8 in: Brown, wet, medium dense, fine to medium SAND, trace fine gravel, trace silt, well-graded (SAND AND GRAVEL). Failed 55x110 mm vane, would not push to 15.0 ft bgs	7DB: GTX #540013 WC = 23.4% Fines = 42.6% A-4 (0), SM
	MV	60/59	15.80 - 20.80	Would Not Push			NQ	113.4		15.8	
	R1			RQD = 70%						Top of Bedrock Elev. 113.4 ft. R1: Blue/grey, coarse grained, strongly foliated, fresh (W1), very strong (R5), GNEISS; discontinuities vertical angle (80°-90°) and parallel to foliation, very closely to closely spaced (0.1-1.7 ft) [VASSALBORO FORMATION]. Rock Core Rate (min:sec): 15.8-16.8 ft (3:41) 16.8-17.8 ft (2:51) 17.8-18.8 ft (1:45) 18.8-19.8 ft (2:06)	q_p = 3279 ksf
20	R2	48/43	20.80 - 24.80	RQD = 58%							
25	R3	38.4/38	24.80 - 28.00	RQD = 50%							

Remarks:

1. As-drilled boring locations and ground surface elevations were provided by MaineDOT. 2. "-" Sample interval disturbed by vane test before sampling; blow counts not representative of undisturbed material.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22)
Location: FREEPORT, MAINE

Boring No.: BB-FMD-106
WIN: 21726.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	129.2	**Auger ID/OD:**	4 in OD Solid Stem
Operator:	Brad Enos	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	Shiv Bhardwaj	**Rig Type:**	SIMCO 2400	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	12/23/19 (10:35); 12/23/19 (16:51)	**Drilling Method:**	Solid Stem Auger / Cased Wash	**Core Barrel:**	1-7/8 in - NQ
Boring Location:	N: 375933.5, E: 1054554.5	**Casing ID/OD:**	3 in/3.5 in	**Water Level*:**	3.1 ft on 12/23/2019 at 16:30
Hammer Efficiency Factor: 0.600		**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample; MD = Unsuccessful Split Spoon Sample Attempt; U = Thin Wall Tube Sample; MU = Unsuccessful Thin Wall Tube Sample Attempt; V = Field Vane Shear Test, PP = Pocket Penetrometer; MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample; SSA = Solid Stem Auger; HSA = Hollow Stem Auger; RC = Roller Cone; WOH = Weight of 140 lb. Hammer; WOR/C = Weight of Rods or Casing; WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf); $S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf); q_p = Unconfined Compressive Strength (ksf); N-uncorrected = Raw Field SPT N-value; Hammer Efficiency Factor = Rig Specific Annual Calibration Value; N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency; N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_V = Pocket Torvane Shear Strength (psf); WC = Water Content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25										19.8-20.8 ft (1:58) 98% Recovery R2: Grey, coarse grained, strongly foliated, fresh (W1), very strong (R5), GNEISS; intermingled with grey and blue, coarse-grained, strongly foliated, fresh (W1), very strong (R5), PEGMATITE; with moderately to vertical discontinuities angle (40° - 90°), very close to closely spaced (0.1'-0.5 ft) [VASSALBORO FORMATION]. Rock Core Rate (min:sec): 20.8-21.8 ft (1:24) 21.8-22.8 ft (3:27) 22.8-23.8 ft (8:01) 23.8-24.8 ft (20:06) 90% Recovery R3: Blue/grey, coarse grained, strongly foliated, fresh (W1), very strong (R5), GNEISS; discontinuities vertical angle (85°-90°) and parallel to foliation, very closely to closely spaced (0.1-1.1 ft) [VASSALBORO FORMATION]. Rock Core Rate (min:sec): 24.8-25.8 ft (6:05) 25.8-26.8 ft (4:20) 26.8-27.8 ft (7:26) 27.8-28.0 ft (1:22) 100% Recovery R4: Grey, coarse grained, strongly foliated, fresh (W1), very strong (R5), GNEISS; intermingled with grey and blue, coarse-grained, strongly foliated, fresh (W1), extremely strong (R6), PEGMATITE; with vertical discontinuities angle (80° - 90°), very close to closely spaced (0.1 - 0.8 ft) [VASSALBORO FORMATION]. Rock Core Rate (min:sec): 28.0-29.0 ft (3:42) 29.0-30.0 ft (3:10) 30.0-31.0 ft (2:55) 31.0-32.0 ft (4:15) 98% Recovery R5: Blue/grey, fine grained, strongly foliated, fresh (W1), very strong (R5), PEGMATITE; discontinuities steep angle (55°-85°) and parallel to foliation, closely to moderately closely spaced (0.4 - 2.9 ft) [VASSALBORO FORMATION]. Rock Core Rate (min:sec): 32.0-33.0 ft (5:22) 33.0-34.0 ft (7:04)	
	R4	48/47	28.00 - 32.00	RQD = 48%							
30											
	R5	46/46	32.00 - 35.83	RQD = 100%							
35								93.4			
40											
45											
50											

Remarks:

1. As-drilled boring locations and ground surface elevations were provided by MaineDOT. 2. "-" Sample interval disturbed by vane test before sampling; blow counts not representative of undisturbed material.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 MALLET DRIVE BRIDGE REPLACEMENT #5721 (EXIT 22)
Location: FREEPORT, MAINE

Boring No.: BB-FMD-106
WIN: 21726.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	129.2	**Auger ID/OD:**	4 in OD Solid Stem
Operator:	Brad Enos	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	Shiv Bhardwaj	**Rig Type:**	SIMCO 2400	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	12/23/19 (10:35); 12/23/19 (16:51)	**Drilling Method:**	Solid Stem Auger / Cased Wash	**Core Barrel:**	1-7/8 in - NQ
Boring Location:	N: 375933.5, E: 1054554.5	**Casing ID/OD:**	3 in/3.5 in	**Water Level*:**	3.1 ft on 12/23/2019 at 16:30
Hammer Efficiency Factor: 0.600		**Hammer Type:**	Automatic ☐ Hydraulic ☐ Rope & Cathead ☒		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140 lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50										34.0-35.0 ft (11:54) 35.0-35.8 ft (9:34) 100% Recovery	
										35.8	
										Bottom of Exploration at 35.8 feet below ground surface. Boring backfilled with soil cuttings, gravel and bentonite chips to ground surface.	
55											
60											
65											
70											
75											

Remarks:

1. As-drilled boring locations and ground surface elevations were provided by MaineDOT. 2. "-" Sample interval disturbed by vane test before sampling; blow counts not representative of undisturbed material.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 Mallet Drive Bridge Replacement #5721 (Exit 22)
Location: Freeport, Maine

Boring No.: BB-FMD-205
WIN: 021726.00

Driller:	SW Cole	**Elevation (ft.)**	147.0	**Auger ID/OD:**	2.5 in
Operator:	S. Shaw	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	J. Sedam	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	06/10/21 (08:30);06/10/21 (09:30)	**Drilling Method:**	Pin Auger / Cased Wash	**Core Barrel:**	NQ
Boring Location:	N 375781.491 ft, E 1054716.636 ft	**Casing ID/OD:**	5.5 in	**Water Level*:**	No measurement
Hammer Efficiency Factor: 0.974		**Hammer Type:**	Automatic ☐ Hydraulic ☒ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample; MD = Unsuccessful Split Spoon Sample Attempt; U = Thin Wall Tube Sample; MU = Unsuccessful Thin Wall Tube Sample Attempt; V = Field Vane Shear Test, PP = Pocket Penetrometer; MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample; SSA = Solid Stem Auger; HSA = Hollow Stem Auger; RC = Roller Cone; WOH = Weight of 140lb. Hammer; WOR/C = Weight of Rods or Casing; WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf); $S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf); q_p = Unconfined Compressive Strength (ksf); N-uncorrected = Raw Field SPT N-value; Hammer Efficiency Factor = Rig Specific Annual Calibration Value; N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency; N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_V = Pocket Torvane Shear Strength (psf); WC = Water Content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/7	0.00 - 2.00	3/2/4/6	6	10		147.0		1DA, Top 2 in: Brown, dry, loose, fine to medium SAND, trace gravel, trace silt, trace organics, poorly-graded (FILL)	
										1DB, Bottom 5 in: Reddish brown, dry, loose, fine to medium SAND, some silt, little gravel, trace organics, well-graded (FILL)	GTX #621776 WC = 14% Fines = 27.1% A-2-4(0), SM
	2D	24/23	2.00 - 4.00	6/7/14/21	21	34				2D: Reddish brown, dry to damp, dense, fine to medium SAND, some silt, little gravel, trace organics, well-graded (FILL)	
	3D R1	7.2/9.6 60/25	4.00 - 4.60 4.70 - 9.70	34/50(1") RQD = 41%	50	81	NQ	142.3		3DA, Top 5 in: Brown, damp, very dense, fine to medium SAND, some silt, little gravel, trace organics, well-graded (FILL)	
5										3DB, Bottom 5 in: Reddish brown, damp, very dense, fine to coarse SAND, some gravel, some silt, well-graded (FILL)	
										Top of bedrock at elev. 142.3 ft.	
										4.7	
										Grey, fine grained, strongly foliated, SCHIST, very strong (R5), fresh to slightly weathered (W1 to W2). Discontinuities low angle to vertical (5-90 deg) and very closely to closely spaced (0.2-2 ft). [VASSALBORO FORMATION]	
10								137.0		Rock Mass Quality: POOR	
										Rock Core Rate (min:sec)	
										4.7-5.7 ft (2:21)	
										5.7-6.7 ft (2:19)	
										6.7-7.7 ft (2:15)	
										7.7-8.7 ft (1:49)	
										8.7-9.7 ft (2:39)	
										100% Recovery	
15										10.0	
										Bottom of Exploration at 10.0 feet below ground surface. Backfilled with gravel and topped with cold patch.	
20											
25											

Remarks:

Hammer calibration obtained from SW Cole calibration report.
As-drilled elevations are derived from survey files within the emails titled "FW Exit 20 and 22 Borings and Probes Freeport" received by Golder on June 11 and June 28, 2021 from MaineDOT.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 Mallet Drive Bridge Replacement #5721 (Exit 22)
Location: Freeport, Maine

Boring No.: BB-FMD-208
WIN: 021726.00

Driller:	SW Cole	**Elevation (ft.)**	166.0	**Auger ID/OD:**	2.5 in
Operator:	J. Layfield	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	B. Kurtoglu	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	06/02/21 (21:12);06/03/21 (02:22)	**Drilling Method:**	Pin Auger / Cased Wash	**Core Barrel:**	NQ
Boring Location:	N 375857.054 ft, E 1054762.839 ft	**Casing ID/OD:**	5.5 in	**Water Level*:**	13.6 ft
Hammer Efficiency Factor: 0.974		**Hammer Type:**	Automatic ☐ Hydraulic ☒ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_V = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/18	0.80 - 2.80	17/13/15/17	28	45		165.2		Asphalt thickness of 10 in (ASPHALT)	
										0.8	
										Tan, dry, dense, fine to coarse SAND, some gravel, trace silt, well-graded (FILL)	
	2D	24/24	2.80 - 4.80	12/14/13/10	27	44				Tan, dry, dense, fine to coarse SAND, some gravel, trace silt, well-graded (FILL)	
	3D	24/18	4.80 - 6.80	10/10/8/11	18	29	44				
5							89			Tan, dry, medium dense, fine to coarse SAND, little gravel, trace silt, well-graded (FILL)	
	4D	24/17	6.80 - 8.80	8/13/13/14	26	42	107				
							54			Tan, dry, dense, fine to coarse SAND, trace gravel, trace silt, poorly-graded (FILL)	WC = 6.2%
	5D	24/19	8.80 - 10.80	7/8/11/17	19	31	78	157.2		8.8	
							162			Tan, damp, dense, fine to coarse SAND, some gravel, little silt, well-graded (SAND AND GRAVEL)	
10	6D	24/16	10.80 - 12.80	10/11/13/11	24	39				Tan and white, damp, dense, fine to coarse SAND, some gravel, little silt, well-graded (SAND AND GRAVEL)	6D: GTX #621772 WC = 6.3% Fines = 15.9% A-1-b, SM
15	7D	24/8	15.00 - 17.00	5/15/15/12	30	49				Greyish tan, damp, dense, GRAVEL, some fine to coarse sand, trace silt, well-graded (SAND AND GRAVEL)	7D: GTX #621773 WC = 6.3% Fines = 1.7% A-1-a, GW
							22				
	R1	60/56	18.50 - 23.50	RQD = 76%			137 NQ	147.5		Top of bedrock at elev. 147.5 ft.	
										18.5	
20										Grey, fine grained, strongly foliated, SCHIST, strong to very strong (R4 to R5), slightly to moderately weathered (W2 to W3). Discontinuities low to moderately dipping (5-35 deg) and very closely to closely spaced (<0.05-0.6 ft). [VASSALBORO FORMATION] Rock Mass Quality: GOOD Rock Core Rate (min:sec) 18.5-19.5 ft (5:12) 19.5-20.5 ft (4:15) 20.5-21.5 ft (1:50) 21.5-22.5 ft (2:48)	
								142.5			
25											

Remarks:

Hammer calibration obtained from SW Cole calibration report.
As-drilled elevations are derived from survey files within the emails titled "FW Exit 20 and 22 Borings and Probes Freeport" received by Golder on June 11 and June 28, 2021 from MaineDOT.
Water level was measured 15 minutes after the completion of the drilling while casing was still in the hole.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: I-295 Mallet Drive Bridge Replacement #5721 (Exit 22)
Location: Freeport, Maine

Boring No.: BB-FMD-208
WIN: 021726.00

Driller:	SW Cole	**Elevation (ft.)**	166.0	**Auger ID/OD:**	2.5 in
Operator:	J. Layfield	**Datum:**	NAD83 (2011) Maine 2000 West	**Sampler:**	Standard Split Spoon
Logged By:	B. Kurtoglu	**Rig Type:**	Diedrich D-50	**Hammer Wt./Fall:**	140 lbs/30 in
Date Start/Finish:	06/02/21 (21:12);06/03/21 (02:22)	**Drilling Method:**	Pin Auger / Cased Wash	**Core Barrel:**	NQ
Boring Location:	N 375857.054 ft, E 1054762.839 ft	**Casing ID/OD:**	5.5 in	**Water Level*:**	13.6 ft
Hammer Efficiency Factor: 0.974		**Hammer Type:**	Automatic ☐ Hydraulic ☒ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140 lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample Information: Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25										22.5-23.5 ft (2:37) 93% Recovery	
										23.5 **Bottom of Exploration at 23.5 feet below ground surface.** Backfilled with gravel and topped with cold patch.	
30											
35											
40											
45											
50											

Remarks:

Hammer calibration obtained from SW Cole calibration report.
As-drilled elevations are derived from survey files within the emails titled "FW Exit 20 and 22 Borings and Probes Freeport" received by Golder on June 11 and June 28, 2021 from MaineDOT.
Water level was measured 15 minutes after the completion of the drilling while casing was still in the hole.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

APPENDIX B

Stability

GOLDER

CALCULATIONS

Date:	7/1/2021	**Made by:**	MEL
Project No.:	20450910	**Checked by:**	AH
Subject:	Global Stability Analysis Abutment No. 1 and No. 2	**Reviewed by:**	JEL
Project Short Title:	MaineDOT I-295 Exit 22 Mallet Drive Bridge Replacement No. 5721		

OBJECTIVE

Calculate global factor of safety for Abutment No. 1 (northwestern) and Abutment No. 2 (southeastern).

REFERENCES

1. AASHTO LRFD Bridge Design Specifications, 9th Ed, 2020.
2. Email communication between Golder and HNTB, subject "RE: Freeport I-295 Exit 20 and Exit 22 - Request for Sections and Design Info", dated June 23, 2020.

3. Golder geotechnical test boring logs (Appendix A, Preliminary Geotechnical Design Report, dated September 2020).
4. HNTB for State of Maine Department of Transportation. Approach Road Bridge Freeport Interstate 295: Mallet Drive South Cross Sections, dated May 2021
5. Das, Braja M. (2011). Principles of Foundation Engineering, 7th Edition. Cengage Learning.
6. FHWA. 2017. Geotechnical Engineering Circular No. 5: Geotechnical Site Characterization. Publication No. FHWA NHI-16-072.
7. GeoTesting Express laboratory testing results, dated February 17, 2020 (Appendix C, Preliminary Geotechnical Design Report, dated September 2020).
8. Golder summary of rock laboratory test results (Table 5, Preliminary Geotechnical Design Report, dated September 2020).
9. Guertin Elkerton & Associates for Maine Department of Transportation. Bridge Design Guide. Dated August 2003 with 2018 updates.
10. Grading schematic provided by HNTB, file name "19129538 Freeport I-295 Exit 22 Southeast (Abutment No. 2) Abutment Cross-Section_HNTB_edits.pdf", dated August 19, 2020.
11. Golder calculation titled "Seismic Site Class" (Appendix E, Preliminary Geotechnical Design Report, dated September 2020).
12. Rocscience Slide Software Package Version 2020 9.010 64-bit, build date Oct 14, 2020.
13. FHWA. 2011. Geotechnical Engineering Circular No. 3 - LRFD Seismic Analysis and Design of Transportation Geotechnical Features and Structural Foundations Reference Manual, Publication No. FHWA-NHI-11-032

ATTACHMENTS

1. Slide output figures
2. HNTB 60% plans

ASSUMPTIONS

1. The load applied by the road and traffic for final design conditions is modeled as a 2 ft equivalent load of soil (Reference 1, Table 3.11.6.4-1) based on a 11 ft abutment height (Reference 2). 2 ft x 125 pcf (fill) = 250 psf.
2. A static FS ≥ 1.5 is recommended for abutment final design conditions per Section 5.9.2 in Reference 8. A pseudo-static FS > 1.1 is recommended in Reference 13.
3. Circular surfaces were analyzed using the Spencer and Bishop simplified methods and auto refine search. Non-circular surfaces were analyzed using the Spencer method and cuckoo search with surface altering optimization.
4. The existing stratigraphy and water table surface are estimated from samples and groundwater measurements encountered during drilling and provided in Reference 3.
5. The existing grading, proposed grading, and construction design features are taken from References 4 and 10.
6. Undrained conditions ($\phi = 0$) were assumed for the clay layers.
7. This analysis did not account for the pile foundations proposed to support the abutment.

Date:	7/1/2021	**Made by:**	MEL
Project No.:	20450910	**Checked by:**	AH
Subject:	Global Stability Analysis Abutment No. 1 and No. 2	**Reviewed by:**	JEL
Project Short Title:	MaineDOT I-295 Exit 22 Mallet Drive Bridge Replacement No. 5721		

CALCULATION

1. Determine input parameters to build the soil model in Slide.

The material parameters selected for use in the Slide models are shown in the table below.

a. The friction angle parameters for the existing fill and sand/gravel layers are based on empirical correlation (Reference 5, Eqn. 2.26) to the average of the N_{60}-values encountered in all borings for each layer (Reference 3).

b. The cohesion parameter for the glaciomarine layer is based on shear strength measurements made in the field and on empirical correlation (Reference 6, Eqn. 7.19) to the average of the N_{60}-values encountered in all borings for each layer (Reference 3).

c. The unit weight parameter for the glaciomarine layer is calculated from soil moisture contents determined in laboratory testing (Reference 7), assuming 100% saturation. The unit weight parameters for the existing fill and sand/gravel layers are selected based on local engineering experience.

d. The UCS and unit weight parameters for the bedrock are selected based on the average of laboratory test results for all borings (Reference 8). The GSI, m_i, and D parameters for the bedrock are selected based on field descriptions of the rock quality encountered in the borings (Reference 3).

e. The friction angle and unit weight parameters for the construction materials are selected based on MaineDOT standard practice (Reference 9, Table 3-3).

Material Name	Unit Weight (pcf)	Strength Type	Cohesion (psf)	Friction Angle (°)	UCS (psf)	GSI	m_i	D
Existing Fill	125	Mohr-Coulomb	0	33	-	-	-	-
Glaciomarine	115	Undrained	1350	0				
Sand and Gravel	125	Mohr-Coulomb	0	36	-	-	-	-
Bedrock	169	Generalized Hoek-Brown	-	-	1,815,000	77	28	0
Granular Borrow	125	Mohr-Coulomb	0	32	-	-	-	-
Gravel Borrow	135	Mohr-Coulomb	0	36	-	-	-	-
Rock Borrow	135	Mohr-Coulomb	0	42	-	-	-	-

Date:	7/1/2021	**Made by:**	MEL
Project No.:	20450910	**Checked by:**	AH
Subject:	Global Stability Analysis Abutment No. 1 and No. 2	**Reviewed by:**	JEL
Project Short Title:	MaineDOT I-295 Exit 22 Mallet Drive Bridge Replacement No. 5721		

2. Use the soil layer parameters listed above to analyze the slope stability with Slide.

The soil layer properties above were used to analyze static scenarios at both Abutment 1 and Abutment 2. Following analysis of the proposed abutment and slope grading system, Golder computed global stability factors of safety less than the recommended factor of safety of 1.5 for potential slope failures in the existing and proposed fill. Golder has presented a recommended slope grading system using gravel and rock borrow materials to produce global stability factors of safety greater than 1.5. The results of the Slide stability analyses are summarized in the following table.

Slope Grading System	Interpreted Subsurface Section	Abutment	Lowest Factor of Safety (Spencer Method)	
			NonCircular Failure Surface - Proposed Fill	NonCircular Failure Surface - Below Road
Proposed	A-A'	1	1.56 (Fig. A.1)	2.27 (Fig. A.2)
Proposed	A-A'	2	1.42 (Fig. B.1)	N/A
Recommended	A-A'	2	1.51 (Fig. B.2)	

Circular Surfaces:

Circular failure surfaces using Spencer and Bishop simplified methods were also evaluated for each scenario. The circular surfaces that were produced were similar in location and size to the noncircular surfaces and had factors of safety similar in magnitude to the noncircular factors of safety. The circular factors of safety ranged from 1.51 to 1.76 for surfaces through the proposed fill and ranged from 2.37 to 2.45 for surfaces extending below the road and through the in situ soil soils.

3. Repeat the Slide analysis with pseudo-static seismic load conditions.

The same scenarios were also analyzed with a horizontal seismic load coefficient of $A_s/2 = 0.064$ (A_s from Reference 11) as recommended in Reference 13. The results of the seismic Slide stability analyses are summarized in the following table.

Slope Grading System	Interpreted Subsurface Section	Abutment	Lowest Factor of Safety (Spencer Method)	
			NonCircular Failure Surface - Proposed Fill	NonCircular Failure Surface - Below Road
Proposed	A-A'	1	1.36 (Fig. C.1)	1.80 (Fig. C.2)
Proposed	A-A'	2	1.24 (Fig. D.1)	N/A
Recommended	A-A'	2	1.31 (Fig. D.2)	

Circular Surfaces:

Circular failure surfaces using Spencer and Bishop simplified methods were also evaluated for each seismic scenario. The circular surfaces that were produced were similar in location and size to the noncircular surfaces and had factors of safety similar in magnitude to the noncircular factors of safety. The circular factors of safety ranged from 1.30 to 1.50 for surfaces through the proposed and existing fill and from 2.01 to 2.02 for surfaces extending below the road and through the in situ soil soils.

Date:	7/1/2021	**Made by:**	MEL
Project No.:	20450910	**Checked by:**	AH
Subject:	Global Stability Analysis Abutment No. 1 and No. 2	**Reviewed by:**	JEL
Project Short Title:	MaineDOT I-295 Exit 22 Mallet Drive Bridge Replacement No. 5721		

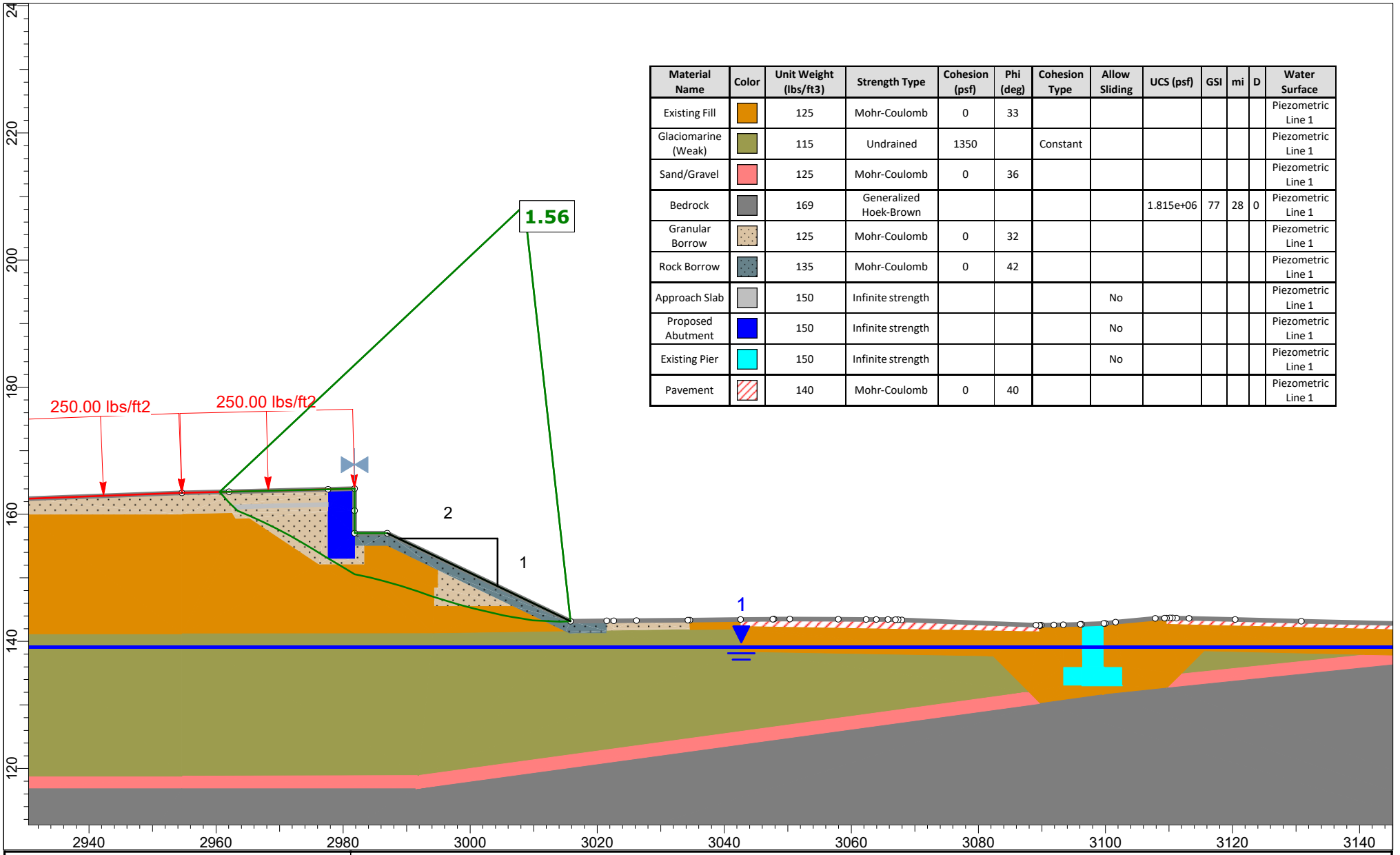
CONCLUSIONS

At Abutment 1 the proposed abutment and slope grading system yields adequate global stability factors of safety (FS > 1.5) for potential slope failures in the existing and proposed fill when using proposed fill engineering parameters recommended in the MaineDOT Bridge Design Guide section 5.9.2 for slopes with footings. Analyses indicate failure surfaces passing underneath the abutment wall.

At Abutment 2 the proposed abutment and slope grading system produces a global stability factor of safety less than the recommended factor of safety of 1.5 for potential slope failures in the existing and proposed fill when using proposed fill engineering parameters recommended in the MaineDOT Bridge Design Guide section 5.9.2 for slopes with footings. Analyses indicate failure surfaces passing underneath the abutment wall. Golder has provided global stability analysis of the recommended slope grading sytem that yields adequate factors of safety (FS > 1.5).

The analysis of the proposed abutment and slope grading system yields adequate factors of safety (FS > 1.5) for the potential deep seated slope failures in native soils underlying the proposed abutment under static conditions.

The analysis of the proposed abutment and slope grading system yields adequate factors of safety (FS > 1.1) for the potential slope failures in both the native soils underlying the proposed abutment and abutment surface fills under pseudo-static conditions where seismic loading is applied.



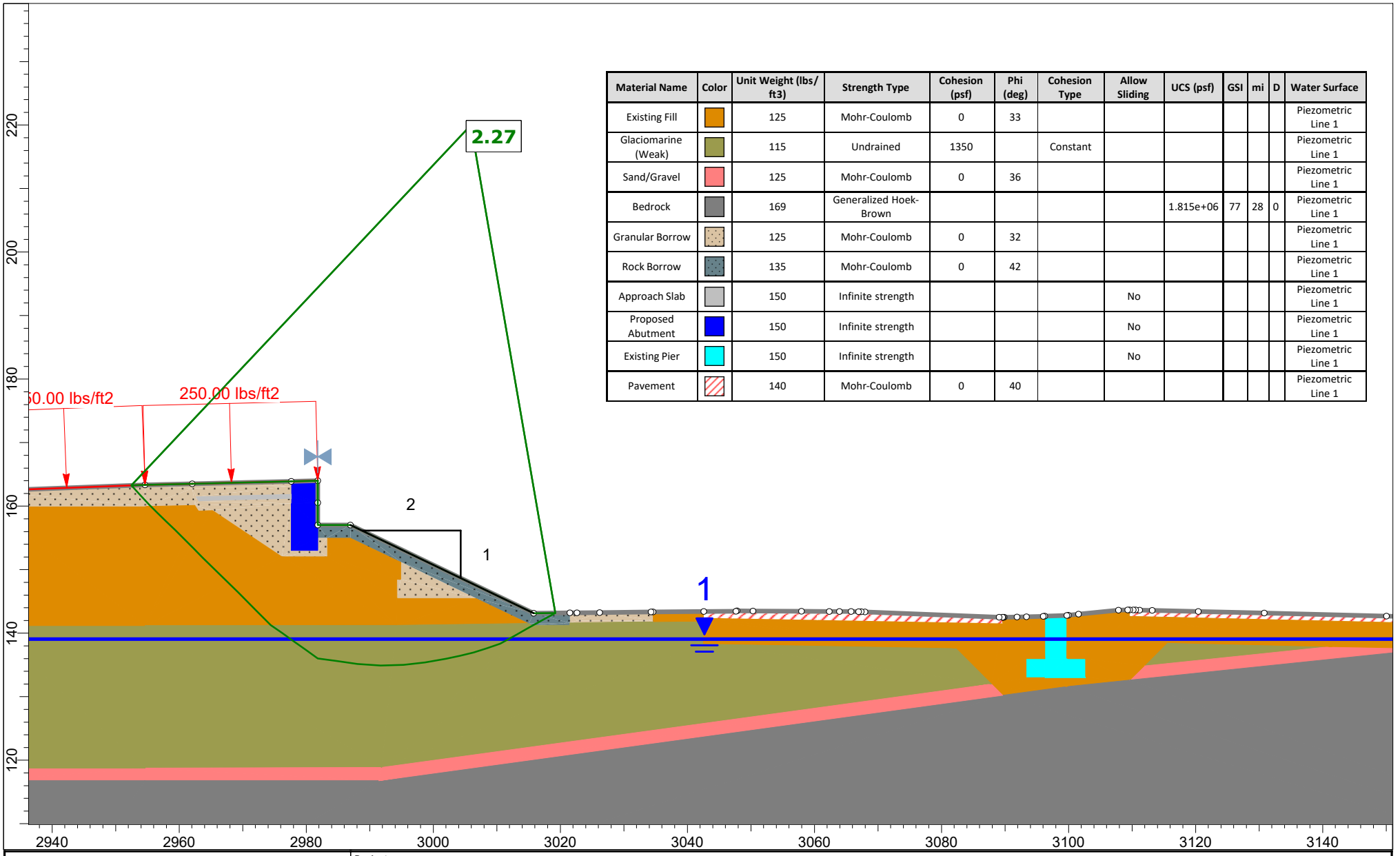
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Allow Sliding	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33							Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant						Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36							Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown					1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32							Piezometric Line 1
Rock Borrow		135	Mohr-Coulomb	0	42							Piezometric Line 1
Approach Slab		150	Infinite strength				No					Piezometric Line 1
Proposed Abutment		150	Infinite strength				No					Piezometric Line 1
Existing Pier		150	Infinite strength				No					Piezometric Line 1
Pavement		140	Mohr-Coulomb	0	40							Piezometric Line 1

GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.011

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721		
Analysis Description	Profile A-A', Proposed Abutment 1 (NonCircular, Cuckoo Search)		
Drawn By MEL	*Checked By* AH	*Reviewed By* JEL	*Scale* 1:250
Date 7/1/2021	*File Name* Mallet Drive Profile A-A' Phase 2 V2.slmd		

Figure A.1



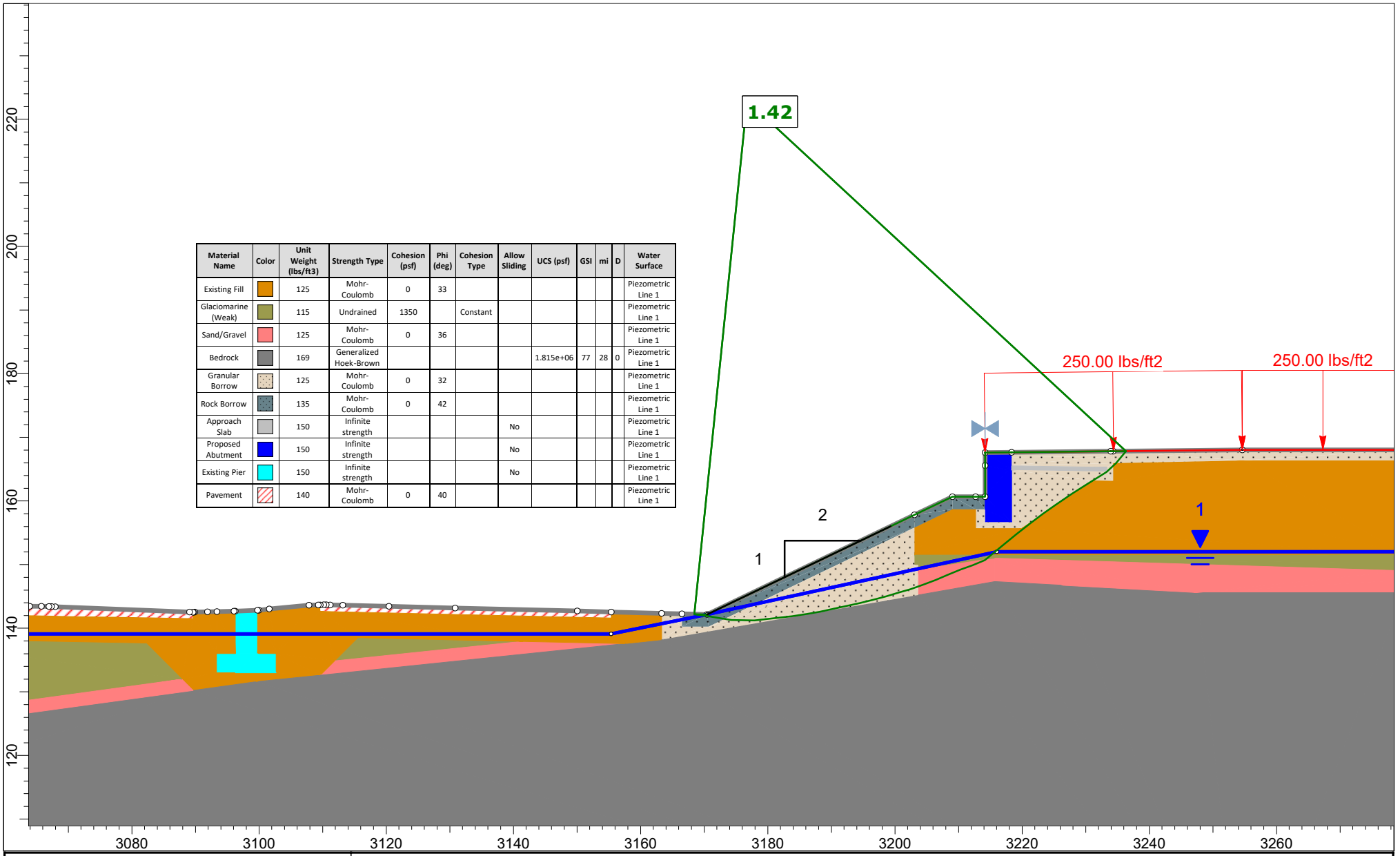
Material Name	Color	Unit Weight (lbs/ ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Allow Sliding	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33							Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant						Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36							Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown					1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32							Piezometric Line 1
Rock Borrow		135	Mohr-Coulomb	0	42							Piezometric Line 1
Approach Slab		150	Infinite strength				No					Piezometric Line 1
Proposed Abutment		150	Infinite strength				No					Piezometric Line 1
Existing Pier		150	Infinite strength				No					Piezometric Line 1
Pavement		140	Mohr-Coulomb	0	40							Piezometric Line 1

GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.011

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721		
Analysis Description	Profile A-A', Proposed Abutment 1 (NonCircular, Cuckoo Search)		
Drawn By MEL	Checked By AH	Reviewed By JEL	Scale 1:250
Date 7/1/2021	File Name Mallet Drive Profile A-A' Phase 2 V2.slmd		

Figure A.2



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Allow Sliding	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33							Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant						Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36							Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown					1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32							Piezometric Line 1
Rock Borrow		135	Mohr-Coulomb	0	42							Piezometric Line 1
Approach Slab		150	Infinite strength				No					Piezometric Line 1
Proposed Abutment		150	Infinite strength				No					Piezometric Line 1
Existing Pier		150	Infinite strength				No					Piezometric Line 1
Pavement		140	Mohr-Coulomb	0	40							Piezometric Line 1

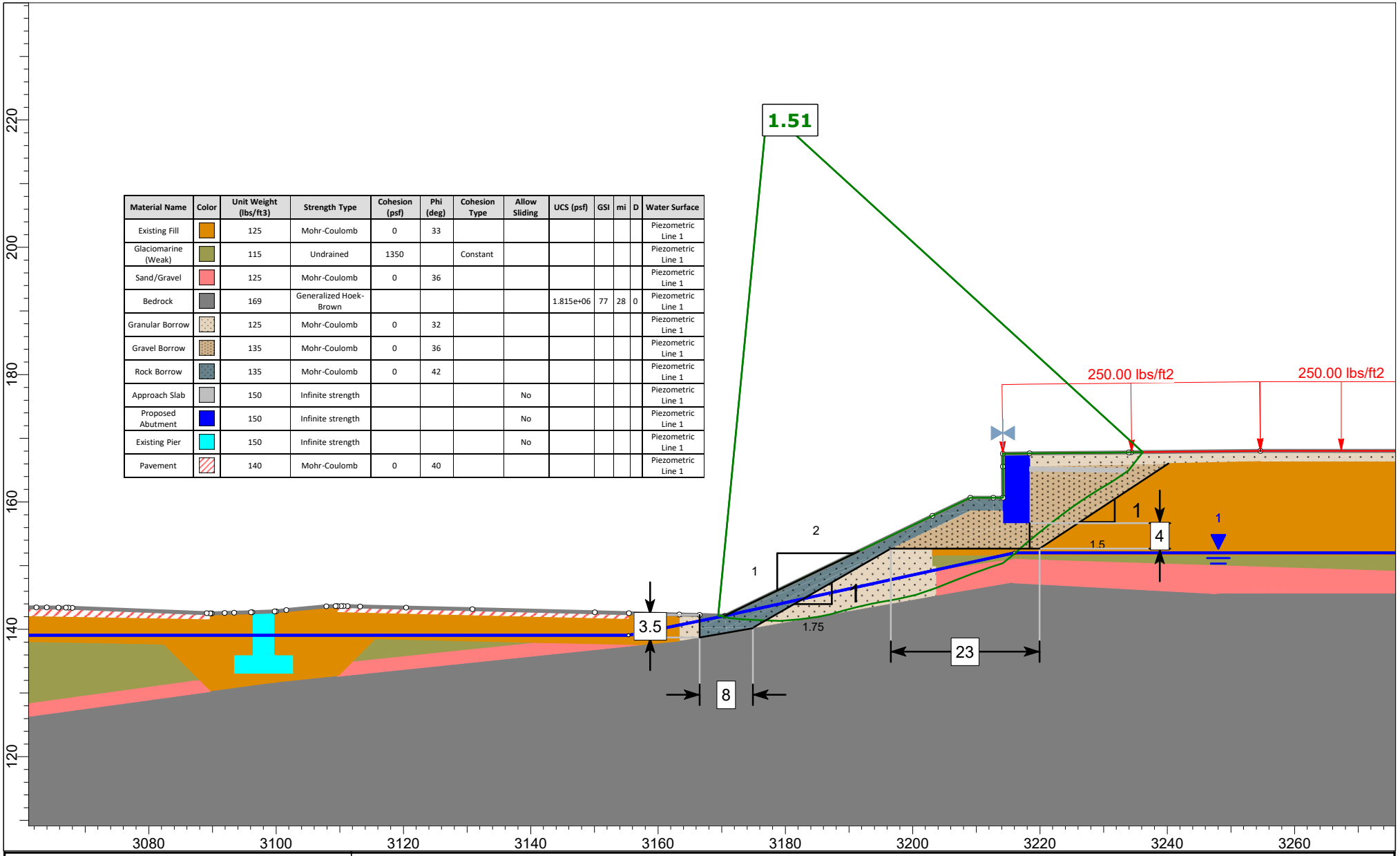
GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.011

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721		
Analysis Description	Profile A-A', Proposed Abutment 2 (NonCircular, Cuckoo)		
Drawn By MEL	Checked By AH	Reviewed By JEL	Scale 1:250
Date 07/01/2021	File Name Mallet Drive Profile A-A' Phase 2 V3.slmd		

Figure B.1

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Allow Sliding	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33							Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant						Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36							Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown					1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32							Piezometric Line 1
Gravel Borrow		135	Mohr-Coulomb	0	36							Piezometric Line 1
Rock Borrow		135	Mohr-Coulomb	0	42							Piezometric Line 1
Approach Slab		150	Infinite strength				No					Piezometric Line 1
Proposed Abutment		150	Infinite strength				No					Piezometric Line 1
Existing Pier		150	Infinite strength				No					Piezometric Line 1
Pavement		140	Mohr-Coulomb	0	40							Piezometric Line 1

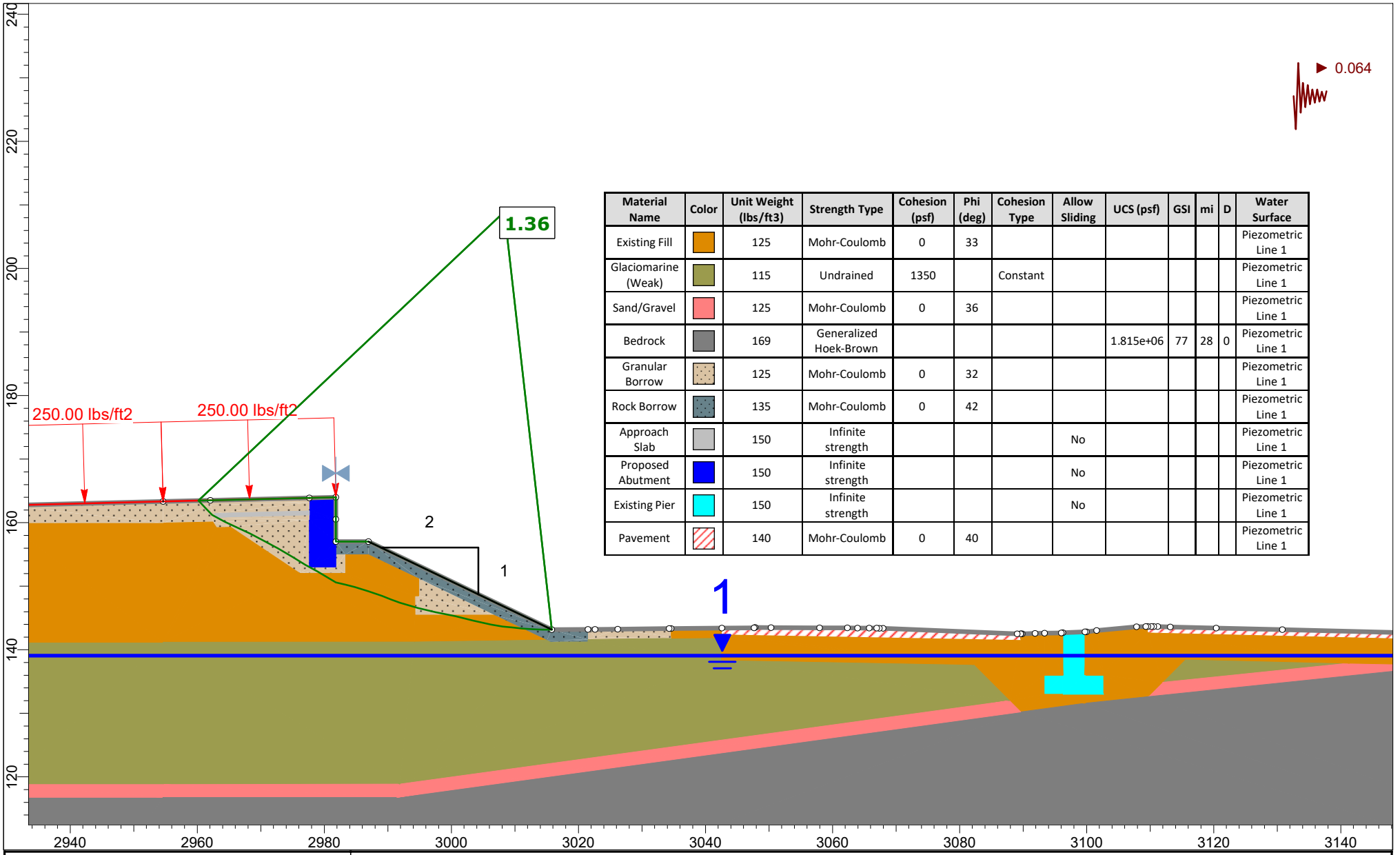


GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.011

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721		
Analysis Description	Profile A-A', Recommended Abutment 2 (NonCircular, Cuckoo)		
Drawn By MEL	Checked By AH	Reviewed By JEL	Scale 1:250
Date 07/01/2021	File Name Mallet Drive Profile A-A' Phase 2 V3.slmd		

Figure B.2



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Allow Sliding	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33							Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant						Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36							Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown					1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32							Piezometric Line 1
Rock Borrow		135	Mohr-Coulomb	0	42							Piezometric Line 1
Approach Slab		150	Infinite strength				No					Piezometric Line 1
Proposed Abutment		150	Infinite strength				No					Piezometric Line 1
Existing Pier		150	Infinite strength				No					Piezometric Line 1
Pavement		140	Mohr-Coulomb	0	40							Piezometric Line 1

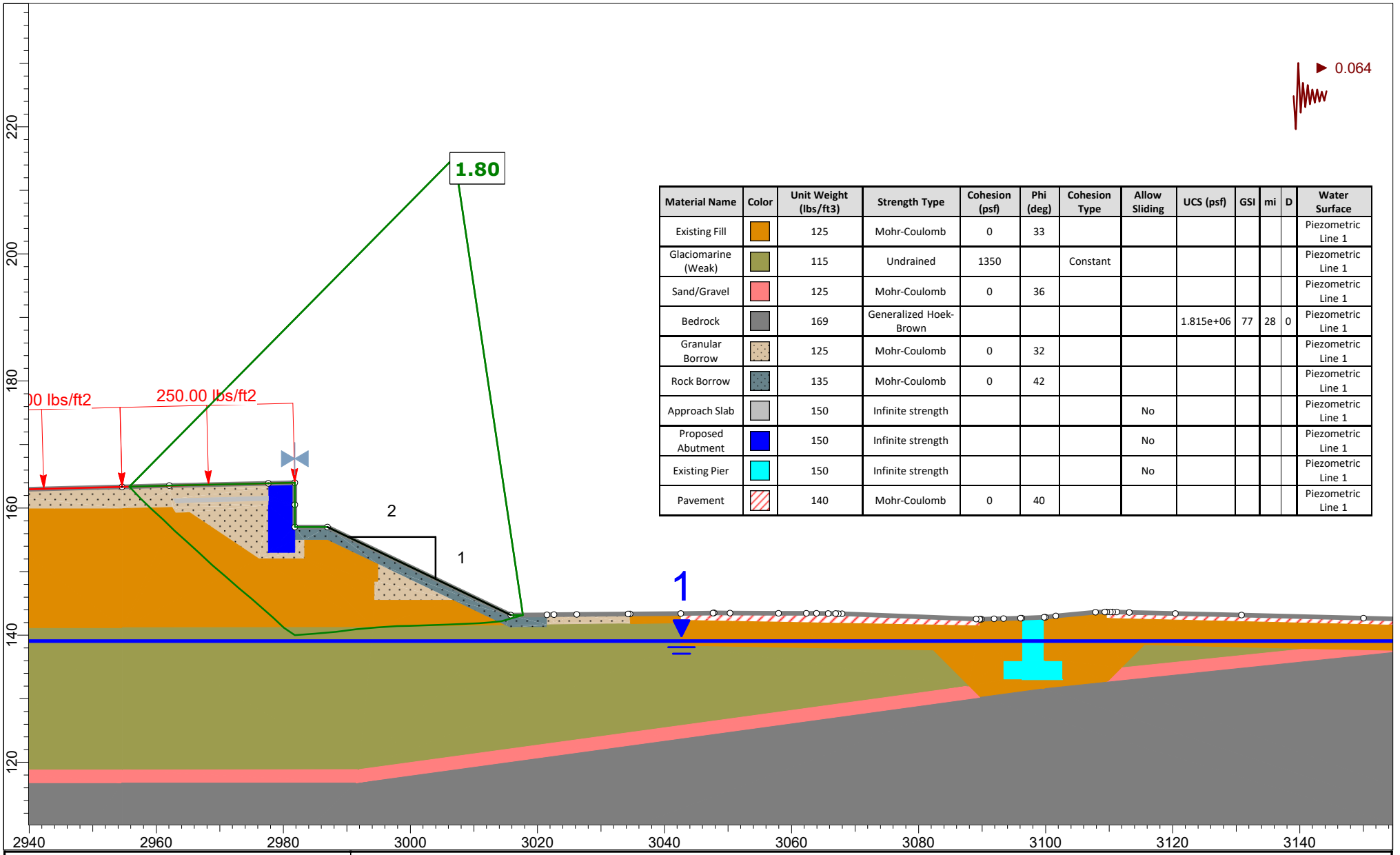
GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.011

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721
Analysis Description	Profile A-A', Proposed Abutment 1 (NonCircular, Cuckoo Search)

Drawn By	Checked By	Reviewed By	Scale
MEL	AH	JEL	1:250
Date: 7/1/2021	File Name: Mallet Drive Profile A-A' Phase 2 V2.slmd		

Figure C.1



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Allow Sliding	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33							Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant						Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36							Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown					1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32							Piezometric Line 1
Rock Borrow		135	Mohr-Coulomb	0	42							Piezometric Line 1
Approach Slab		150	Infinite strength				No					Piezometric Line 1
Proposed Abutment		150	Infinite strength				No					Piezometric Line 1
Existing Pier		150	Infinite strength				No					Piezometric Line 1
Pavement		140	Mohr-Coulomb	0	40							Piezometric Line 1

GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.011

Project: 21450910 I-295 MaineDOT Mallet Drive Bridge no 5721

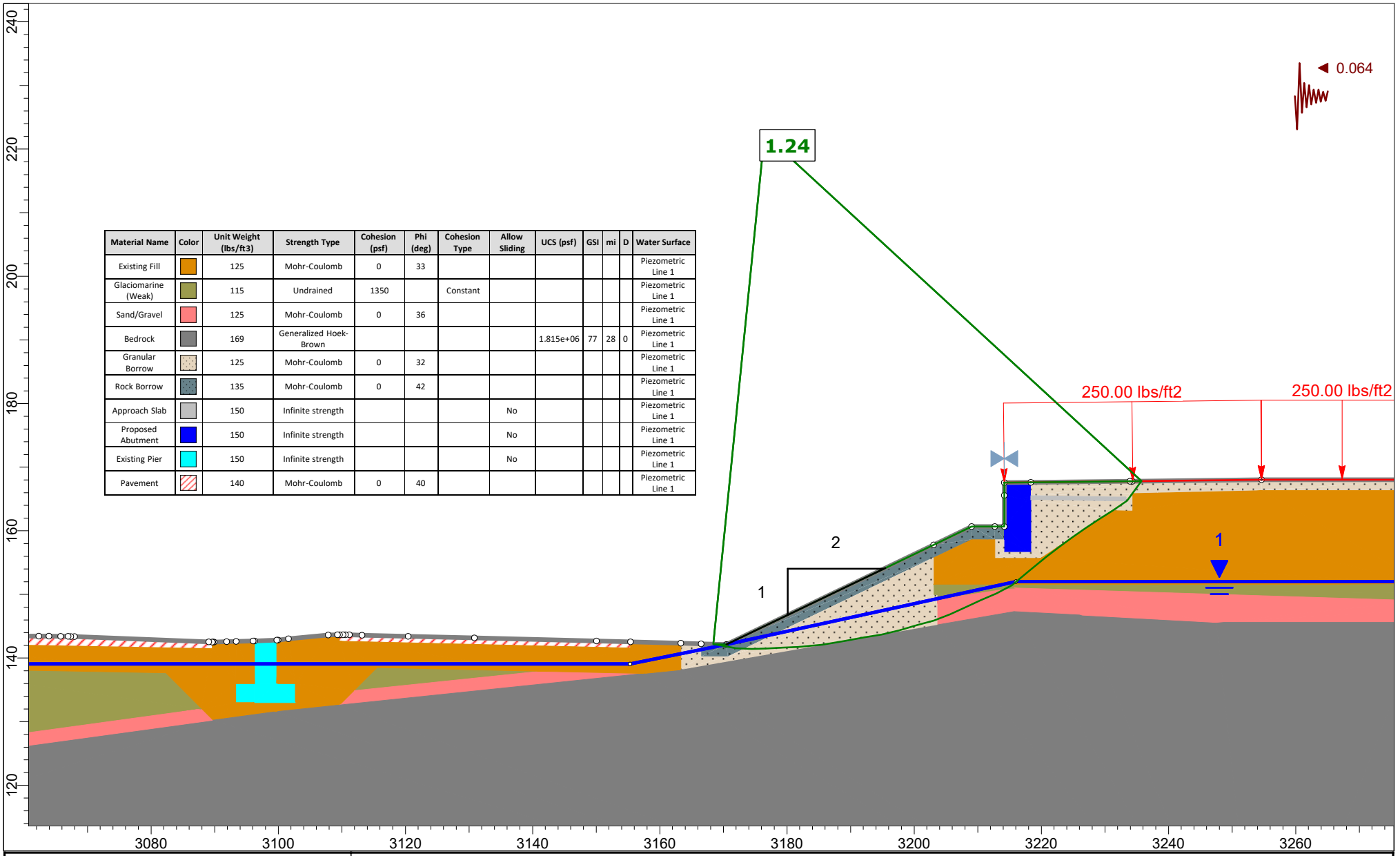
Analysis Description: Profile A-A', Proposed Abutment 1 (NonCircular, Cuckoo Search)

Drawn By	Checked By	Reviewed By	Scale
MEL	AH	JEL	1:250

Date: 7/1/2021

File Name: Mallet Drive Profile A-A' Phase 2 V2.slmd

Figure C.2



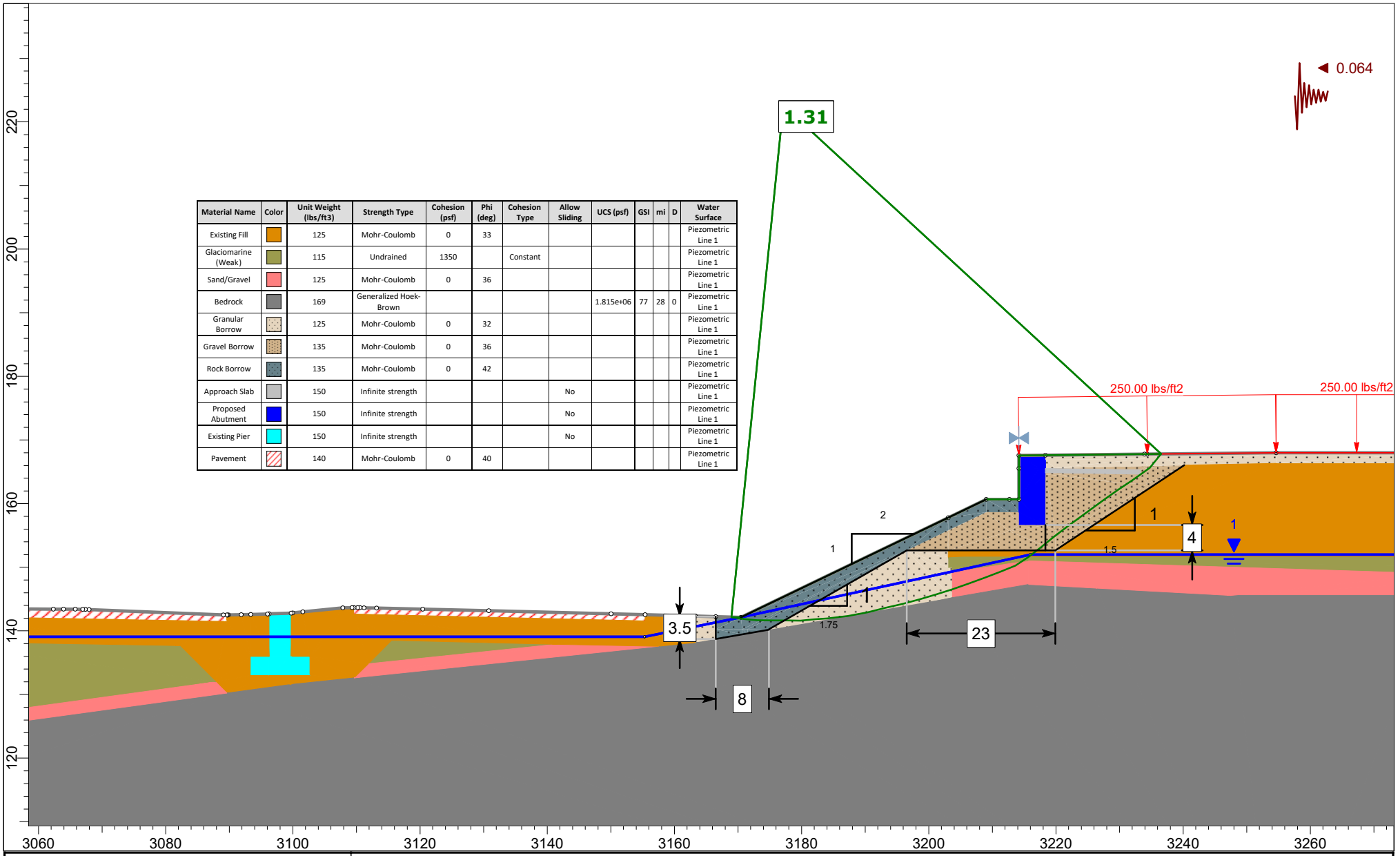
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Allow Sliding	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33							Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant						Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36							Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown					1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32							Piezometric Line 1
Rock Borrow		135	Mohr-Coulomb	0	42							Piezometric Line 1
Approach Slab		150	Infinite strength				No					Piezometric Line 1
Proposed Abutment		150	Infinite strength				No					Piezometric Line 1
Existing Pier		150	Infinite strength				No					Piezometric Line 1
Pavement		140	Mohr-Coulomb	0	40							Piezometric Line 1

GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.011

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721		
Analysis Description	Profile A-A', Proposed Abutment 2 (NonCircular, Cuckoo)		
Drawn By MEL	Checked By AH	Reviewed By JEL	Scale 1:250
Date 07/01/2021	File Name Mallet Drive Profile A-A' Phase 2 V3.slmd		

Figure D.1



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	Allow Sliding	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33							Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant						Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36							Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown					1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32							Piezometric Line 1
Gravel Borrow		135	Mohr-Coulomb	0	36							Piezometric Line 1
Rock Borrow		135	Mohr-Coulomb	0	42							Piezometric Line 1
Approach Slab		150	Infinite strength				No					Piezometric Line 1
Proposed Abutment		150	Infinite strength				No					Piezometric Line 1
Existing Pier		150	Infinite strength				No					Piezometric Line 1
Pavement		140	Mohr-Coulomb	0	40							Piezometric Line 1

GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.011

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721		
Analysis Description	Profile A-A', Recommended Abutment 2 (NonCircular, Cuckoo)		
Drawn By MEL	*Checked By* AH	*Reviewed By* JEL	*Scale* 1:250
Date 07/01/2021	*File Name* Mallet Drive Profile A-A' Phase 2 V3.slmd		

Figure D.2

Date:	7/2/2021	**Made by:**	AH
Project No.:	21450910	**Checked by:**	KAR
Subject:	Global Stability Analysis: Approach Embankment	**Reviewed by:**	JEL
Project Short Title:	I-295 Mallet Drive Bridge Replacement no 5721 Phase 2		

OBJECTIVE

Calculate global factor of safety for the Abutment No. 1 proposed bridge approach embankment.

REFERENCES

1. AASHTO LRFD Bridge Design Specifications, 9th Ed, 2020.
2. Email communication between Golder and HNTB, subject "RE: Freeport I-295 Exit 20 and Exit 22 - Request for Sections and Design Info", dated June 23, 2020.
3. Golder geotechnical test boring logs (Appendix A, Preliminary Geotechnical Design Report, dated September 2020).
4. HNTB for State of Maine Department of Transportation. Approach Road Bridge Freeport Interstate 295: Mallet Drive South Cross Sections, dated May 7, 2021
5. Das, Braja M. (2011). Principles of Foundation Engineering, 7th Edition. Cengage Learning.
6. FHWA. 2017. Geotechnical Engineering Circular No. 5: Geotechnical Site Characterization. Publication No. FHWA NHI-16-072.
7. GeoTesting Express laboratory testing results, dated February 17, 2020 (Appendix C, Preliminary Geotechnical Design Report, dated September 2020).
8. Golder summary of rock laboratory test results (Table 5, Preliminary Geotechnical Design Report, dated September 2020).
9. Guertin Elkerton & Associates for Maine Department of Transportation. Bridge Design Guide. Dated August 2003 with 2018 updates.
10. Golder calculation titled "Seismic Site Class" (Appendix E, Preliminary Geotechnical Design Report, dated September 2020).
11. Rocscience Slide Software Package Version 2020 9.007 64-bit, build date May 29, 2020.
12. FHWA. 2011. Geotechnical Engineering Circular No. 3 - LRFD Seismic Analysis and Design of Transportation Geotechnical Features and Structural Foundations Reference Manual, Publication No. FHWA-NHI-11-032

ATTACHMENTS

1. Slide output figures
2. HNTB 60% Plans

ASSUMPTIONS

1. The load applied by the road and traffic for final design conditions is modeled as a 2 ft equivalent load of soil (Reference 1, Table 3.11.6.4-1) based on a 11 ft abutment height (Reference 2). 2 ft x 125 pcf (fill) = 250 psf.
2. A static FS ≥ 1.5 is recommended for abutment final design conditions per Section 5.9.2 in Reference 8. A pseudo-static FS > 1.1 is recommended in Reference 12.
3. Circular surfaces were analyzed using the Spencer and Bishop simplified methods and auto refine search. Non-circular surfaces were analyzed using the Spencer method and cuckoo search with surface altering optimization.
4. The existing stratigraphy and water table surface are estimated from samples and groundwater measurements encountered during drilling and provided in Reference 3.
5. The existing grading, proposed grading, and construction design features are taken from Reference 4.
6. Undrained conditions ($\phi = 0$) were assumed for the clay layers.

Date:	7/2/2021	**Made by:**	AH
Project No.:	21450910	**Checked by:**	KAR
Subject:	Global Stability Analysis: Approach Embankment	**Reviewed by:**	JEL
Project Short Title:	I-295 Mallet Drive Bridge Replacement no 5721 Phase 2		

CALCULATION

1. Determine input parameters to build the soil model in Slide.
The material parameters selected for use in the Slide models are shown in the table below.

a. The friction angle parameters for the existing fill and sand/gravel layers are based on empirical correlation (Reference 5, Eqn. 2.26) to the average of the N_{60}-values encountered in all borings for each layer (Reference 3).

b. The cohesion parameters for the glaciomarine layers are based on shear strength measurements made in the field and on empirical correlation (Reference 6, Eqn. 7.19) to the average of the N_{60}-values encountered in all borings for each layer (Reference 3).

c. The unit weight parameter for the glaciomarine layers is calculated from soil moisture contents determined in laboratory testing (Reference 7), assuming 100% saturation. The unit weight parameters for the existing fill and sand/gravel layers are selected based on local engineering experience.

d. The UCS and unit weight parameters for the bedrock are selected based on the average of laboratory test results for all borings (Reference 8). The GSI, m_i, and D parameters for the bedrock are selected based on field descriptions of the rock quality encountered in the borings (Reference 3).

e. The friction angle and unit weight parameters for the construction materials are selected based on MaineDOT standard practice (Reference 9, Table 3-3).

Material Name	Unit Weight (pcf)	Strength Type	Cohesion (psf)	Friction Angle (°)	UCS (psf)	GSI	m_i	D
Existing Fill	125	Mohr-Coulomb	0	33	-	-	-	-
Glaciomarine	115	Undrained	1350	0				
Glaciomarine (Stiff)	115	Undrained	3500	0	-	-	-	-
Sand and Gravel	125	Mohr-Coulomb	0	36	-	-	-	-
Bedrock	169	Generalized Hoek-Brown	-	-	1,815,000	77	28	0
Granular Borrow	125	Mohr-Coulomb	0	32	-	-	-	-
New Subbase	135	Mohr-Coulomb	0	36	-	-	-	-

2. Use the soil layer parameters listed above to analyze the slope stability with Slide.
This analysis evaluates the fills at the proposed Abutment No. 1 approach embankment since the proposed fills and the underlying foundation clays are the thickest. The glaciomarine clay was split into two layers based on interpreted cohesion, and two different zones of the very stiff, compressed glaciomarine clay underneath the existing embankment. The results of the Slide stability analyses are summarized in the following table.

Date:	7/2/2021	**Made by:**	AH
Project No.:	21450910	**Checked by:**	KAR
Subject:	Global Stability Analysis: Approach Embankment	**Reviewed by:**	JEL
Project Short Title:	I-295 Mallet Drive Bridge Replacement no 5721 Phase 2		

Station	Feature	Slope		Lowest Factor of Safety (Spencer Method)			
				NonCircular Failure Surface - Proposed Fill		NonCircular Failure Surface - Below Road	
29+75	Approach Embank.	North (existing)		1.32	(Fig. A.1)	2.09	(Fig. A.2)
		South (proposed)		1.27	(Fig. A.3)	1.51	(Fig. A.4)

Circular failure surfaces using Spencer and Bishop simplified methods were also evaluated for each scenario. The circular surfaces that were produced were similar in location and size to the noncircular surfaces and had factors of safety similar in magnitude to the noncircular factors of safety. The circular factors of safety ranged from 1.27 to 1.33 for surfaces through the proposed fill and from 1.63 to 2.46 for surfaces extending below the road and through the in situ soil soils, including through the glaciomarine deposit.

3. Repeat the Slide analysis with pseudo-static seismic load conditions.

The same scenarios were also analyzed with a horizontal seismic load coefficient of $A_s/2 = 0.064$ (A_s from Reference 10) as recommended in Reference 12. The results of the seismic Slide stability analyses are summarized in the following table.

Station	Feature	Slope		Lowest Factor of Safety (Spencer Method)			
				NonCircular Failure Surface - Proposed Fill		NonCircular Failure Surface - Below Road	
29+75	Approach Embank.	North (existing)		1.14	(Fig. B.1)	1.81	(Fig. B.2)
		South (proposed)		1.09	(Fig. B.3)	1.29	(Fig. B.4)

Circular failure surfaces using Spencer and Bishop simplified methods were also evaluated for each seismic scenario. The circular surfaces that were produced were similar in location and size to the noncircular surfaces and had factors of safety similar in magnitude to the noncircular factors of safety. The circular factors of safety ranged from 1.09 to 1.15 for surfaces through the proposed fill and from 1.39 to 2.13 for surfaces extending below the road and through the in situ soil soils, including through the glaciomarine deposit.

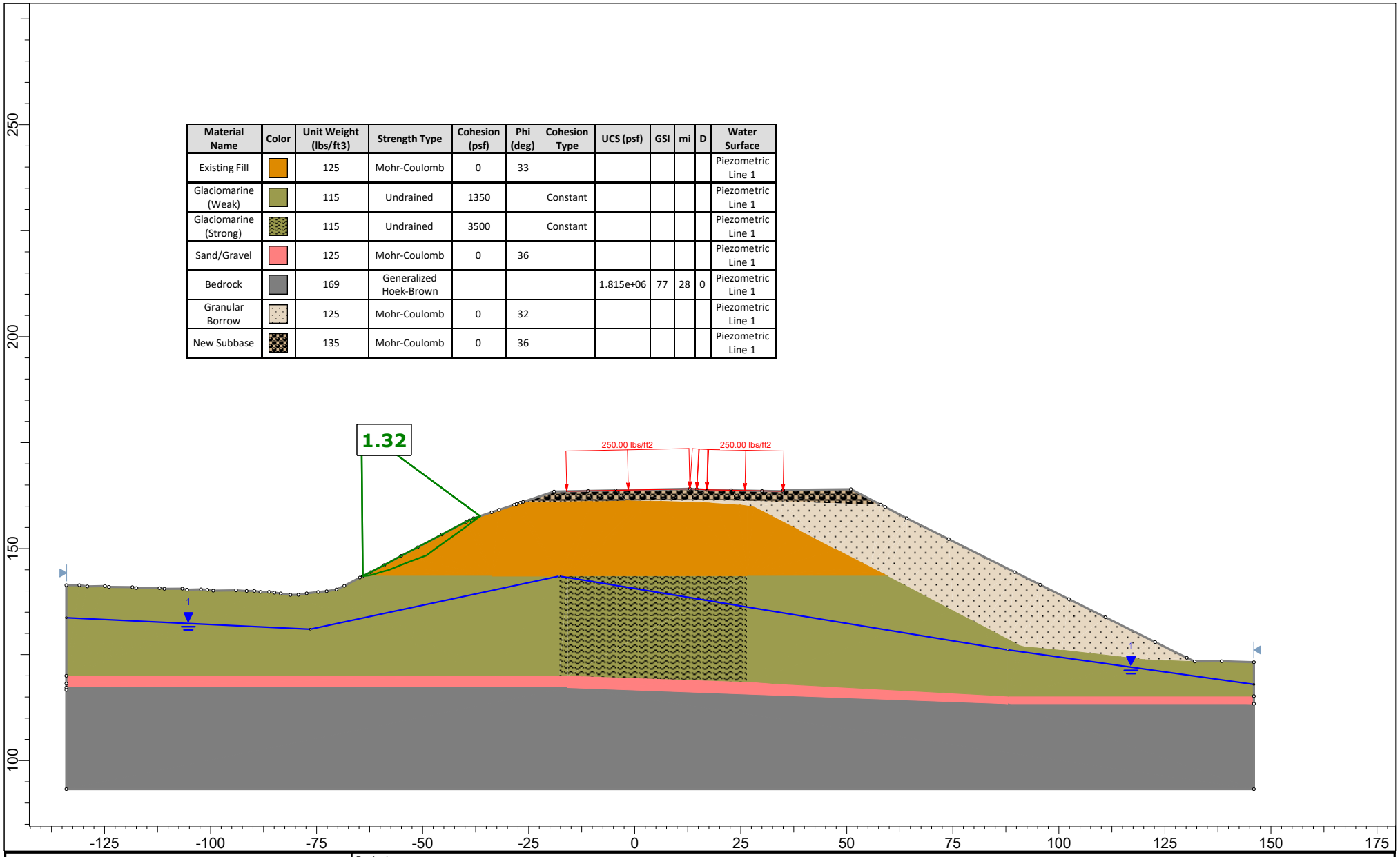
CONCLUSIONS

The proposed embankment and slope grading system produces a global stability factor of safety less than the recommended factor of safety of 1.3 for potential surficial slope failures in the embankment fill when using embankment fill engineering parameters recommended in the MaineDOT Bridge Design Guide. Failure surfaces wtih FS < 1.3 are surficial in nature through the embankment slope and not through the in situ soils.

The analysis of the proposed embankment and slope grading system yields adequate factors of safety (FS > 1.3) for the potential deep seated slope failures in native soils underlying the proposed embankment under static conditions.

The analysis of the proposed embankment and slope grading system yields adequate factors of safety (FS > 1.1 based on Ref. 12) for the potential slope failures in both the native soils underlying the proposed embankment and embankment fills under pseudo-static conditions where seismic loading is applied with the exception of the proposed south slope potential failure surface through the embankment slope proposed fill.

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33						Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant					Piezometric Line 1
Glaciomarine (Strong)		115	Undrained	3500		Constant					Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36						Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown				1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32						Piezometric Line 1
New Subbase		135	Mohr-Coulomb	0	36						Piezometric Line 1

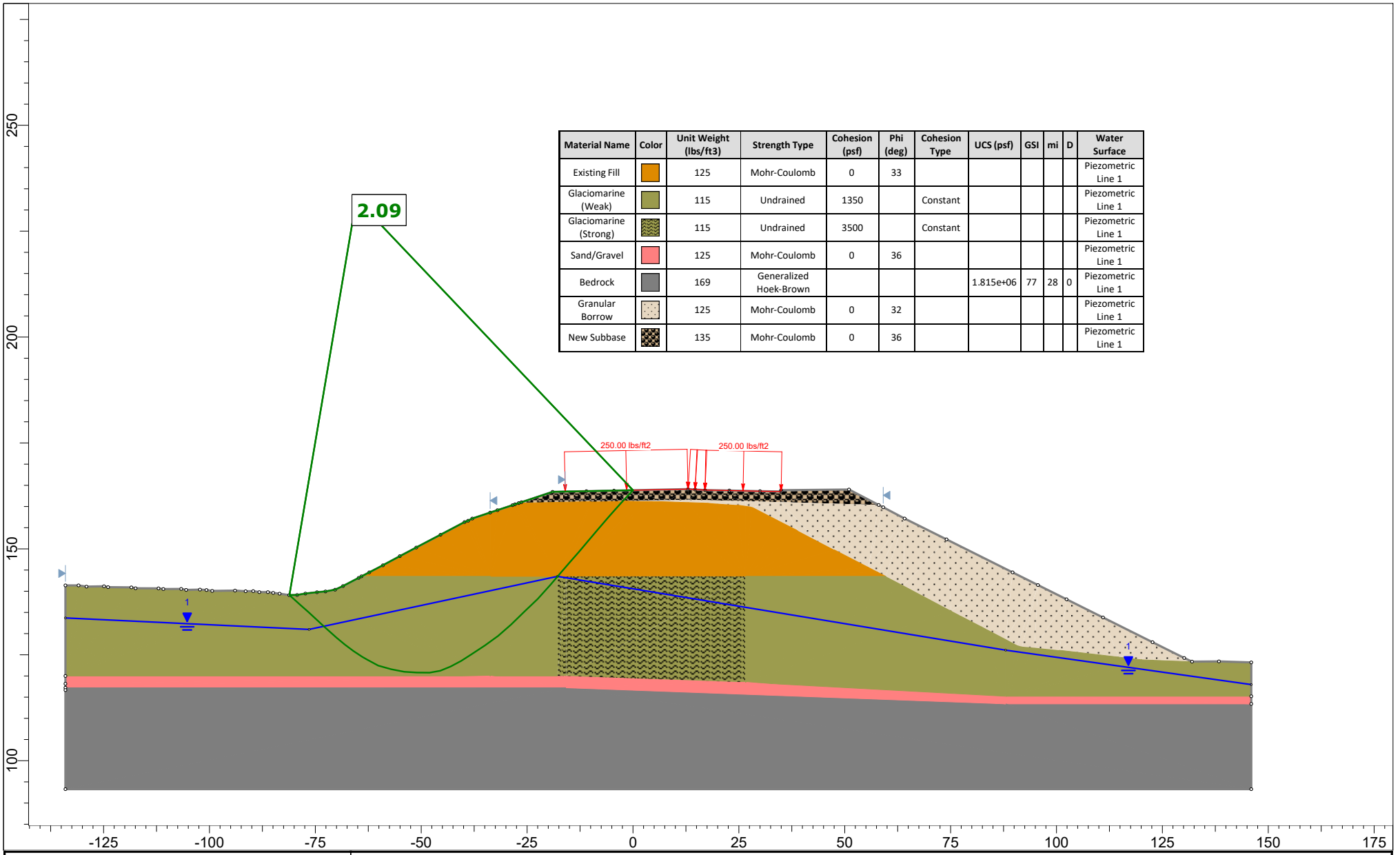


GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.016

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721		
Analysis Description	Station 29+75 North Slope Static (NonCircular, Cuckoo Search)		
Drawn By HTV/AH/MEL	*Checked By* KAR	*Reviewed By* JEL	*Scale* 1:375
Date 7/13/2021	*File Name* Mallet Drive XSec 29+75 Phase 2.slmd		

Figure A.1



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33						Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant					Piezometric Line 1
Glaciomarine (Strong)		115	Undrained	3500		Constant					Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36						Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown				1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32						Piezometric Line 1
New Subbase		135	Mohr-Coulomb	0	36						Piezometric Line 1

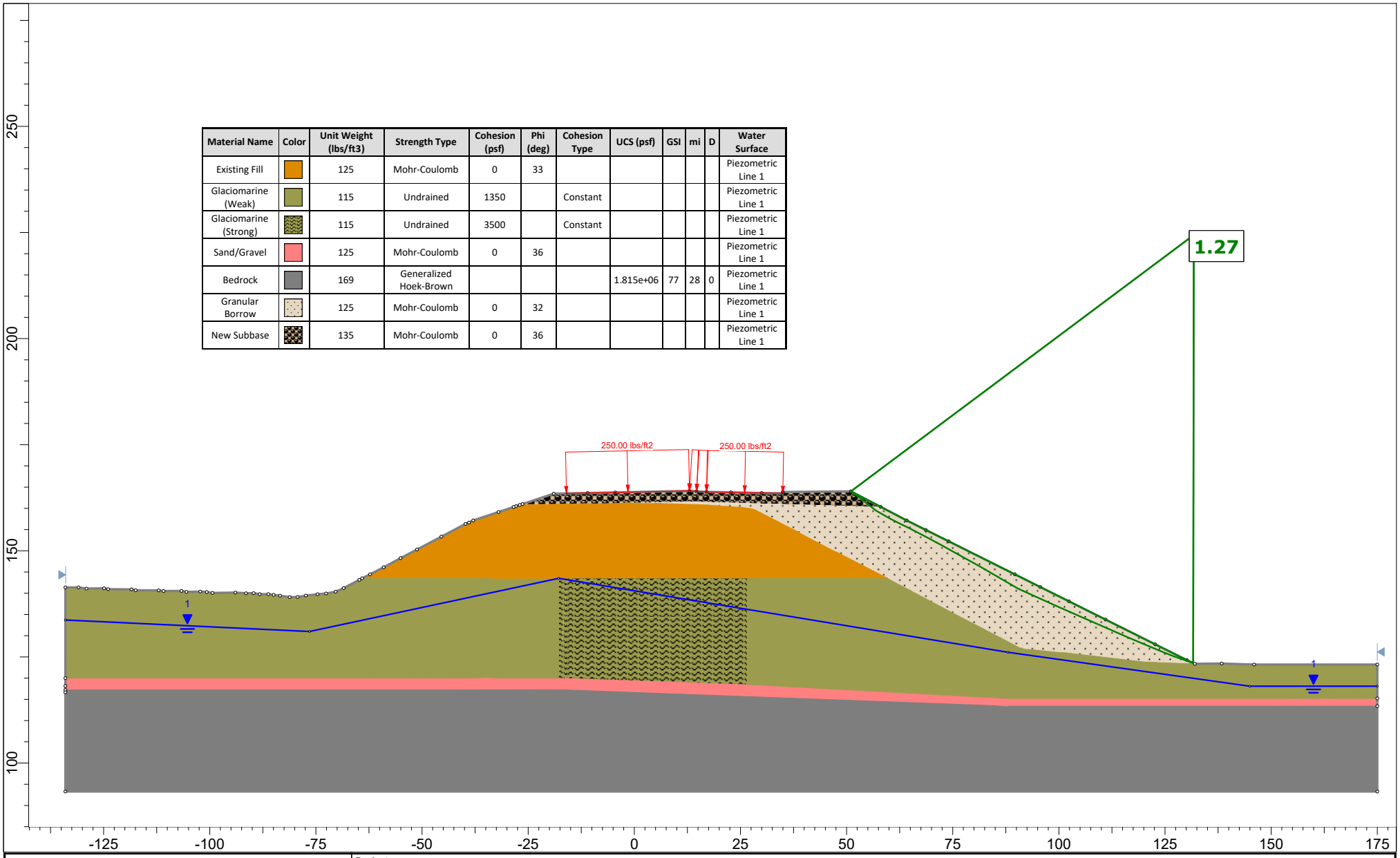
GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.016

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721		
Analysis Description	Station 29+75 North Slope Static (NonCircular, Cuckoo Search)		
Drawn By KAR/AH/MEL	*Checked By* KAR	*Reviewed By* JEL	*Scale* 1:375
Date 7/13/2021	*File Name* Mallet Drive XSec 29+75 Phase 2.slmd		

Figure A.2

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33						Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant					Piezometric Line 1
Glaciomarine (Strong)		115	Undrained	3500		Constant					Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36						Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown				1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32						Piezometric Line 1
New Subbase		135	Mohr-Coulomb	0	36						Piezometric Line 1



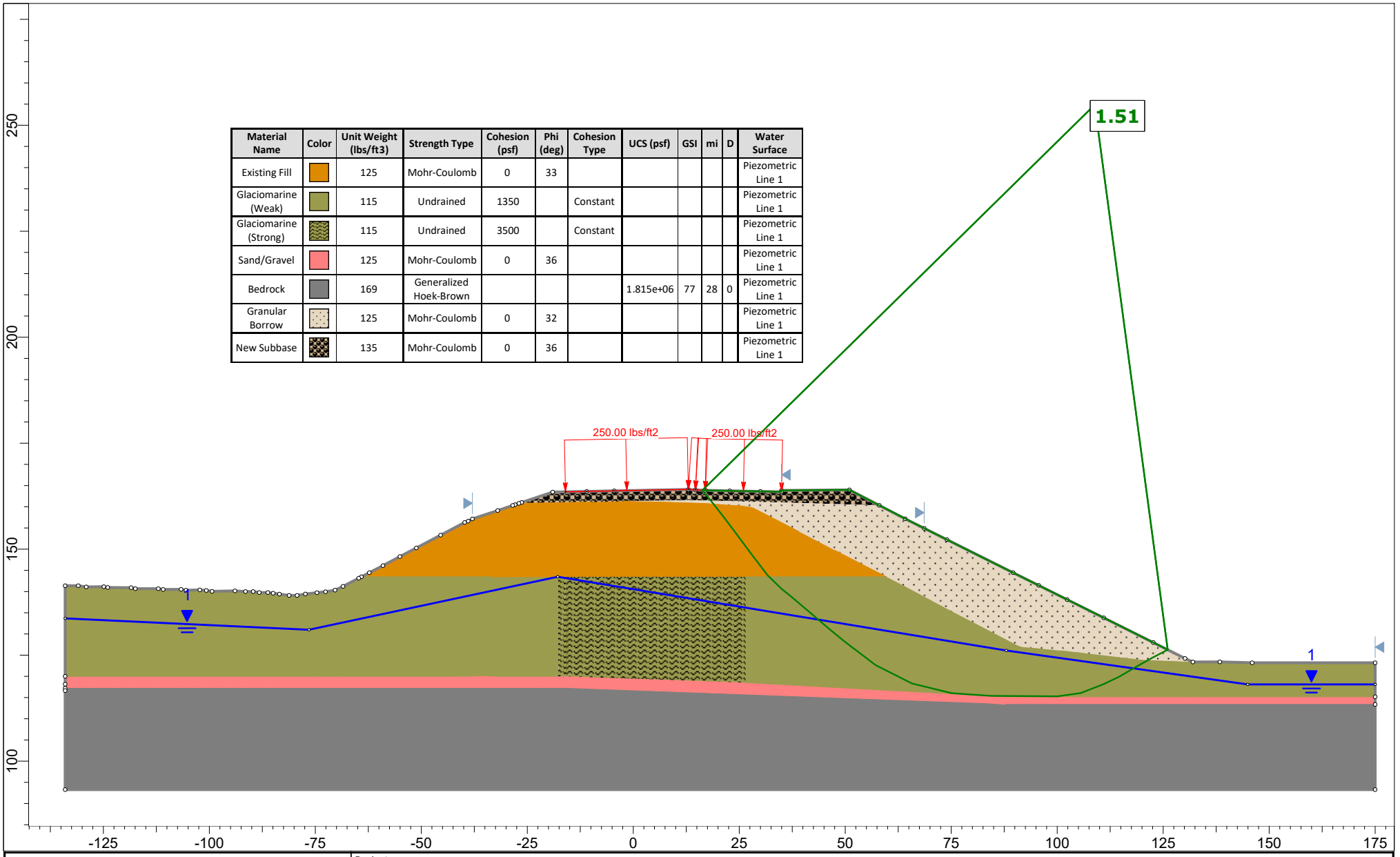
GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.016

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721		
Analysis Description	Station 29+75 South Slope Static (NonCircular, Cuckoo Search)		
Drawn By HTV/AH/MEL	*Checked By* KAR	*Reviewed By* JEL	*Scale* 1:375
Date 7/13/2021	*File Name* Mallet Drive XSec 29+75 Phase 2.slmd		

Figure A.3

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33						Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant					Piezometric Line 1
Glaciomarine (Strong)		115	Undrained	3500		Constant					Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36						Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown				1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32						Piezometric Line 1
New Subbase		135	Mohr-Coulomb	0	36						Piezometric Line 1

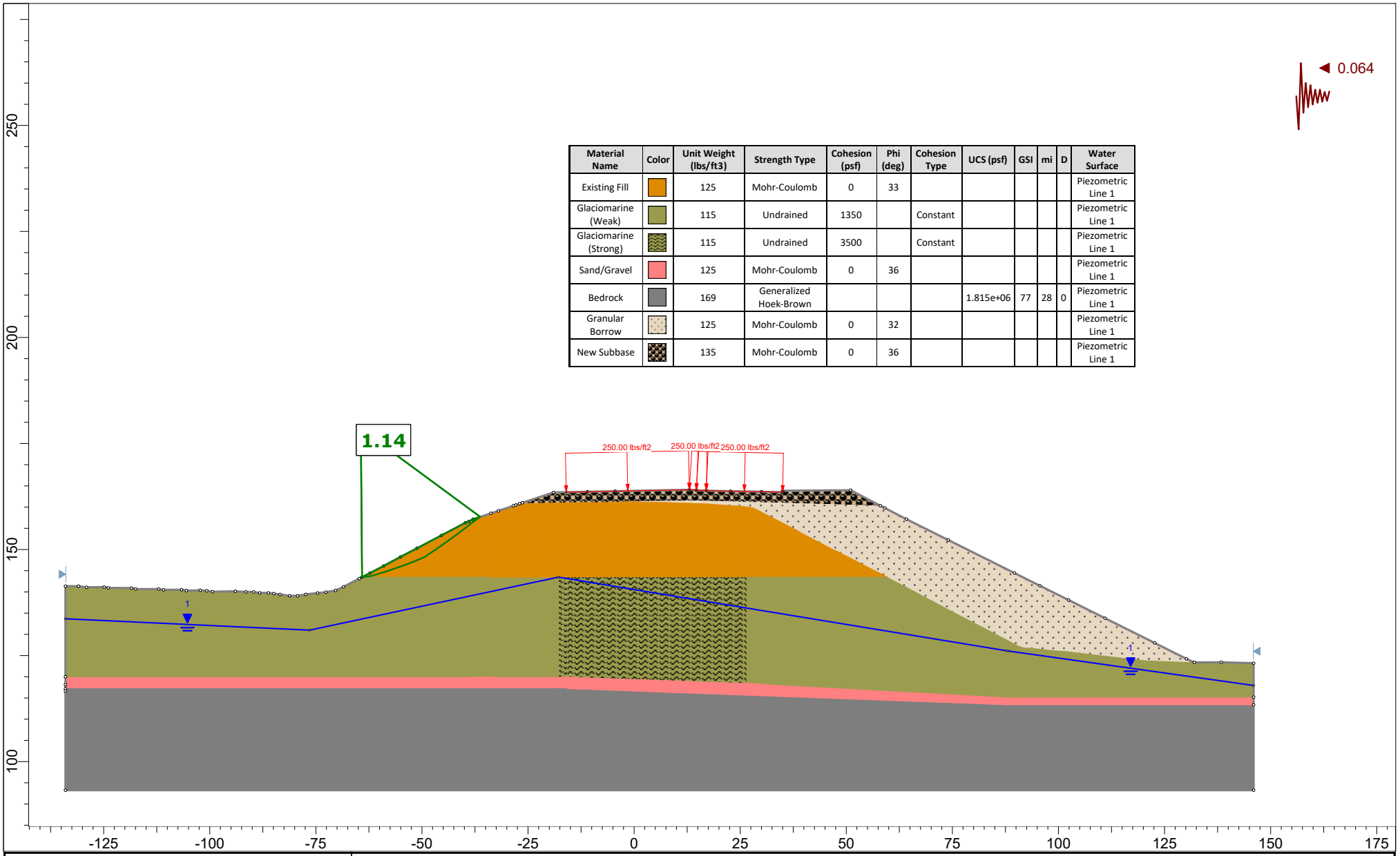


GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.016

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721		
Analysis Description	Station 29+75 South Slope Static (NonCircular, Cuckoo Search)		
Drawn By KAR/AH/MEL	*Checked By* KAR	*Reviewed By* JEL	*Scale* 1:375
Date 7/13/2021	*File Name* Mallet Drive XSec 29+75 Phase 2.slmd		

Figure A.4



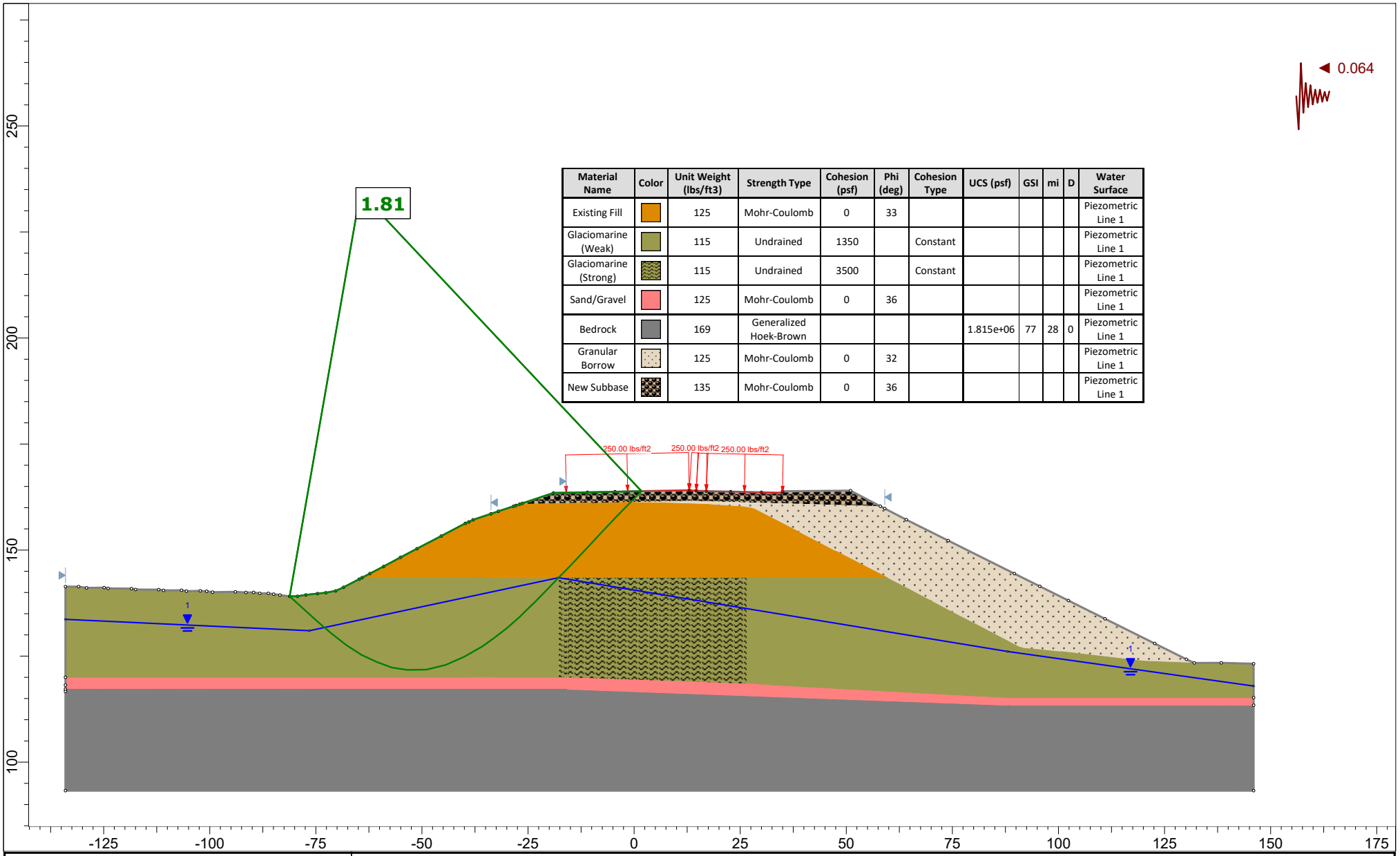
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33						Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant					Piezometric Line 1
Glaciomarine (Strong)		115	Undrained	3500		Constant					Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36						Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown				1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32						Piezometric Line 1
New Subbase		135	Mohr-Coulomb	0	36						Piezometric Line 1

GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.016

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721		
Analysis Description	Station 29+75 North Slope Seismic (NonCircular, Cuckoo Search)		
Drawn By HTV/AH/MEL	Checked By KAR	Reviewed By JEL	Scale 1:375
Date 7/13/2021	File Name Mallet Drive XSec 29+75 Phase 2.slmd		

Figure B.1



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33						Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant					Piezometric Line 1
Glaciomarine (Strong)		115	Undrained	3500		Constant					Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36						Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown				1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32						Piezometric Line 1
New Subbase		135	Mohr-Coulomb	0	36						Piezometric Line 1

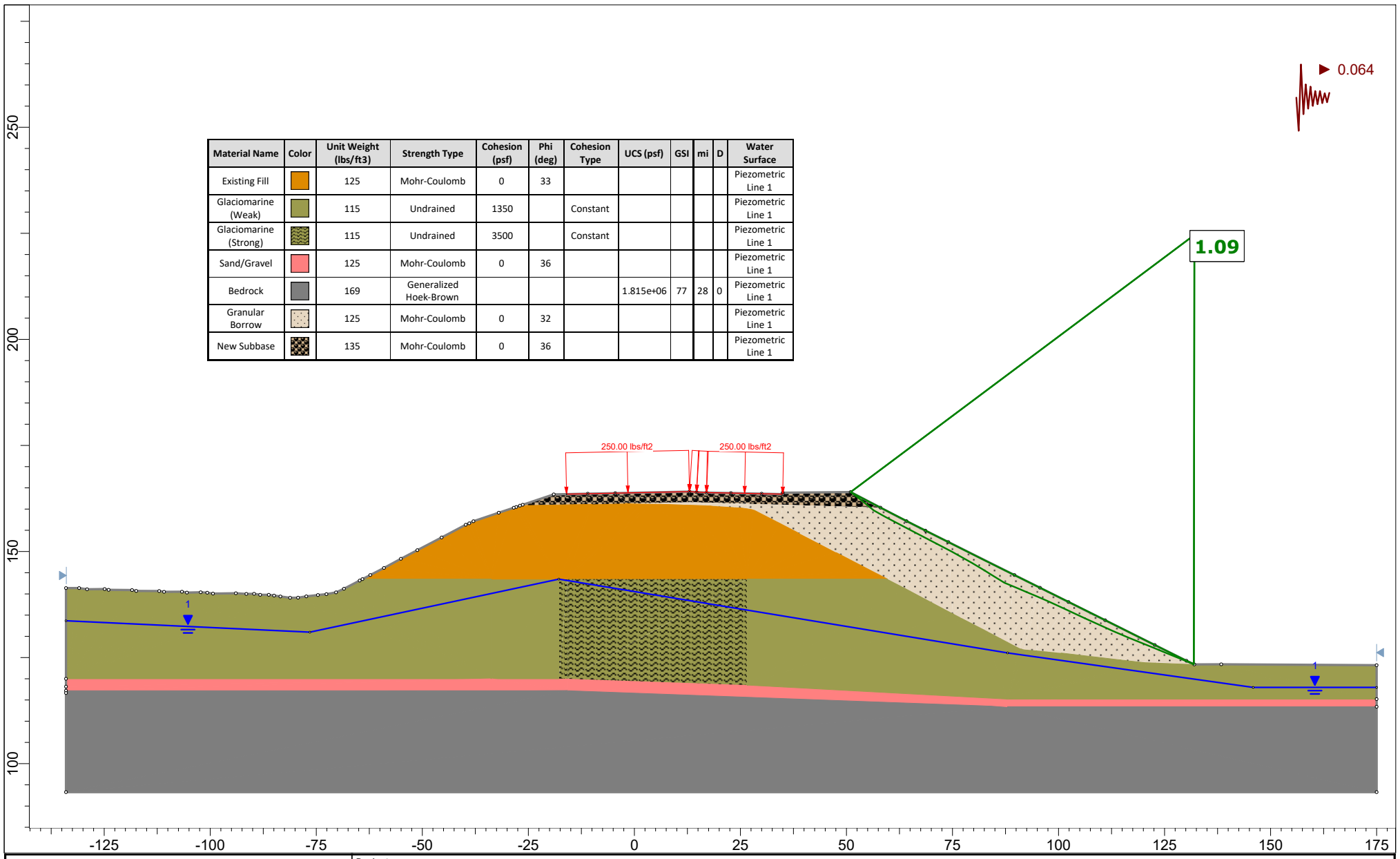
GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.016

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721		
Analysis Description	Station 29+75 North Slope Seismic (NonCircular, Cuckoo Search)		
Drawn By KAR/AH/MEL	*Checked By* KAR	*Reviewed By* JEL	*Scale* 1:375
Date 7/13/2021	*File Name* Mallet Drive XSec 29+75 Phase 2.slmd		

Figure B.2

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33						Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant					Piezometric Line 1
Glaciomarine (Strong)		115	Undrained	3500		Constant					Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36						Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown				1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32						Piezometric Line 1
New Subbase		135	Mohr-Coulomb	0	36						Piezometric Line 1



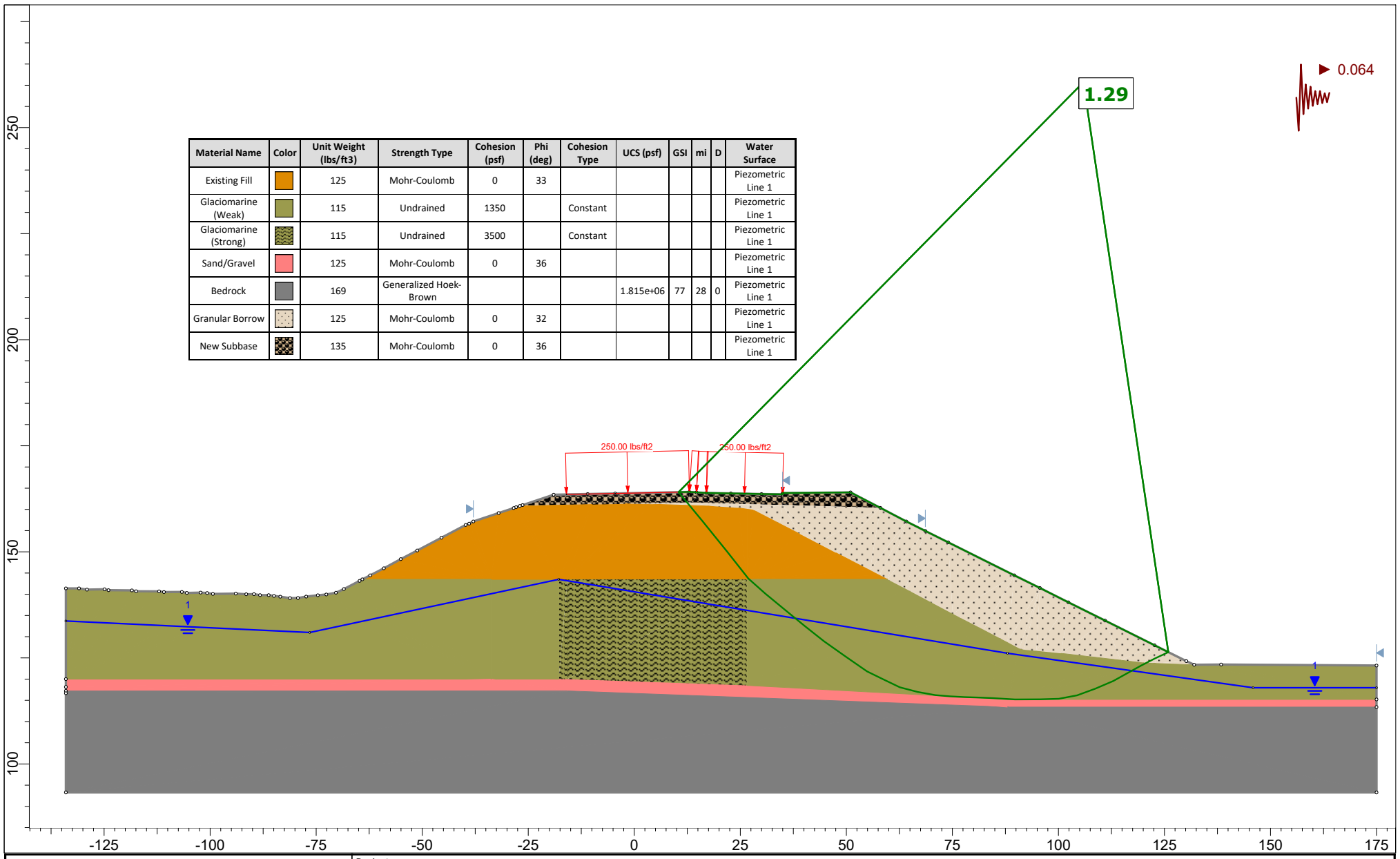
GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.016

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721		
Analysis Description	Station 29+75 South Slope Seismic (NonCircular, Cuckoo Search)		
Drawn By HTV/AH/MEL	*Checked By* KAR	*Reviewed By* JEL	*Scale* 1:375
Date 7/13/2021	*File Name* Mallet Drive XSec 29+75 Phase 2.slmd		

Figure B.3

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Cohesion Type	UCS (psf)	GSI	mi	D	Water Surface
Existing Fill		125	Mohr-Coulomb	0	33						Piezometric Line 1
Glaciomarine (Weak)		115	Undrained	1350		Constant					Piezometric Line 1
Glaciomarine (Strong)		115	Undrained	3500		Constant					Piezometric Line 1
Sand/Gravel		125	Mohr-Coulomb	0	36						Piezometric Line 1
Bedrock		169	Generalized Hoek-Brown				1.815e+06	77	28	0	Piezometric Line 1
Granular Borrow		125	Mohr-Coulomb	0	32						Piezometric Line 1
New Subbase		135	Mohr-Coulomb	0	36						Piezometric Line 1



GOLDER
MEMBER OF WSP

SLIDEINTERPRET 9.016

Project	21450910 I-295 MaineDOT Mallet Drive Bridge no 5721		
Analysis Description	Station 29+75 South Slope Seismic (NonCircular, Cuckoo Search)		
Drawn By KAR/AH/MEL	*Checked By* KAR	*Reviewed By* JEL	*Scale* 1:375
Date 7/13/2021	*File Name* Mallet Drive XSec 29+75 Phase 2.slmd		

Figure B.4

APPENDIX C

Settlement

Settle3 Model Development & Results

Date:	6/29/2021	**Made by:**	MEL
Project No.:	21450910	**Checked by:**	DAF
Subject:	Basis for Model Development: 3D Settlement for Site Improvements	**Reviewed by:**	JEL
Project Short Title:	MaineDOT WIN 021726.00 - Freeport Exit 22 Mallet Drive		

OBJECTIVE

Estimate the settlement expected to take place at the proposed embankments and abutment and pile locations using a three-dimensional model of the proposed roadway and embankment fills.

REFERENCES

1. Geotechnical test boring logs: Appendix A in: Golder Associates, Inc., Preliminary Geotechnical Design Report: I-295 Mallet Drive Bridge Replacement #5721 (Exit 22), Freeport, Maine, MaineDOT WIN 021726.00, December 21, 2020.

2. Subsurface investigation laboratory testing results: Appendix D in: Golder Associates, Inc., Preliminary Geotechnical Design Report: I-295 Mallet Drive Bridge Replacement #5721 (Exit 22), Freeport, Maine, MaineDOT WIN 021726.00, December 21, 2020.

3. Summary of Laboratory Soil Index and Classification Test Results: Table 5 in: Golder Associates, Inc., Preliminary Geotechnical Design Report: I-295 Mallet Drive Bridge Replacement #5721 (Exit 22), Freeport, Maine, MaineDOT WIN 021726.00, December 21, 2020.

4. Interpreted Subsurface Profile, Sheet 3 from the report and updated from Sheet 3 in: Golder Associates, Inc., Preliminary Geotechnical Design Report: I-295 Mallet Drive Bridge Replacement #5721 (Exit 22), Freeport, Maine, MaineDOT WIN 021726.00, December 21, 2020.

5. HNTB, May 21, 2021, Freeport Apporoach Road Bridge over Interstate 295: 60% Plans, Filename: Freeport 20021726_Exit 2022_60pctPLANS.pdf.

6. Rocscience Settle3 Ver. 5.006, Build date: June 30, 2021

7. Das, B. M. (1997). Principles of geotechnical engineering. Boston: PWS.

MODEL PARAMETERS

1. The existing stratigraphy (Ref. 4) and water table surface are estimated from samples and groundwater measurements encountered during drilling (Ref. 1) and interpreted across the site (Ref. 4).

2. Glaciomarine unit weight and consolidation parameters are based on laboratory measured parameters in Golder's historical project database for this unit (Presumpscot Formation) from regional project locations. We assume the clay is sufficiently overconsolidated and will experience recompression settlement only after loading. CR and CC are the strain-based recompression and compression ratios, respectively. Cr and Cc are the void ratio based recompression and compression indices, respectively. Void ratio, e, is estimated based on the average water content from Ref. 3 and an assumed specific gravity of G_s = 2.7.

γ (pcf) =	115
CC =	0.25
C_c =	0.50
CR =	0.02
C_r =	0.04
c_v (ft^2/year)=	120
c_v (ft^2/day)=	0
e_0 =	1.00
OCR	> 3.0

3. Material properties for the Fill and Sand and Gravel (Ref. 4) were correlated using average of the N-values encountered in all borings for each layer (Ref. 1), and are as follows:

N_{Fill} =	30
$N_{Sand\&Gravel}$ =	35

4. The existing topographic elevations for all site features and the proposed elevations for the embankments, roadway, and MSE walls are provided in Ref. 5.

5. The Settle3 model (Ref. 6) is from Station 28+50 To Station 33+50 and includes proposed design features provide in Ref. 5 between these stations.

6. Cohesionless materials were modeled to have elastic settlment only. Cohesive soils were modeled to have consolidation settlement only - elastic settlment and secondary compression are not considered.

Settle3 Model Development & Results

Date:	6/29/2021	**Made by:**	MEL
Project No.:	21450910	**Checked by:**	DAF
Subject:	Basis for Model Development: 3D Settlement for Site Improvements	**Reviewed by:**	JEL
Project Short Title:	MaineDOT WIN 021726.00 - Freeport Exit 22 Mallet Drive		

A. Coarse-grained soil modulus E_s for Settle3 model (using Reference 7).

$$\frac{E_s}{p_a} = \alpha N_{60}$$

atmospheric pressure, p_a (ksf) = 2.116

α =		
	5	sand with fines
	10	clean normally consolidated sand
	15	clean overconsolidated sand

Material	Material Info	N_{60}	α	E_s (ksf)	γ (pcf)
Fill	fine to coarse Sand, some silt, little gravel	30	5	318	125
Sand and Gravel	Gravel or fine to coarse Sand, some silt	35	5	371	125

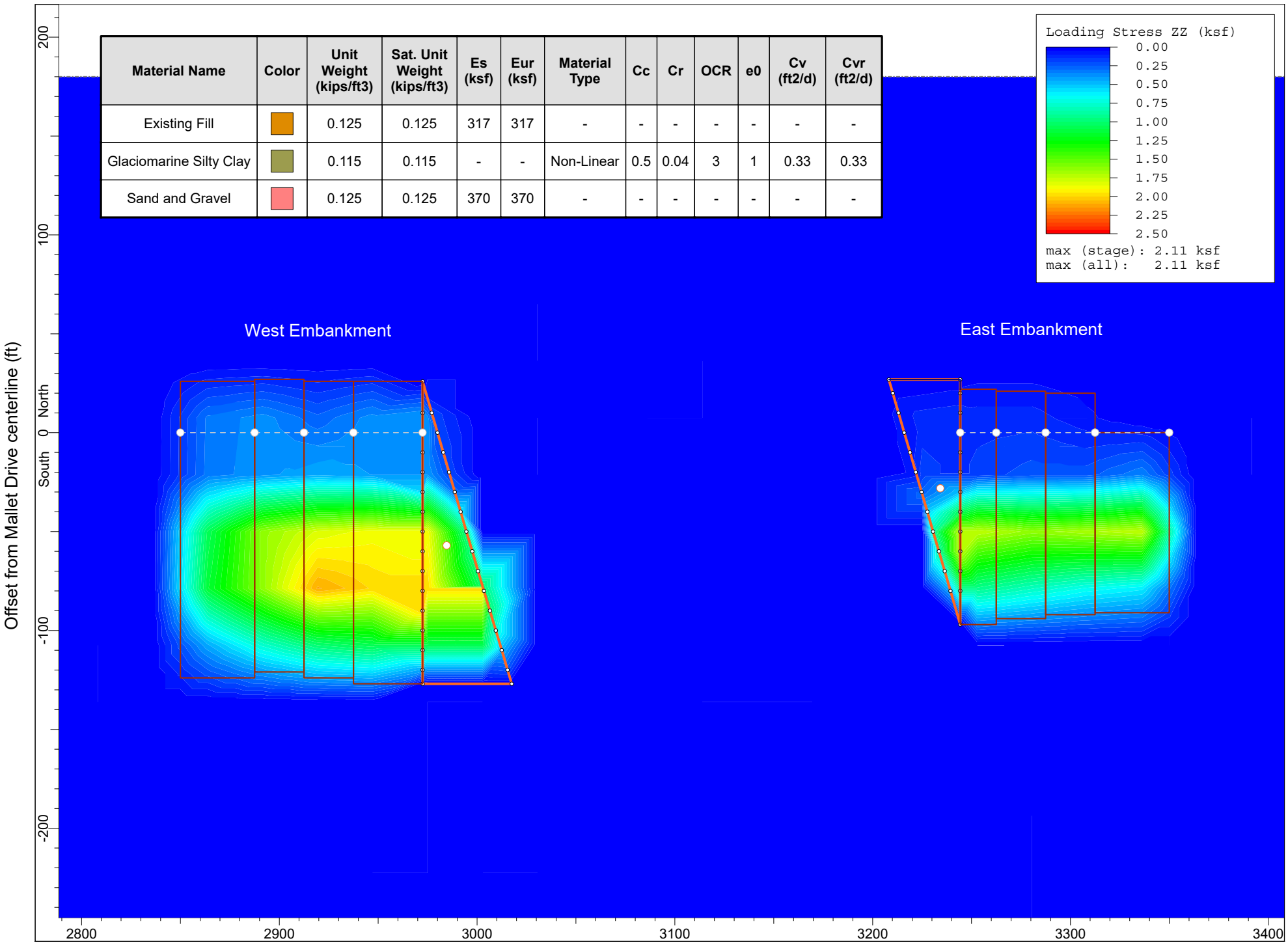
Unit weight assumed based on information in Ref. 1, Ref. 2, and Ref. 3

MODEL RESULTS

Attachment 1 - Loading from Proposed Site Improvements West and East of I-295 Median
Attachment 2 - Total Settlement from Proposed Site Improvements West and East of I-295 Median
Attachment 3 - Total Settlement from Proposed Site Improvements along Abutment 1
Attachment 4 - Total Settlement from Proposed Site Improvements along Abutment 2
Attachment 5 - Total Settlement from Proposed Site Improvements at Station 29+75
Attachment 6 - Total Settlement from Proposed Site Improvements along Profile A-A'

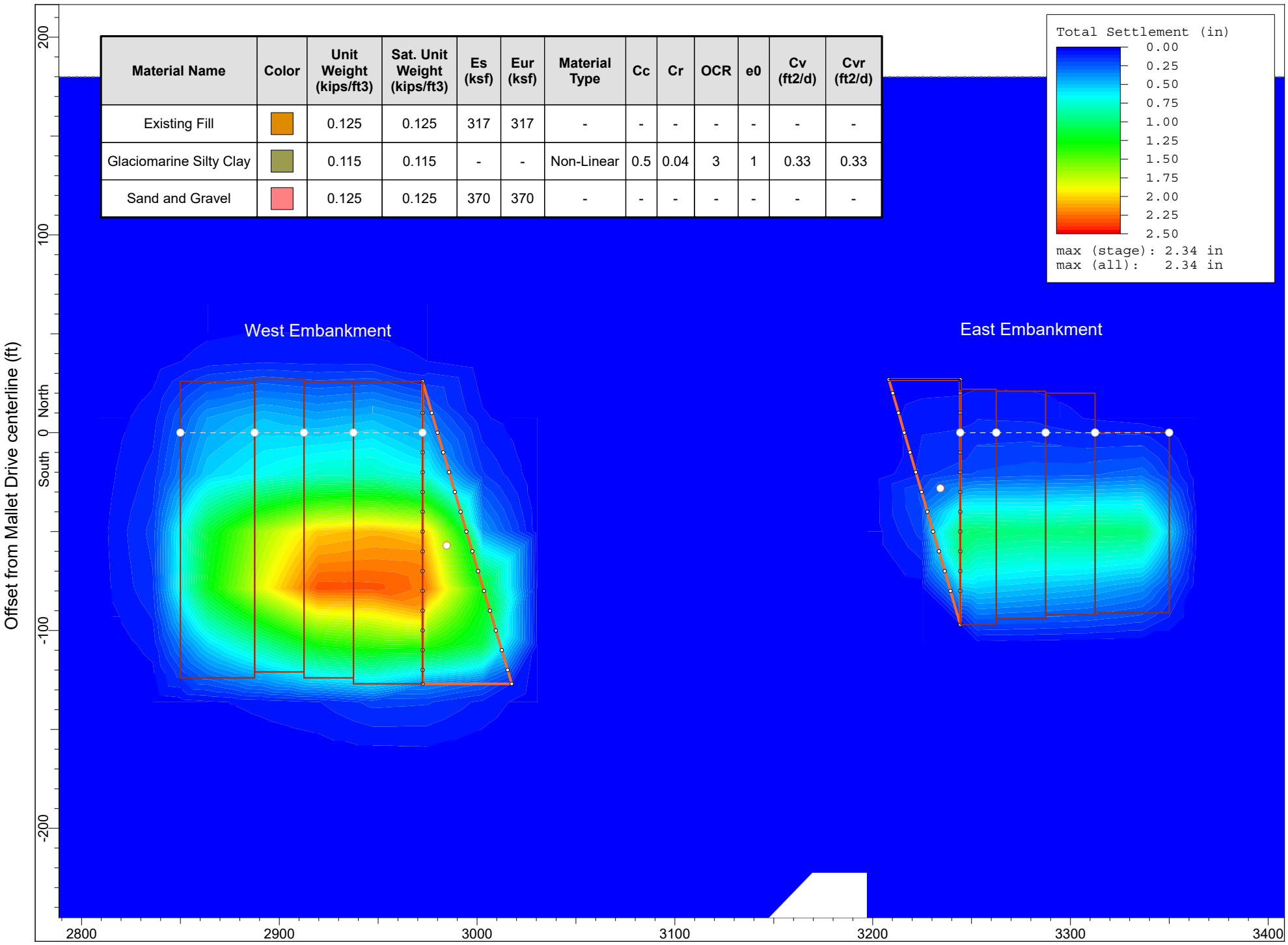
Attachment 1 - Loading from Proposed Site Improvements West and East of I-295 Median

Material Name	Color	Unit Weight (kips/ft3)	Sat. Unit Weight (kips/ft3)	Es (ksf)	Eur (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (ft2/d)	Cvr (ft2/d)
Existing Fill		0.125	0.125	317	317	-	-	-	-	-	-	-
Glaciomarine Silty Clay		0.115	0.115	-	-	Non-Linear	0.5	0.04	3	1	0.33	0.33
Sand and Gravel		0.125	0.125	370	370	-	-	-	-	-	-	-

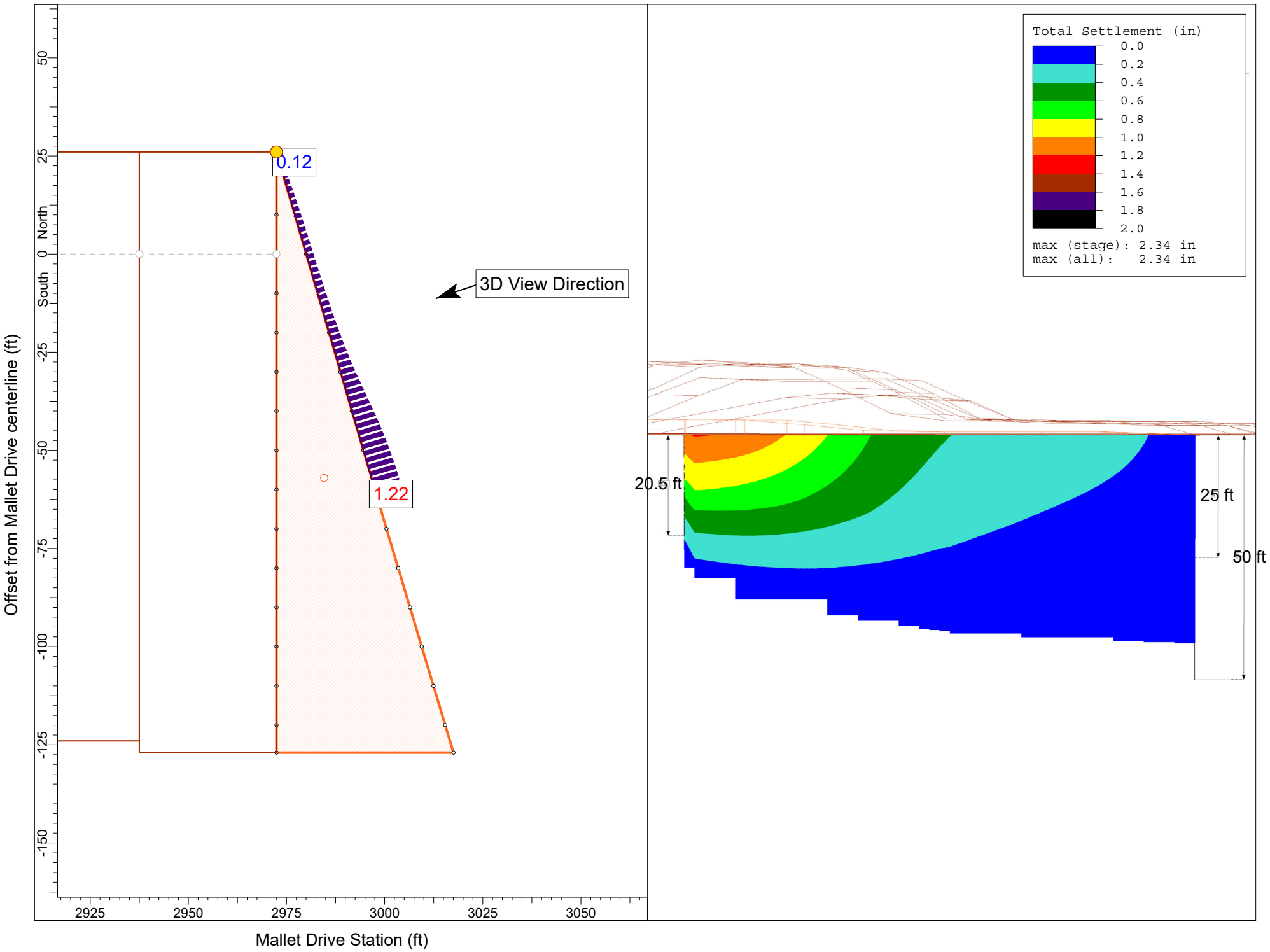


Attachment 2 - Total Settlement from Proposed Site Improvements West and East of I-295 Median

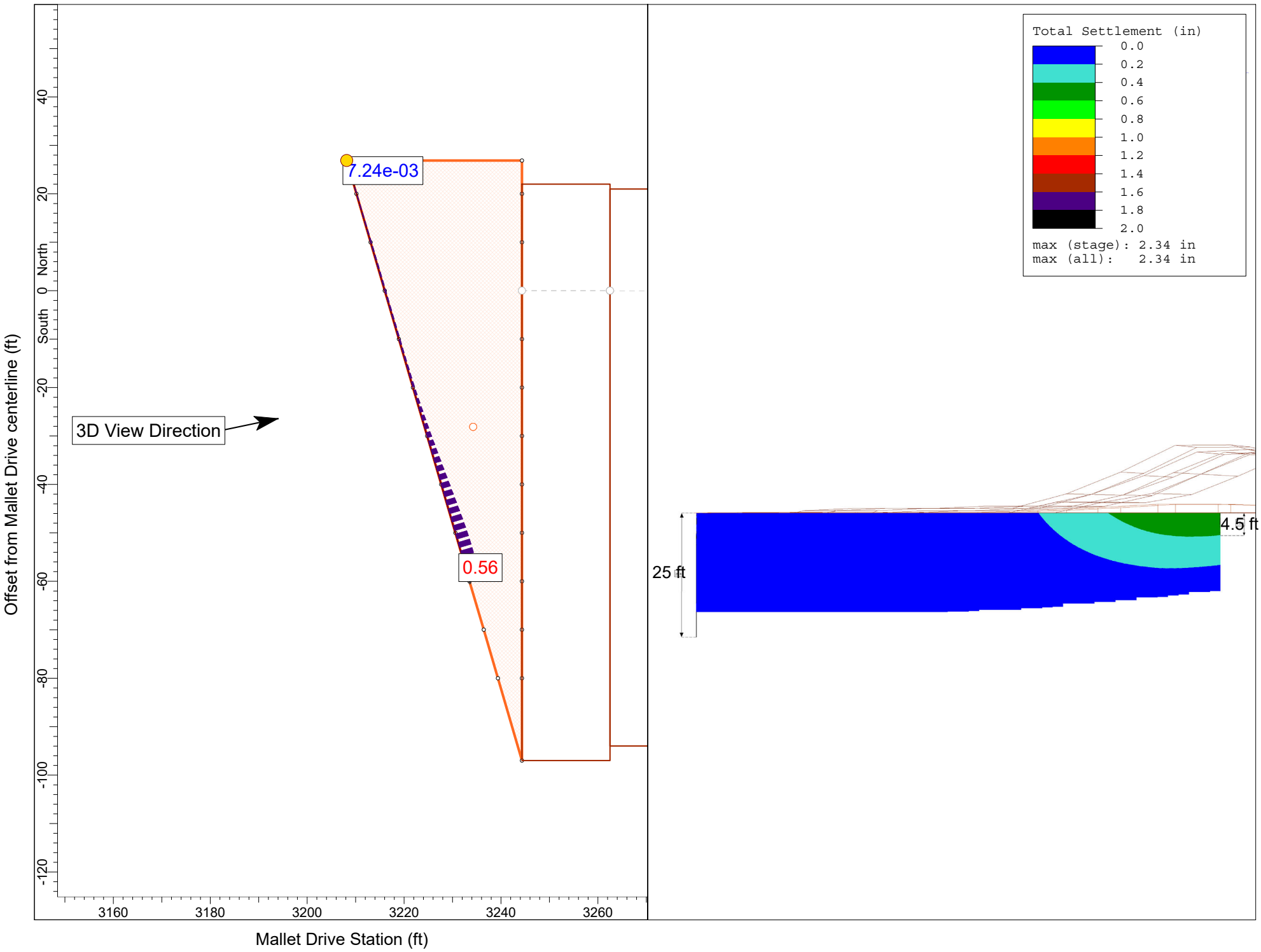
Material Name	Color	Unit Weight (kips/ft3)	Sat. Unit Weight (kips/ft3)	Es (ksf)	Eur (ksf)	Material Type	Cc	Cr	OCR	e0	Cv (ft2/d)	Cvr (ft2/d)
Existing Fill		0.125	0.125	317	317	-	-	-	-	-	-	-
Glaciomarine Silty Clay		0.115	0.115	-	-	Non-Linear	0.5	0.04	3	1	0.33	0.33
Sand and Gravel		0.125	0.125	370	370	-	-	-	-	-	-	-



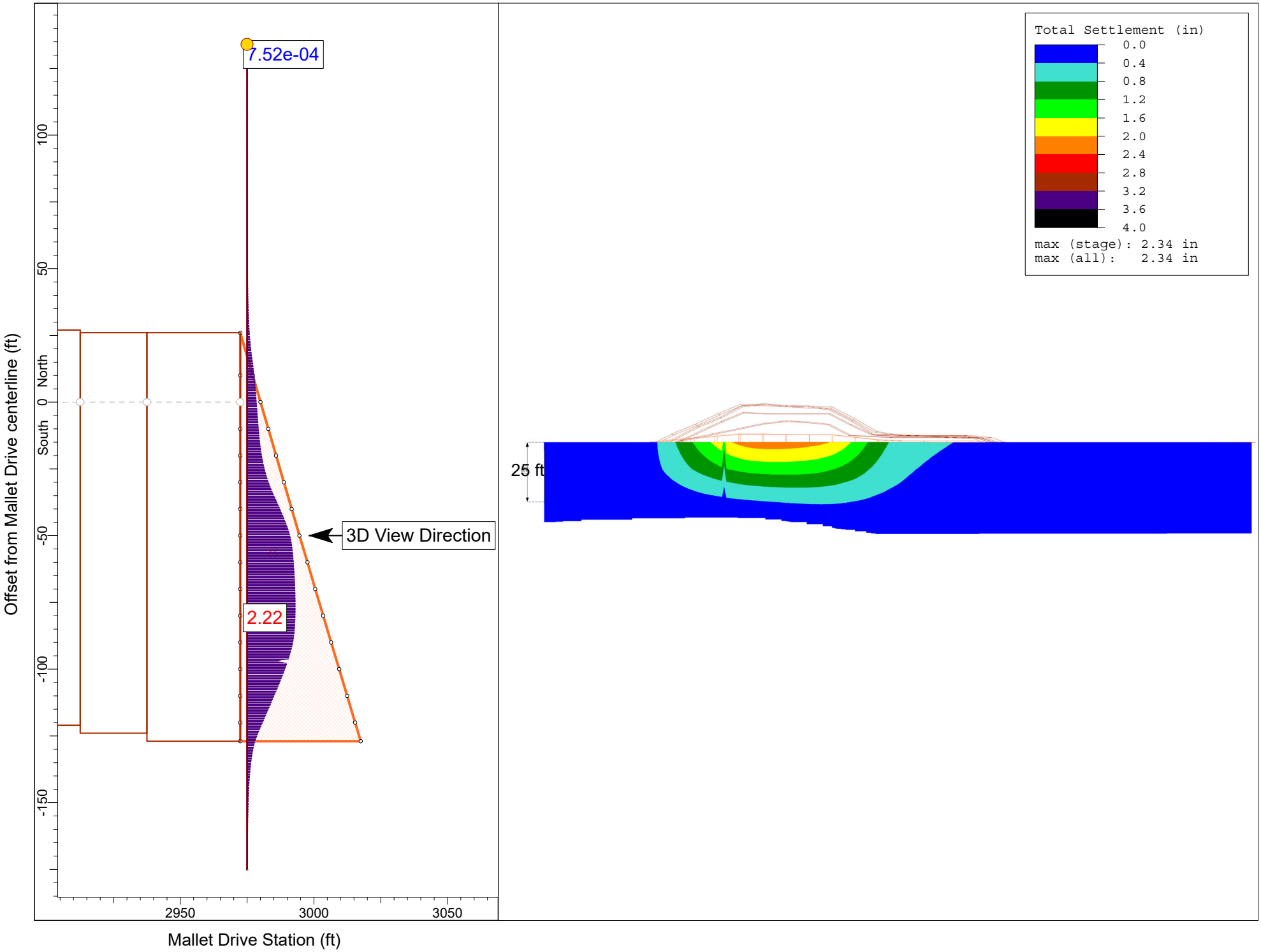
Attachment 3 - Total Settlement from Proposed Site Improvements along Abutment 1



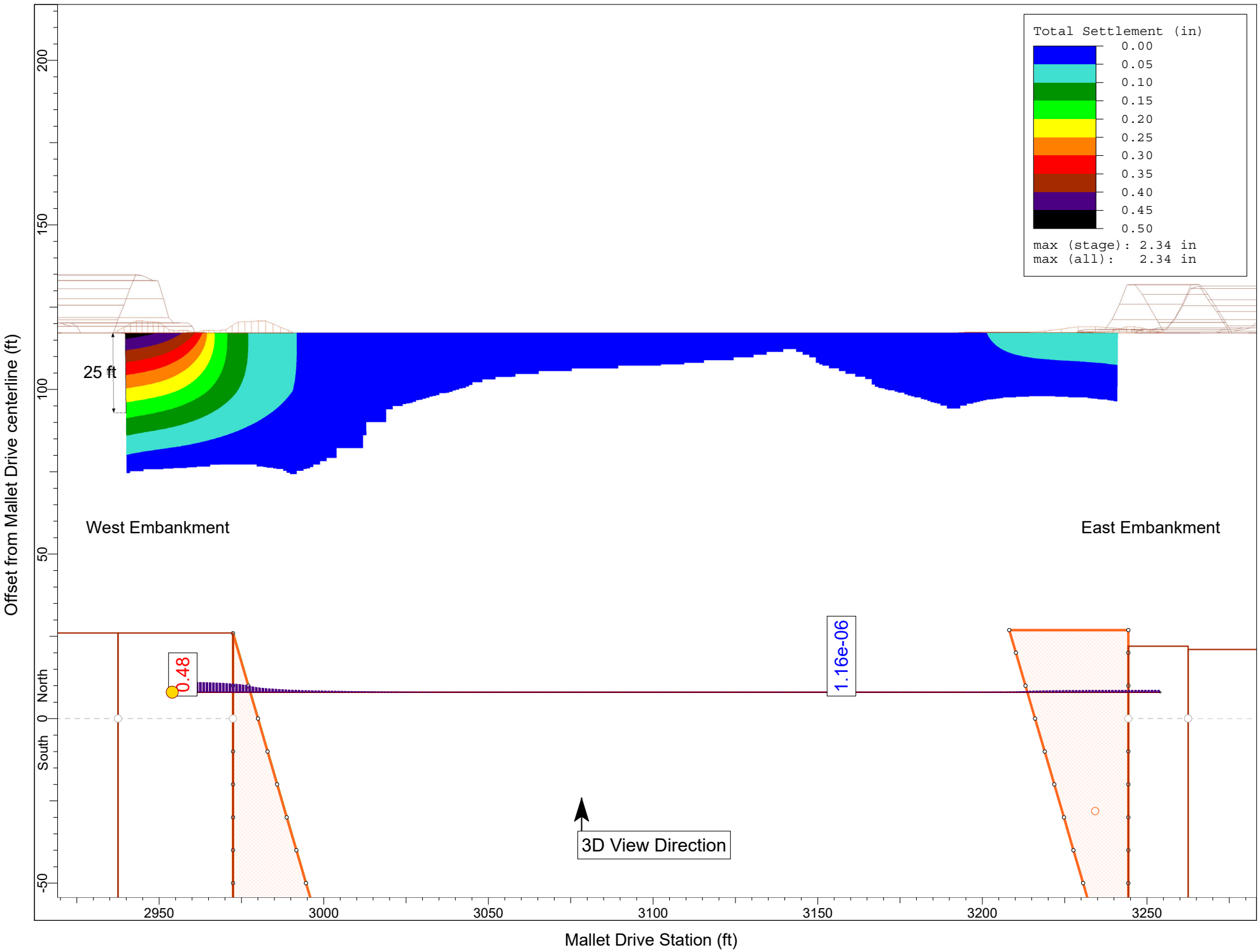
Attachment 4 - Total Settlement from Proposed Site Improvements along Abutment 2



Attachment 5 - Total Settlement from Proposed Site Improvements at Station 29+75



Attachment 6 - Total Settlement from Proposed Site Improvements along Profile A-A'



APPENDIX D

Abutment Lateral Earth Pressure

GOLDER
MEMBER OF WSP

CALCULATIONS

Date:	6/14/2020	**Made by:**	MEL
Project No.:	21450910	**Checked by:**	BK
Subject:	Lateral Earth Pressure	**Reviewed by:**	CCB
Project Short Title:	MaineDOT I-295 Exit 22 Mallett Drive Bridge Replacement No. 5721		

OBJECTIVE

Determine lateral earth pressure acting on the proposed bridge abutments from the 60% plans (May 7, 2021).

REFERENCES

1. Golder interpreted subsurface section A-A' (Figure 3, Preliminary Geotechnical Design Report, dated September 2020).
2. AASHTO LRFD Bridge Design Specifications, 9th Ed, 2020 (LRFD).
3. HNTB, May 7, 2021. Merrill Road Bridge 60% plans. Abutment 1 Reinforcement Sections Sheet 94 of 113. In an email Golder receieved from Steven Hodgdon of HNTB on June 14, 2021, he confirmed the same movements are expected for the Mallet Drive bridge.
4. HNTB, May 7, 2021. Approach Road Bridge 60% plans. Route 136/125 (Mallett Dr.) Profile 2 Sheet 8 of 113.
5. Email and telephone communication between Golder and Laura Krusinski on July 29 and July 30, 2020 recommending the use of MassDOT passive earth pressure coefficient.
6. MassDOT LRFD Bridge Manual - Part 1, January 2020 Revision (https://www.mass.gov/doc/chapter-3-lrfd-bridge-design-guidelines/download)
7. Guertin Elkerton & Associates for Maine Department of Transportation. Bridge Design Guide. Dated August 2003 with 2018 updates.

ASSUMPTIONS

1. The backfill surface behind the abutments is assumed to be horizontal.
2. The fill is assumed to be free draining (i.e., no water pressure is allowed to build up behind the abutment walls).
3. The elevation of the base of the abutments is assumed to equal 153 feet at Abutment No. 1 and 156.7 feet at Abutment No. 2 (Ref. 4).

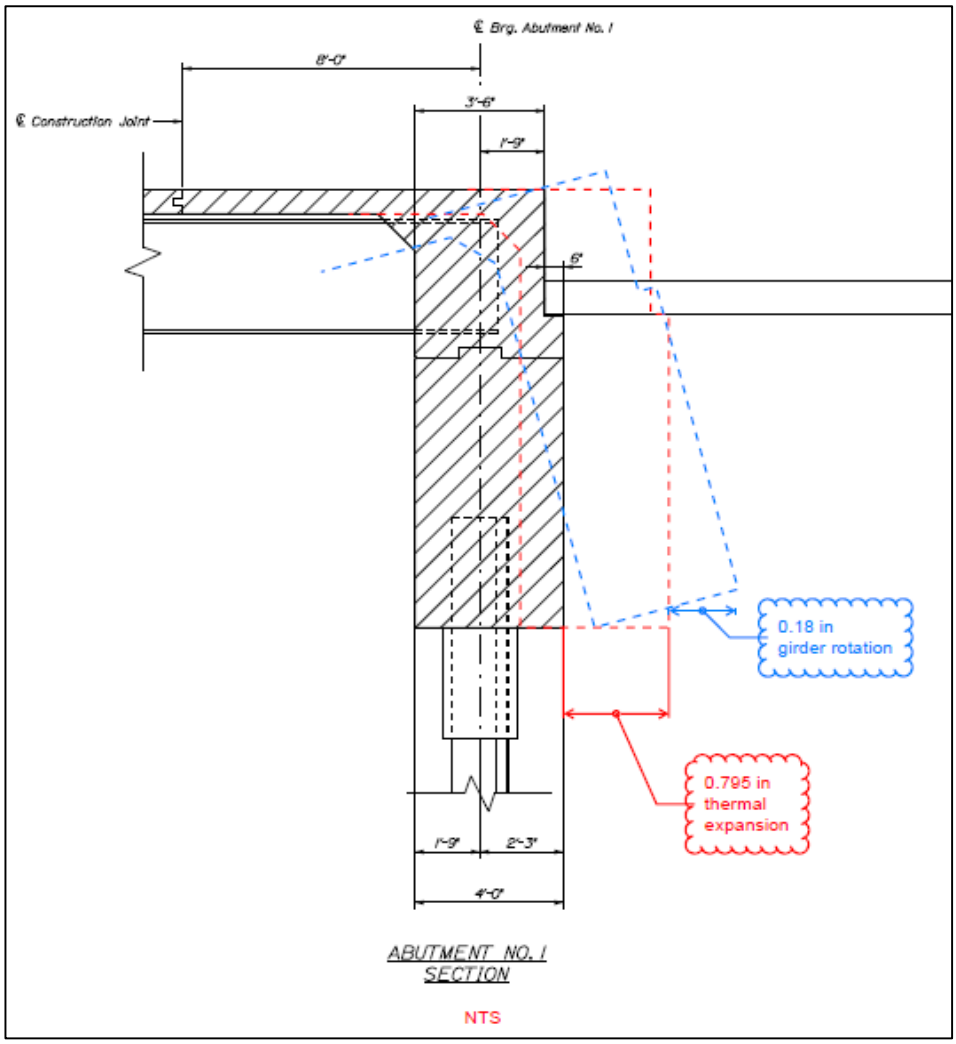
CALCULATION

1. Calculate expected wall rotation for the integral abutments to select earth pressure case.

As per Ref. 2 Table C3.11.1-1, full passive earth pressure development requires that wall rotation (the ratio of lateral abutment movement to abutment height) exceeding 0.02 for medium dense sand similarly to that used for the wall backfill. If full passive conditions are not achieved, MaineDOT and Golder discussed that the passive earth pressure coefficient in the Massachusetts DOT LRFD Bridge Design Manual (Ref. 6) would be more realistic.

Maximum lateral thermal movement =	0.795	inches	=	0.07	feet	(Ref. 3)
Maximum girder rotation =	0.18	inches	=	0.02	feet	(Ref. 3)
Abutment height =	10.6	feet				(Ref. 4)
Maximum wall rotation =	0.008					

Date:	6/14/2020	**Made by:**	MEL
Project No.:	21450910	**Checked by:**	BK
Subject:	Lateral Earth Pressure	**Reviewed by:**	CCB
Project Short Title:	MaineDOT I-295 Exit 22 Mallett Drive Bridge Replacement No. 5721		



← Ref. 3 Schematic

Maximum wall rotation is estimated to be 0.008 and thus full passive earth pressure are not expected to develop. Partial passive earth pressure is determined using Ref. 6. Active earth pressure is determined using the Rankine method.

2. Calculate the active and passive earth pressure coefficients using Rankine theory.

$$K_a = \tan^2\left(45° - \frac{\phi}{2}\right)$$ (Ref. 7, page 3-7)

for horizontal backfill surface, where:

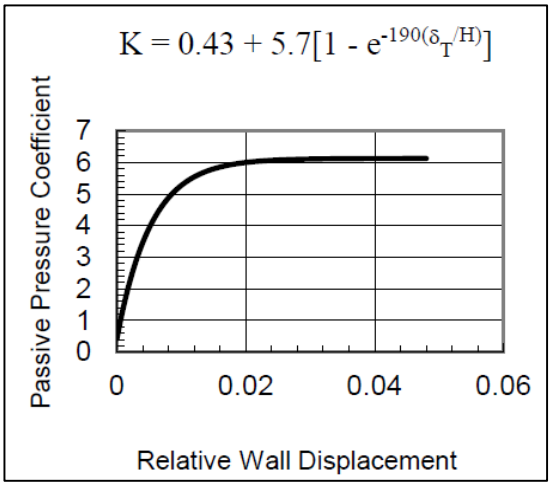
ϕ = internal friction angle of fill

ϕ = 32 degrees ("Granular borrow", Ref. 7, Table 3-3)

K_a = 0.31

Date:	6/14/2020	**Made by:**	MEL
Project No.:	21450910	**Checked by:**	BK
Subject:	Lateral Earth Pressure	**Reviewed by:**	CCB
Project Short Title:	MaineDOT I-295 Exit 22 Mallett Drive Bridge Replacement No. 5721		

3. Calculate the earth pressure coefficient under partially passive conditions per MASSDOT LRFD Bridge Manual Figure 3.10.8-1. (Note, full passive conditions are not met as per Calculation 1).



δ_T/H = 0.008 (relative wall displacement)
K_p = 4.89

3. Determine the unfactored passive pressure P_p acting on the abutments.

$$P_p = \frac{1}{2} \cdot \gamma_{soil} \cdot H_{abut}^{\ 2} \cdot k_p$$ (Ref. 7, page 5-51)

where:

γ_{soil} = unit weight of fill — γ_{soil} = 125 pcf ("Granular borrow", Ref. 7, Table 3-3)
H_{abut} = height of the abutment backwall — H_{abut} = 10.6 feet (Ref. 4)

P_p = 34,340 lbs per foot of abutment width

The resultant lateral earth load acts at a height of H/3 above the base of the wall.

For Abutment No. 1, the load acts at: 156.5 feet elevation
For Abutment No. 2, the load acts at: 160.2 feet elevation

CONCLUSIONS

For the designer-given wall geometry, thermal lateral movement, and girder rotation, the calculated rotation is less than that required to develop full passive pressure. Thus the MassDOT method was used to determine the partial passive earth pressure. For the recommended soil parameters and given wall geometry, the partial passive earth pressure coefficient is K_p = 4.89, which corresponds to an unfactored passive earth force of P_p = 34,340 pounds per linear foot acting at elevations 156.5 feet and 160.2 feet on Abutment No. 1 and No. 2, respectively. The Rankine method was used to determine the active earth pressure coefficient of K_a = 0.31.

APPENDIX E

Abutment 1 Pile Design

GOLDER
MEMBER OF WSP

CALCULATIONS

Date:	7/14/2021	**Made by:**	DAF
Project No.:	21450910	**Checked by:**	KAR
Subject:	Pile Design at Abutment 1	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

OBJECTIVE

Determine if the proposed HP 14x89 piles will provide adequate support for Abutment 1 (the northwestern integral abutment) based on the anticipated thermal movement, girder rotation, and final design loads.

METHOD

Use the procedure outlined in AASHTO LRFD (Ref. 1) and the design method provided in the MaineDOT Bridge Design Guide (Ref. 2).

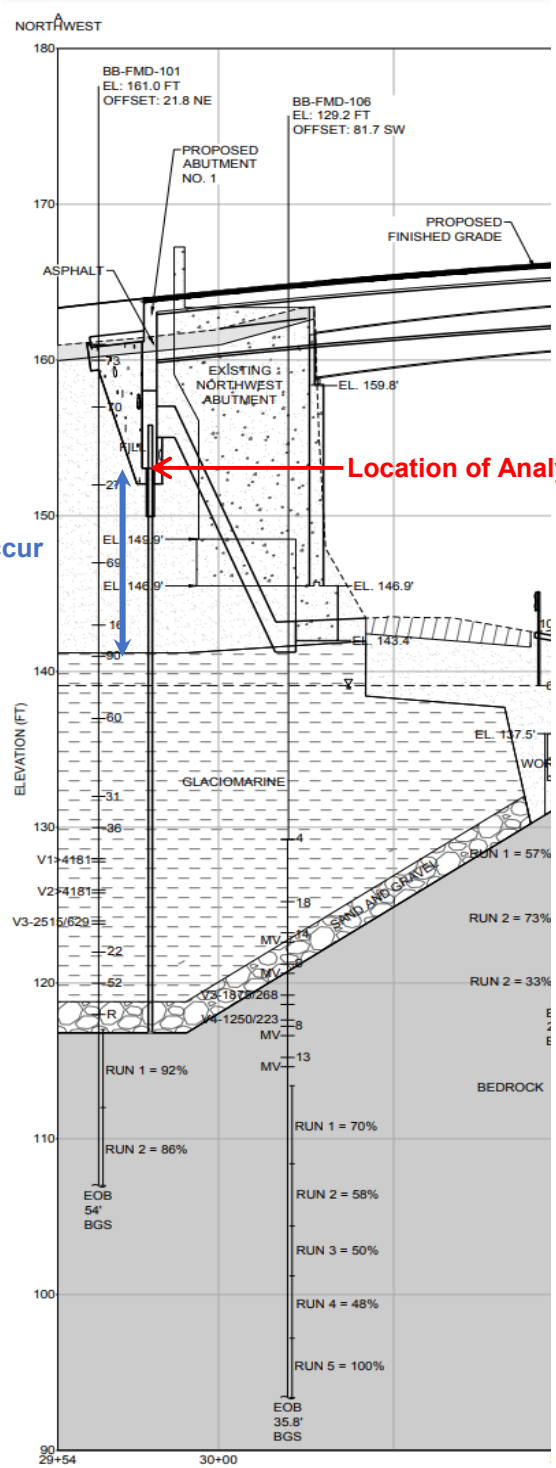
REFERENCES

1. AASHTO LRFD Bridge Design Specifications, 9th Ed. 2020.
2. Guertin Elkerton & Associates for Maine Department of Transportation. Bridge Design Guide. Dated August 2003 with 2018 updates.
3. Email communication between Golder and HNTB, subject "RE: Freeport I-295 Exit 20 and Exit 22 - Request for Sections and Design Info", dated June 23, 2020.
4. Isenhower, W.M. et al. LPile v2019 Technical Manual: A Program for the Analysis of Deep Foundations Under Lateral Loading. Ensoft, Inc. Dated March 2020.
5. Golder interpreted subsurface profile A-A' (Figure 3, Preliminary Geotechnical Design Report, dated December 21, 2020).
6. Golder geotechnical test boring logs (Appendix A, Preliminary Geotechnical Design Report, dated December 21, 2020).
7. Bridge Software Institute. FB-MultiPier Soil Parameter Table (US Customary Units). Accessed July 2020. https://bsi.ce.ufl.edu/downloads/files/MultiPier_Soil_Table.pdf
8. VTrans Integral Abutment Committee. Integral Abutment Bridge Design Guidelines, 2nd Ed. 2008.
9. AISC Steel Construction Manual, 13th Ed.
10. HNTB calculation titled "Freeport Bridges_Loads_Bottom of Footing_flat.pdf", dated May 26, 2021.
11. Oregon Department of Transportation, Geo-Environmental Section. Geotechnical Design Manual: Chapter 8 - Foundations, Version 2.1. Dated May 6, 2019.
12. HNTB for State of Maine Department of Transportation. Approach Road Bridge over Interstate 295 and Signalized Intersections, Exit 22 Interchange: 60% Plans, dated May 7, 2021.
13. Golder calculation titled "21450910 Freeport Exit 22 APILE Downdrag - Abutment 1", dated May 27, 2021.
14. HNTB for State of Maine Department of Transportation. Merrill Road Bridge over Interstate 295, Freeport, Cumberland: Abutment 1 Reinforcement Sections, Sheet 94, dated May 7, 2021.

ASSUMPTIONS

1. The selected pile orientation is weak axis bending (Ref. 2, page 5-42).
2. The vertical load is assumed to be evenly distributed.

Date:	7/14/2021	**Made by:**	DAF
Project No.:	21450910	**Checked by:**	KAR
Subject:	Pile Design at Abutment 1	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		



Date:	7/14/2021	**Made by:**	DAF
Project No.:	21450910	**Checked by:**	KAR
Subject:	Pile Design at Abutment 1	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

ATTACHMENTS

1. LPile analysis output for Strength I
2. LPile analysis output for Strength I with Plastic Hinge
3. Downdrag Analysis
4. Driveability Analysis

CALCULATION

1. Select the preliminary pile size.

Determine the factored applied superstructure vertical dead and live load (P_u) distributed to each pile.

Design P_u = 456 kips (Total factored axial load including downdrag and pile weight, Ref. 13)

Select the steel pile strength.

F_y = 50 ksi
E = 29,000 ksi

Determine resistance factors (Φ_c and Φ_f) for the structural strength in the upper and lower zones of the pile.

ϕ_{cl} =	0.50	for axial resistance in the lower zone of the pile (Ref. 2, page 5-41)
ϕ_{cu} =	0.70	for axial resistance in the upper zone of the pile under combined axial and flexural loading (Ref. 2, page 5-42)
ϕ_f =	1.00	for flexural resistance in the upper zone of the pile under combined axial and flexural loading (Ref. 2, page 5-42)

Determine the maximum required nominal axial pile resistance (Ref. 1, Article 6.9.2.1).

$$R_{n.upper} = \frac{P_u}{\phi_{cu}}$$

$R_{n.upper}$ = 652 kips

$$R_{n.lower} = \frac{P_u}{\phi_{cl}}$$

$R_{n.lower}$ = 912.4436 kips

$$R_n = \max\left(R_{n.upper}, R_{n.lower}\right)$$

R_n = 912.4436 kips

Date:	7/14/2021	**Made by:**	DAF
Project No.:	21450910	**Checked by:**	KAR
Subject:	Pile Design at Abutment 1	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

Use the required nominal axial pile resistance to estimate the required pile area.

$$A_{s.req} = \frac{R_n}{0.80\ Fy}$$ (Ref. 2, page 5-42)

$A_{s.req}$ = 22.8 in^2

Select a pile size with an area of $A_{s.req}$ or greater.

Preferred selection is HP 14x89 based on June 16, 2020 meeting with MaineDOT and HNTB.
Check that preferred selection satisfies pile area requirement:

HP 14x89 A_s = 26.1 in^2 (Ref. 4, Table 5.6.3)

A_s > $A_{s.req}$ OK

2. Use LPile analysis to determine the pile unbraced length and maximum moment at the top of the pile.

The following input parameters were used in the LPile analysis:

Pile Properties

Section type:	Steel H Section Weak Axis		(Assumption 1)
Length of section:	36.2	ft	(piles driven to bedrock with no rock socketing)
Flange width, b:	14.695	in	(Ref. 4, Table 5.6.3)
Section depth, d:	13.83	in	(Ref. 4, Table 5.6.3)
Flange thickness, t_f:	0.615	in	(Ref. 4, Table 5.6.3)
Web thickness, t_w:	0.615	in	(Ref. 4, Table 5.6.3)
Pile batter:	Vertical		(pile battering not required)

Pile Loading

Lateral deflection due to abutment thermal expansion or contraction:	0.795	in	(Ref. 10)
Lateral deflection due to girder rotation:	0.18	in	(Ref. 14)
Total lateral deflection at pile head:	0.975	in	
Axial load:	456,222	lbs	(Ref. 10)

Soil Layers

Layer	Depth below base of abutment[1]	Lateral Model	Effective Unit Weight (pcf)	Undrained Shear Strength (psf)[2]	Friction Angle (°)[2]	Subgrade Modulus (pci)[3]	Major Principal Strain at 50%[3]	UCS (psi)[2]
Existing Fill	0 - 11.8 ft	Sand (Reese)	125	-	33	165	-	-

Glaciomarine Silty Clay (above water table)	11.8 - 13.9 ft	Stiff Clay with Free Water (Reese)	115	3500	-	500	0.005	-
Glaciomarine Silty Clay (below water table)	13.9 - 34.2 ft	Stiff Clay w/o Free Water (Reese)	52.6	3500	-	-	0.005	-
Sand and Gravel	34.2 - 36.2 ft	Sand (Reese)	62.6	-	36	100	-	-
Bedrock	>36.2 ft	Strong Rock (Vuggy Limestone)	106.6	-	-	-	-	12604

1) Ref. 5
2) Ref. 6
3) Ref. 7. Interpolation based on average N_{60} value for each layer.

The full LPile output is provided in Attachment 1.

Obtain the maximum moment at the top of the pile.

$M_{u.Top}$ = 2950 in-kips (LPile)

Obtain the unbraced lengths of the top segment and the second segment of the upper zone of the pile.

$l_{b.top}$ = 4.4 ft (LPile)
$l_{b.top}$ = 53.2 in

$l_{b.2nd}$ = 11.1 ft (LPile)
$l_{b.2nd}$ = 132.6 in

3. Determine if the applied moment on the pile will cause pile head plastic deformation by using the interaction of combined axial and flexural load effects on a single pile.

Determine K values for the top and bottom of the pile and calculate the column slenderness factor (λ) for each segment.

For the top segment (fixed at top and pinned at bottom):

$$\lambda_{top} = \frac{K_{top} l_{b.top}}{r_y} \leq 120$$ (Ref. 1, Article 6.9.3)

$$r_y = \sqrt{I_{yy}/A_s}$$

where:

K_{top} = 1.2 (Ref. 1, Table C4.6.2.5-1)
I_{yy} = 326 in^4 (Ref. 4, Table 5.6.3)
r_y = 3.53 in

λ_{top} = 18.07 OK

For the second segment (pinned at top and bottom):

$$\lambda_{2nd} = \frac{K_{2nd} l_{b.2nd}}{r_y} \leq 120$$ (Ref. 1, Article 6.9.3)

where:

K_{2nd} = 1.0 (Ref. 1, Table C4.6.2.5-1)

λ_{2nd} = 37.52 OK

Calculate the critical elastic buckling resistance, P_e, and the nominal yield resistance, P_o.

Use Ref. 1 Table 6.9.4.1.1-1 to select equation for P_e based on cross-section shape and potential buckling mode.

$$P_e = \frac{\pi^2 E}{\left(\frac{K l_b}{r_y}\right)^2} A_s$$ (Ref. 1, Eqn 6.9.4.1.2-1)

$P_{e.top}$ = 22872 kips
$P_{e.2nd}$ = 5305 kips

$$P_o = F_y A_s$$ (Ref. 1, Article 6.9.4.1)

P_o = 1305 kips

Calculate the nominal structural pile resistance, P_n, for both segments of the upper zone of the pile as well as the lower zone of the pile.

Determine P_o/P_e to select equation for P_n as per Ref. 1 Article 6.9.4.1.

$P_o/P_{e.top}$ = 0.06 ≤ 2.25
$P_o/P_{e.2nd}$ = 0.25 ≤ 2.25

thus use Ref. 1 Eqn 6.9.4.1.1-1:

$$P_n = \left[0.658^{\left(\frac{P_o}{P_e}\right)}\right] P_o$$

$P_{n.top}$ = 1274 kips
$P_{n.2nd}$ = 1177 kips

$$P_{n.bottom} = (0.658^{(0)}) \times F_y A_s$$ (0 for a fully braced pile - Ref. 8, Appendix B, Eqn 6-9)

$P_{n.bottom}$ = 1305 kips

Calculate the factored structural pile resistance, P_r, for both segments of the upper zone of the pile as well as the lower zone of the pile.

$$P_{r.top} = \phi_{cu} P_{n.top}$$
$P_{r.top}$ = 892 kips

$$P_{r.2nd} = \phi_{cu} P_{n.2nd}$$
$P_{r.2nd}$ = 824 kips

$$P_{r.bottom} = \phi_{cl} P_{n.bottom}$$
$P_{r.bottom}$ = 653 kips

Compare the ratio of P_u to the structural resistance in the upper portion of the pile – the pile size should be such that the ratio is not less than 0.20.

$\frac{P_u}{P_{r.top}}$ = 0.51 OK

$\frac{P_u}{P_{r.2nd}}$ = 0.55 OK

Since the lower zone of the pile will have virtually no moment, the entire section can carry the required vertical loads. Make sure the applied load will not exceed the resistance of the lower zone.

$$\text{Check}\left(\frac{P_u}{P_{r.bottom}} < 1\right)$$

$\frac{P_u}{P_{r.bottom}}$ = 0.70 OK

Determine the nominal and factored flexural resistance about H-Pile weak axis (LRFD 6.12.2.2).

Slenderness ratio for the flange:

$$\lambda_f = \frac{b_f}{2t_f}$$ (Ref. 1, Eqn 6.12.2.2.1-3)

λ_f = 11.95

Limiting slenderness ratio for a compact flange:

$$\lambda_{pf} = 0.38\sqrt{\frac{E}{F_y}}$$ (Ref. 1, Eqn 6.12.2.2.1-4)

λ_{pf} = 9.15

Limiting slenderness ratio for a noncompact flange:

$$\lambda_{rf} = 0.83\sqrt{\frac{E}{F_y}}$$ (Ref. 1, Eqn 6.12.2.2.1-5)

λr_f = 19.99

Elastic and plastic section moduli about the weak axis:

$$S_y = \frac{I_{yy}}{b/2}$$

$$Z_y = (b^2 t_f)/2 + 0.25 t_w^2 (d - 2t_f)$$

S_y = 44.4 in^3

Z_y = 67.6 in^3

Nominal flexural resistance:

$$M_n = M_p = (F_y Z_y) \quad \text{if } \lambda_f \le \lambda_{pf}$$ (Ref. 1, Eqn 6.12.2.2.1-1)

$$M_n = \left[1 - \left(1 - \frac{S_y}{Z_y}\right)\left(\frac{\lambda_f - \lambda_{pf}}{0.45\sqrt{\frac{E}{F_y}}}\right)\right] F_y Z_y \quad \text{if } \lambda_{pf} < \lambda_f \le \lambda_{rf}$$ (Ref. 1, Eqn 6.12.2.2.1-2)

Since $\lambda_{pf} < \lambda_f \le \lambda_{rf}$,

M_n = 3080 in-kips

Factored flexural resistance:

ϕ_f = 1.00 (Ref. 2, page 5-42)

$$M_r = \phi_f M_n$$

M_r = 3080 in-kips

Date:	7/14/2021	**Made by:**	DAF
Project No.:	21450910	**Checked by:**	KAR
Subject:	Pile Design at Abutment 1	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

Calculate the moment that will cause a plastic hinge at the top of the pile, M_p'(Ref. 2, Article 6.9.2.2).

$$M'_p = \frac{9}{8}\left(1 - \frac{P_u}{P_{r.top}}\right)M_r \qquad \text{(Ref. 8, Appendix B, Eqn 6-24)}$$

M_p' = 1693 in-kips = 1692761.1 inch-lb

If the applied moment exceeds the moment that would cause a plastic hinge, it can be assumed that the pile head has entered plastic deformation and therefore the moment that can be applied to the pile head cannot exceed M_p'.

$M_{u.Top}$ =	2950	in-kips	(From Step 2)
$M_{u.Top}$	>	M_p'	Plastic Hinge Forms

4. Run a second LPile analysis with displacement, plastic moment (M_p'), and P_u as load conditions, and calculate new unbraced lengths from the moment vs. depth curve. Then repeat Step 3 with the new unbraced lengths.

$l_{b.top}$ =	3.2	ft	(LPile)
$l_{b.top}$ =	38.2	in	
$l_{b.2nd}$ =	11.7	ft	(LPile)
$l_{b.2nd}$ =	139.9	in	
$M_{u.2nd}$ =	1257	in-kips	(LPile)

Since a plastic hinge developed at the pile head, the value of K for the top segment becomes 2.1 (Ref. 2, page 5-43).

K_{top} =	2.1		(Ref. 1, Table C4.6.2.5-1)
K_{2nd} =	1.0		(Ref. 1, Table C4.6.2.5-1)
λ_{top} =	22.72	< 120	OK
λ_{2nd} =	39.60	< 120	OK
$P_{e.top}$ =	14476	kips	
$P_{e.2nd}$ =	4765	kips	
$P_o/P_{e.top}$ =	0.09	≤ 2.25	(to select P_n equation)
$P_o/P_{e.2nd}$ =	0.27	≤ 2.25	(to select P_n equation)
$P_{n.top}$ =	1257	kips	
$P_{n.2nd}$ =	1164	kips	

$P_{r.top}$ = 880 kips

$P_{r.2nd}$ = 815 kips

$\frac{P_u}{P_{r.top}} =$ 0.52 > 0.20 OK

$\frac{P_u}{P_{r.2nd}} =$ 0.56 > 0.20 OK

Since the pile is appropriately sized, the second segment of the upper zone of the pile needs to be checked with the interaction equation of LRFD Section 6.9.2.2. It is important that this segment of the pile does not form a plastic hinge. A plastic hinge in this segment will cause the pile to fail.

Check: $\frac{P_u}{P_{r.2nd}} + \frac{8}{9}\left(\frac{M_{u.2nd}}{M_r}\right) < 1$ (Ref. 8, Appendix B, Eqn 7-13)

Check: 0.92 < 1 OK

5. Because the piles have weak axis orientation and the flanges resist the shear as opposed to the web, check the maximum shear from the LPile output against the structural shear resistance per AISC G7.

V_u = 43.1 kips (LPile)

AASHTO LRFD does not directly address weak axis shear. This analysis will use the AISC Steel Construction Manual 13th edition (G7) to ensure the pile will not shear under the longitudinal load.

k_v = 1.2 (Ref. 9, Section G2.1)

$C_v = 1.0 \quad \text{if} \quad b/t_f \leq 1.1\sqrt{k_v E/F_y}$ (Ref. 9, Eqn. G2-3)

C_v = 1.0

Both flanges will resist shear forces:

$A_w = 2b_f t_f$ (Ref. 8, Appendix B, Eqn 7-17)

A_w = 18.07 in^2

$V_n = 0.6F_y A_w C_V$ (Ref. 9, Eqn G2-1)

V_n = 542 kips

$$V_r = \Phi_v V_n$$

ϕ_v = 1.00 (Ref. 1, Article 6.5.4.2)

V_r = 542 kips

Check that the shear resistance is sufficient:

V_u < V_r OK

6. Check that the maximum factored applied pile load does not exceed the factored pile drivability resistance.

While driving the pile, the maximum stress that is permitted in the pile is:

$$\sigma_{dr} = 0.9\Phi_{da}F_y$$ (Ref. 8, Appendix B, Eqn 7-22)

ϕ_{da} = 1.00 (Ref. 1, Article 6.5.4.2)

σ_{dr} = 45 ksi

This translates into an ultimate maximum driving force that can be applied to the pile of:

$$P_0 = \sigma_{dr}A_s$$ (Ref. 8, Appendix B, Eqn 7-23)

P_0 = 1175 kips

Calculate the nominal pile driving resistance (R_{ndr}) from the applied load divided by the resistance factor associated with the pile monitoring method. In this design, the pile will be bearing on rock. The driving criteria will be established by dynamic testing.

ϕ_{mon} = 0.65 (Ref. 1, Table 10.5.5.2.3-1)

$$R_{ndr} = \frac{P_u}{\phi_{mon}}$$ (Ref. 8, Appendix B, Eqn 7-25)

R_{ndr} = 702 kips

The nominal pile driving resistance (R_{ndr}) should exceed neither the nominal structural pile resistance (P_n) nor the maximum driving force (P_0) calculated above.

$P_{n.top}$ = 1257 kips (From Step 4)

$P_{n.2nd}$ = 1164 kips (From Step 4)

Check $R_{ndr} < P_n$: OK

Check $R_{ndr} < P_0$: OK

Date:	7/14/2021	**Made by:**	DAF
Project No.:	21450910	**Checked by:**	KAR
Subject:	Pile Design at Abutment 1	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

CONCLUSIONS

HP 14x89 piles were evaluated for Abutment 1. The results of the analysis indicate that a maximum moment of 2950 in-kips (246 ft-kips) occurs at the top of the pile, with a maximum bridge expansion or contraction of 0.8 inches, a maximum lateral deflection due to girder rotation of 0.2 inches, and a maximum factored axial load of 456 kips including downdrag and pile weight at the strength 1 load case. The results indicate that the depth to bedrock is sufficient for driven piles to achieve fixity. The design is controlled by pile driving and a nominal pile driving resistance of 702 kips is recommended based on the factored design load and the assumption that pile driving will be established by dynamic testing.

Attachment 1

==========

LPile for Windows, Version 2019-11.005

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

==========

This copy of LPile is being used by:

KAR
Golder Associates, Inc.

Serial Number of Security Device: 239146533

This copy of LPile is licensed for exclusive use by:

GOLDER, Manchester, NH

Use of this program by any entity other than GOLDER, Manchester, NH
is a violation of the software license agreement.

Files Used for Analysis

Path to file locations:
\\golderassociates.sharepoint.com@SSL\DavWWWRoot\sites\139982\Project Files\5 Technical Work\06 Analysis\Phase II - Pile Design\LPILE\Abutment 1 Strength I\

Name of input data file:
Freeport Exit 22 Abutment 1 - KAR check - girder rotation.lp11d

Name of output report file:
Freeport Exit 22 Abutment 1 - KAR check - girder rotation.lp11o

Name of plot output file:
Freeport Exit 22 Abutment 1 - KAR check - girder rotation.lp11p

Name of runtime message file:
Freeport Exit 22 Abutment 1 - KAR check - girder rotation.lp11r

---

Date and Time of Analysis

Date: July 14, 2021 Time: 16:44:41

Problem Title

Project Name: MaineDOT I-295 Exit 22 Mallet Drive Bridge No. 5721
Job Number: 19129538
Client: MaineDOT
Engineer: KAR
Description: Northwest Abutment Pile Design - Strength I

Program Options and Settings

Computational Options:
- Conventional Analysis

Engineering Units Used for Data Input and Computations:
- US Customary System Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
- Static loading specified

- Use of p-y modification factors for p-y curves not selected
- Analysis uses layering correction (Method of Georgiadis)
- No distributed lateral loads are entered
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Input of moment resistance at the pile tip not selected
- Input of side resistance moment along pile not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- Output files use decimal points to denote decimal symbols.
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 36.200 ft
Depth of ground surface below top of pile = 0.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	14.6950
2	36.200	14.6950

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is a H weak axis steel pile
Length of section = 36.200000 ft
Pile width = 13.830000 in
Shear capacity of section = 0.0000 lbs

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 0.0000 ft
Distance from top of pile to bottom of layer = 11.800000 ft

Effective unit weight at top of layer = 125.000000 pcf
Effective unit weight at bottom of layer = 125.000000 pcf
Friction angle at top of layer = 33.000000 deg.
Friction angle at bottom of layer = 33.000000 deg.
Subgrade k at top of layer = 165.000000 pci
Subgrade k at bottom of layer = 165.000000 pci

Layer 2 is stiff clay with water-induced erosion

Distance from top of pile to top of layer = 11.800000 ft
Distance from top of pile to bottom of layer = 13.900000 ft
Effective unit weight at top of layer = 115.000000 pcf
Effective unit weight at bottom of layer = 115.000000 pcf
Undrained cohesion at top of layer = 3500. psf
Undrained cohesion at bottom of layer = 3500. psf
Epsilon-50 at top of layer = 0.005000
Epsilon-50 at bottom of layer = 0.005000
Subgrade k at top of layer = 500.000000 pci
Subgrade k at bottom of layer = 500.000000 pci

Layer 3 is stiff clay without free water

Distance from top of pile to top of layer = 13.900000 ft
Distance from top of pile to bottom of layer = 34.200000 ft
Effective unit weight at top of layer = 52.600000 pcf
Effective unit weight at bottom of layer = 52.600000 pcf
Undrained cohesion at top of layer = 3500. psf
Undrained cohesion at bottom of layer = 3500. psf
Epsilon-50 at top of layer = 0.005000
Epsilon-50 at bottom of layer = 0.005000

Layer 4 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 34.200000 ft
Distance from top of pile to bottom of layer = 36.200000 ft
Effective unit weight at top of layer = 62.600000 pcf
Effective unit weight at bottom of layer = 62.600000 pcf
Friction angle at top of layer = 36.000000 deg.
Friction angle at bottom of layer = 36.000000 deg.
Subgrade k at top of layer = 100.000000 pci
Subgrade k at bottom of layer = 100.000000 pci

Layer 5 is strong rock (vuggy limestone)

Distance from top of pile to top of layer = 36.200000 ft
Distance from top of pile to bottom of layer = 50.000000 ft
Effective unit weight at top of layer = 106.600000 pcf
Effective unit weight at bottom of layer = 106.600000 pcf
Uniaxial compressive strength at top of layer = 12604. psi
Uniaxial compressive strength at bottom of layer = 12604. psi

(Depth of the lowest soil layer extends 13.800 ft below the pile tip)

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	Uniaxial qu psi	E50 or krm	kpy pci
1	Sand	0.00	125.0000	--	33.0000	--	--	165.0000
	(Reese, et al.)	11.8000	125.0000	--	33.0000	--	--	165.0000
2	Stiff Clay	11.8000	115.0000	3500.	--	--	0.00500	500.0000
	with Free Water	13.9000	115.0000	3500.	--	--	0.00500	500.0000
3	Stiff Clay	13.9000	52.6000	3500.	--	--	0.00500	--
	w/o Free Water	34.2000	52.6000	3500.	--	--	0.00500	--
4	Sand	34.2000	62.6000	--	36.0000	--	--	100.0000
	(Reese, et al.)	36.2000	62.6000	--	36.0000	--	--	100.0000
5	Strong Rock	36.2000	106.6000	--	--	12604.	--	--
	(Vuggy Limestone)	50.0000	106.6000	--	--	12604.	--	--

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	5	y = -0.975000 in	S = 0.0000 in/in	456000.	N.A.	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness
---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Dimensions and Properties of Steel H Weak Axis:

Length of Section = 36.200000 ft
Flange Width = 14.695000 in
Section Depth = 13.830000 in
Flange Thickness = 0.615000 in
Web Thickness = 0.615000 in
Yield Stress of Pipe = 50.000000 ksi
Elastic Modulus = 29000. ksi
Cross-sectional Area = 25.823850 sq. in.
Moment of Inertia = 325.505721 in^4
Elastic Bending Stiffness = 9439666. kip-in^2
Plastic Modulus, Z = 67.593889in^3
Plastic Moment Capacity = Fy Z = 3380.in-kip

Axial Structural Capacities:

Nom. Axial Structural Capacity = Fy As = 1291.193 kips
Nominal Axial Tensile Capacity = -1291.193 kips

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	456.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 456.000 kips

Bending Curvature	Bending Moment	Bending Stiffness	Depth to N Axis	Max Total Stress	Run Msg

rad/in.	in-kip	kip-in2	in	ksi	
0.00000420	39.6205985	9438779.	152.4051465	18.5435736	
0.00000840	79.2411970	9438779.	79.8763232	19.4290521	
0.00001259	118.8617955	9438779.	55.7000488	20.3145309	
0.00001679	158.4823940	9438779.	43.6119116	21.2000090	
0.00002099	198.1029925	9438779.	36.3590293	22.0854876	
0.00002519	237.7235910	9438779.	31.5237744	22.9709661	
0.00002938	277.3441895	9438779.	28.0700209	23.8564445	
0.00003358	316.9647880	9438779.	25.4797058	24.7419230	
0.00003778	356.5853865	9438779.	23.4650163	25.6274016	
0.00004198	396.2059850	9438779.	21.8532646	26.5128801	
0.00004617	435.8265835	9438779.	20.5345588	27.3983586	
0.00005037	475.4471820	9438779.	19.4356372	28.2838371	
0.00005457	515.0677805	9438779.	18.5057805	29.1693155	
0.00005877	554.6883790	9438779.	17.7087605	30.0547941	
0.00006296	594.3089775	9438779.	17.0180098	30.9402726	
0.00006716	633.9295760	9438779.	16.4136029	31.8257511	
0.00007136	673.5501745	9438779.	15.8803027	32.7112296	
0.00007556	713.1707730	9438779.	15.4062581	33.5967081	
0.00007976	752.7913715	9438779.	14.9821130	34.4821867	
0.00008395	792.4119700	9438779.	14.6003823	35.3676651	
0.00008815	832.0325685	9438779.	14.2550070	36.2531435	
0.00009235	871.6531671	9438779.	13.9410294	37.1386220	
0.00009655	911.2737656	9438779.	13.6543542	38.0241006	
0.0001007	950.8943641	9438779.	13.3915686	38.9095791	
0.0001049	990.5149626	9438779.	13.1498059	39.7950576	
0.0001091	1030.	9438779.	12.9266402	40.6805361	
0.0001133	1070.	9438779.	12.7200054	41.5660146	
0.0001175	1109.	9438779.	12.5281302	42.4514931	
0.0001217	1149.	9438779.	12.3494878	43.3369716	
0.0001259	1189.	9438779.	12.1827549	44.2224500	
0.0001301	1228.	9438779.	12.0267789	45.1079286	
0.0001343	1268.	9438779.	11.8805515	45.9934071	
0.0001385	1307.	9438779.	11.7431863	46.8788856	
0.0001427	1347.	9438779.	11.6139014	47.7643641	
0.0001469	1387.	9438779.	11.4920042	48.6498426	
0.0001511	1426.	9438779.	11.3768791	49.5353211	
0.0001553	1465.	9435191.	11.2686355	50.0000000	Y
0.0001595	1503.	9422728.	11.1677725	50.0000000	Y
0.0001637	1539.	9401508.	11.0738753	50.0000000	Y
0.0001721	1607.	9340072.	10.9041920	50.0000000	Y
0.0001805	1671.	9259553.	10.7553987	50.0000000	Y
0.0001889	1731.	9165302.	10.6243406	50.0000000	Y
0.0001973	1788.	9061631.	10.5083781	50.0000000	Y
0.0002057	1841.	8952022.	10.4052804	50.0000000	Y
0.0002141	1892.	8838729.	10.3132864	50.0000000	Y
0.0002225	1941.	8723007.	10.2310497	50.0000000	Y
0.0002309	1987.	8607122.	10.1570771	50.0000000	Y
0.0002393	2032.	8491570.	10.0904491	50.0000000	Y
0.0002477	2075.	8376799.	10.0303579	50.0000000	Y
0.0002561	2116.	8263953.	9.9758696	50.0000000	Y
0.0002645	2156.	8153267.	9.9263741	50.0000000	Y
0.0002728	2195.	8044937.	9.8813337	50.0000000	Y

0.0002812	2233.	7939120.	9.8402729	50.0000000	Y
0.0002896	2270.	7835946.	9.8027682	50.0000000	Y
0.0002980	2305.	7735514.	9.7684417	50.0000000	Y
0.0003064	2340.	7637903.	9.7369539	50.0000000	Y
0.0003148	2375.	7543168.	9.7079992	50.0000000	Y
0.0003232	2408.	7451349.	9.6813009	50.0000000	Y
0.0003316	2441.	7361923.	9.6568253	50.0000000	Y
0.0003400	2474.	7275105.	9.6342800	50.0000000	Y
0.0003484	2505.	7189344.	9.6128066	50.0000000	Y
0.0003568	2534.	7102294.	9.5917261	50.0000000	Y
0.0003652	2562.	7014167.	9.5712107	50.0000000	Y
0.0003736	2588.	6926270.	9.5508867	50.0000000	Y
0.0003820	2612.	6837783.	9.5311013	50.0000000	Y
0.0003904	2635.	6749647.	9.5113973	50.0000000	Y
0.0003988	2657.	6662033.	9.4922174	50.0000000	Y
0.0004072	2677.	6575676.	9.4733442	50.0000000	Y
0.0004156	2697.	6490021.	9.4549655	50.0000000	Y
0.0004240	2716.	6405293.	9.4364777	50.0000000	Y
0.0004324	2733.	6321641.	9.4187632	50.0000000	Y
0.0004408	2750.	6239745.	9.4011547	50.0000000	Y
0.0004491	2766.	6158445.	9.3837703	50.0000000	Y
0.0004575	2781.	6079056.	9.3669203	50.0000000	Y
0.0004659	2796.	6000846.	9.3499542	50.0000000	Y
0.0004743	2810.	5923929.	9.3336379	50.0000000	Y
0.0004827	2823.	5848523.	9.3174978	50.0000000	Y
0.0004911	2836.	5774619.	9.3014074	50.0000000	Y
0.0004995	2848.	5702094.	9.2858551	50.0000000	Y
0.0005331	2892.	5425654.	9.2255915	50.0000000	Y
0.0005667	2930.	5170790.	9.1689097	50.0000000	Y
0.0006003	2963.	4936245.	9.1156323	50.0000000	Y
0.0006338	2991.	4719295.	9.0654228	50.0000000	Y
0.0006674	3016.	4519285.	9.0178856	50.0000000	Y
0.0007010	3038.	4334457.	8.9729284	50.0000000	Y
0.0007346	3058.	4163153.	8.9304344	50.0000000	Y
0.0007682	3076.	4004139.	8.8900053	50.0000000	Y
0.0008017	3092.	3856278.	8.8514621	50.0000000	Y
0.0008353	3106.	3718382.	8.8150743	50.0000000	Y
0.0008689	3119.	3589808.	8.7802818	50.0000000	Y
0.0009025	3131.	3469676.	8.7470918	50.0000000	Y
0.0009361	3142.	3356577.	8.7153810	50.0000000	Y

Summary of Results for Nominal Moment Capacity for Section 1

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	456.0000000000	3142.

Note that the values in the above table are not factored by a strength

reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or Rock Layer is Below	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	0.00	0.00	N.A.	No	0.00	184181.
2	11.8000	165.6667	No	No	184181.	8681.
3	13.9000	9.0046	No	No	192862.	762983.
4	34.2000	22.4166	No	No	955845.	267969.
5	36.2000	36.2000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Displacement and Pile-head Rotation (Loading Type 5)
Displacement of pile head = -0.975000 inches
Rotation of pile head = 0.000E+00 radians
Axial load on pile head = 456000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	-0.9750	2950148.	-58011.	0.00	84251.	5.02E+09	0.00	0.00	0.00
0.3620	-0.9695	2696275.	-57760.	0.00244	78520.	5.02E+09	46.4369	208.0773	0.00

0.7240	-0.9538	2438659.	-57438.	0.00433	72705.	7.37E+09	101.8270	463.7698	0.00	
1.0860	-0.9319	2180116.	-56866.	0.00563	66869.	8.09E+09	161.2724	751.7887	0.00	
1.4480	-0.9049	1922297.	-56035.	0.00669	61049.	8.77E+09	221.2688	1062.	0.00	
1.8100	-0.8737	1666767.	-54951.	0.00756	55281.	9.27E+09	277.9021	1382.	0.00	
2.1720	-0.8392	1414932.	-53621.	0.00828	49597.	9.44E+09	334.5957	1732.	0.00	
2.5340	-0.8018	1168122.	-52056.	0.00887	44026.	9.44E+09	385.5608	2089.	0.00	
2.8960	-0.7621	927522.	-50283.	0.00935	38595.	9.44E+09	430.8824	2456.	0.00	
3.2580	-0.7206	694208.	-48315.	0.00973	33328.	9.44E+09	475.0958	2864.	0.00	
3.6200	-0.6776	469226.	-46156.	0.00999	28250.	9.44E+09	519.3029	3329.	0.00	
3.9820	-0.6337	253616.	-43768.	0.01016	23383.	9.44E+09	580.0471	3976.	0.00	
4.3440	-0.5893	48720.	-41111.	0.01023	18758.	9.44E+09	643.1136	4740.	0.00	
4.7060	-0.5449	-144085.	-38198.	0.01021	20910.	9.44E+09	698.0549	5565.	0.00	
5.0680	-0.5007	-323585.	-35108.	0.01010	24962.	9.44E+09	724.7052	6288.	0.00	
5.4300	-0.4571	-489115.	-31882.	0.00991	28699.	9.44E+09	760.6782	7229.	0.00	
5.7920	-0.4145	-639846.	-28517.	0.00965	32101.	9.44E+09	788.4544	8262.	0.00	
6.1540	-0.3732	-775114.	-25049.	0.00933	35154.	9.44E+09	808.2514	9407.	0.00	
6.5160	-0.3335	-894424.	-21492.	0.00894	37848.	9.44E+09	829.0949	10800.	0.00	
6.8780	-0.2955	-997273.	-17859.	0.00851	40169.	9.44E+09	843.9246	12405.	0.00	
7.2400	-0.2596	-1083287.	-14173.	0.00803	42111.	9.44E+09	853.1322	14277.	0.00	
7.6020	-0.2258	-1152215.	-10459.	0.00752	43667.	9.44E+09	856.6017	16481.	0.00	
7.9640	-0.1943	-1203929.	-6749.	0.00697	44834.	9.44E+09	851.5508	19040.	0.00	
8.3260	-0.1652	-1238476.	-3081.	0.00641	45614.	9.44E+09	837.4432	22022.	0.00	
8.6880	-0.1386	-1256091.	506.8486	0.00584	46011.	9.44E+09	814.2085	25522.	0.00	
9.0500	-0.1145	-1257196.	3974.	0.00526	46036.	9.44E+09	781.9005	29669.	0.00	
9.4120	-0.09290	-1242401.	7281.	0.00468	45702.	9.44E+09	740.6910	34636.	0.00	
9.7740	-0.07380	-1212496.	10390.	0.00412	45027.	9.44E+09	690.8564	40668.	0.00	
10.1360	-0.05712	-1168448.	13265.	0.00357	44033.	9.44E+09	632.7523	48124.	0.00	
10.4980	-0.04277	-1111396.	15870.	0.00305	42745.	9.44E+09	566.7655	57558.	0.00	
10.8600	-0.03065	-1042635.	18173.	0.00255	41193.	9.44E+09	493.2194	69893.	0.00	
11.2220	-0.02062	-963616.	20139.	0.00209	39409.	9.44E+09	412.1729	86837.	0.00	
11.5840	-0.01251	-875941.	21657.	0.00167	37430.	9.44E+09	286.9229	99635.	0.00	
11.9460	-0.00615	-782053.	23238.	0.00128	35311.	9.44E+09	440.9131	311361.	0.00	
12.3080	-0.00136	-679132.	24414.	9.47E-04	32988.	9.44E+09	100.2054	320796.	0.00	
12.6700	0.00208	-573701.	24288.	6.59E-04	30608.	9.44E+09	-158.1140	330231.	0.00	
13.0320	0.00437	-470731.	23202.	4.19E-04	28284.	9.44E+09	-341.6796	339666.	0.00	
13.3940	0.00572	-373779.	21462.	2.24E-04	26095.	9.44E+09	-459.5615	349101.	0.00	
13.7560	0.00632	-285158.	19331.	7.28E-05	24095.	9.44E+09	-521.6256	358536.	0.00	
14.1180	0.00635	-206121.	17012.	-4.02E-05	22311.	9.44E+09	-545.8775	373352.	0.00	
14.4800	0.00597	-137197.	14633.	-1.19E-04	20755.	9.44E+09	-549.3191	399662.	0.00	
14.8420	0.00532	-78513.	12256.	-1.69E-04	19430.	9.44E+09	-545.0575	445426.	0.00	
15.2040	0.00450	-30043.	9913.	-1.94E-04	18336.	9.44E+09	-533.9272	514995.	0.00	
15.5660	0.00363	8378.	7632.	-1.99E-04	17847.	9.44E+09	-516.3748	617659.	0.00	
15.9280	0.00278	37048.	5440.	-1.88E-04	18494.	9.44E+09	-492.5817	770703.	0.00	
16.2900	0.00200	56389.	3366.	-1.67E-04	18931.	9.44E+09	-462.4909	1006953.	0.00	
16.6520	0.00133	66951.	1437.	-1.38E-04	19169.	9.44E+09	-425.7361	1393965.	0.00	
17.0140	7.92E-04	69419.	-316.4263	-1.07E-04	19225.	9.44E+09	-381.3564	2091424.	0.00	
17.3760	3.96E-04	64627.	-1854.	-7.63E-05	19117.	9.44E+09	-326.7372	3581831.	0.00	
17.7380	1.30E-04	53610.	-2860.	-4.90E-05	18868.	9.44E+09	-136.1213	4561472.	0.00	
18.1000	-2.98E-05	39976.	-3086.	-2.75E-05	18560.	9.44E+09	31.8749	4643194.	0.00	
18.4620	-1.09E-04	26906.	-2759.	-1.21E-05	18265.	9.44E+09	118.9413	4724883.	0.00	
18.8240	-1.35E-04	16057.	-2179.	-2.23E-06	18021.	9.44E+09	147.7584	4751250.	0.00	
19.1860	-1.29E-04	7981.	-1553.	3.30E-06	17838.	9.44E+09	140.8006	4751250.	0.00	
19.5480	-1.06E-04	2555.	-993.9441	5.73E-06	17716.	9.44E+09	116.3906	4751250.	0.00	
19.9100	-7.90E-05	-676.8442	-553.4976	6.16E-06	17673.	9.44E+09	86.3932	4751250.	0.00	

20.2720	-5.29E-05	-2278.	-240.1450	5.48E-06	17710.	9.44E+09	57.8759	4751250.	0.00
20.6340	-3.14E-05	-2785.	-39.8524	4.31E-06	17721.	9.44E+09	34.3398	4751250.	0.00
20.9960	-1.54E-05	-2641.	71.4261	3.06E-06	17718.	9.44E+09	16.8934	4751250.	0.00
21.3580	-4.77E-06	-2177.	119.4620	1.96E-06	17707.	9.44E+09	5.2226	4751250.	0.00
21.7200	1.54E-06	-1611.	127.1374	1.08E-06	17694.	9.44E+09	-1.6888	4751250.	0.00
22.0820	4.64E-06	-1076.	112.4417	4.65E-07	17682.	9.44E+09	-5.0772	4751250.	0.00
22.4440	5.59E-06	-636.1284	88.1384	7.14E-08	17672.	9.44E+09	-6.1122	4751250.	0.00
22.8060	5.26E-06	-310.7758	62.3605	-1.46E-07	17665.	9.44E+09	-5.7561	4751250.	0.00
23.1680	4.32E-06	-93.7600	39.6052	-2.40E-07	17660.	9.44E+09	-4.7205	4751250.	0.00
23.5300	3.18E-06	34.2631	21.7938	-2.53E-07	17659.	9.44E+09	-3.4799	4751250.	0.00
23.8920	2.12E-06	96.5874	9.2088	-2.23E-07	17660.	9.44E+09	-2.3142	4751250.	0.00
24.2540	1.24E-06	115.1530	1.2288	-1.74E-07	17661.	9.44E+09	-1.3598	4751250.	0.00
24.6160	6.01E-07	107.9543	-3.1518	-1.23E-07	17661.	9.44E+09	-0.6571	4751250.	0.00
24.9780	1.74E-07	88.2578	-4.9927	-7.79E-08	17660.	9.44E+09	-0.1905	4751250.	0.00
25.3400	-7.60E-08	64.8866	-5.2257	-4.27E-08	17660.	9.44E+09	0.08316	4751250.	0.00
25.7020	-1.96E-07	43.0256	-4.5783	-1.78E-08	17659.	9.44E+09	0.2149	4751250.	0.00
26.0640	-2.31E-07	25.1807	-3.5630	-2.13E-09	17659.	9.44E+09	0.2526	4751250.	0.00
26.4260	-2.15E-07	12.0791	-2.5036	6.44E-09	17658.	9.44E+09	0.2352	4751250.	0.00
26.7880	-1.75E-07	3.4043	-1.5771	1.00E-08	17658.	9.44E+09	0.1914	4751250.	0.00
27.1500	-1.28E-07	-1.6626	-0.8572	1.04E-08	17658.	9.44E+09	0.1401	4751250.	0.00
27.5120	-8.46E-08	-4.0841	-0.3520	9.08E-09	17658.	9.44E+09	0.09249	4751250.	0.00
27.8740	-4.92E-08	-4.7565	-0.03424	7.05E-09	17658.	9.44E+09	0.05380	4751250.	0.00
28.2360	-2.33E-08	-4.4095	0.1380	4.94E-09	17658.	9.44E+09	0.02551	4751250.	0.00
28.5980	-6.28E-09	-3.5770	0.2083	3.10E-09	17658.	9.44E+09	0.00686	4751250.	0.00
28.9600	3.62E-09	-2.6118	0.2146	1.68E-09	17658.	9.44E+09	-0.00396	4751250.	0.00
29.3220	8.30E-09	-1.7189	0.1863	6.81E-10	17658.	9.44E+09	-0.00907	4751250.	0.00
29.6840	9.54E-09	-0.9957	0.1440	5.60E-11	17658.	9.44E+09	-0.01043	4751250.	0.00
30.0460	8.78E-09	-0.4684	0.1004	-2.81E-10	17658.	9.44E+09	-0.00961	4751250.	0.00
30.4080	7.10E-09	-0.1220	0.06272	-4.17E-10	17658.	9.44E+09	-0.00776	4751250.	0.00
30.7700	5.16E-09	0.07812	0.03360	-4.27E-10	17658.	9.44E+09	-0.00565	4751250.	0.00
31.1320	3.39E-09	0.1716	0.01328	-3.69E-10	17658.	9.44E+09	-0.00370	4751250.	0.00
31.4940	1.95E-09	0.1950	5.96E-04	-2.85E-10	17658.	9.44E+09	-0.00214	4751250.	0.00
31.8560	9.11E-10	0.1779	-0.00621	-1.99E-10	17658.	9.44E+09	-9.96E-04	4751250.	0.00
32.2180	2.23E-10	0.1418	-0.00891	-1.26E-10	17658.	9.44E+09	-2.44E-04	4751250.	0.00
32.5800	-1.80E-10	0.1010	-0.00901	-6.97E-11	17658.	9.44E+09	1.97E-04	4751250.	0.00
32.9420	-3.82E-10	0.06386	-0.00767	-3.18E-11	17658.	9.44E+09	4.18E-04	4751250.	0.00
33.3040	-4.57E-10	0.03452	-0.00568	-9.15E-12	17658.	9.44E+09	5.00E-04	4751250.	0.00
33.6660	-4.62E-10	0.01458	-0.00349	2.14E-12	17658.	9.44E+09	5.05E-04	4751250.	0.00
34.0280	-4.38E-10	0.00416	-0.00136	6.46E-12	17658.	9.44E+09	4.79E-04	4751250.	0.00
34.3900	-4.06E-10	0.00277	-2.79E-04	8.05E-12	17658.	9.44E+09	1.67E-05	179268.	0.00
34.7520	-3.68E-10	0.00170	-2.09E-04	9.08E-12	17658.	9.44E+09	1.54E-05	181155.	0.00
35.1140	-3.27E-10	9.19E-04	-1.46E-04	9.68E-12	17658.	9.44E+09	1.38E-05	183042.	0.00
35.4760	-2.84E-10	3.96E-04	-8.97E-05	9.98E-12	17658.	9.44E+09	1.21E-05	184929.	0.00
35.8380	-2.40E-10	1.00E-04	-4.10E-05	1.01E-11	17658.	9.44E+09	1.03E-05	186816.	0.00
36.2000	-1.96E-10	0.00	0.00	1.01E-11	17658.	9.44E+09	8.53E-06	94352.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

Pile-head deflection = -0.97500000 inches
Computed slope at pile head = 0.000000 radians
Maximum bending moment = 2950148. inch-lbs
Maximum shear force = -58011. lbs
Depth of maximum bending moment = 0.000000 feet below pile head
Depth of maximum shear force = 0.000000 feet below pile head
Number of iterations = 17
Number of zero deflection points = 6

Summary of Pile-head Responses for Conventional Analyses

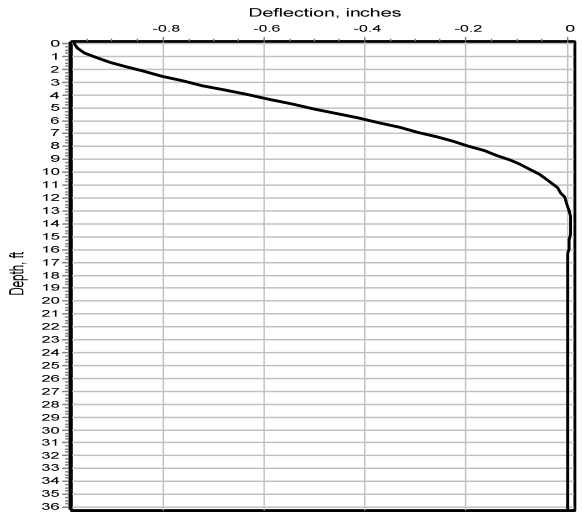
Definitions of Pile-head Loading Conditions:

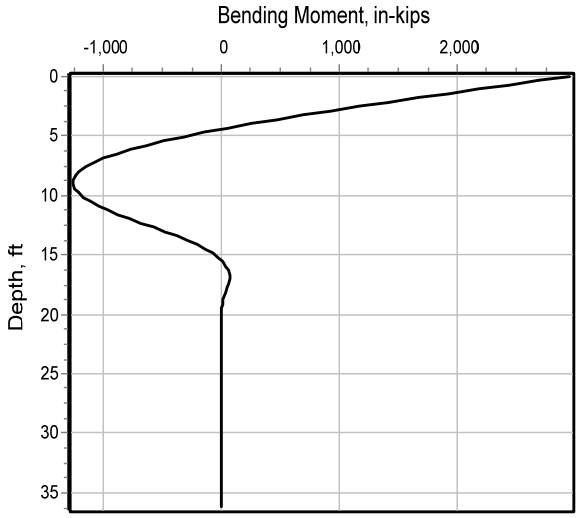
Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

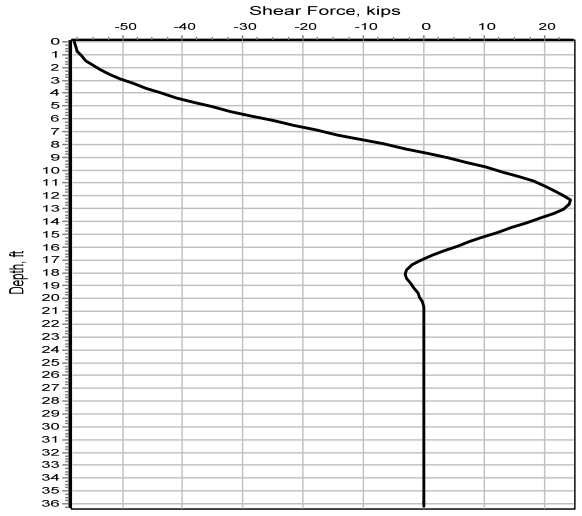
Load Case No.	Load Type	Load 1 Pile-head	Load Type	Load 2 Pile-head	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	y, in	-0.9750	S, rad	0.00	456000.	-0.9750	0.00	-58011.	2950148.

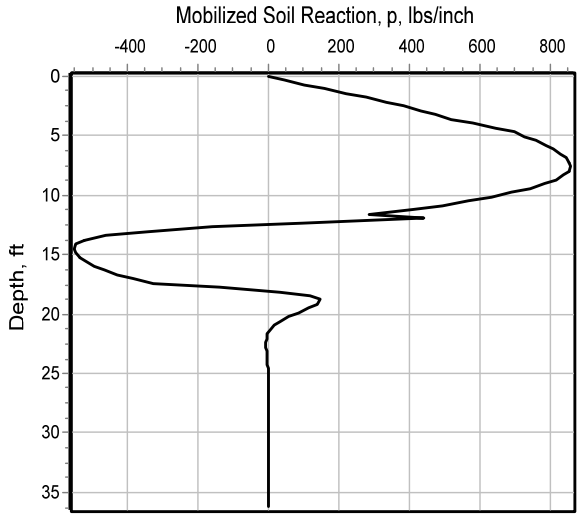
Maximum pile-head deflection = -0.9750000000 inches
Maximum pile-head rotation = 0.0000000000 radians = 0.000000 deg.

The analysis ended normally.


Deflection, inches
-0.8
-0.6
-0.4
-0.2
0
Depth, ft


Bending Moment, in-kips
-1,000
0
1,000
2,000
Depth, ft


Shear Force, kips
-50
-40
-30
-20
-10
0
10
20
Depth, ft


Mobilized Soil Reaction, p, lbs/inch
-400
-200
0
200
400
600
800
Depth, ft

Attachment 2

==========

LPile for Windows, Version 2019-11.005

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

==========

This copy of LPile is being used by:

KAR
Golder Associates, Inc.

Serial Number of Security Device: 239146533

This copy of LPile is licensed for exclusive use by:

GOLDER, Manchester, NH

Use of this program by any entity other than GOLDER, Manchester, NH
is a violation of the software license agreement.

Files Used for Analysis

Path to file locations:
\\golderassociates.sharepoint.com@SSL\DavWWWRoot\sites\139982\Project Files\5 Technical Work\06 Analysis\Phase II - Pile Design\LPILE\Abutment 1 Strength I\

Name of input data file:
Freeport Exit 22 Abutment 1 - KAR check - girder rotation Plastic Hinge.lp11d

Name of output report file:
Freeport Exit 22 Abutment 1 - KAR check - girder rotation Plastic Hinge.lp11o

Name of plot output file:
Freeport Exit 22 Abutment 1 - KAR check - girder rotation Plastic Hinge.lp11p

Name of runtime message file:
Freeport Exit 22 Abutment 1 - KAR check - girder rotation Plastic Hinge.lp11r

---

Date and Time of Analysis

Date: July 14, 2021 Time: 16:53:34

Problem Title

Project Name: MaineDOT I-295 Exit 22 Mallet Drive Bridge No. 5721
Job Number: 19129538
Client: MaineDOT
Engineer: KAR
Description: Northwest Abutment Pile Design - Strength I

Program Options and Settings

Computational Options:
- Conventional Analysis

Engineering Units Used for Data Input and Computations:
- US Customary System Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 500
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
- Static loading specified

- Use of p-y modification factors for p-y curves not selected
- Analysis uses layering correction (Method of Georgiadis)
- No distributed lateral loads are entered
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Input of moment resistance at the pile tip not selected
- Input of side resistance moment along pile not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- Output files use decimal points to denote decimal symbols.
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 36.200 ft
Depth of ground surface below top of pile = 0.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	14.6950
2	36.200	14.6950

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is a H weak axis steel pile
Length of section = 36.200000 ft
Pile width = 13.830000 in
Shear capacity of section = 0.0000 lbs

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 5 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 0.0000 ft
Distance from top of pile to bottom of layer = 11.800000 ft

Effective unit weight at top of layer = 125.000000 pcf
Effective unit weight at bottom of layer = 125.000000 pcf
Friction angle at top of layer = 33.000000 deg.
Friction angle at bottom of layer = 33.000000 deg.
Subgrade k at top of layer = 165.000000 pci
Subgrade k at bottom of layer = 165.000000 pci

Layer 2 is stiff clay with water-induced erosion

Distance from top of pile to top of layer = 11.800000 ft
Distance from top of pile to bottom of layer = 13.900000 ft
Effective unit weight at top of layer = 115.000000 pcf
Effective unit weight at bottom of layer = 115.000000 pcf
Undrained cohesion at top of layer = 3500. psf
Undrained cohesion at bottom of layer = 3500. psf
Epsilon-50 at top of layer = 0.005000
Epsilon-50 at bottom of layer = 0.005000
Subgrade k at top of layer = 500.000000 pci
Subgrade k at bottom of layer = 500.000000 pci

Layer 3 is stiff clay without free water

Distance from top of pile to top of layer = 13.900000 ft
Distance from top of pile to bottom of layer = 34.200000 ft
Effective unit weight at top of layer = 52.600000 pcf
Effective unit weight at bottom of layer = 52.600000 pcf
Undrained cohesion at top of layer = 3500. psf
Undrained cohesion at bottom of layer = 3500. psf
Epsilon-50 at top of layer = 0.005000
Epsilon-50 at bottom of layer = 0.005000

Layer 4 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 34.200000 ft
Distance from top of pile to bottom of layer = 36.200000 ft
Effective unit weight at top of layer = 62.600000 pcf
Effective unit weight at bottom of layer = 62.600000 pcf
Friction angle at top of layer = 36.000000 deg.
Friction angle at bottom of layer = 36.000000 deg.
Subgrade k at top of layer = 100.000000 pci
Subgrade k at bottom of layer = 100.000000 pci

Layer 5 is strong rock (vuggy limestone)

Distance from top of pile to top of layer = 36.200000 ft
Distance from top of pile to bottom of layer = 50.000000 ft
Effective unit weight at top of layer = 106.600000 pcf
Effective unit weight at bottom of layer = 106.600000 pcf
Uniaxial compressive strength at top of layer = 12604. psi
Uniaxial compressive strength at bottom of layer = 12604. psi

(Depth of the lowest soil layer extends 13.800 ft below the pile tip)

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Undrained Cohesion psf	Angle of Friction deg.	Uniaxial qu psi	E50 or krm	kpy pci
1	Sand	0.00	125.0000	--	33.0000	--	--	165.0000
	(Reese, et al.)	11.8000	125.0000	--	33.0000	--	--	165.0000
2	Stiff Clay	11.8000	115.0000	3500.	--	--	0.00500	500.0000
	with Free Water	13.9000	115.0000	3500.	--	--	0.00500	500.0000
3	Stiff Clay	13.9000	52.6000	3500.	--	--	0.00500	--
	w/o Free Water	34.2000	52.6000	3500.	--	--	0.00500	--
4	Sand	34.2000	62.6000	--	36.0000	--	--	100.0000
	(Reese, et al.)	36.2000	62.6000	--	36.0000	--	--	100.0000
5	Strong Rock	36.2000	106.6000	--	--	12604.	--	--
	(Vuggy Limestone)	50.0000	106.6000	--	--	12604.	--	--

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	5	y = -0.975000 in	S = 0.0000 in/in	456000.	N.A.	Yes
2	4	y = -0.975000 in	M = 1692761. in-lbs	456000.	N.A.	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness
---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Dimensions and Properties of Steel H Weak Axis:

Length of Section = 36.200000 ft
Flange Width = 14.695000 in
Section Depth = 13.830000 in
Flange Thickness = 0.615000 in
Web Thickness = 0.615000 in
Yield Stress of Pipe = 50.000000 ksi
Elastic Modulus = 29000. ksi
Cross-sectional Area = 25.823850 sq. in.
Moment of Inertia = 325.505721 in^4
Elastic Bending Stiffness = 9439666. kip-in^2
Plastic Modulus, Z = 67.593889in^3
Plastic Moment Capacity = Fy Z = 3380.in-kip

Axial Structural Capacities:

Nom. Axial Structural Capacity = Fy As = 1291.193 kips
Nominal Axial Tensile Capacity = -1291.193 kips

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	456.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 456.000 kips

Bending	Bending	Bending	Depth to	Max Total	Run

Curvature rad/in.	Moment in-kip	Stiffness kip-in2	N Axis in	Stress ksi	Msg
0.00000420	39.6205985	9438779.	152.4051465	18.5435736	
0.00000840	79.2411970	9438779.	79.8763232	19.4290521	
0.00001259	118.8617955	9438779.	55.7000488	20.3145309	
0.00001679	158.4823940	9438779.	43.6119116	21.2000090	
0.00002099	198.1029925	9438779.	36.3590293	22.0854876	
0.00002519	237.7235910	9438779.	31.5237744	22.9709661	
0.00002938	277.3441895	9438779.	28.0700209	23.8564445	
0.00003358	316.9647880	9438779.	25.4797058	24.7419230	
0.00003778	356.5853865	9438779.	23.4650163	25.6274016	
0.00004198	396.2059850	9438779.	21.8532646	26.5128801	
0.00004617	435.8265835	9438779.	20.5345588	27.3983586	
0.00005037	475.4471820	9438779.	19.4356372	28.2838371	
0.00005457	515.0677805	9438779.	18.5057805	29.1693155	
0.00005877	554.6883790	9438779.	17.7087605	30.0547941	
0.00006296	594.3089775	9438779.	17.0180098	30.9402726	
0.00006716	633.9295760	9438779.	16.4136029	31.8257511	
0.00007136	673.5501745	9438779.	15.8803027	32.7112296	
0.00007556	713.1707730	9438779.	15.4062581	33.5967081	
0.00007976	752.7913715	9438779.	14.9821130	34.4821867	
0.00008395	792.4119700	9438779.	14.6003823	35.3676651	
0.00008815	832.0325685	9438779.	14.2550070	36.2531435	
0.00009235	871.6531671	9438779.	13.9410294	37.1386220	
0.00009655	911.2737656	9438779.	13.6543542	38.0241006	
0.0001007	950.8943641	9438779.	13.3915686	38.9095791	
0.0001049	990.5149626	9438779.	13.1498059	39.7950576	
0.0001091	1030.	9438779.	12.9266402	40.6805361	
0.0001133	1070.	9438779.	12.7200054	41.5660146	
0.0001175	1109.	9438779.	12.5281302	42.4514931	
0.0001217	1149.	9438779.	12.3494878	43.3369716	
0.0001259	1189.	9438779.	12.1827549	44.2224500	
0.0001301	1228.	9438779.	12.0267789	45.1079286	
0.0001343	1268.	9438779.	11.8805515	45.9934071	
0.0001385	1307.	9438779.	11.7431863	46.8788856	
0.0001427	1347.	9438779.	11.6139014	47.7643641	
0.0001469	1387.	9438779.	11.4920042	48.6498426	
0.0001511	1426.	9438779.	11.3768791	49.5353211	
0.0001553	1465.	9435191.	11.2686355	50.0000000	Y
0.0001595	1503.	9422728.	11.1677725	50.0000000	Y
0.0001637	1539.	9401508.	11.0738753	50.0000000	Y
0.0001721	1607.	9340072.	10.9041920	50.0000000	Y
0.0001805	1671.	9259553.	10.7553987	50.0000000	Y
0.0001889	1731.	9165302.	10.6243406	50.0000000	Y
0.0001973	1788.	9061631.	10.5083781	50.0000000	Y
0.0002057	1841.	8952022.	10.4052804	50.0000000	Y
0.0002141	1892.	8838729.	10.3132864	50.0000000	Y
0.0002225	1941.	8723007.	10.2310497	50.0000000	Y
0.0002309	1987.	8607122.	10.1570771	50.0000000	Y
0.0002393	2032.	8491570.	10.0904491	50.0000000	Y
0.0002477	2075.	8376799.	10.0303579	50.0000000	Y
0.0002561	2116.	8263953.	9.9758696	50.0000000	Y
0.0002645	2156.	8153267.	9.9263741	50.0000000	Y

0.0002728	2195.	8044937.	9.8813337	50.0000000	Y
0.0002812	2233.	7939120.	9.8402729	50.0000000	Y
0.0002896	2270.	7835946.	9.8027682	50.0000000	Y
0.0002980	2305.	7735514.	9.7684417	50.0000000	Y
0.0003064	2340.	7637903.	9.7369539	50.0000000	Y
0.0003148	2375.	7543168.	9.7079992	50.0000000	Y
0.0003232	2408.	7451349.	9.6813009	50.0000000	Y
0.0003316	2441.	7361923.	9.6568253	50.0000000	Y
0.0003400	2474.	7275105.	9.6342800	50.0000000	Y
0.0003484	2505.	7189344.	9.6128066	50.0000000	Y
0.0003568	2534.	7102294.	9.5917261	50.0000000	Y
0.0003652	2562.	7014167.	9.5712107	50.0000000	Y
0.0003736	2588.	6926270.	9.5508867	50.0000000	Y
0.0003820	2612.	6837783.	9.5311013	50.0000000	Y
0.0003904	2635.	6749647.	9.5113973	50.0000000	Y
0.0003988	2657.	6662033.	9.4922174	50.0000000	Y
0.0004072	2677.	6575676.	9.4733442	50.0000000	Y
0.0004156	2697.	6490021.	9.4549655	50.0000000	Y
0.0004240	2716.	6405293.	9.4364777	50.0000000	Y
0.0004324	2733.	6321641.	9.4187632	50.0000000	Y
0.0004408	2750.	6239745.	9.4011547	50.0000000	Y
0.0004491	2766.	6158445.	9.3837703	50.0000000	Y
0.0004575	2781.	6079056.	9.3669203	50.0000000	Y
0.0004659	2796.	6000846.	9.3499542	50.0000000	Y
0.0004743	2810.	5923929.	9.3336379	50.0000000	Y
0.0004827	2823.	5848523.	9.3174978	50.0000000	Y
0.0004911	2836.	5774619.	9.3014074	50.0000000	Y
0.0004995	2848.	5702094.	9.2858551	50.0000000	Y
0.0005331	2892.	5425654.	9.2255915	50.0000000	Y
0.0005667	2930.	5170790.	9.1689097	50.0000000	Y
0.0006003	2963.	4936245.	9.1156323	50.0000000	Y
0.0006338	2991.	4719295.	9.0654228	50.0000000	Y
0.0006674	3016.	4519285.	9.0178856	50.0000000	Y
0.0007010	3038.	4334457.	8.9729284	50.0000000	Y
0.0007346	3058.	4163153.	8.9304344	50.0000000	Y
0.0007682	3076.	4004139.	8.8900053	50.0000000	Y
0.0008017	3092.	3856278.	8.8514621	50.0000000	Y
0.0008353	3106.	3718382.	8.8150743	50.0000000	Y
0.0008689	3119.	3589808.	8.7802818	50.0000000	Y
0.0009025	3131.	3469676.	8.7470918	50.0000000	Y
0.0009361	3142.	3356577.	8.7153810	50.0000000	Y

Summary of Results for Nominal Moment Capacity for Section 1

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	456.0000000000	3142.

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf Above Rock Layer	Same Layer Type As Layer	Layer is Rock or is Below	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	0.00	0.00	N.A.	No	0.00	184181.
2	11.8000	165.6667	No	No	184181.	8681.
3	13.9000	9.0046	No	No	192862.	762983.
4	34.2000	22.4166	No	No	955845.	267969.
5	36.2000	36.2000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Displacement and Pile-head Rotation (Loading Type 5)
Displacement of pile head = -0.975000 inches
Rotation of pile head = 0.000E+00 radians
Axial load on pile head = 456000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	-0.9750	2950148.	-58011.	0.00	84251.	5.02E+09	0.00	0.00	0.00

0.3620	-0.9695	2696275.	-57760.	0.00244	78520.	5.02E+09	46.4369	208.0773	0.00
0.7240	-0.9538	2438659.	-57438.	0.00433	72705.	7.37E+09	101.8270	463.7698	0.00
1.0860	-0.9319	2180116.	-56866.	0.00563	66869.	8.09E+09	161.2724	751.7887	0.00
1.4480	-0.9049	1922297.	-56035.	0.00669	61049.	8.77E+09	221.2688	1062.	0.00
1.8100	-0.8737	1666767.	-54951.	0.00756	55281.	9.27E+09	277.9021	1382.	0.00
2.1720	-0.8392	1414932.	-53621.	0.00828	49597.	9.44E+09	334.5957	1732.	0.00
2.5340	-0.8018	1168122.	-52056.	0.00887	44026.	9.44E+09	385.5608	2089.	0.00
2.8960	-0.7621	927522.	-50283.	0.00935	38595.	9.44E+09	430.8824	2456.	0.00
3.2580	-0.7206	694208.	-48315.	0.00973	33328.	9.44E+09	475.0958	2864.	0.00
3.6200	-0.6776	469226.	-46156.	0.00999	28250.	9.44E+09	519.3029	3329.	0.00
3.9820	-0.6337	253616.	-43768.	0.01016	23383.	9.44E+09	580.0471	3976.	0.00
4.3440	-0.5893	48720.	-41111.	0.01023	18758.	9.44E+09	643.1136	4740.	0.00
4.7060	-0.5449	-144085.	-38198.	0.01021	20910.	9.44E+09	698.0549	5565.	0.00
5.0680	-0.5007	-323585.	-35108.	0.01010	24962.	9.44E+09	724.7052	6288.	0.00
5.4300	-0.4571	-489115.	-31882.	0.00991	28699.	9.44E+09	760.6782	7229.	0.00
5.7920	-0.4145	-639846.	-28517.	0.00965	32101.	9.44E+09	788.4544	8262.	0.00
6.1540	-0.3732	-775114.	-25049.	0.00933	35154.	9.44E+09	808.2514	9407.	0.00
6.5160	-0.3335	-894424.	-21492.	0.00894	37848.	9.44E+09	829.0949	10800.	0.00
6.8780	-0.2955	-997273.	-17859.	0.00851	40169.	9.44E+09	843.9246	12405.	0.00
7.2400	-0.2596	-1083287.	-14173.	0.00803	42111.	9.44E+09	853.1322	14277.	0.00
7.6020	-0.2258	-1152215.	-10459.	0.00752	43667.	9.44E+09	856.6017	16481.	0.00
7.9640	-0.1943	-1203929.	-6749.	0.00697	44834.	9.44E+09	851.5508	19040.	0.00
8.3260	-0.1652	-1238476.	-3081.	0.00641	45614.	9.44E+09	837.4432	22022.	0.00
8.6880	-0.1386	-1256091.	506.8486	0.00584	46011.	9.44E+09	814.2085	25522.	0.00
9.0500	-0.1145	-1257196.	3974.	0.00526	46036.	9.44E+09	781.9005	29669.	0.00
9.4120	-0.09290	-1242401.	7281.	0.00468	45702.	9.44E+09	740.6910	34636.	0.00
9.7740	-0.07380	-1212496.	10390.	0.00412	45027.	9.44E+09	690.8564	40668.	0.00
10.1360	-0.05712	-1168448.	13265.	0.00357	44033.	9.44E+09	632.7523	48124.	0.00
10.4980	-0.04277	-1111396.	15870.	0.00305	42745.	9.44E+09	566.7655	57558.	0.00
10.8600	-0.03065	-1042635.	18173.	0.00255	41193.	9.44E+09	493.2194	69893.	0.00
11.2220	-0.02062	-963616.	20139.	0.00209	39409.	9.44E+09	412.1729	86837.	0.00
11.5840	-0.01251	-875941.	21657.	0.00167	37430.	9.44E+09	286.9229	99635.	0.00
11.9460	-0.00615	-782053.	23238.	0.00128	35311.	9.44E+09	440.9131	311361.	0.00
12.3080	-0.00136	-679132.	24414.	9.47E-04	32988.	9.44E+09	100.2054	320796.	0.00
12.6700	0.00208	-573701.	24288.	6.59E-04	30608.	9.44E+09	-158.1140	330231.	0.00
13.0320	0.00437	-470731.	23202.	4.19E-04	28284.	9.44E+09	-341.6796	339666.	0.00
13.3940	0.00572	-373779.	21462.	2.24E-04	26095.	9.44E+09	-459.5615	349101.	0.00
13.7560	0.00632	-285158.	19331.	7.28E-05	24095.	9.44E+09	-521.6256	358536.	0.00
14.1180	0.00635	-206121.	17012.	-4.02E-05	22311.	9.44E+09	-545.8775	373352.	0.00
14.4800	0.00597	-137197.	14633.	-1.19E-04	20755.	9.44E+09	-549.3191	399662.	0.00
14.8420	0.00532	-78513.	12256.	-1.69E-04	19430.	9.44E+09	-545.0575	445426.	0.00
15.2040	0.00450	-30043.	9913.	-1.94E-04	18336.	9.44E+09	-533.9272	514995.	0.00
15.5660	0.00363	8378.	7632.	-1.99E-04	17847.	9.44E+09	-516.3748	617659.	0.00
15.9280	0.00278	37048.	5440.	-1.88E-04	18494.	9.44E+09	-492.5817	770703.	0.00
16.2900	0.00200	56389.	3366.	-1.67E-04	18931.	9.44E+09	-462.4909	1006953.	0.00
16.6520	0.00133	66951.	1437.	-1.38E-04	19169.	9.44E+09	-425.7361	1393965.	0.00
17.0140	7.92E-04	69419.	-316.4263	-1.07E-04	19225.	9.44E+09	-381.3564	2091424.	0.00
17.3760	3.96E-04	64627.	-1854.	-7.63E-05	19117.	9.44E+09	-326.7372	3581831.	0.00
17.7380	1.30E-04	53610.	-2860.	-4.90E-05	18868.	9.44E+09	-136.1213	4561472.	0.00
18.1000	-2.98E-05	39976.	-3086.	-2.75E-05	18560.	9.44E+09	31.8749	4643194.	0.00
18.4620	-1.09E-04	26906.	-2759.	-1.21E-05	18265.	9.44E+09	118.9413	4724883.	0.00
18.8240	-1.35E-04	16057.	-2179.	-2.23E-06	18021.	9.44E+09	147.7584	4751250.	0.00
19.1860	-1.29E-04	7981.	-1553.	3.30E-06	17838.	9.44E+09	140.8006	4751250.	0.00
19.5480	-1.06E-04	2555.	-993.9441	5.73E-06	17716.	9.44E+09	116.3906	4751250.	0.00

19.9100	-7.90E-05	-676.8442	-553.4976	6.16E-06	17673.	9.44E+09	86.3932	4751250.	0.00
20.2720	-5.29E-05	-2278.	-240.1450	5.48E-06	17710.	9.44E+09	57.8759	4751250.	0.00
20.6340	-3.14E-05	-2785.	-39.8524	4.31E-06	17721.	9.44E+09	34.3398	4751250.	0.00
20.9960	-1.54E-05	-2641.	71.4261	3.06E-06	17718.	9.44E+09	16.8934	4751250.	0.00
21.3580	-4.77E-06	-2177.	119.4620	1.96E-06	17707.	9.44E+09	5.2226	4751250.	0.00
21.7200	1.54E-06	-1611.	127.1374	1.08E-06	17694.	9.44E+09	-1.6888	4751250.	0.00
22.0820	4.64E-06	-1076.	112.4417	4.65E-07	17682.	9.44E+09	-5.0772	4751250.	0.00
22.4440	5.59E-06	-636.1284	88.1384	7.14E-08	17672.	9.44E+09	-6.1122	4751250.	0.00
22.8060	5.26E-06	-310.7758	62.3605	-1.46E-07	17665.	9.44E+09	-5.7561	4751250.	0.00
23.1680	4.32E-06	-93.7600	39.6052	-2.40E-07	17660.	9.44E+09	-4.7205	4751250.	0.00
23.5300	3.18E-06	34.2631	21.7938	-2.53E-07	17659.	9.44E+09	-3.4799	4751250.	0.00
23.8920	2.12E-06	96.5874	9.2088	-2.23E-07	17660.	9.44E+09	-2.3142	4751250.	0.00
24.2540	1.24E-06	115.1530	1.2288	-1.74E-07	17661.	9.44E+09	-1.3598	4751250.	0.00
24.6160	6.01E-07	107.9543	-3.1518	-1.23E-07	17661.	9.44E+09	-0.6571	4751250.	0.00
24.9780	1.74E-07	88.2578	-4.9927	-7.79E-08	17660.	9.44E+09	-0.1905	4751250.	0.00
25.3400	-7.60E-08	64.8866	-5.2257	-4.27E-08	17660.	9.44E+09	0.08316	4751250.	0.00
25.7020	-1.96E-07	43.0256	-4.5783	-1.78E-08	17659.	9.44E+09	0.2149	4751250.	0.00
26.0640	-2.31E-07	25.1807	-3.5630	-2.13E-09	17659.	9.44E+09	0.2526	4751250.	0.00
26.4260	-2.15E-07	12.0791	-2.5036	6.44E-09	17658.	9.44E+09	0.2352	4751250.	0.00
26.7880	-1.75E-07	3.4043	-1.5771	1.00E-08	17658.	9.44E+09	0.1914	4751250.	0.00
27.1500	-1.28E-07	-1.6626	-0.8572	1.04E-08	17658.	9.44E+09	0.1401	4751250.	0.00
27.5120	-8.46E-08	-4.0841	-0.3520	9.08E-09	17658.	9.44E+09	0.09249	4751250.	0.00
27.8740	-4.92E-08	-4.7565	-0.03424	7.05E-09	17658.	9.44E+09	0.05380	4751250.	0.00
28.2360	-2.33E-08	-4.4095	0.1380	4.94E-09	17658.	9.44E+09	0.02551	4751250.	0.00
28.5980	-6.28E-09	-3.5770	0.2083	3.10E-09	17658.	9.44E+09	0.00686	4751250.	0.00
28.9600	3.62E-09	-2.6118	0.2146	1.68E-09	17658.	9.44E+09	-0.00396	4751250.	0.00
29.3220	8.30E-09	-1.7189	0.1863	6.81E-10	17658.	9.44E+09	-0.00907	4751250.	0.00
29.6840	9.54E-09	-0.9957	0.1440	5.60E-11	17658.	9.44E+09	-0.01043	4751250.	0.00
30.0460	8.78E-09	-0.4684	0.1004	-2.81E-10	17658.	9.44E+09	-0.00961	4751250.	0.00
30.4080	7.10E-09	-0.1220	0.06272	-4.17E-10	17658.	9.44E+09	-0.00776	4751250.	0.00
30.7700	5.16E-09	0.07812	0.03360	-4.27E-10	17658.	9.44E+09	-0.00565	4751250.	0.00
31.1320	3.39E-09	0.1716	0.01328	-3.69E-10	17658.	9.44E+09	-0.00370	4751250.	0.00
31.4940	1.95E-09	0.1950	5.96E-04	-2.85E-10	17658.	9.44E+09	-0.00214	4751250.	0.00
31.8560	9.11E-10	0.1779	-0.00621	-1.99E-10	17658.	9.44E+09	-9.96E-04	4751250.	0.00
32.2180	2.23E-10	0.1418	-0.00891	-1.26E-10	17658.	9.44E+09	-2.44E-04	4751250.	0.00
32.5800	-1.80E-10	0.1010	-0.00901	-6.97E-11	17658.	9.44E+09	1.97E-04	4751250.	0.00
32.9420	-3.82E-10	0.06386	-0.00767	-3.18E-11	17658.	9.44E+09	4.18E-04	4751250.	0.00
33.3040	-4.57E-10	0.03452	-0.00568	-9.15E-12	17658.	9.44E+09	5.00E-04	4751250.	0.00
33.6660	-4.62E-10	0.01458	-0.00349	2.14E-12	17658.	9.44E+09	5.05E-04	4751250.	0.00
34.0280	-4.38E-10	0.00416	-0.00136	6.46E-12	17658.	9.44E+09	4.79E-04	4751250.	0.00
34.3900	-4.06E-10	0.00277	-2.79E-04	8.05E-12	17658.	9.44E+09	1.67E-05	179268.	0.00
34.7520	-3.68E-10	0.00170	-2.09E-04	9.08E-12	17658.	9.44E+09	1.54E-05	181155.	0.00
35.1140	-3.27E-10	9.19E-04	-1.46E-04	9.68E-12	17658.	9.44E+09	1.38E-05	183042.	0.00
35.4760	-2.84E-10	3.96E-04	-8.97E-05	9.98E-12	17658.	9.44E+09	1.21E-05	184929.	0.00
35.8380	-2.40E-10	1.00E-04	-4.10E-05	1.01E-11	17658.	9.44E+09	1.03E-05	186816.	0.00
36.2000	-1.96E-10	0.00	0.00	1.01E-11	17658.	9.44E+09	8.53E-06	94352.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

Pile-head deflection = -0.97500000 inches
Computed slope at pile head = 0.000000 radians
Maximum bending moment = 2950148. inch-lbs
Maximum shear force = -58011. lbs
Depth of maximum bending moment = 0.000000 feet below pile head
Depth of maximum shear force = 0.000000 feet below pile head
Number of iterations = 17
Number of zero deflection points = 6

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Displacement and Moment (Loading Type 4)
Displacement of pile head = -0.975000 inches
Moment at pile head = 1692761.0 in-lbs
Axial load at pile head = 456000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	-0.9750	1692761.	-43079.	0.00694	55868.	9.22E+09	0.00	0.00	0.00
0.3620	-0.9431	1491094.	-42978.	0.00769	51316.	9.22E+09	46.4368	213.8838	0.00
0.7240	-0.9082	1288912.	-42656.	0.00833	46752.	9.44E+09	101.8264	487.0342	0.00
1.0860	-0.8707	1087477.	-42085.	0.00888	42205.	9.44E+09	161.2711	804.5714	0.00
1.4480	-0.8311	888093.	-41254.	0.00934	37705.	9.44E+09	221.2666	1157.	0.00
1.8100	-0.7896	692075.	-40170.	0.00970	33280.	9.44E+09	277.8990	1529.	0.00
2.1720	-0.7468	500671.	-38840.	0.00997	28960.	9.44E+09	334.5916	1946.	0.00
2.5340	-0.7030	315123.	-37275.	0.01016	24771.	9.44E+09	385.5555	2383.	0.00
2.8960	-0.6585	136564.	-35502.	0.01027	20741.	9.44E+09	430.8759	2842.	0.00
3.2580	-0.6138	-33988.	-33534.	0.01029	18425.	9.44E+09	475.0881	3362.	0.00
3.6200	-0.5691	-195545.	-31375.	0.01024	22072.	9.44E+09	519.2937	3964.	0.00
3.9820	-0.5248	-347124.	-29024.	0.01011	25494.	9.44E+09	562.7428	4658.	0.00
4.3440	-0.4813	-487768.	-26523.	0.00992	28668.	9.44E+09	588.6818	5314.	0.00
4.7060	-0.4387	-616858.	-23939.	0.00967	31582.	9.44E+09	601.2566	5954.	0.00
5.0680	-0.3973	-734040.	-21295.	0.00935	34227.	9.44E+09	616.0171	6735.	0.00
5.4300	-0.3574	-838928.	-18564.	0.00899	36595.	9.44E+09	641.2253	7794.	0.00
5.7920	-0.3192	-930952.	-15740.	0.00859	38672.	9.44E+09	659.2387	8972.	0.00
6.1540	-0.2828	-1009686.	-12851.	0.00814	40449.	9.44E+09	670.6377	10301.	0.00
6.5160	-0.2485	-1074845.	-9905.	0.00766	41920.	9.44E+09	685.6266	11987.	0.00
6.8780	-0.2163	-1126086.	-6906.	0.00715	43077.	9.44E+09	695.0945	13962.	0.00
7.2400	-0.1863	-1163184.	-3883.	0.00663	43914.	9.44E+09	697.0935	16252.	0.00
7.6020	-0.1587	-1186067.	-866.9362	0.00608	44431.	9.44E+09	691.3492	18923.	0.00
7.9640	-0.1335	-1194823.	2107.	0.00554	44628.	9.44E+09	677.7154	22059.	0.00
8.3260	-0.1106	-1189701.	5004.	0.00499	44513.	9.44E+09	656.1579	25772.	0.00
8.6880	-0.09012	-1171112.	7790.	0.00445	44093.	9.44E+09	626.7519	30211.	0.00
9.0500	-0.07198	-1139629.	10432.	0.00391	43382.	9.44E+09	589.6738	35587.	0.00

9.4120	-0.05612	-1095979.	12897.	0.00340	42397.	9.44E+09	545.1837	42200.	0.00
9.7740	-0.04245	-1041042.	15154.	0.00291	41157.	9.44E+09	493.5915	50510.	0.00
10.1360	-0.03086	-975843.	17171.	0.00244	39685.	9.44E+09	435.1921	61255.	0.00
10.4980	-0.02123	-901541.	18920.	0.00201	38008.	9.44E+09	370.1297	75751.	0.00
10.8600	-0.01339	-819433.	20349.	0.00162	36155.	9.44E+09	287.9360	93408.	0.00
11.2220	-0.00719	-731144.	21322.	0.00126	34162.	9.44E+09	159.8516	96522.	0.00
11.5840	-0.00246	-639172.	21792.	9.43E-04	32086.	9.44E+09	56.4111	99635.	0.00
11.9460	9.97E-04	-545554.	21759.	6.70E-04	29973.	9.44E+09	-71.4896	311361.	0.00
12.3080	0.00336	-452786.	21064.	4.41E-04	27879.	9.44E+09	-248.3930	320796.	0.00
12.6700	0.00482	-364294.	19728.	2.52E-04	25881.	9.44E+09	-366.7599	330231.	0.00
13.0320	0.00556	-282390.	17988.	1.04E-04	24032.	9.44E+09	-434.5251	339666.	0.00
13.3940	0.00573	-208428.	16044.	-9.27E-06	22363.	9.44E+09	-460.1024	349101.	0.00
13.7560	0.00548	-142959.	14063.	-9.01E-05	20885.	9.44E+09	-452.0172	358536.	0.00
14.1180	0.00494	-85889.	11968.	-1.43E-04	19597.	9.44E+09	-512.6250	450579.	0.00
14.4800	0.00424	-38414.	9760.	-1.71E-04	18525.	9.44E+09	-504.0637	516911.	0.00
14.8420	0.00345	-415.6605	7602.	-1.80E-04	17667.	9.44E+09	-489.2293	615452.	0.00
15.2040	0.00267	28351.	5523.	-1.74E-04	18298.	9.44E+09	-468.3526	762188.	0.00
15.5660	0.00194	48254.	3547.	-1.56E-04	18747.	9.44E+09	-441.4324	987310.	0.00
15.9280	0.00131	59782.	1701.	-1.31E-04	19008.	9.44E+09	-408.1924	1351920.	0.00
16.2900	8.01E-04	63554.	15.5670	-1.03E-04	19093.	9.44E+09	-367.8643	1996243.	0.00
16.6520	4.16E-04	60326.	-1475.	-7.45E-05	19020.	9.44E+09	-318.3938	3321079.	0.00
17.0140	1.53E-04	51035.	-2503.	-4.89E-05	18810.	9.44E+09	-154.9240	4397925.	0.00
17.3760	-8.38E-06	38773.	-2821.	-2.82E-05	18533.	9.44E+09	8.6449	4479717.	0.00
17.7380	-9.23E-05	26640.	-2592.	-1.32E-05	18259.	9.44E+09	96.8930	4561472.	0.00
18.1000	-1.23E-04	16310.	-2096.	-3.30E-06	18026.	9.44E+09	131.3702	4643194.	0.00
18.4620	-1.21E-04	8445.	-1525.	2.40E-06	17849.	9.44E+09	131.5315	4724883.	0.00
18.8240	-1.02E-04	3054.	-996.5495	5.04E-06	17727.	9.44E+09	111.6371	4751250.	0.00
19.1860	-7.71E-05	-232.9560	-570.9085	5.69E-06	17663.	9.44E+09	84.3303	4751250.	0.00
19.5480	-5.26E-05	-1928.	-262.7817	5.20E-06	17702.	9.44E+09	57.5329	4751250.	0.00
19.9100	-3.20E-05	-2537.	-61.9035	4.17E-06	17715.	9.44E+09	34.9525	4751250.	0.00
20.2720	-1.64E-05	-2483.	52.9326	3.01E-06	17714.	9.44E+09	17.9187	4751250.	0.00
20.6340	-5.77E-06	-2089.	105.5660	1.96E-06	17705.	9.44E+09	6.3140	4751250.	0.00
20.9960	6.61E-07	-1573.	117.7086	1.12E-06	17694.	9.44E+09	-0.7235	4751250.	0.00
21.3580	3.95E-06	-1070.	106.7531	5.11E-07	17682.	9.44E+09	-4.3204	4751250.	0.00
21.7200	5.10E-06	-647.9853	85.2566	1.15E-07	17673.	9.44E+09	-5.5767	4751250.	0.00
22.0820	4.95E-06	-330.1809	61.3803	-1.10E-07	17666.	9.44E+09	-5.4160	4751250.	0.00
22.4440	4.14E-06	-114.2778	39.7702	-2.12E-07	17661.	9.44E+09	-4.5334	4751250.	0.00
22.8060	3.11E-06	16.1832	22.5372	-2.35E-07	17658.	9.44E+09	-3.4008	4751250.	0.00
23.1680	2.11E-06	82.4547	10.1470	-2.12E-07	17660.	9.44E+09	-2.3037	4751250.	0.00
23.5300	1.27E-06	105.1802	2.1313	-1.69E-07	17660.	9.44E+09	-1.3868	4751250.	0.00
23.8920	6.40E-07	101.6403	-2.4011	-1.21E-07	17660.	9.44E+09	-0.6999	4751250.	0.00
24.2540	2.15E-07	84.7996	-4.4325	-7.83E-08	17660.	9.44E+09	-0.2353	4751250.	0.00
24.6160	-4.01E-08	63.4410	-4.8484	-4.42E-08	17660.	9.44E+09	0.04386	4751250.	0.00
24.9780	-1.69E-07	42.8521	-4.3528	-1.97E-08	17659.	9.44E+09	0.1843	4751250.	0.00
25.3400	-2.11E-07	25.7023	-3.4505	-3.93E-09	17659.	9.44E+09	0.2311	4751250.	0.00
25.7020	-2.03E-07	12.8896	-2.4672	4.95E-09	17658.	9.44E+09	0.2216	4751250.	0.00
26.0640	-1.68E-07	4.2474	-1.5862	8.90E-09	17658.	9.44E+09	0.1840	4751250.	0.00
26.4260	-1.25E-07	-0.9266	-0.8888	9.66E-09	17658.	9.44E+09	0.1371	4751250.	0.00
26.7880	-8.43E-08	-3.5129	-0.3908	8.64E-09	17658.	9.44E+09	0.09219	4751250.	0.00
27.1500	-5.03E-08	-4.3563	-0.07116	6.83E-09	17658.	9.44E+09	0.05498	4751250.	0.00
27.5120	-2.50E-08	-4.1582	0.1076	4.87E-09	17658.	9.44E+09	0.02730	4751250.	0.00
27.8740	-7.96E-09	-3.4412	0.1857	3.12E-09	17658.	9.44E+09	0.00871	4751250.	0.00
28.2360	2.16E-09	-2.5568	0.1995	1.74E-09	17658.	9.44E+09	-0.00236	4751250.	0.00
28.5980	7.17E-09	-1.7146	0.1774	7.58E-10	17658.	9.44E+09	-0.00784	4751250.	0.00

28.9600	8.74E-09	-1.0187	0.1396	1.29E-10	17658.	9.44E+09	-0.00956	4751250.	0.00
29.3220	8.29E-09	-0.5024	0.09912	-2.21E-10	17658.	9.44E+09	-0.00906	4751250.	0.00
29.6840	6.83E-09	-0.1567	0.06322	-3.73E-10	17658.	9.44E+09	-0.00747	4751250.	0.00
30.0460	5.05E-09	0.04830	0.03500	-3.98E-10	17658.	9.44E+09	-0.00552	4751250.	0.00
30.4080	3.37E-09	0.1490	0.01500	-3.52E-10	17658.	9.44E+09	-0.00369	4751250.	0.00
30.7700	1.99E-09	0.1800	0.00226	-2.76E-10	17658.	9.44E+09	-0.00218	4751250.	0.00
31.1320	9.70E-10	0.1697	-0.00478	-1.96E-10	17658.	9.44E+09	-0.00106	4751250.	0.00
31.4940	2.88E-10	0.1393	-0.00777	-1.25E-10	17658.	9.44E+09	-3.15E-04	4751250.	0.00
31.8560	-1.15E-10	0.1027	-0.00818	-6.92E-11	17658.	9.44E+09	1.25E-04	4751250.	0.00
32.2180	-3.12E-10	0.06849	-0.00716	-2.98E-11	17658.	9.44E+09	3.42E-04	4751250.	0.00
32.5800	-3.73E-10	0.04062	-0.00553	-4.65E-12	17658.	9.44E+09	4.08E-04	4751250.	0.00
32.9420	-3.53E-10	0.02042	-0.00381	9.40E-12	17658.	9.44E+09	3.86E-04	4751250.	0.00
33.3040	-2.92E-10	0.00749	-0.00228	1.58E-11	17658.	9.44E+09	3.19E-04	4751250.	0.00
33.6660	-2.15E-10	5.65E-04	-0.00107	1.77E-11	17658.	9.44E+09	2.36E-04	4751250.	0.00
34.0280	-1.38E-10	-0.00191	-2.34E-04	1.74E-11	17658.	9.44E+09	1.51E-04	4751250.	0.00
34.3900	-6.45E-11	-0.00154	9.94E-05	1.66E-11	17658.	9.44E+09	2.66E-06	179268.	0.00
34.7520	5.90E-12	-0.00112	1.05E-04	1.60E-11	17658.	9.44E+09	-2.46E-07	181155.	0.00
35.1140	7.41E-11	-6.94E-04	9.73E-05	1.55E-11	17658.	9.44E+09	-3.12E-06	183042.	0.00
35.4760	1.41E-10	-3.32E-04	7.75E-05	1.53E-11	17658.	9.44E+09	-6.00E-06	184929.	0.00
35.8380	2.07E-10	-8.18E-05	4.51E-05	1.52E-11	17658.	9.44E+09	-8.91E-06	186816.	0.00
36.2000	2.73E-10	0.00	0.00	1.52E-11	17658.	9.44E+09	-1.19E-05	94352.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 2:

Pile-head deflection = -0.97500000 inches
Computed slope at pile head = 0.00693672 radians
Maximum bending moment = 1692761. inch-lbs
Maximum shear force = -43079. lbs
Depth of maximum bending moment = 0.000000 feet below pile head
Depth of maximum shear force = 0.000000 feet below pile head
Number of iterations = 14
Number of zero deflection points = 7

Summary of Pile-head Responses for Conventional Analyses

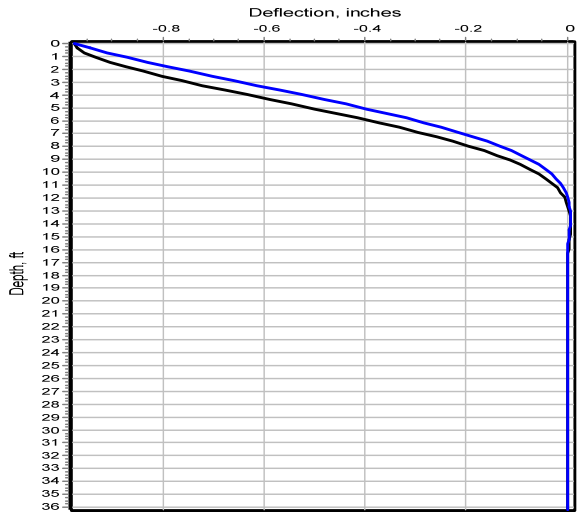
Definitions of Pile-head Loading Conditions:

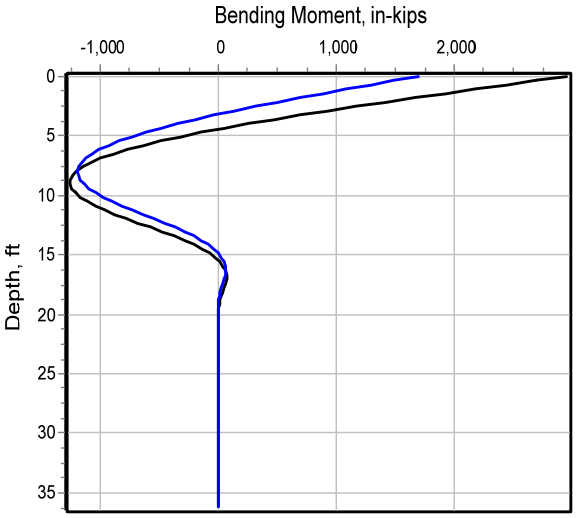
Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

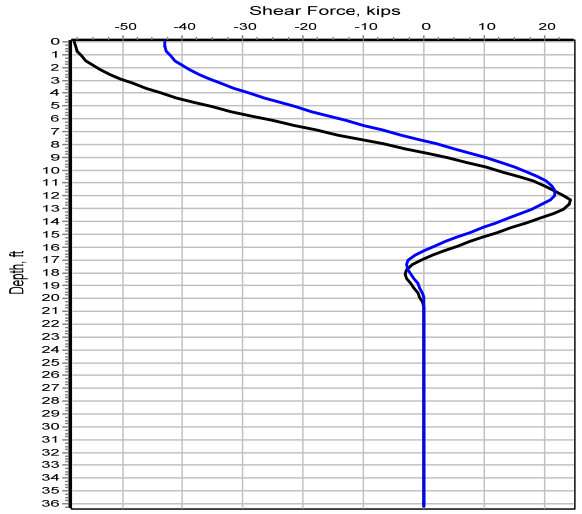
Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	y, in	-0.9750	S, rad	0.00	456000.	-0.9750	0.00	-58011.	2950148.
2	y, in	-0.9750	M, in-lb	1692761.	456000.	-0.9750	0.00694	-43079.	1692761.

Maximum pile-head deflection = -0.9750000000 inches
Maximum pile-head rotation = 0.0069367218 radians = 0.397445 deg.

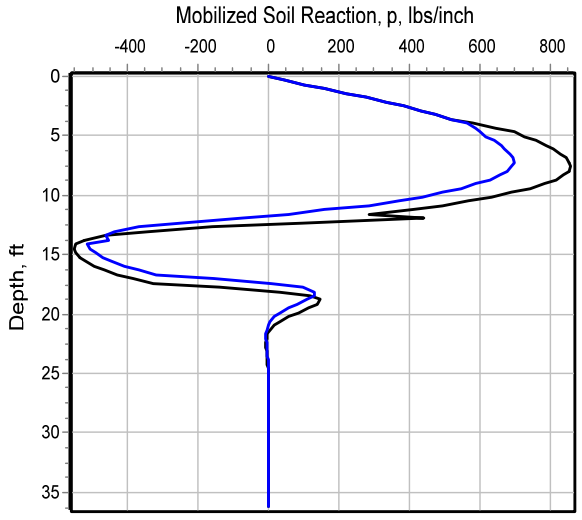
The analysis ended normally.







Legend:
----- First Iteration Load Case
(with axial load and lateral deflection applied to pile head)
----- Second Iteration Load Case
(with axial load, lateral deflection, and plastic hinge moment applied to pile head)



Attachment 3

SUBJECT:	MaineDOT Mallet Drive Bridge 5721 (Exit 22)		
Job No.:	21450910	**Prepared:**	KAR
Location:	Freeport, Maine	**Checked:**	MLM
Date:	5/27/2021	**Reviewed:**	CCB

Description:

Evaluate the downdrag load for Abutment 1 driven piles using APILE

References:

1 Golder Associates Inc.; "Preliminary Geotechnical Design Report - I-295 Mallet Drive Bridge Replacement"; December 21, 2020
2 AASHTO; "AASHTO LRFD Bridge Design Specifications - 9th Edition", 2020
3 FHWA; Design and Construction of Driven Pile Foundations - Volume 1; FHWA GEC 012; FHWA-NHI-16-009; July 2016
4 FHWA; Design and Construction of Driven Pile Foundations - Volume 2; FHWA GEC 012; FHWA-NHI-16-009; July 2016
5 FHWA; Design and Construction of Driven Pile Foundations - Comprehensive Design Examples; FHWA GEC 012; FHWA-NHI-16-064; September 2016
6 Wyllie, DA; Foundations on Rock, 2nd Edition; E&FN Spon; 1999
7 Siegel, TC et al; "Alternative Design Approach for Drag Load and Downdrag of Deep Foundations within the LRFD Framework"; Proceedings 38th Deep Foundations; 2013.
8 Geotechnical Design Manual, Chapter 8 - Foundations, Oregon Department of Transportation, Geo-Environmental Section, Version 2.1, May 6, 2019.
9 Isenhower, W.M. et al. LPile v2019 Technical Manual: A Program for the Analysis of Deep Foundations Under Lateral Loading. Ensoft, Inc. Dated March 2020.
10 Golder settlement model created using Rocscience Settle3 software package, Version 5.010 64-bit, build date Mar 5, 2021
11 HNTB. May 7, 2021. Approach Road Bridge, Interstate 295, Route 136/125 (Mallett Dr.): 60% Plans.
12 HNTB. May 26, 2021. Freeport Bridges_Loads_Bottom of Footing_flat.pdf.
13 Golder's Phase II Updated Interpreted Subsurface Profile using HNTB design references.

Assumptions:

1. Settlement greater than or equal to 0.4" is needed for downdrag to fully develop (Ref 2).
2. The soil profile analyzed (Ref 1) is the interpreted profile where maximum settlement occurs along the abutment.
3. Any downdrag load that may develop along the back of the abutment due to settlement is not included in the pile downdrag analysis.
4. The FHWA automated computation method provided in APILE is used for the software computations of unit load transfers and axial pile capacity.

Calculations:

				Top Elev (ft)	Bot. Elev (ft)	Thickness (ft)
Granular Backfill Unit Weight:	γ	125	pcf	160.0	153.0	7.0
Granular Backfill Friction Angle:	φ	32	deg			
Passive Earth Pressure Coefficient	K_p	3.93				
Active Earth Pressure Coefficient	K_a	0.31				

Strength I Loads

Strength I Factored Vertical Load per pile (kips) = 402 No. piles = 8 (Ref. 12)

Starting elevation of the pile	-	153.0	ft	Ref. 11 (below the base of the abutment)
Ending elevation of the pile	-	116.8	ft	Ref. 1, Ref. 13
Box perimeter of pile	P:	57.05	in	for HP14x89
Segment Length:	L:	6	in	
Cross-sectional Area:	A_s:	26.1	in^2	for HP14x89
Elastic Modulus of Pile	E:	29000	ksi	
Nominal Weight of Pile		0.089	kips/ft	
Factored Pile Strength = ϕFyAs	P_r:	652.5	kips	Ref 3 Eq 8-35
	Fy :	50	ksi	Ref 3 Table 8-2
	ϕ :	0.5	-	Ref 2 Article 6.5.4.2 for axial resistance of H-piles in compression and subject to severe driving conditions

Non-Cohesive Soil Layers -Nordlund/Thurman Method

	Parameters						
Soil Layer	**ϕ_f (deg)**	**γ (pcf)**	**γ_{pDD}**	Top Elev (ft)	Bot. Elev (ft)	Thickness (ft)	
Soil 1	33	125	1.1	153.0	141.2	11.8	Fill, Ref. 1, Ref. 13
Soil 3	36	125	1.1	118.8	116.8	2.0	Sand/Gravel, Ref. 1, Ref. 13

ϕ_f: Based on empirical correlation to avg of N_{60} values encountered in all borings for layer
γ: Unit Weight
γ_{pDD}: STR 1 Load Factor for Downdrag (Ref. 1, Ref. 13, and Ref. 8)

Cohesive Soil Layers - Alpha Method

Pile Depth	D_b:	22.4 ft	Ref 2, C10.7.3.8.6b
Pile Width	D:	1.15 ft	
Ratio D_b/D	D_b:	19 D	

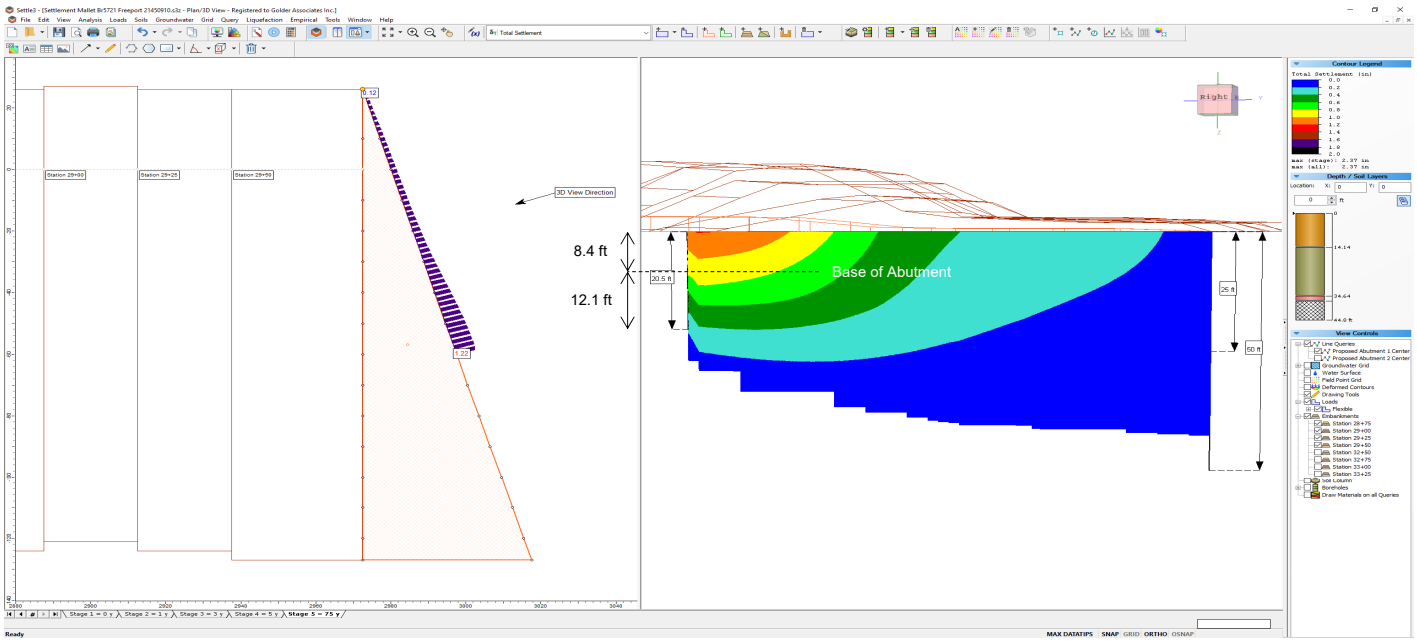
	Parameters							
Soil Layer	S_u (ksf)	γ (pcf)	α	q_s (ksf)	γ_{pDD}	Top Elev (ft)	Bot. Elev (ft)	Thickness (ft)	
Soil 2	3.50	115	0.76	2.66	1.4	141.2	118.8	22.4	Glaciomarine clay, Ref. 1, Ref. 13

SUBJECT:	MaineDOT Mallet Drive Bridge 5721 (Exit 22)			
Job No.:	21450910	**Prepared:**	KAR	
Location:	Freeport, Maine	**Checked:**	MLM	
Date:	5/27/2021	**Reviewed:**	CCB	

1. Identify deepest depth below the ground surface along the abutment centerline where settlement less than or equal to 0.4 inches.

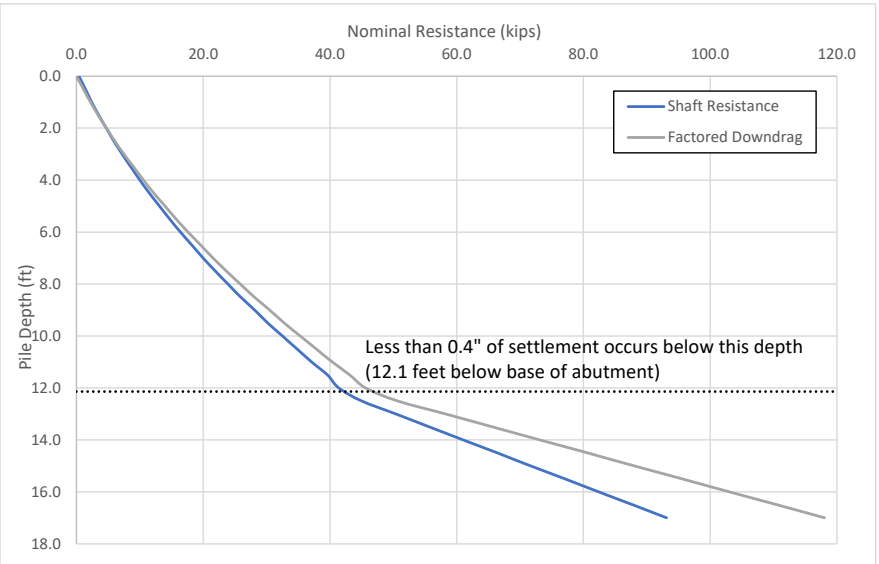
Ref. 2 Article 3.11.8 indicates that full downdrag loading occurs where settlement is equal to or greater than 0.4 inches.
From the Settle3 model (Ref 10) image below, maximum depth to the 0.4" or less settlement contour below base of pile cap (ft): **12.1**
Thus, downdrag loading below this elevation is not considered fully developed and is not included in this analysis.

Settle3 Model from Abutment 2 loading.



2. Determine downdrag loading using APILE (Ensoft) Shaft Resistance

Pile Depth Below Pile Cap	Type of Soil	Shaft Resistance	Factored Downdrag Load	Total Factored Axial Load w/ Down Drag & Pile Weight
(feet)	(-)	(kips)	(kips)	(kips)
0.0	1	0.4	0	402.0
0.5	1	1.4	1.1	403.1
1.0	1	2.4	2.2	404.3
1.5	1	3.5	3.4	405.5
2.0	1	4.7	4.7	406.9
2.5	1	5.9	6.1	408.3
3.0	1	7.2	7.5	409.7
3.5	1	8.6	9.0	411.3
4.0	1	10.0	10.6	412.9
4.5	1	11.5	12.2	414.6
5.0	1	13.1	14.0	416.4
5.5	1	14.7	15.7	418.2
6.0	1	16.4	17.6	420.1
6.5	1	18.2	19.6	422.2
7.0	1	20.0	21.6	424.2
7.5	1	21.9	23.7	426.3
8.0	1	23.9	25.9	428.6
8.5	1	25.9	28.1	430.8
9.0	1	28.1	30.5	433.3
9.5	1	30.2	32.8	435.6
10.0	1	32.5	35.3	438.2
10.5	1	34.8	37.8	440.8
11.0	1	37.1	40.4	443.3
11.5	1	39.6	43.1	446.1
12.0	2	41.4	45.6	448.7
12.5	**2**	**45.0**	**50.7**	**453.8**
13.0	2	50.4	58.2	461.4
13.5	2	55.7	65.7	468.9
14.0	2	61.0	73.1	476.3



Type of Soil	γ_{pDD}	Downdrag Load Factor
1	1.1	Strength I Load Factor for Down Drag (Ref 2, Ref 8 Table 8.2)
2	1.4	
3	1.1	
1 - 3	1.0	Service and Extreme Load Factor for Down Drag (Ref 2, Ref 8)

653	Factored Strength of Pile
454	Maximum Factored Axial Load w/ Downdrag & Pile Weight
OK	OK?

14.5	2	66.4	80.6	483.9
15.0	2	71.7	88.1	491.4
15.5	2	77.1	95.6	499.0
16.0	2	82.4	103.0	506.5
16.5	2	87.8	110.6	514.1
17.0	2	93.1	118.0	521.5

Total Factored Downdrag Load, Strength I Limit State	**51 kips**	(per pile)
	405 kips	(per abutment - 8 piles/abutment)
Total Factored Downdrag Load, Extreme & Service Limit States	**45 kips**	(per pile)
	360 kips	(per abutment - 8 piles/abutment)

CONCLUSION

Based on the Settle3 model, downdrag is estimated to develop along the upper 12.1 feet of the pile. A total factored downdrag load of 51 kips per pile was calculated for the Strength I load case and a total factored downdrag load of 45 kips per pile was calculated for the Extreme and Service limit load cases and will be conservatively applied to the top of the pile in the lateral response analysis.

==========

APILE for Windows, Version 2019.9.6

Serial Number : 161219145

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

==========

This program is licensed to :

Golder Associates, Ltd.
Gladstone, MI

Path to file locations : C:\Users\dfalish\Golder Associates\21450910 MaineDOT Mallet Dr. Bridge5721 p2 Freeport - Project Files\5 Technical Work\06 Analysis\Downdrag_MSG\HP14x89\
Name of input data file : HP14x89_Abutment 1.ap9d
Name of output file : HP14x89_Abutment 1.ap9o
Name of plot output file : HP14x89_Abutment 1.ap9p

Time and Date of Analysis

Date: June 02, 2021 Time: 11:45:41

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

New Pile

DESIGNER :

JOB NUMBER :

METHOD FOR UNIT LOAD TRANSFERS :

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

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 26.10 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 43.20 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 0.00 FT.
- ZERO FRICTION LENGTH, ZFL = 7.00 FT.
- PERIMETER OF PILE = 57.05 IN.
- TIP AREA OF PILE = 26.10 IN2
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION = 0.50 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	SAND	0.80*	125.00	32.00	28.00**
7.00	SAND	0.80*	125.00	32.00	28.00**
7.00	SAND	0.80*	125.00	33.00	32.00**
18.80	SAND	0.80*	125.00	33.00	32.00**
18.80	CLAY	0.80*	52.60	0.00	8.00**
41.20	CLAY	0.80*	52.60	0.00	8.00**
41.20	SAND	0.80*	62.60	36.00	42.00**
43.20	SAND	0.80*	62.60	36.00	42.00**
43.20	SAND	0.80*	145.00	50.00	50.00**
60.00	SAND	0.80*	145.00	50.00	50.00**

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

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E-05	0.10E-05	0.00	0.00	0.00	0.00	0.00
0.10E-05	0.10E-05	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	3.50	3.50	0.00	0.00	0.00
0.10E+08*	0.10E+08*	3.50	3.50	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00

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

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
7.00	1.000	1.000
7.00	1.000	1.000
18.80	1.000	1.000
18.80	0.730	1.000
41.20	0.730	1.000
41.20	1.000	1.000
43.20	1.000	1.000
43.20	1.000	1.000
60.00	1.000	1.000

1

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

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

PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.0	0.0
0.50	0.0	0.0	0.0
1.00	0.0	0.0	0.0
1.50	0.0	0.0	0.0
2.00	0.0	0.0	0.0
2.50	0.0	0.0	0.0
3.00	0.0	0.0	0.0
3.50	0.0	0.0	0.0
4.00	0.0	0.0	0.0
4.50	0.0	0.0	0.0
5.00	0.0	0.3	0.3
5.50	0.0	0.9	0.9
6.00	0.0	1.5	1.5
6.50	0.0	2.1	2.1
7.00	0.4	2.8	3.2
7.50	1.4	3.5	4.9
8.00	2.4	4.3	6.7
8.50	3.5	5.1	8.6
9.00	4.7	5.9	10.6
9.50	5.9	6.6	12.5
10.00	7.2	6.9	14.1
10.50	8.6	7.2	15.8
11.00	10.0	7.6	17.6
11.50	11.5	7.9	19.4
12.00	13.1	8.2	21.3
12.50	14.7	8.4	23.1
13.00	16.4	8.6	25.0
13.50	18.2	8.8	27.0
14.00	20.0	8.9	28.9
14.50	21.9	9.0	30.9
15.00	23.9	9.0	33.0
15.50	25.9	9.1	35.0
16.00	28.1	9.1	37.1
16.50	30.2	9.1	39.3
17.00	32.5	8.9	41.3
17.50	34.8	8.5	43.3
18.00	37.1	8.1	45.3
18.50	39.6	7.8	47.3
19.00	41.4	7.4	48.8
19.50	45.0	7.0	52.0
20.00	50.4	6.6	57.0
20.50	55.7	6.3	62.0
21.00	61.0	5.9	66.9
21.50	66.4	5.7	72.1
22.00	71.7	5.7	77.4
22.50	77.1	5.7	82.8
23.00	82.4	5.7	88.1
23.50	87.8	5.7	93.5
24.00	93.1	5.7	98.8
24.50	98.5	5.7	104.2
25.00	103.8	5.7	109.5

25.50	109.1	5.7	114.8
26.00	114.5	5.7	120.2
26.50	119.8	5.7	125.5
27.00	125.2	5.7	130.9
27.50	130.5	5.7	136.2
28.00	135.9	5.7	141.6
28.50	141.2	5.7	146.9
29.00	146.5	5.7	152.3
29.50	151.9	5.7	157.6
30.00	157.2	5.7	162.9
30.50	162.6	5.7	168.3
31.00	167.9	5.7	173.6
31.50	173.3	5.7	179.0
32.00	178.6	5.7	184.3
32.50	184.0	5.7	189.7
33.00	189.3	5.7	195.0
33.50	194.6	5.7	200.4
34.00	200.0	5.7	205.7
34.50	205.3	5.7	211.0
35.00	210.7	5.7	216.4
35.50	216.0	5.7	221.7
36.00	221.4	5.7	227.1
36.50	226.7	5.7	232.4
37.00	232.1	5.7	237.8
37.50	237.4	5.7	243.1
38.00	242.7	5.7	248.5
38.50	248.1	5.7	253.8
39.00	253.4	5.7	259.1
39.50	258.8	7.0	265.8
40.00	264.1	9.4	273.5
40.50	268.6	11.8	280.4
41.00	271.5	14.2	285.7
41.50	275.5	22.9	298.4
42.00	280.4	37.0	317.4
42.50	285.5	51.1	336.6
43.00	290.6	65.2	355.8

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

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

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

```
1       10      0.0000E+00
                        0.0000E+00      0.0000E+00
                        0.0000E+00      0.2906E-01
                        0.0000E+00      0.5629E-01
                        0.0000E+00      0.1035E+00
                        0.0000E+00      0.1453E+00
                        0.0000E+00      0.1816E+00
                        0.0000E+00      0.3632E+00
                        0.0000E+00      0.5448E+00
                        0.0000E+00      0.9080E+00
                        0.0000E+00      0.3632E+01
2       10      0.3525E+01
                        0.0000E+00      0.0000E+00
                        0.0000E+00      0.2906E-01
                        0.0000E+00      0.5629E-01
                        0.0000E+00      0.1035E+00
                        0.0000E+00      0.1453E+00
                        0.0000E+00      0.1816E+00
                        0.0000E+00      0.3632E+00
                        0.0000E+00      0.5448E+00
                        0.0000E+00      0.9080E+00
                        0.0000E+00      0.3632E+01
3       10      0.6958E+01
                        0.0000E+00      0.0000E+00
                        0.6893E+00      0.2906E-01
                        0.1149E+01      0.5629E-01
                        0.1723E+01      0.1035E+00
                        0.2068E+01      0.1453E+00
                        0.2298E+01      0.1816E+00
                        0.2298E+01      0.3632E+00
                        0.2298E+01      0.5448E+00
                        0.2298E+01      0.9080E+00
                        0.2298E+01      0.3632E+01
4       10      0.7000E+01
                        0.0000E+00      0.0000E+00
                        0.7520E+00      0.2906E-01
                        0.1253E+01      0.5629E-01
                        0.1880E+01      0.1035E+00
                        0.2256E+01      0.1453E+00
                        0.2507E+01      0.1816E+00
                        0.2507E+01      0.3632E+00
                        0.2507E+01      0.5448E+00
                        0.2507E+01      0.9080E+00
                        0.2507E+01      0.3632E+01
5       10      0.1293E+02
                        0.0000E+00      0.0000E+00
                        0.1514E+01      0.2906E-01
                        0.2523E+01      0.5629E-01
                        0.3785E+01      0.1035E+00
                        0.4542E+01      0.1453E+00
                        0.5046E+01      0.1816E+00
                        0.5046E+01      0.3632E+00
                        0.5046E+01      0.5448E+00
                        0.5046E+01      0.9080E+00
```

0.5046E+01 0.3632E+01
6 10 0.1876E+02
0.0000E+00 0.0000E+00
0.2197E+01 0.2906E-01
0.3662E+01 0.5629E-01
0.5493E+01 0.1035E+00
0.6591E+01 0.1453E+00
0.7324E+01 0.1816E+00
0.7324E+01 0.3632E+00
0.7324E+01 0.5448E+00
0.7324E+01 0.9080E+00
0.7324E+01 0.3632E+01
7 10 0.1880E+02
0.0000E+00 0.0000E+00
0.2202E+01 0.2906E-01
0.3670E+01 0.5629E-01
0.5505E+01 0.1035E+00
0.6606E+01 0.1453E+00
0.7340E+01 0.1816E+00
0.6606E+01 0.3632E+00
0.6606E+01 0.5448E+00
0.6606E+01 0.9080E+00
0.6606E+01 0.3632E+01
8 10 0.3003E+02
0.0000E+00 0.0000E+00
0.6416E+01 0.2906E-01
0.1069E+02 0.5629E-01
0.1604E+02 0.1035E+00
0.1925E+02 0.1453E+00
0.2139E+02 0.1816E+00
0.1925E+02 0.3632E+00
0.1925E+02 0.5448E+00
0.1925E+02 0.9080E+00
0.1925E+02 0.3632E+01
9 10 0.4116E+02
0.0000E+00 0.0000E+00
0.3283E+01 0.2906E-01
0.5472E+01 0.5629E-01
0.8208E+01 0.1035E+00
0.9850E+01 0.1453E+00
0.1094E+02 0.1816E+00
0.9850E+01 0.3632E+00
0.9850E+01 0.5448E+00
0.9850E+01 0.9080E+00
0.9850E+01 0.3632E+01
10 10 0.4120E+02
0.0000E+00 0.0000E+00
0.3380E+01 0.2906E-01
0.5633E+01 0.5629E-01
0.8450E+01 0.1035E+00
0.1014E+02 0.1453E+00
0.1127E+02 0.1816E+00
0.1127E+02 0.3632E+00
0.1127E+02 0.5448E+00

		0.1127E+02	0.9080E+00
		0.1127E+02	0.3632E+01
11	10	0.4223E+02	
		0.0000E+00	0.0000E+00
		0.4453E+01	0.2906E-01
		0.7422E+01	0.5629E-01
		0.1113E+02	0.1035E+00
		0.1336E+02	0.1453E+00
		0.1484E+02	0.1816E+00
		0.1484E+02	0.3632E+00
		0.1484E+02	0.5448E+00
		0.1484E+02	0.9080E+00
		0.1484E+02	0.3632E+01
12	10	0.4316E+02	
		0.0000E+00	0.0000E+00
		0.4513E+01	0.2906E-01
		0.7522E+01	0.5629E-01
		0.1128E+02	0.1035E+00
		0.1354E+02	0.1453E+00
		0.1504E+02	0.1816E+00
		0.1504E+02	0.3632E+00
		0.1504E+02	0.5448E+00
		0.1504E+02	0.9080E+00
		0.1504E+02	0.3632E+01
13	10	0.4320E+02	
		0.0000E+00	0.0000E+00
		0.4513E+01	0.2906E-01
		0.7522E+01	0.5629E-01
		0.1128E+02	0.1035E+00
		0.1354E+02	0.1453E+00
		0.1504E+02	0.1816E+00
		0.1504E+02	0.3632E+00
		0.1504E+02	0.5448E+00
		0.1504E+02	0.9080E+00
		0.1504E+02	0.3632E+01
14	10	0.5163E+02	
		0.0000E+00	0.0000E+00
		0.4513E+01	0.2906E-01
		0.7522E+01	0.5629E-01
		0.1128E+02	0.1035E+00
		0.1354E+02	0.1453E+00
		0.1504E+02	0.1816E+00
		0.1504E+02	0.3632E+00
		0.1504E+02	0.5448E+00
		0.1504E+02	0.9080E+00
		0.1504E+02	0.3632E+01
15	10	0.5996E+02	
		0.0000E+00	0.0000E+00
		0.4513E+01	0.2906E-01
		0.7522E+01	0.5629E-01
		0.1128E+02	0.1035E+00
		0.1354E+02	0.1453E+00
		0.1504E+02	0.1816E+00
		0.1504E+02	0.3632E+00

0.1504E+02	0.5448E+00
0.1504E+02	0.9080E+00
0.1504E+02	0.3632E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.4075E+01	0.9080E-02
0.8149E+01	0.1816E-01
0.1630E+02	0.3632E-01
0.3260E+02	0.2361E+00
0.4890E+02	0.7627E+00
0.5867E+02	0.1326E+01
0.6519E+02	0.1816E+01
0.6519E+02	0.2724E+01
0.6519E+02	0.3632E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.6028E+00	0.3655E-03	0.4488E-01	0.1000E-03
0.6028E+01	0.3655E-02	0.4488E+00	0.1000E-02
0.3018E+02	0.1828E-01	0.2244E+01	0.5000E-02
0.6063E+02	0.3667E-01	0.4488E+01	0.1000E-01
0.1178E+03	0.7249E-01	0.8975E+01	0.2000E-01
0.2287E+03	0.1542E+00	0.1741E+02	0.5000E-01
0.2975E+03	0.2161E+00	0.1986E+02	0.8000E-01
0.3342E+03	0.2540E+00	0.2149E+02	0.1000E+00
0.3996E+03	0.3897E+00	0.2965E+02	0.2000E+00
0.3869E+03	0.6856E+00	0.4077E+02	0.5000E+00
0.3957E+03	0.9916E+00	0.4954E+02	0.8000E+00
0.3992E+03	0.1194E+01	0.5302E+02	0.1000E+01
0.4114E+03	0.2202E+01	0.6519E+02	0.2000E+01

Attachment 4

GOLDER
MEMBER OF WSP

CALCULATIONS

Date:	7/14/2021	**Made by:**	DAF
Project No.:	21450910	**Checked by:**	KAR
Subject:	Pile Driveability at Abutment 1	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

OBJECTIVE

Perform a driveability analysis using GRLWEAP to determine if the proposed piles can be driven to the nominal pile driving resistance at Abutment 1 while maintaining blow counts and pile stresses within the specified limits.

REFERENCES

1. GRLWEAP Software Package Version 2010-8, Built November 28, 2018.
2. AASHTO LRFD Bridge Design Specifications, 9th Edition, 2020
3. MaineDOT 2020 Standard Specifications Section 501.042
4. Golder interpreted subsurface section A-A' (Figure 3, Preliminary Geotechnical Design Report, dated December 2020).
5. HNTB calculation titled "Freeport Bridges_Loads_Bottom of Footing_flat.pdf", dated May 26, 2021.

ASSUMPTIONS

1. The pile will be bearing on bedrock with 90% tip resistance, 10% shaft resistance.
2. The number of hammer blows at the required resistance indicated by the wave equation analysis will be between 3 and 15 blows per inch (Ref. 3)
3. The factored axial load is 453 kips including downdrag for Abutment 1 with HP 14x89 piles.
4. The hammer cushion will consist of 50% aluminum and 50% conbest, 2" thick.
5. The HP 14x89 piles will be driven a total length of approximately 36 feet.
6. A resistance factor of 0.65 will be used for a driving criteria established by dynamic testing (Ref. 2).
7. A Delmag D 30 single acting diesel pile driving hammer is assumed for the analysis as it is a common pile driving hammer used on MaineDOT projects.

ATTACHMENTS

1. GRLWEAP Table of recommended quake and damping values for impact driven piles.
2. GRLWEAP output for a variable resistance analysis using the DELMAG D30 hammer.

CALCULATION

1. Determine the input parameters:

Nominal pile driving resistance:

P_u = 456 Applied axial load including downdrag

ϕ_{mon} = 0.65 Resistance factor associated with pile monitoring method

$$R_{ndr} = \frac{P_u}{\phi_{mon}}$$

Abutment 1: R_{ndr} = 702 kips

GOLDER
MEMBER OF WSP

CALCULATIONS

Date:	7/14/2021	**Made by:**	DAF
Project No.:	21450910	**Checked by:**	KAR
Subject:	Pile Driveability at Abutment 1	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

Soil layering:

Abutment 1

Layer (Ref. 4)	Depth below base of abutment
Existing Fill	0.0 - 11.8 ft
Glaciomarine Silty Clay (above water table)	11.8 - 13.9 ft
Glaciomarine Silty Clay (above water table)	13.9 - 34.2 ft
Sand and Gravel	34.2 - 36.2 ft
Bedrock	>36.2 ft

Shaft quake = 0.1 in Shaft damping = 0.1 s/ft
Toe quake = 0.04 in Toe damping = 0.15 s/ft

(Attachment 1)

2. Analyze an open ended diesel (OED) hammer to determine the blow count and stress at R_{ndr} for the abutment.

Hammer	Energy / Power (lb-ft)	Fuel Setting	Location	R_{ndr} (kips)	Blows/ft	Blows/in	Stress (ksi)
DELMAG D 30	59,730	Fuel Setting 3 (81%)	Abutment 1	702	122.4	10.2	42.9

CONCLUSIONS

The analysis indicates the Delmag D30 hammer operated at fuel setting 3 (81% of the combustion pressure) should be able to drive the piles at Abutment 1 to the nominal structural pile resistance while staying at a blow count between 3 and 15 blows per inch and limiting the driving stresses to below 45 kips per square inch (ksi), in accordance with Section 501.042 of the MaineDOT 2020 Standard Specifications.

Date:	7/14/2021	**Made by:**	DAF
Project No.:	21450910	**Checked by:**	KAR
Subject:	Pile Driveability at Abutment 1	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

Attachment 1

Recommended Quake Values for Impact Driven Piles*

	Soil Type	Pile Type or Size	Quake (in) Quake (mm)
Shaft Quake	All soil types	All Types	0.10 2.5
Toe Quake	All soil types, soft Rock	Non-displacement piles** i.e. driving unplugged	0.10 2.5
	Very dense or hard soils	Displacement Piles*** of diameter or width D	D/120 D/120
	Soils which are not very dense or hard	Displacement Piles*** of diameter or width D	D/60 D/60
	Hard Rock	All Types	0.04 1.0

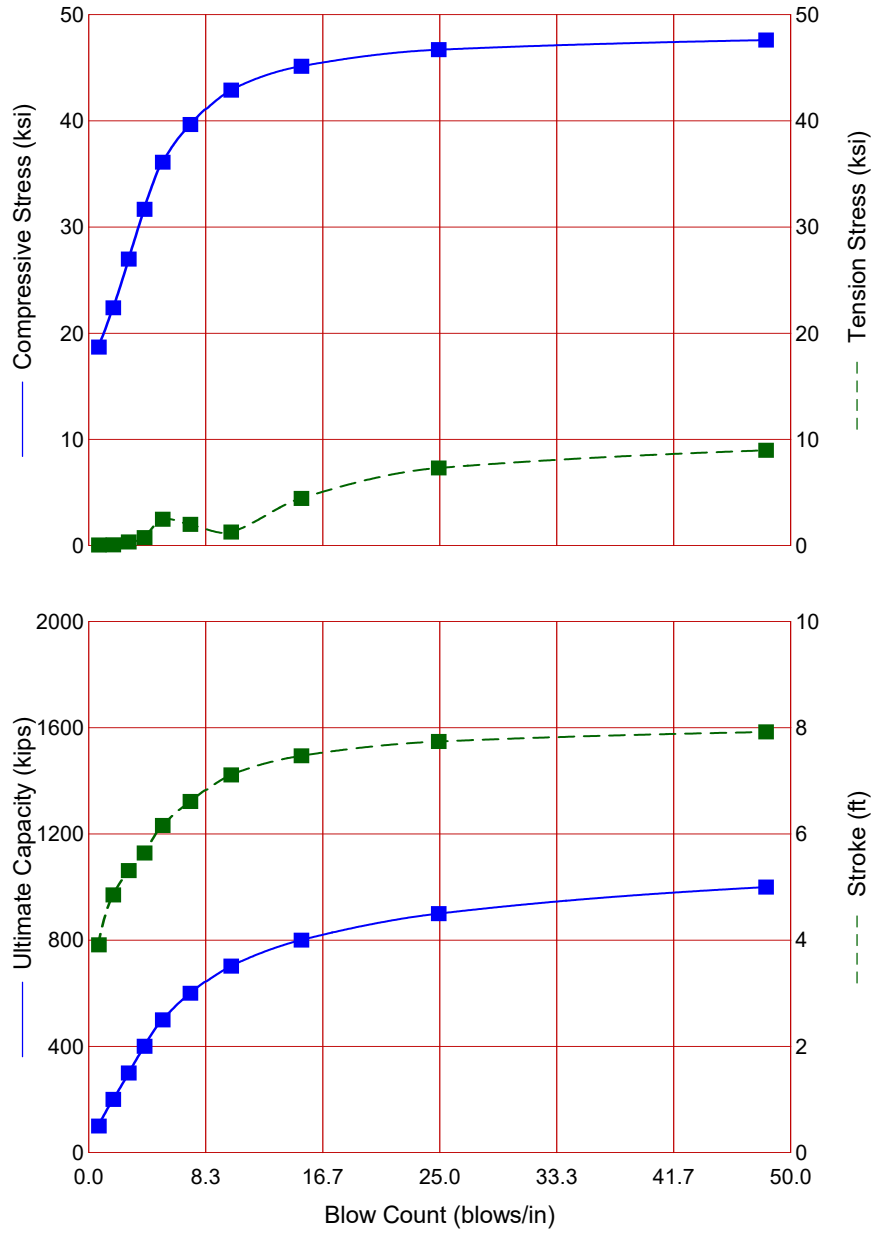
*For vibratory driven piles in cohesive soils, quakes should be doubled.
** Non-displacement piles are sheet pile, H-Piles, or open-ended pipe piles which are not plugging during driving. Normally it can be assumed that pipe piles with diameters of 30 inches (900 mm) or more will not plug during driving while H-Piles and pipe piles of diameter 20 inches (500 mm) or less will plug during driving into a bearing layer. Between 20 and 30 inches (500 and 750 mm), pipe piles may or may not plug.
*** Displacement piles are closed-ended pipe piles, pipe piles, or H-Piles that are plugged during driving and solid concrete piles. Normally, we would analyze H-Piles and pipe piles with diameters 20 inches (500 mm) or less as displacement piles.

Recommended quake values, both shaft and toe, for vibratory driven piles are somewhat speculative recommendations as not much experience exists.

Recommended Damping Values for Impact Driven Piles*

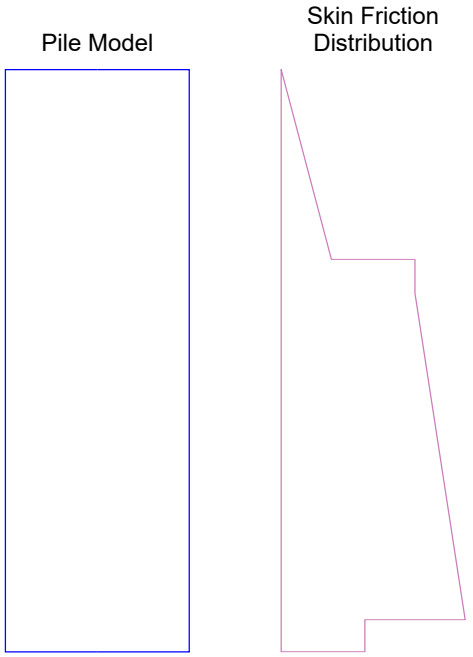
	Soil Type	Damping Factor s/ft	Damping Factor s/m
Shaft Damping	Non-cohesive soils**	0.05	0.16
	Cohesive soils**	0.20	0.65
Toe damping	In all soil types	0.15	0.50

* For vibratory driven piles, use double values (Smith-viscous).
** For mixed soils, intermediate values may be appropriate; for example, a sandy silt or clayey sand may be modeled with 0.10 s/ft (0.33 s/m), a cohesive silt or a sandy clay with 0.15 s/ft (0.50 s/m).



DELMAG D 30

Ram Weight	6.60	kips
Efficiency	0.800	
Pressure	1198 (81%)	psi
Helmet Weight	2.70	kips
Hammer Cushion	109975	kips/in
COR of H.C.	0.800	
Skin Quake	0.100	in
Toe Quake	0.040	in
Skin Damping	0.100	s/ft
Toe Damping	0.150	s/ft
Pile Length	36.20	ft
Pile Penetration	36.20	ft
Pile Top Area	26.10	in2



Res. Shaft = 10 %
(Proportional)

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count blows/in	Stroke ft	Energy kips-ft
100.0	18.69	0.07	0.7	3.91	21.57
200.0	22.39	0.08	1.8	4.85	19.25
300.0	26.97	0.35	2.9	5.31	18.80
400.0	31.66	0.76	4.0	5.64	19.30
500.0	36.09	2.49	5.3	6.16	20.81
600.0	39.64	2.00	7.3	6.61	22.06
702.0	42.88	1.28	10.2	7.11	23.72
800.0	45.13	4.45	15.2	7.47	25.20
900.0	46.69	7.32	24.9	7.74	26.31
1000.0	47.60	8.98	48.3	7.92	27.06

APPENDIX F1

Abutment 2 Pile Design - Longer Pile

GOLDER
MEMBER OF WSP

CALCULATIONS

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Maximum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

OBJECTIVE

Determine if the proposed HP 14x89 piles will provide adequate support for Abutment 2 (the southeastern integral abutment) based on the anticipated thermal movement and final design loads. This analysis is performed at the location along the abutment where bedrock depth (and thus pile soil embedment) is anticipated to be greatest.

METHOD

Use the procedure outlined in AASHTO LRFD (Ref. 1) and the design method provided in the MaineDOT Bridge Design Guide (Ref. 2).

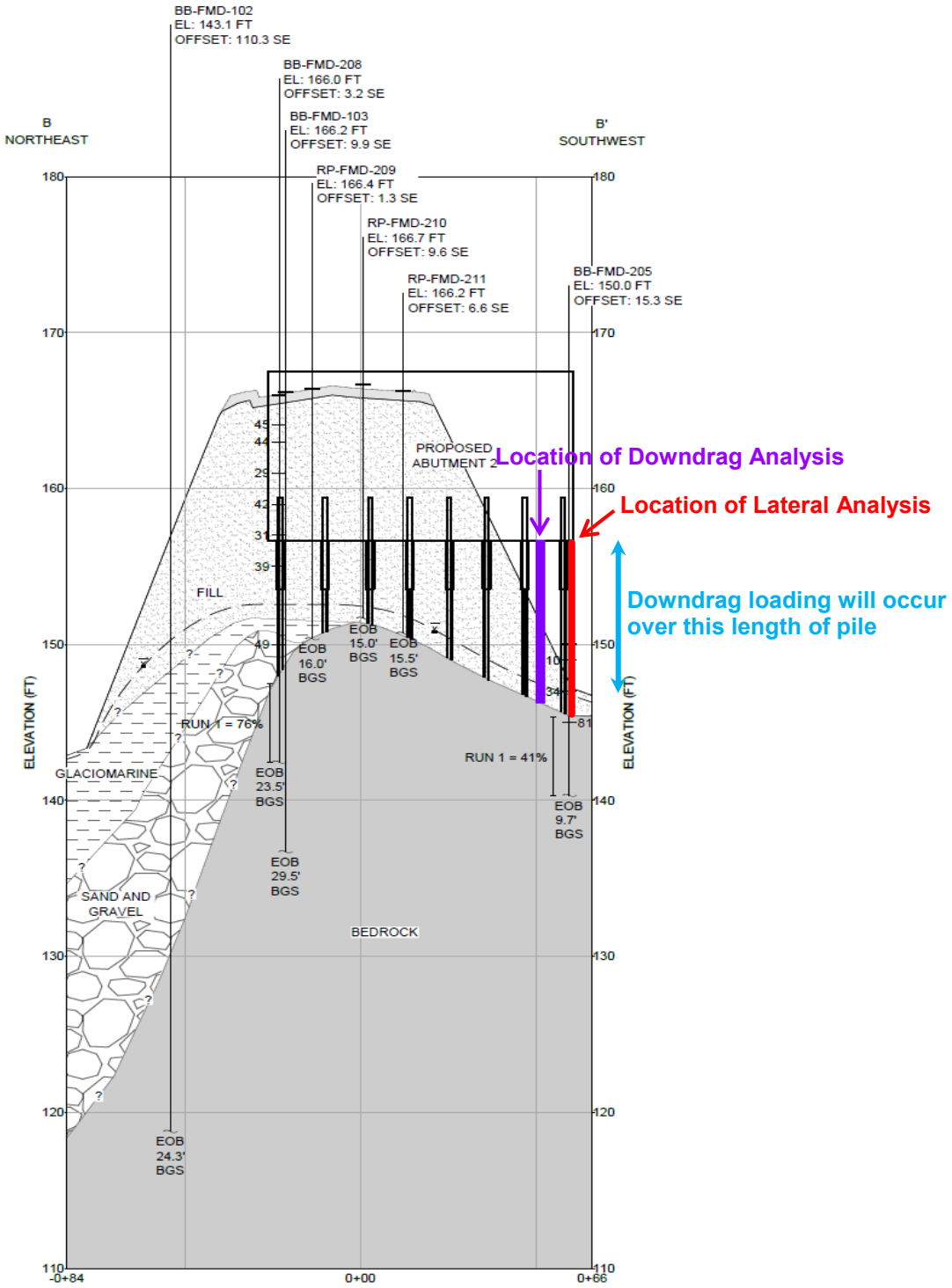
REFERENCES

1. AASHTO LRFD Bridge Design Specifications, 9th Ed. 2020.
2. Guertin Elkerton & Associates for Maine Department of Transportation. Bridge Design Guide. Dated August 2003 with 2018 updates.
3. Email communication between Golder and HNTB, subject "RE: Freeport I-295 Exit 20 and Exit 22 - Request for Sections and Design Info", dated June 23, 2020.
4. Isenhower, W.M. et al. LPile v2019 Technical Manual: A Program for the Analysis of Deep Foundations Under Lateral Loading. Ensoft, Inc. Dated March 2020.
5. Updated Golder interpreted subsurface profiles A-A' and B-B', dated June 2021.
6. Golder geotechnical test boring logs (Appendix A, Preliminary Geotechnical Design Report, dated December 2020).
7. Bridge Software Institute. FB-MultiPier Soil Parameter Table (US Customary Units). Accessed July 2020. https://bsi.ce.ufl.edu/downloads/files/MultiPier_Soil_Table.pdf
8. VTrans Integral Abutment Committee. Integral Abutment Bridge Design Guidelines, 2nd Ed. 2008.
9. AISC Steel Construction Manual, 13th Ed.
10. HNTB calculation titled "Freeport Bridges_Loads_Bottom of Footing_flat.pdf", dated May 26, 2021.
11. Oregon Department of Transportation, Geo-Environmental Section. Geotechnical Design Manual: Chapter 8 - Foundations, Version 2.1. Dated May 6, 2019.
12. HNTB for State of Maine Department of Transportation. Approach Road Bridge over Interstate 295 and Signalized Intersections, Exit 22 Interchange: 60% Plans, dated May 7, 2021.
13. Golder calculation titled "21450910 Freeport Exit 22 APILE Downdrag - Abutment 2", dated June 29, 2021.
14. HNTB for State of Maine Department of Transportation. Merrill Road Bridge over Interstate 295, Freeport, Cumberland: Abutment 1 Reinforcement Sections, Sheet 94, dated May 7, 2021.

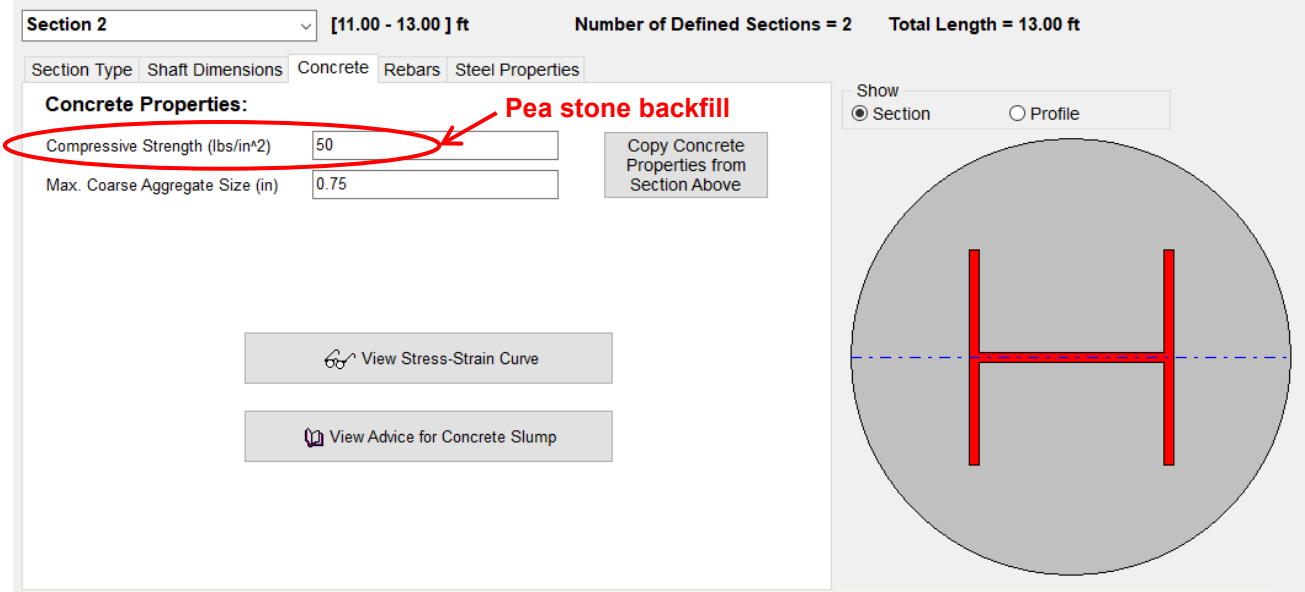
ASSUMPTIONS

1. The selected pile orientation is weak axis bending (Ref. 2, page 5-42).
2. The vertical load is assumed to be evenly distributed.
3. A rock socket diameter of 30 inches (approximately twice the pile flange width) is assumed in order to permit pile rotation.
4. Since LPile capability for modeling round shafts is limited to concrete backfill, a low compressive strength of 50 psi is assumed in order to represent pea stone backfill in the annular space between the pile and the rock socket wall. The compressive strength input is illustrated in the LPile image below.
5. For the lateral analysis, the soil profile is analyzed at the location along the abutment where bedrock depth (and thus pile soil embedment) is anticipated to be greatest. For the downdrag analysis (Ref. 13 and Attachment 3), the soil profile is analyzed at the location along the abutment where settlement (and thus downdrag load) is anticipated to be greatest. These locations are illustrated in the interpreted subsurface profile below.

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Maximum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		



Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Maximum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		



ATTACHMENTS

1. LPile analysis output for Strength I
2. LPile analysis output for Strength I with Plastic Hinge
3. Downdrag Analysis

CALCULATION

1. Select the preliminary pile size.

Determine the factored applied superstructure vertical dead and live load (P_u) distributed to each pile.

Strength I factored vertical load per abutment =	3216	kips	(Ref. 10, page 2)
divided by	8	piles at Abutment 2 (Ref. 12, Sheet 95) =	
Strength I factored vertical load per pile =	402	kips	
Strength I factored downdrag load per pile =	42	kips	(Ref. 13)

Pile weight = 0.089 kip/ft x 13.0 ft = 1 kips

P_u = 445 kips (Total factored axial load including downdrag and pile weight)

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Maximum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

Select the steel pile strength.

F_y = 50 ksi
E = 29,000 ksi

Determine resistance factors (Φ_c and Φ_f) for the structural strength in the upper and lower zones of the pile.

ϕ_{cl} = 0.50 for axial resistance in the lower zone of the pile (Ref. 2, page 5-41)
ϕ_{cu} = 0.70 for axial resistance in the upper zone of the pile (Ref. 2, page 5-42)
ϕ_f = 1.00 for flexural resistance in the upper zone of the pile (Ref. 2, page 5-42)

Determine the maximum required nominal axial pile resistance (Ref. 1, Article 6.9.2.1).

$$R_{n.upper} = \frac{P_u}{\phi_{cu}}$$

$R_{n.upper}$ = 636 kips

$$R_{n.lower} = \frac{P_u}{\phi_{cl}}$$

$R_{n.lower}$ = 890 kips

$$R_n = \max\left(R_{n.upper}, R_{n.lower}\right)$$

R_n = 890 kips

Use the required nominal axial pile resistance to estimate the required pile area.

$$A_{s.req} = \frac{R_n}{0.80\ Fy}$$ (Ref. 2, page 5-42)

$A_{s.req}$ = 22.3 in^2

Select a pile size with an area of $A_{s.req}$ or greater.

Preferred selection is HP 14x89 based on June 16, 2020 meeting with MaineDOT and HNTB.
Check that preferred selection satisfies pile area requirement:

HP 14x89 A_s = 26.1 in^2 (Ref. 4, Table 5.6.3)
A_s > $A_{s.req}$ OK

2. Use LPile analysis to determine the pile unbraced length and maximum moment at the top of the pile.

The following input parameters were used in the LPile analysis:

GOLDER
MEMBER OF WSP

CALCULATIONS

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Maximum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

Pile Properties

Section type:	Steel H Section Weak Axis		(Assumption 1)
Length of section:	13	ft	(2-foot embedment into a 2-foot rock socket)
Flange width, b:	14.695	in	(Ref. 4, Table 5.6.3)
Section depth, d:	13.83	in	(Ref. 4, Table 5.6.3)
Flange thickness, t_f:	0.615	in	(Ref. 4, Table 5.6.3)
Web thickness, t_w:	0.615	in	(Ref. 4, Table 5.6.3)
Pile batter:	Vertical		(pile battering not required)

Rock Socket Properties

Socket length:	2	ft	
Socket diameter:	30	in	(Assumption 3)
Socket fill material:	Pea stone with compressive strength of 50 psi		(Assumption 4)

Pile Loading

Lateral deflection due to abutment thermal expansion or contraction:	0.795	in	(Ref. 10, page 2)
Lateral deflection due to girder rotation:	0.18	in	(Ref. 14)
Total lateral deflection at pile head:	0.975	in	
Axial load:	445,000	lbs	(from Step 1)

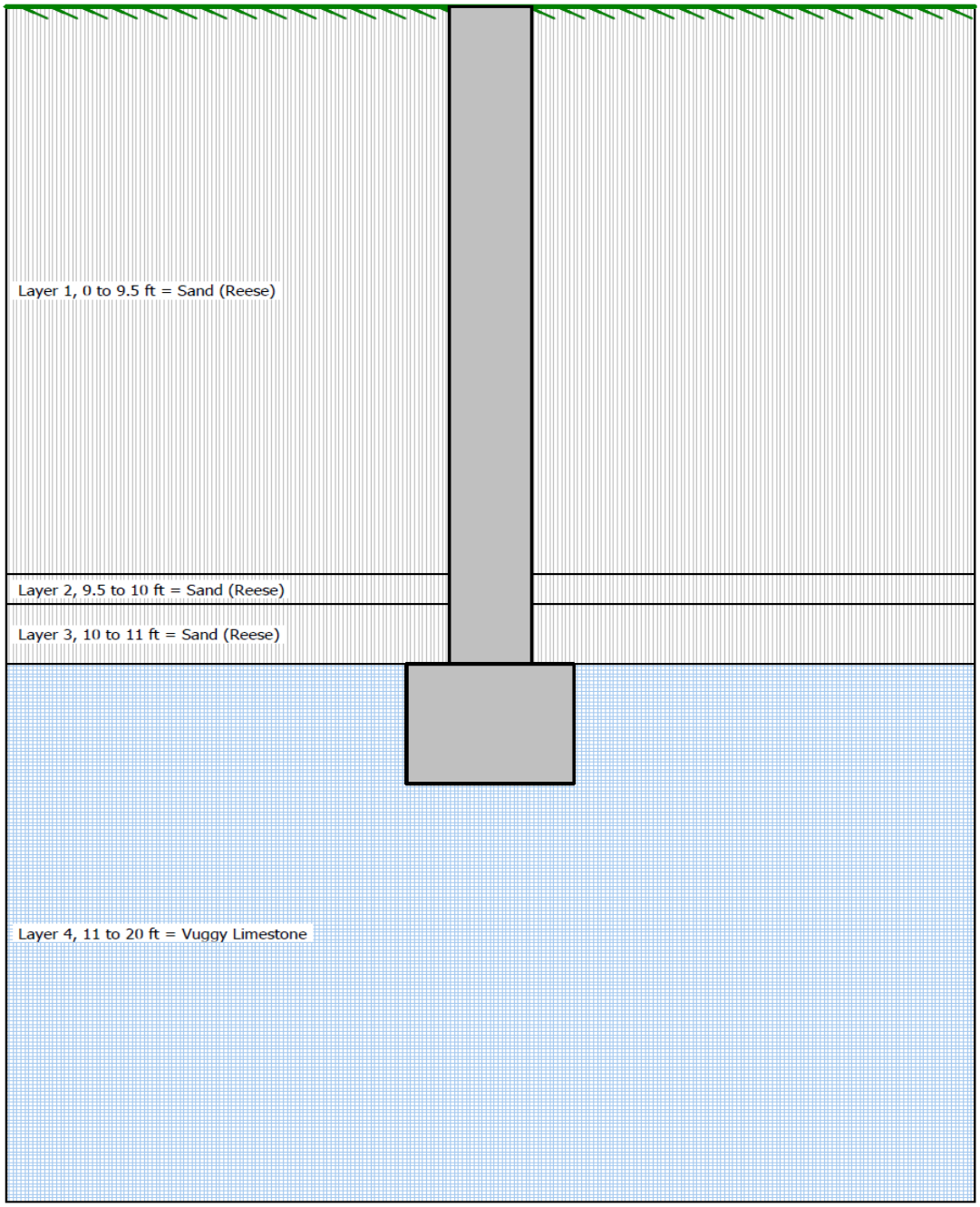
Soil Layers

Layer	Depth below base of abutment[1]	Lateral Model	Effective Unit Weight (pcf)	Undrained Shear Strength (psf)	Friction Angle (°)	Subgrade Modulus (pci)[3]	Major Principal Strain at 50%	UCS (psi)[2]
Proposed Fill	0 - 9.5 ft	Sand (Reese)	125	-	32	88	-	-
Existing Fill (above water table)	9.5 - 10 ft	Sand (Reese)	125	-	33	165	-	-
Existing Fill (below water table)	10 - 11 ft	Sand (Reese)	62.6	-	33	100	-	-
Bedrock	> 11 ft	Strong Rock (Vuggy Limestone)	106.6	-	-	-	-	2486

1) Ref. 5
2) Ref. 6. Using lowest UCS value from laboratory test results due to low RQD encountered in boring BB-FMD-103 closest to southeastern abutment.

3) Ref. 7. Interpolation based on average N_{60} value for existing fill and on design friction angle for proposed fill.

An image of the LPile model setup is provided below. The full LPile output is provided in Attachments 1 and 2.



Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Maximum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

From the LPile output:
Obtain the maximum moment at the top of the pile.

$M_{u.Top}$ = 2860 in-kips (LPile)

Obtain the unbraced lengths of the top segment and the second segment of the upper zone of the pile.

$l_{b.top}$ = 4.8 ft (LPile)
$l_{b.top}$ = 58.0 in

$l_{b.2nd}$ = 6.6 ft (LPile)
$l_{b.2nd}$ = 79.4 in

3. Determine if the applied moment on the pile will cause pile head plastic deformation by using the interaction

Determine K values for the top and bottom of the pile and calculate the column slenderness factor (λ) for each segment.

For the top segment (fixed at top and pinned at bottom):

$$\lambda_{top} = \frac{K_{top} l_{b.top}}{r_y} \leq 120 \qquad \text{(Ref. 1, Article 6.9.3)}$$

$$r_y = \sqrt{I_{yy} / A_s}$$

where:
K_{top} = 1.2 (Ref. 1, Table C4.6.2.5-1)
I_{yy} = 326 in^4 (Ref. 4, Table 5.6.3)
r_y = 3.53 in

λ_{top} = 19.68 OK

For the second segment (pinned at top and bottom):

$$\lambda_{2nd} = \frac{K_{2nd} l_{b.2nd}}{r_y} \leq 120 \qquad \text{(Ref. 1, Article 6.9.3)}$$

where:
K_{2nd} = 1.0 (Ref. 1, Table C4.6.2.5-1)

λ_{2nd} = 22.46 OK

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Maximum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

Calculate the critical elastic buckling resistance, P_e, and the nominal yield resistance, P_o.

Use Ref. 1 Table 6.9.4.1.1-1 to select equation for P_e based on cross-section shape and potential buckling mode.

$$P_e = \frac{\pi^2 E}{\left(\frac{K\, l_b}{r_y}\right)^2} A_s \qquad \text{(Ref. 1, Eqn 6.9.4.1.2-1)}$$

$P_{e.top}$ = 19281 kips
$P_{e.2nd}$ = 14806 kips

$$P_o = F_y A_s \qquad \text{(Ref. 1, Article 6.9.4.1)}$$

P_o = 1305 kips

Calculate the nominal structural pile resistance, P_n, for both segments of the upper zone of the pile as well as the lower zone of the pile.

Determine P_o/P_e to select equation for P_n as per Ref. 1 Article 6.9.4.1.

$P_o/P_{e.top}$ = 0.07 ≤ 2.25
$P_o/P_{e.2nd}$ = 0.09 ≤ 2.25

thus use Ref. 1 Eqn 6.9.4.1.1-1:

$$P_n = \left[0.658^{\left(\frac{P_o}{P_e}\right)}\right] P_o$$

$P_{n.top}$ = 1269 kips
$P_{n.2nd}$ = 1258 kips

$$P_{n.bottom} = (0.658^{(0)}) \times F_y A_s \qquad \text{(0 for a fully braced pile - Ref. 8, Appendix B, Eqn 6-9)}$$

$P_{n.bottom}$ = 1305 kips

Calculate the factored structural pile resistance, P_r, for both segments of the upper zone of the pile as well as the lower zone of the pile.

$$P_{r.top} = \phi_{cu}\, P_{n.top}$$
$P_{r.top}$ = 888 kips

$$P_{r.2nd} = \phi_{cu}\, P_{n.2nd}$$
$P_{r.2nd}$ = 880 kips

$$P_{r.bottom} = \phi_{cl} P_{n.bottom}$$

$P_{r.bottom}$ = 653 kips

Compare the ratio of P_u to the structural resistance in the upper portion of the pile – the pile size should be such that the ratio is not less than 0.20.

$$\frac{P_u}{P_{r.top}} = \quad 0.50 \quad \text{OK}$$

$$\frac{P_u}{P_{r.2nd}} = \quad 0.51 \quad \text{OK}$$

Since the lower zone of the pile will have virtually no moment, the entire section can carry the required vertical loads. Make sure the applied load will not exceed the resistance of the lower zone.

$$\text{Check} \left(\frac{P_u}{P_{r.bottom}} < 1 \right)$$

$$\frac{P_u}{P_{r.bottom}} = \quad 0.68 \quad \text{OK}$$

Determine the nominal and factored flexural resistance about H-Pile weak axis (LRFD 6.12.2.2).

Slenderness ratio for the flange:

$$\lambda_f = \frac{b_f}{2t_f} \qquad \text{(Ref. 1, Eqn 6.12.2.2.1-3)}$$

λ_f = 11.95

Limiting slenderness ratio for a compact flange:

$$\lambda_{pf} = 0.38\sqrt{\frac{E}{F_y}} \qquad \text{(Ref. 1, Eqn 6.12.2.2.1-4)}$$

λ_{pf} = 9.15

Limiting slenderness ratio for a noncompact flange:

$$\lambda_{rf} = 0.83\sqrt{\frac{E}{F_y}} \qquad \text{(Ref. 1, Eqn 6.12.2.2.1-5)}$$

λr_f = 19.99

Elastic and plastic section moduli about the weak axis:

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Maximum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

$$S_y = \frac{I_{yy}}{b/2}$$

$$Z_y = (b^2 t_f)/2 + 0.25 t_w^2 (d - 2t_f)$$

S_y = 44.4 in^3
Z_y = 67.6 in^3

Nominal flexural resistance:

$$M_n = M_p = (F_y Z_y) \quad \text{if } \lambda_f \le \lambda_{pf}$$ (Ref. 1, Eqn 6.12.2.2.1-1)

$$M_n = \left[1 - \left(1 - \frac{S_y}{Z_y}\right)\left(\frac{\lambda_f - \lambda_{pf}}{0.45\sqrt{\frac{E}{F_y}}}\right)\right] F_y Z_y \quad \text{if } \lambda_{pf} < \lambda_f \le \lambda_{rf}$$ (Ref. 1, Eqn 6.12.2.2.1-2)

Since $\lambda_{pf} < \lambda_f \le \lambda_{rf}$,
M_n = 3080 in-kips

Factored flexural resistance:

ϕ_f = 1.00 (Ref. 2, page 5-42)

$$M_r = \phi_f M_n$$

M_r = 3080 in-kips

Calculate the moment that will cause a plastic hinge at the top of the pile, M_p'(Ref. 2, Article 6.9.2.2).

$$M_p' = \frac{9}{8}\left(1 - \frac{P_u}{P_{r.top}}\right) M_r$$ (Ref. 8, Appendix B, Eqn 6-24)

M_p' = 1729 in-kips = 1728649.4 inch-lb

If the applied moment exceeds the moment that would cause a plastic hinge, it can be assumed that the pile head has entered plastic deformation and therefore the moment that can be applied to the pile head cannot exceed M_p'.

$M_{u.Top}$ =	2860	in-kips	(From Step 2)
$M_{u.Top}$	>	M_p'	Plastic Hinge Forms

4. Run a second LPile analysis with displacement, plastic moment (M_p'), and P_u as load conditions, and calculate new unbraced lengths from the moment vs. depth curve. Then repeat Step 4 with the new unbraced lengths.

$l_{b.top}$ = 3.8 ft (LPile)
$l_{b.top}$ = 45.9 in

$l_{b.2nd}$ = 6.9 ft (LPile)
$l_{b.2nd}$ = 83.2 in

$M_{u.2nd}$ = 871 in-kips (LPile)

Since a plastic hinge developed at the pile head, the value of K for the top segment becomes 2.1 (Ref. 2, page 5-43).

K_{top} = 2.1 (Ref. 1, Table C4.6.2.5-1)
K_{2nd} = 1.0 (Ref. 1, Table C4.6.2.5-1)

λ_{top} = 27.30 < 120 OK
λ_{2nd} = 23.55 < 120 OK

$P_{e.top}$ = 10021 kips
$P_{e.2nd}$ = 13467 kips

$P_o/P_{e.top}$ = 0.13 ≤ 2.25 (to select P_n equation)
$P_o/P_{e.2nd}$ = 0.10 ≤ 2.25 (to select P_n equation)

$P_{n.top}$ = 1236 kips
$P_{n.2nd}$ = 1253 kips

$P_{r.top}$ = 865 kips
$P_{r.2nd}$ = 877 kips

$\frac{P_u}{P_{r.top}}$ = 0.51 > 0.20 OK

$\frac{P_u}{P_{r.2nd}}$ = 0.51 > 0.20 OK

Since the pile is appropriately sized, the second segment of the upper zone of the pile needs to be checked with the interaction equation of LRFD Section 6.9.2.2. It is important that this segment of the pile does not form a plastic hinge. A plastic hinge in this segment will cause the pile to fail.

Check: $\frac{P_u}{P_{r.2nd}} + \frac{8}{9}\left(\frac{M_{u.2nd}}{M_r}\right) < 1$ (Ref. 8, Appendix B, Eqn 7-13)

Check: 0.76 < 1 OK

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Maximum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

5. Because the piles have weak axis orientation and the flanges resist the shear as opposed to the web, check the maximum shear from the LPile output against the structural shear resistance per AISC G7.

V_u = 52.2 kips (LPile)

AASHTO LRFD does not directly address weak axis shear. This analysis will use the AISC Steel Construction Manual 13th edition (G7) to ensure the pile will not shear under the longitudinal load.

k_v = 1.2 (Ref. 9, Section G2.1)

$C_v = 1.0 \quad \text{if} \quad b/t_f \leq 1.1\sqrt{k_v E/F_y}$ (Ref. 9, Eqn. G2-3)

C_v = 1.0

Both flanges will resist shear forces:

$A_w = 2b_f t_f$ (Ref. 8, Appendix B, Eqn 7-17)

A_w = 18.07 in^2

$V_n = 0.6F_y A_w C_V$ (Ref. 9, Eqn G2-1)

V_n = 542 kips

$V_r = \Phi_v V_n$

ϕ_v = 1.00 (Ref. 1, Article 6.5.4.2)

V_r = 542 kips

Check that the shear resistance is sufficient:

V_u < V_r OK

6. Check that the maximum factored applied pile load does not exceed the factored pile drivability resistance.

While driving the pile, the maximum stress that is permitted in the pile is:

$\sigma_{dr} = 0.9\Phi_{da} F_y$ (Ref. 8, Appendix B, Eqn 7-22)

ϕ_{da} = 1.00 (Ref. 1, Article 6.5.4.2)

σ_{dr} = 45 ksi

This translates into an ultimate maximum driving force that can be applied to the pile of:

$P_0 = \sigma_{dr} A_s$ (Ref. 8, Appendix B, Eqn 7-23)

P_0 = 1175 kips

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Maximum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

Calculate the nominal pile driving resistance (R_{ndr}) from the applied load divided by the resistance factor associated with the pile monitoring method. In this design, the pile will be bearing on rock. The driving criteria will be established by dynamic testing.

ϕ_{mon} = 0.65 (Ref. 1, Table 10.5.5.2.3-1)

$$R_{ndr} = \frac{P_u}{\phi_{mon}}$$ (Ref. 8, Appendix B, Eqn 7-25)

R_{ndr} = 685 kips

The nominal pile driving resistance (R_{ndr}) should exceed neither the nominal structural pile resistance (P_n) nor the maximum driving force (P_0) calculated above.

$P_{n.top}$ = 1236 kips (From Step 4)
$P_{n.2nd}$ = 1253 kips (From Step 4)

Check $R_{ndr} < P_n$: OK
Check $R_{ndr} < P_0$: OK

7. Verify the assumption of a pinned support at the base of the pile by comparing the ratio of the shear and axial forces acting at the pile tip to the factored friction coefficient at the bedrock/pile interface.

V_u at pile tip = 6.08 kips (LPile)
ϕ_v = 1.00 (Ref. 1, Article 6.5.4.2)
$V_{factored}$ at pile tip = 6.08 kips

	Unfactored Vertical Dead Load per Abut. (Ref. 10, pg. 2)	Load Factor (Ref. 1, Table 3.4.1-1)
	kips	-
DC_{super}	633	1.25
DC_{sub}	636	1.25
DW	86	1.50

Strength I factored dead load per abutment = 1715 kips
divided by 8 piles at Abutment 2 (Ref. 12, Sheet 95) =
P = 214 kips

V / P = 0.028

Friction coefficient, μ = 0.40 (Ref. 1, Table C3.11.5.3-1: steel sheet piles against clean gravel, gravel-sand mixtures, well-graded rock fill with spalls)

Resistance factor = 0.5 (per discussion with MaineDOT)

μ * resistance factor = 0.2

If the shear/axial ratio is less than μ multiplied by the resistance factor, then the chosen pile section can be considered pinned.

V / P	<	μ * resistance factor
0.028	<	0.2

The chosen pile section can be considered pinned.

8. Check the pile toe displacement.

The target pile toe displacement (as computed with LPile) is under 1/4 inch (0.25 inches) and preferably under 1/8 inch (0.125 inches), based on engineering judgement.

Lateral Pile Deflection at pile tip =	0.002	inches	< 0.125 inches	OK

CONCLUSIONS

The results of the analysis indicate that, at the location along the abutment where bedrock depth (and thus pile soil embedment) is anticipated to be greatest, a maximum moment of 2860 in-kips (238 ft-kips) occurs at the top of the pile under the Strength I load case with a maximum bridge expansion or contraction of 0.8 inches and a maximum lateral deflection due to girder rotation of 0.2 inches. The results indicate that 2-foot pile embedment into a 2-foot rock socket backfilled with pea stone is sufficient to limit translation of the pile tip to a negligible amount (i.e., less than 1/8 inch). HP 14x89 piles will provide adequate support for Abutment 2 based on the anticipated thermal movement, girder rotation, and final design loads.

Attachment 1

==========

LPile for Windows, Version 2019-11.005

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

==========

This copy of LPile is being used by:

KAR
Golder Associates, Inc.

Serial Number of Security Device: 239146533

This copy of LPile is licensed for exclusive use by:

GOLDER, Manchester, NH

Use of this program by any entity other than GOLDER, Manchester, NH
is a violation of the software license agreement.

Files Used for Analysis

Path to file locations:
\\golderassociates.sharepoint.com@SSL\DavWWWRoot\sites\139982\Project Files\5 Technical Work\06 Analysis\Phase II - Pile Design\LPILE\Abutment 2 Strength I\

Name of input data file:
Freeport Exit 22 Abutment 2 with Socket MaxSoil 2ftPile GirderRotation.lp11d

Name of output report file:
Freeport Exit 22 Abutment 2 with Socket MaxSoil 2ftPile GirderRotation.lp11o

Name of plot output file:
Freeport Exit 22 Abutment 2 with Socket MaxSoil 2ftPile GirderRotation.lp11p

Name of runtime message file:
Freeport Exit 22 Abutment 2 with Socket MaxSoil 2ftPile GirderRotation.lp11r

---

Date and Time of Analysis

Date: July 14, 2021 Time: 16:15:51

Problem Title

Project Name: MaineDOT I-295 Exit 22 Mallet Drive Bridge No. 5721
Job Number: 21450910
Client: MaineDOT
Engineer: KAR
Description: Abutment 2 Pile Design - Strength I (Rock Socket)

Program Options and Settings

Computational Options:
- Conventional Analysis

Engineering Units Used for Data Input and Computations:
- US Customary System Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 1000
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 130

Loading Type and Number of Cycles of Loading:
- Static loading specified

- Use of p-y modification factors for p-y curves not selected
- Analysis uses layering correction (Method of Georgiadis)
- No distributed lateral loads are entered
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Input of moment resistance at the pile tip not selected
- Input of side resistance moment along pile not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- Output files use decimal points to denote decimal symbols.
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 2
Total length of pile = 13.000 ft
Depth of ground surface below top of pile = 0.0000 ft

Pile diameters used for p-y curve computations are defined using 4 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	14.6950
2	11.000	14.6950
3	11.000	30.0000
4	13.000	30.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is a H weak axis steel pile
Length of section = 11.000000 ft
Pile width = 13.830000 in
Shear capacity of section = 0.0000 lbs

Pile Section No. 2:

Section 2 is a drilled shaft with casing and H section core/insert
Length of section = 2.000000 ft
Section Diameter = 30.000000 in
Shear capacity of section = 0.0000 lbs

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 0.0000 ft
Distance from top of pile to bottom of layer = 9.500000 ft
Effective unit weight at top of layer = 125.000000 pcf
Effective unit weight at bottom of layer = 125.000000 pcf
Friction angle at top of layer = 32.000000 deg.
Friction angle at bottom of layer = 32.000000 deg.
Subgrade k at top of layer = 88.000000 pci
Subgrade k at bottom of layer = 88.000000 pci

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 9.500000 ft
Distance from top of pile to bottom of layer = 10.000000 ft
Effective unit weight at top of layer = 125.000000 pcf
Effective unit weight at bottom of layer = 125.000000 pcf
Friction angle at top of layer = 33.000000 deg.
Friction angle at bottom of layer = 33.000000 deg.
Subgrade k at top of layer = 165.000000 pci
Subgrade k at bottom of layer = 165.000000 pci

Layer 3 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 10.000000 ft
Distance from top of pile to bottom of layer = 11.000000 ft
Effective unit weight at top of layer = 62.600000 pcf
Effective unit weight at bottom of layer = 6.260000 pcf
Friction angle at top of layer = 33.000000 deg.
Friction angle at bottom of layer = 33.000000 deg.
Subgrade k at top of layer = 100.000000 pci
Subgrade k at bottom of layer = 100.000000 pci

Layer 4 is strong rock (vuggy limestone)

Distance from top of pile to top of layer = 11.000000 ft
Distance from top of pile to bottom of layer = 20.000000 ft
Effective unit weight at top of layer = 106.600000 pcf
Effective unit weight at bottom of layer = 106.600000 pcf
Uniaxial compressive strength at top of layer = 2486. psi
Uniaxial compressive strength at bottom of layer = 2486. psi

(Depth of the lowest soil layer extends 7.000 ft below the pile tip)

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	Uniaxial qu psi	kpy pci
1	Sand	0.00	125.0000	32.0000	--	88.0000
	(Reese, et al.)	9.5000	125.0000	32.0000	--	88.0000
2	Sand	9.5000	125.0000	33.0000	--	165.0000
	(Reese, et al.)	10.0000	125.0000	33.0000	--	165.0000
3	Sand	10.0000	62.6000	33.0000	--	100.0000
	(Reese, et al.)	11.0000	6.2600	33.0000	--	100.0000
4	Strong Rock	11.0000	106.6000	--	2486.	--
	(Vuggy Limestone)	20.0000	106.6000	--	2486.	--

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	5	y = -0.975000 in	S = 0.0000 in/in	445000.	N.A.	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 2

Pile Section No. 1:

Dimensions and Properties of Steel H Weak Axis:

Length of Section = 11.000000 ft
Flange Width = 14.695000 in
Section Depth = 13.830000 in
Flange Thickness = 0.615000 in
Web Thickness = 0.615000 in
Yield Stress of Pipe = 50.000000 ksi
Elastic Modulus = 29000. ksi
Cross-sectional Area = 25.823850 sq. in.
Moment of Inertia = 325.505721 in^4
Elastic Bending Stiffness = 9439666. kip-in^2
Plastic Modulus, Z = 67.593889in^3
Plastic Moment Capacity = Fy Z = 3380.in-kip

Axial Structural Capacities:

Nom. Axial Structural Capacity = Fy As = 1291.193 kips
Nominal Axial Tensile Capacity = -1291.193 kips

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	445.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 445.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000422	39.8712137	9438779.	148.0161667	18.1232118	
0.00000845	79.7424273	9438779.	77.6818334	19.0142911	
0.00001267	119.6136410	9438779.	54.2370556	19.9053706	
0.00001690	159.4848546	9438779.	42.5146667	20.7964500	
0.00002112	199.3560683	9438779.	35.4812333	21.6875295	

0.00002535	239.2272819	9438779.	30.7922778	22.5786090	
0.00002957	279.0984956	9438779.	27.4430238	23.4696887	
0.00003379	318.9697093	9438779.	24.9310833	24.3607682	
0.00003802	358.8409229	9438779.	22.9773519	25.2518476	
0.00004224	398.7121366	9438779.	21.4143667	26.1429271	
0.00004647	438.5833502	9438779.	20.1355606	27.0340066	
0.00005069	478.4545639	9438779.	19.0698889	27.9250860	
0.00005491	518.3257775	9438779.	18.1681667	28.8161655	
0.00005914	558.1969912	9438779.	17.3952619	29.7072450	
0.00006336	598.0682049	9438779.	16.7254111	30.5983245	
0.00006759	637.9394185	9438779.	16.1392917	31.4894039	
0.00007181	677.8106322	9438779.	15.6221275	32.3804834	
0.00007604	717.6818458	9438779.	15.1624259	33.2715629	
0.00008026	757.5530595	9438779.	14.7511140	34.1626425	
0.00008448	797.4242731	9438779.	14.3809333	35.0537219	
0.00008871	837.2954868	9438779.	14.0460079	35.9448015	
0.00009293	877.1667005	9438779.	13.7415303	36.8358810	
0.00009716	917.0379141	9438779.	13.4635290	37.7269604	
0.0001014	956.9091278	9438779.	13.2086944	38.6180399	
0.0001056	996.7803414	9438779.	12.9742467	39.5091194	
0.0001098	1037.	9438779.	12.7578333	40.4001989	
0.0001141	1077.	9438779.	12.5574506	41.2912783	
0.0001183	1116.	9438779.	12.3713810	42.1823578	
0.0001225	1156.	9438779.	12.1981437	43.0734373	
0.0001267	1196.	9438779.	12.0364556	43.9645168	
0.0001309	1236.	9438779.	11.8851989	44.8555963	
0.0001352	1276.	9438779.	11.7433958	45.7466757	
0.0001394	1316.	9438779.	11.6101869	46.6377552	
0.0001436	1356.	9438779.	11.4848137	47.5288347	
0.0001478	1395.	9438779.	11.3666048	48.4199142	
0.0001521	1435.	9438779.	11.2549630	49.3109937	
0.0001563	1475.	9437067.	11.1496701	50.0000000	Y
0.0001605	1513.	9426369.	11.0515978	50.0000000	Y
0.0001647	1550.	9407830.	10.9601450	50.0000000	Y
0.0001732	1619.	9350066.	10.7952114	50.0000000	Y
0.0001816	1684.	9272173.	10.6508365	50.0000000	Y
0.0001901	1745.	9180270.	10.5237852	50.0000000	Y
0.0001985	1802.	9078703.	10.4114698	50.0000000	Y
0.0002070	1857.	8970923.	10.3117171	50.0000000	Y
0.0002154	1908.	8858170.	10.2230711	50.0000000	Y
0.0002239	1958.	8744039.	10.1436334	50.0000000	Y
0.0002323	2005.	8628493.	10.0725409	50.0000000	Y
0.0002408	2050.	8513781.	10.0084332	50.0000000	Y
0.0002492	2093.	8399743.	9.9506904	50.0000000	Y
0.0002577	2135.	8287097.	9.8985268	50.0000000	Y
0.0002661	2176.	8176587.	9.8512036	50.0000000	Y
0.0002746	2215.	8068412.	9.8081975	50.0000000	Y
0.0002830	2254.	7962730.	9.7690447	50.0000000	Y
0.0002915	2291.	7859672.	9.7333330	50.0000000	Y
0.0002999	2327.	7759339.	9.7006939	50.0000000	Y
0.0003084	2363.	7661810.	9.6707965	50.0000000	Y
0.0003168	2397.	7567143.	9.6433428	50.0000000	Y
0.0003253	2431.	7474974.	9.6182185	50.0000000	Y
0.0003337	2465.	7385342.	9.5951883	50.0000000	Y

0.0003422	2497.	7298311.	9.5738347	50.0000000	Y
0.0003506	2528.	7209946.	9.5527829	50.0000000	Y
0.0003591	2556.	7119836.	9.5323352	50.0000000	Y
0.0003675	2583.	7029282.	9.5120993	50.0000000	Y
0.0003760	2609.	6938766.	9.4921610	50.0000000	Y
0.0003844	2632.	6848188.	9.4727887	50.0000000	Y
0.0003928	2655.	6758754.	9.4535662	50.0000000	Y
0.0004013	2677.	6669692.	9.4350782	50.0000000	Y
0.0004097	2697.	6581531.	9.4164255	50.0000000	Y
0.0004182	2716.	6494008.	9.3983995	50.0000000	Y
0.0004266	2734.	6408390.	9.3806174	50.0000000	Y
0.0004351	2751.	6323609.	9.3631625	50.0000000	Y
0.0004435	2768.	6240019.	9.3459336	50.0000000	Y
0.0004520	2784.	6158627.	9.3290310	50.0000000	Y
0.0004604	2798.	6077521.	9.3124488	50.0000000	Y
0.0004689	2813.	5998574.	9.2961248	50.0000000	Y
0.0004773	2826.	5921058.	9.2799508	50.0000000	Y
0.0004858	2839.	5844660.	9.2642581	50.0000000	Y
0.0004942	2852.	5770103.	9.2487422	50.0000000	Y
0.0005027	2864.	5696955.	9.2332190	50.0000000	Y
0.0005365	2907.	5418472.	9.1745062	50.0000000	Y
0.0005703	2944.	5162039.	9.1192596	50.0000000	Y
0.0006041	2975.	4925588.	9.0672850	50.0000000	Y
0.0006379	3003.	4708046.	9.0183539	50.0000000	Y
0.0006716	3028.	4507716.	8.9720369	50.0000000	Y
0.0007054	3049.	4322082.	8.9282954	50.0000000	Y
0.0007392	3068.	4150447.	8.8866078	50.0000000	Y
0.0007730	3085.	3991130.	8.8474011	50.0000000	Y
0.0008068	3101.	3843269.	8.8099043	50.0000000	Y
0.0008406	3115.	3705157.	8.7742739	50.0000000	Y
0.0008744	3127.	3576304.	8.7403185	50.0000000	Y
0.0009082	3139.	3456004.	8.7078844	50.0000000	Y
0.0009420	3150.	3343467.	8.6771919	50.0000000	Y

Summary of Results for Nominal Moment Capacity for Section 1

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	445.0000000000	3150.

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural

design standard being followed.

Pile Section No. 2:

Dimensions and Properties of Drilled Shaft (Bored Pile) with Casing and H Weak Axis Core/Insert:

Length of Section = 2.000000 ft
Outside Diameter of Casing = 30.000000 in
Casing Wall Thickness = 0.0000 in
Moment of Inertia of Steel Casing = 0.0000 in^4
Width Flange of Core/Insert = 14.695000 in
Depth of Core/Insert = 13.830000 in
Flange Thickness of Core/Insert = 0.615000 in
Web Thickness of Core/Insert = 0.615000 in
Moment of Inertia of Steel Core/Insert = 325.505721 in^4
Yield Stress of Casing = 50000. psi
Elastic Modulus of Casing = 29000000. psi
Yield Stress of Core/Insert = 50000. psi
Elastic Modulus of Core/Insert = 29000000. psi
Number of Reinforcing Bars = 0 bars
Gross Area of Pile = 706.858347 sq. in.
Area of Concrete = 681.034497 sq. in.
Cross-sectional Area of Steel Casing = 0.0000 sq. in.
Cross-sectional Area of Steel Core/Insert = 25.823850 sq. in.
Area of All Steel (Casing, Core/Insert, and Bars) = 25.823850 sq. in.
Area Ratio of All Steel to Gross Area = 3.65 percent

Note that the core is assumed to be void of concrete.

Axial Structural Capacities:

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As = 1320.136 kips
Tensile Load for Cracking of Concrete = NaN kips
Nominal Axial Tensile Capacity = -1291.193 kips

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	445.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 445.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Max Core Stress	Run Msg
0.00000422	39.5556389	9364072.	145.0568738	0.0006127	0.0004860	0.0494237	0.00000	0.00000	16.8325576	
0.00000845	79.1112779	9364072.	80.0284369	0.0006761	0.0004227	0.0495548	0.00000	0.00000	17.7329441	
0.00001267	118.6669168	9364072.	58.3522913	0.0007395	0.0003593	0.0496859	0.00000	0.00000	18.6333307	
0.00001690	158.2225557	9364072.	47.5142184	0.0008028	0.0002959	0.0498170	0.00000	0.00000	19.5337171	
0.00002112	197.7781947	9364072.	41.0113748	0.0008662	0.0002326	0.0499481	0.00000	0.00000	20.4341037	
0.00002535	237.4406843	9368288.	36.6765360	0.0009296	0.0001692	0.0499997	0.00000	0.00000	21.3347772	
0.00002957	278.8172667	9429268.	33.5858646	0.0009931	0.0001060	0.0499909	0.00000	0.00000	22.2402887	
0.00003379	324.1631864	9592461.	31.2799832	0.0010571	0.00004326	0.0499999	0.00000	0.00000	23.1576801	
0.00003802	374.7731154	9857851.	29.5015594	0.0011216	-0.00001895	0.0499917	0.00000	0.00000	24.0916528	
0.00004224	430.3800432	10188458.	28.0925868	0.0011867	-0.00008057	0.0499867	0.00000	0.00000	25.0424894	
0.00004647	488.5383174	10513863.	26.9476907	0.0012522	-0.0001418	0.0499943	0.00000	0.00000	26.0039710	
0.00005069	546.8677085	10788408.	25.9962074	0.0013178	-0.0002030	0.0499909	0.00000	0.00000	26.9692701	
0.00005491	603.5877650	10991410.	25.1899807	0.0013833	-0.0002641	0.0499771	0.00000	0.00000	27.9327769	
0.00005914	657.3777991	11115867.	24.4952668	0.0014486	-0.0003255	0.0499902	0.00000	0.00000	28.8900027	
0.00006336	707.2219898	11161456.	23.8877639	0.0015136	-0.0003873	0.0499987	0.00000	0.00000	29.8372734	
0.00006759	752.2953376	11130758.	23.3495304	0.0015781	-0.0004495	0.0499978	0.00000	0.00000	30.7714738	
0.00007181	791.8885244	11027358.	22.8670183	0.0016421	-0.0005122	0.0499977	0.00000	0.00000	31.6898472	
0.00007604	825.3473929	10854770.	22.4297659	0.0017055	-0.0005756	0.0903338	0.00000	0.00000	32.5898013	
0.00008026	852.0576038	10616264.	22.0295821	0.0017681	-0.0006397	0.1452765	0.00000	0.00000	33.4689062	
0.00008448	871.3990057	10314387.	21.6599039	0.0018299	-0.0007046	0.2101435	0.00000	0.00000	34.3247044	
0.00008871	882.7368375	9951036.	21.3154060	0.0018908	-0.0007704	0.2853885	0.00000	0.00000	35.1547073	
0.00009293	885.3938469	9527307.	20.9916778	0.0019508	-0.0008372	0.3715275	0.00000	0.00000	35.9562822	
0.00009716	878.6270864	9043428.	20.6849906	0.0020097	-0.0009050	0.4691491	0.00000	0.00000	36.7265566	
0.0001014	861.6029034	8498695.	20.3921152	0.0020674	-0.0009741	0.5789301	0.00000	0.00000	37.4622988	
0.0001056	833.3803318	7891500.	20.1102150	0.0021237	-0.0010444	0.7016488	0.00000	0.00000	38.1598973	
0.0001098	792.8747652	7219175.	19.8367191	0.0021786	-0.0011162	0.8382101	0.00000	0.00000	38.8151975	
0.0001141	738.8089343	6477758.	19.5692024	0.0022319	-0.0011897	0.9896821	0.00000	0.00000	39.4232670	
0.0001183	669.6722883	5661880.	19.3053339	0.0022834	-0.0012649	1.1573305	0.00000	0.00000	39.9783077	
0.0001225	583.6355400	4764311.	19.0427536	0.0023328	-0.0013423	1.3426835	0.00000	0.00000	40.4732756	
0.0001267	478.4345084	3775353.	18.7789415	0.0023798	-0.0014220	1.5476252	0.00000	0.00000	40.8993841	
0.0001309	351.2253597	2682134.	18.5111154	0.0024240	-0.0015045	1.7745104	0.00000	0.00000	41.2456142	
0.0001352	198.3131472	1467094.	18.2359771	0.0024650	-0.0015902	2.0263768	0.00000	0.00000	41.4975623	
0.0001394	14.7274051	105650.	17.9493606	0.0025021	-0.0016798	2.3072827	0.00000	0.00000	41.6356996	
0.0001436	-206.4922145	-1437743.	17.6456816	0.0025343	-0.0017744	2.6228681	0.00000	0.00000	41.6325487	

Summary of Results for Nominal Moment Capacity for Section 2

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	445.0000000000	-206.4922145475

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or Rock Layer	F0 Integral is Below for Layer lbs	F1 Integral for Layer lbs
1	0.00	0.00	N.A.	No	0.00	94334.
2	9.5000	9.2184	Yes	No	94334.	14260.
3	10.0000	9.7183	Yes	No	108594.	31867.
4	11.0000	11.0000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Displacement and Pile-head Rotation (Loading Type 5)
Displacement of pile head = -0.975000 inches
Rotation of pile head = 0.000E+00 radians
Axial load on pile head = 445000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	-0.9750	2859584.	-52723.	0.00	81780.	5.73E+09	0.00	0.00	0.00

0.10000	-0.9746	2796169.	-52706.	5.92E-04	80349.	5.73E+09	11.0838	13.6466	0.00
0.2000	-0.9736	2732456.	-52686.	0.00114	78911.	6.42E+09	23.0013	28.3506	0.00
0.3000	-0.9719	2668504.	-52651.	0.00163	77467.	6.70E+09	35.6710	44.0427	0.00
0.4000	-0.9697	2604348.	-52600.	0.00210	76019.	6.95E+09	49.0114	60.6543	0.00
0.5000	-0.9669	2540023.	-52533.	0.00254	74567.	7.17E+09	62.9410	78.1175	0.00
0.6000	-0.9636	2475562.	-52449.	0.00295	73112.	7.35E+09	77.3782	96.3646	0.00
0.7000	-0.9598	2410996.	-52347.	0.00334	71654.	7.53E+09	92.1329	115.1918	0.00
0.8000	-0.9555	2346357.	-52227.	0.00372	70195.	7.71E+09	107.1721	134.5901	0.00
0.9000	-0.9509	2281678.	-52090.	0.00408	68735.	7.88E+09	122.4222	154.4987	0.00
1.0000	-0.9458	2216990.	-51933.	0.00441	67275.	8.06E+09	137.7970	174.8394	0.00
1.1000	-0.9403	2152324.	-51759.	0.00474	65816.	8.24E+09	153.2103	195.5322	0.00
1.2000	-0.9344	2087711.	-51566.	0.00504	64357.	8.41E+09	168.5760	216.4942	0.00
1.3000	-0.9282	2023182.	-51354.	0.00533	62901.	8.58E+09	184.0272	237.9234	0.00
1.4000	-0.9216	1958767.	-51124.	0.00561	61447.	8.74E+09	199.3884	259.6204	0.00
1.5000	-0.9147	1894495.	-50876.	0.00587	59996.	8.89E+09	214.5141	281.4195	0.00
1.6000	-0.9075	1830396.	-50609.	0.00612	58549.	9.02E+09	229.3230	303.2333	0.00
1.7000	-0.9000	1766497.	-50326.	0.00636	57106.	9.14E+09	243.7336	324.9703	0.00
1.8000	-0.8923	1702825.	-50025.	0.00658	55669.	9.24E+09	257.6643	346.5350	0.00
1.9000	-0.8842	1639406.	-49707.	0.00680	54238.	9.33E+09	272.1682	369.3671	0.00
2.0000	-0.8759	1576266.	-49371.	0.00701	52813.	9.39E+09	286.9351	393.0914	0.00
2.1000	-0.8674	1513432.	-49018.	0.00720	51394.	9.43E+09	301.2897	416.8149	0.00
2.2000	-0.8586	1450928.	-48649.	0.00739	49983.	9.44E+09	315.1670	440.4612	0.00
2.3000	-0.8497	1388781.	-48262.	0.00757	48580.	9.44E+09	328.5016	463.9496	0.00
2.4000	-0.8405	1327011.	-47861.	0.00774	47186.	9.44E+09	341.2284	487.1950	0.00
2.5000	-0.8311	1265644.	-47444.	0.00791	45801.	9.44E+09	353.8863	510.9794	0.00
2.6000	-0.8215	1204699.	-47011.	0.00807	44425.	9.44E+09	366.5074	535.3800	0.00
2.7000	-0.8117	1144201.	-46564.	0.00822	43060.	9.44E+09	378.4867	559.5347	0.00
2.8000	-0.8018	1084170.	-46103.	0.00836	41705.	9.44E+09	389.7657	583.3573	0.00
2.9000	-0.7917	1024627.	-45629.	0.00849	40361.	9.44E+09	400.2863	606.7559	0.00
3.0000	-0.7814	965591.	-45143.	0.00862	39028.	9.44E+09	409.9903	629.6320	0.00
3.1000	-0.7710	907079.	-44645.	0.00874	37707.	9.44E+09	420.5564	654.5839	0.00
3.2000	-0.7604	849112.	-44132.	0.00885	36399.	9.44E+09	433.2981	683.7764	0.00
3.3000	-0.7497	791711.	-43605.	0.00895	35103.	9.44E+09	445.5529	713.1346	0.00
3.4000	-0.7389	734897.	-43063.	0.00905	33821.	9.44E+09	457.2811	742.6078	0.00
3.5000	-0.7280	678692.	-42508.	0.00914	32552.	9.44E+09	468.4431	772.1416	0.00
3.6000	-0.7170	623116.	-41940.	0.00922	31297.	9.44E+09	478.9993	801.6766	0.00
3.7000	-0.7059	568187.	-41358.	0.00930	30058.	9.44E+09	490.7022	834.1950	0.00
3.8000	-0.6947	513927.	-40759.	0.00937	28833.	9.44E+09	507.1552	876.0677	0.00
3.9000	-0.6834	460361.	-40141.	0.00943	27624.	9.44E+09	523.5341	919.2881	0.00
4.0000	-0.6720	407518.	-39503.	0.00948	26431.	9.44E+09	539.8200	963.8941	0.00
4.1000	-0.6606	355425.	-38845.	0.00953	25255.	9.44E+09	555.9945	1010.	0.00
4.2000	-0.6492	304109.	-38168.	0.00957	24097.	9.44E+09	572.0388	1057.	0.00
4.3000	-0.6377	253595.	-37472.	0.00961	22956.	9.44E+09	587.9343	1106.	0.00
4.4000	-0.6261	203911.	-36757.	0.00964	21835.	9.44E+09	603.6625	1157.	0.00
4.5000	-0.6145	155083.	-36024.	0.00966	20733.	9.44E+09	619.2047	1209.	0.00
4.6000	-0.6029	107135.	-35271.	0.00968	19650.	9.44E+09	634.5422	1263.	0.00
4.7000	-0.5913	60094.	-34501.	0.00969	18589.	9.44E+09	649.6564	1318.	0.00
4.8000	-0.5797	13985.	-33712.	0.00969	17548.	9.44E+09	664.5287	1376.	0.00
4.9000	-0.5680	-31169.	-32906.	0.00969	17936.	9.44E+09	679.2843	1435.	0.00
5.0000	-0.5564	-75342.	-32077.	0.00969	18933.	9.44E+09	702.5631	1515.	0.00
5.1000	-0.5448	-118499.	-31223.	0.00967	19907.	9.44E+09	720.0094	1586.	0.00
5.2000	-0.5332	-160611.	-30352.	0.00966	20858.	9.44E+09	731.9033	1647.	0.00
5.3000	-0.5216	-201658.	-29467.	0.00963	21784.	9.44E+09	743.2869	1710.	0.00
5.4000	-0.5101	-241620.	-28569.	0.00961	22686.	9.44E+09	754.1419	1774.	0.00

5.5000	-0.4985	-280481.	-27658.	0.00957	23563.	9.44E+09	764.4508	1840.	0.00
5.6000	-0.4871	-318221.	-26734.	0.00953	24415.	9.44E+09	774.1968	1907.	0.00
5.7000	-0.4757	-354826.	-25800.	0.00949	25241.	9.44E+09	783.3638	1976.	0.00
5.8000	-0.4643	-390278.	-24855.	0.00944	26042.	9.44E+09	791.9364	2047.	0.00
5.9000	-0.4530	-424563.	-23900.	0.00939	26816.	9.44E+09	799.9002	2119.	0.00
6.0000	-0.4418	-457667.	-22935.	0.00934	27563.	9.44E+09	807.2413	2193.	0.00
6.1000	-0.4306	-489578.	-21963.	0.00928	28283.	9.44E+09	813.9465	2268.	0.00
6.2000	-0.4195	-520284.	-20981.	0.00921	28976.	9.44E+09	821.7573	2351.	0.00
6.3000	-0.4085	-549771.	-19990.	0.00914	29642.	9.44E+09	829.6086	2437.	0.00
6.4000	-0.3976	-578026.	-18990.	0.00907	30280.	9.44E+09	836.9990	2526.	0.00
6.5000	-0.3867	-605036.	-17982.	0.00900	30889.	9.44E+09	843.9263	2619.	0.00
6.6000	-0.3760	-630791.	-16965.	0.00892	31471.	9.44E+09	850.3892	2714.	0.00
6.7000	-0.3653	-655277.	-15941.	0.00884	32023.	9.44E+09	856.3872	2813.	0.00
6.8000	-0.3548	-678486.	-14910.	0.00875	32547.	9.44E+09	861.9203	2916.	0.00
6.9000	-0.3443	-700408.	-13873.	0.00866	33042.	9.44E+09	866.9893	3022.	0.00
7.0000	-0.3340	-721034.	-12830.	0.00857	33508.	9.44E+09	871.5956	3132.	0.00
7.1000	-0.3237	-740356.	-11781.	0.00848	33944.	9.44E+09	875.7414	3246.	0.00
7.2000	-0.3136	-758366.	-10728.	0.00839	34350.	9.44E+09	879.4291	3365.	0.00
7.3000	-0.3036	-775059.	-9671.	0.00829	34727.	9.44E+09	882.6622	3489.	0.00
7.4000	-0.2937	-790428.	-8610.	0.00819	35074.	9.44E+09	885.4442	3617.	0.00
7.5000	-0.2840	-804468.	-7546.	0.00809	35391.	9.44E+09	887.7795	3752.	0.00
7.6000	-0.2743	-817176.	-6480.	0.00798	35678.	9.44E+09	889.6728	3892.	0.00
7.7000	-0.2648	-828546.	-5411.	0.00788	35935.	9.44E+09	891.1292	4038.	0.00
7.8000	-0.2554	-838577.	-4341.	0.00777	36161.	9.44E+09	892.1542	4192.	0.00
7.9000	-0.2461	-847267.	-3270.	0.00767	36357.	9.44E+09	892.7538	4352.	0.00
8.0000	-0.2370	-854613.	-2199.	0.00756	36523.	9.44E+09	892.8191	4521.	0.00
8.1000	-0.2280	-860616.	-1128.	0.00745	36658.	9.44E+09	892.1541	4696.	0.00
8.2000	-0.2191	-865276.	-58.1634	0.00734	36764.	9.44E+09	890.7378	4878.	0.00
8.3000	-0.2104	-868594.	1009.	0.00723	36839.	9.44E+09	888.5509	5068.	0.00
8.4000	-0.2018	-870574.	2074.	0.00712	36883.	9.44E+09	885.5733	5267.	0.00
8.5000	-0.1933	-871219.	3134.	0.00701	36898.	9.44E+09	881.7835	5474.	0.00
8.6000	-0.1850	-870536.	4190.	0.00690	36882.	9.44E+09	877.1589	5691.	0.00
8.7000	-0.1767	-868530.	5239.	0.00679	36837.	9.44E+09	871.6752	5918.	0.00
8.8000	-0.1687	-865210.	6281.	0.00668	36762.	9.44E+09	865.3062	6156.	0.00
8.9000	-0.1607	-860585.	7315.	0.00657	36658.	9.44E+09	858.0236	6406.	0.00
9.0000	-0.1529	-854667.	8340.	0.00646	36524.	9.44E+09	849.7967	6669.	0.00
9.1000	-0.1452	-847466.	9354.	0.00635	36362.	9.44E+09	840.5918	6946.	0.00
9.2000	-0.1377	-838998.	10357.	0.00624	36170.	9.44E+09	830.3719	7238.	0.00
9.3000	-0.1302	-829277.	11346.	0.00614	35951.	9.44E+09	819.0961	7547.	0.00
9.4000	-0.1229	-818320.	12322.	0.00603	35704.	9.44E+09	806.7187	7874.	0.00
9.5000	-0.1158	-806146.	13275.	0.00593	35429.	9.44E+09	781.7125	8103.	0.00
9.6000	-0.1087	-792792.	14224.	0.00583	35127.	9.44E+09	799.9853	8830.	0.00
9.7000	-0.1018	-778231.	15174.	0.00573	34799.	9.44E+09	783.9905	9243.	0.00
9.8000	-0.09498	-762489.	16105.	0.00563	34443.	9.44E+09	766.5800	9686.	0.00
9.9000	-0.08828	-745592.	17013.	0.00553	34062.	9.44E+09	747.6644	10163.	0.00
10.0000	-0.08170	-727567.	17898.	0.00544	33655.	9.44E+09	727.1296	10680.	0.00
10.1000	-0.07523	-708445.	18755.	0.00535	33224.	9.44E+09	701.2358	11186.	0.00
10.2000	-0.06886	-688266.	19580.	0.00526	32768.	9.44E+09	673.4877	11736.	0.00
10.3000	-0.06260	-667070.	20370.	0.00517	32290.	9.44E+09	643.7797	12340.	0.00
10.4000	-0.05645	-644902.	21124.	0.00509	31789.	9.44E+09	611.9777	13010.	0.00
10.5000	-0.05039	-621809.	21838.	0.00501	31268.	9.44E+09	577.9081	13763.	0.00
10.6000	-0.04443	-597841.	22509.	0.00493	30727.	9.44E+09	541.3436	14622.	0.00
10.7000	-0.03855	-573053.	23131.	0.00486	30167.	9.44E+09	495.0358	15408.	0.00
10.8000	-0.03277	-547514.	23683.	0.00479	29591.	9.44E+09	424.6930	15552.	0.00

10.9000	-0.02707	-521326.	24150.	0.00472	29000.	9.44E+09	354.0544	15696.	0.00
11.0000	-0.02145	-494592.	34291.	0.00465	28396.	9.44E+09	16547.	925868.	0.00
11.1000	-0.01590	-443997.	62409.	0.00460	0.00	1.03E+10	30316.	2287889.	0.00
11.2000	-0.01042	-349719.	96136.	0.00455	0.00	9.73E+09	25896.	2983200.	0.00
11.3000	-0.00498	-218128.	119108.	0.00451	0.00	9.37E+09	12392.	2983200.	0.00
11.4000	4.14E-04	-68679.	125926.	0.00449	0.00	9.36E+09	-1029.	2983200.	0.00
11.5000	0.00580	79293.	116654.	0.00450	0.00	9.36E+09	-14424.	2983200.	0.00
11.6000	0.01120	206489.	91290.	0.00163	0.00	-4.32E+07	-27849.	2983200.	0.00
11.7000	0.00971	296647.	60090.	-0.00122	0.00	9.50E+09	-24150.	2983200.	0.00
11.8000	0.00827	352009.	33262.	-0.00118	0.00	9.75E+09	-20563.	2983200.	0.00
11.9000	0.00688	377736.	10661.	-0.00114	0.00	9.88E+09	-17105.	2983200.	0.00
12.0000	0.00554	378808.	-7874.	-0.00109	0.00	9.88E+09	-13785.	2983200.	0.00
12.1000	0.00426	360004.	-22505.	-0.00105	0.00	9.79E+09	-10601.	2983200.	0.00
12.2000	0.00304	325912.	-33395.	-0.00100	0.00	9.60E+09	-7549.	2983200.	0.00
12.3000	0.00186	280928.	-40695.	-9.64E-04	0.00	9.44E+09	-4618.	2983200.	0.00
12.4000	7.22E-04	229273.	-44543.	-9.32E-04	0.00	9.37E+09	-1795.	2983200.	0.00
12.5000	-3.79E-04	175019.	-45055.	-9.06E-04	0.00	9.36E+09	941.7461	2983200.	0.00
12.6000	-0.00145	122110.	-42323.	-8.87E-04	0.00	9.36E+09	3611.	2983200.	0.00
12.7000	-0.00251	74391.	-36416.	-8.74E-04	0.00	9.36E+09	6234.	2983200.	0.00
12.8000	-0.00355	35645.	-27379.	-8.67E-04	0.00	9.36E+09	8828.	2983200.	0.00
12.9000	-0.00459	9608.	-15237.	-8.64E-04	0.00	9.36E+09	11409.	2983200.	0.00
13.0000	-0.00563	0.00	0.00	-8.64E-04	0.00	9.36E+09	13986.	1491600.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

Pile-head deflection = -0.97500000 inches
Computed slope at pile head = 0.000000 radians
Maximum bending moment = 2859584. inch-lbs
Maximum shear force = 125926. lbs
Depth of maximum bending moment = 0.000000 feet below pile head
Depth of maximum shear force = 11.40000000 feet below pile head
Number of iterations = 38
Number of zero deflection points = 2

Summary of Pile-head Responses for Conventional Analyses

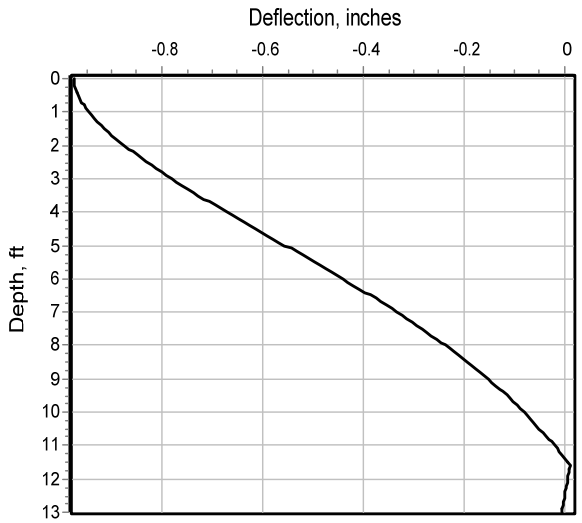
Definitions of Pile-head Loading Conditions:

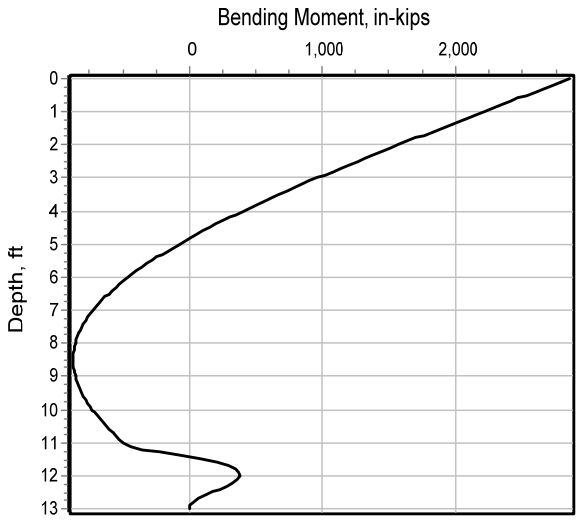
Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

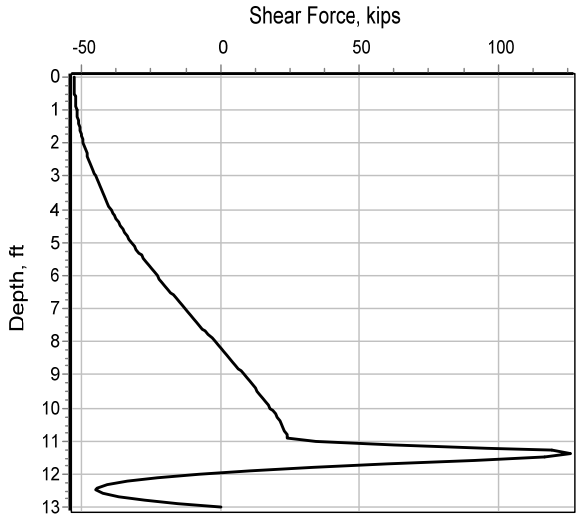
Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Axial Pile-head Load 2	Pile-head Loading lbs	Pile-head Deflection inches	Max Shear Rotation radians	Max Moment in Pile lbs	in Pile in-lbs
1	y, in	-0.9750	S, rad	0.00	445000.	-0.9750	0.00	125926.	2859584.

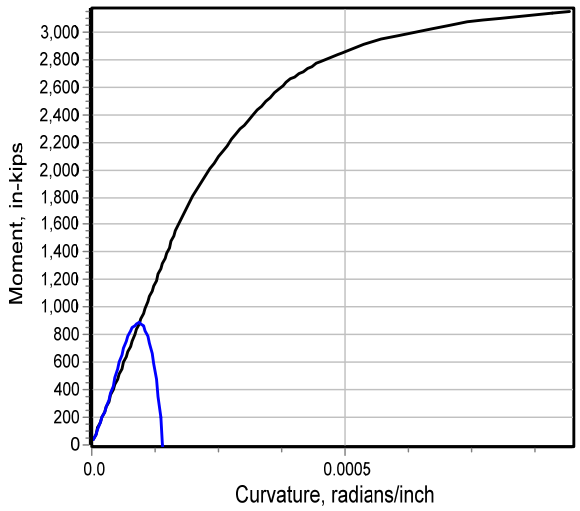
Maximum pile-head deflection = -0.9750000000 inches
Maximum pile-head rotation = 0.0000000000 radians = 0.000000 deg.

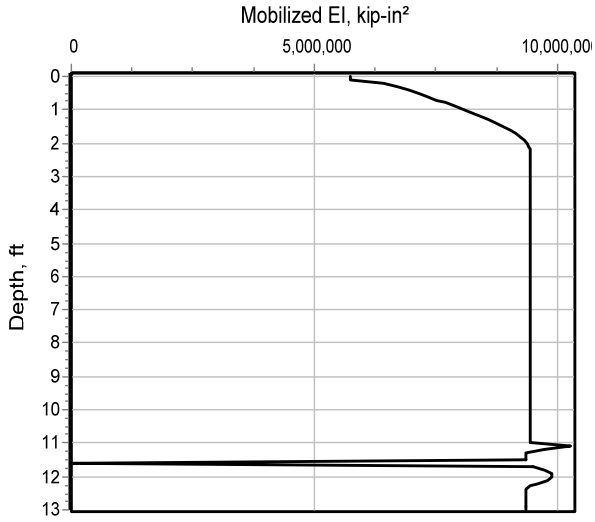
The analysis ended normally.

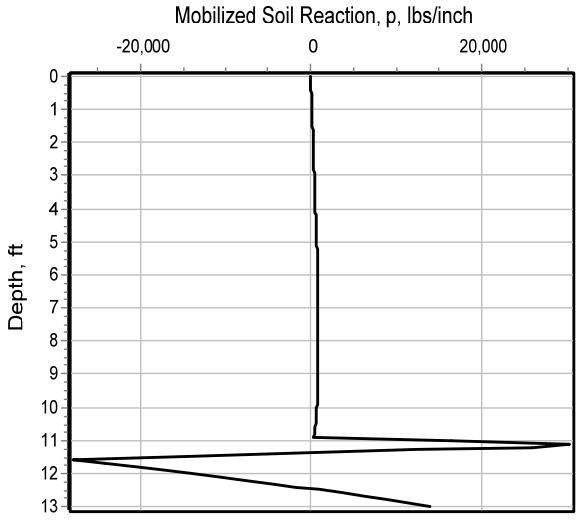

Deflection, inches
-0.8
-0.6
-0.4
-0.2
0
Depth, ft
0
1
2
3
4
5
6
7
8
9
10
11
12
13


Bending Moment, in-kips
0
1,000
2,000
Depth, ft
0
1
2
3
4
5
6
7
8
9
10
11
12
13


Shear Force, kips
-50
0
50
100
Depth, ft
0
1
2
3
4
5
6
7
8
9
10
11
12
13


Moment, in-kips
3,000
2,800
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0.0
0.0005
Curvature, radians/inch


Mobilized EI, kip-in²
0
5,000,000
10,000,00
Depth, ft
0
1
2
3
4
5
6
7
8
9
10
11
12
13


Mobilized Soil Reaction, p, lbs/inch
-20,000
0
20,000
Depth, ft
0
1
2
3
4
5
6
7
8
9
10
11
12
13

Attachment 2

==========

LPile for Windows, Version 2019-11.005

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

==========

This copy of LPile is being used by:

KAR
Golder Associates, Inc.

Serial Number of Security Device: 239146533

This copy of LPile is licensed for exclusive use by:

GOLDER, Manchester, NH

Use of this program by any entity other than GOLDER, Manchester, NH
is a violation of the software license agreement.

Files Used for Analysis

Path to file locations:
\\golderassociates.sharepoint.com@SSL\DavWWWRoot\sites\139982\Project Files\5 Technical Work\06 Analysis\Phase II - Pile Design\LPILE\Abutment 2 Strength I\

Name of input data file:
Freeport Exit 22 Abutment 2 with Socket MaxSoil 2ftPile GirderRotation PlasticHinge.lp11d

Name of output report file:
Freeport Exit 22 Abutment 2 with Socket MaxSoil 2ftPile GirderRotation PlasticHinge.lp11o

Name of plot output file:
Freeport Exit 22 Abutment 2 with Socket MaxSoil 2ftPile GirderRotation PlasticHinge.lp11p

Name of runtime message file:
Freeport Exit 22 Abutment 2 with Socket MaxSoil 2ftPile GirderRotation PlasticHinge.lp11r

---

Date and Time of Analysis

Date: July 14, 2021 Time: 16:20:08

Problem Title

Project Name: MaineDOT I-295 Exit 22 Mallet Drive Bridge No. 5721
Job Number: 21450910
Client: MaineDOT
Engineer: KAR
Description: Abutment 2 Pile Design - Strength I (Rock Socket)

Program Options and Settings

Computational Options:
- Conventional Analysis

Engineering Units Used for Data Input and Computations:
- US Customary System Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 1000
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 130

Loading Type and Number of Cycles of Loading:
- Static loading specified

- Use of p-y modification factors for p-y curves not selected
- Analysis uses layering correction (Method of Georgiadis)
- No distributed lateral loads are entered
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Input of moment resistance at the pile tip not selected
- Input of side resistance moment along pile not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- Output files use decimal points to denote decimal symbols.
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 2
Total length of pile = 13.000 ft
Depth of ground surface below top of pile = 0.0000 ft

Pile diameters used for p-y curve computations are defined using 4 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	14.6950
2	11.000	14.6950
3	11.000	30.0000
4	13.000	30.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is a H weak axis steel pile
Length of section = 11.000000 ft
Pile width = 13.830000 in
Shear capacity of section = 0.0000 lbs

Pile Section No. 2:

Section 2 is a drilled shaft with casing and H section core/insert
Length of section = 2.000000 ft
Section Diameter = 30.000000 in
Shear capacity of section = 0.0000 lbs

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 4 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 0.0000 ft
Distance from top of pile to bottom of layer = 9.500000 ft
Effective unit weight at top of layer = 125.000000 pcf
Effective unit weight at bottom of layer = 125.000000 pcf
Friction angle at top of layer = 32.000000 deg.
Friction angle at bottom of layer = 32.000000 deg.
Subgrade k at top of layer = 88.000000 pci
Subgrade k at bottom of layer = 88.000000 pci

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 9.500000 ft
Distance from top of pile to bottom of layer = 10.000000 ft
Effective unit weight at top of layer = 125.000000 pcf
Effective unit weight at bottom of layer = 125.000000 pcf
Friction angle at top of layer = 33.000000 deg.
Friction angle at bottom of layer = 33.000000 deg.
Subgrade k at top of layer = 165.000000 pci
Subgrade k at bottom of layer = 165.000000 pci

Layer 3 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 10.000000 ft
Distance from top of pile to bottom of layer = 11.000000 ft
Effective unit weight at top of layer = 62.600000 pcf
Effective unit weight at bottom of layer = 6.260000 pcf
Friction angle at top of layer = 33.000000 deg.
Friction angle at bottom of layer = 33.000000 deg.
Subgrade k at top of layer = 100.000000 pci
Subgrade k at bottom of layer = 100.000000 pci

Layer 4 is strong rock (vuggy limestone)

Distance from top of pile to top of layer = 11.000000 ft
Distance from top of pile to bottom of layer = 20.000000 ft
Effective unit weight at top of layer = 106.600000 pcf
Effective unit weight at bottom of layer = 106.600000 pcf
Uniaxial compressive strength at top of layer = 2486. psi
Uniaxial compressive strength at bottom of layer = 2486. psi

(Depth of the lowest soil layer extends 7.000 ft below the pile tip)

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	Uniaxial qu psi	kpy pci
1	Sand	0.00	125.0000	32.0000	--	88.0000
	(Reese, et al.)	9.5000	125.0000	32.0000	--	88.0000
2	Sand	9.5000	125.0000	33.0000	--	165.0000
	(Reese, et al.)	10.0000	125.0000	33.0000	--	165.0000
3	Sand	10.0000	62.6000	33.0000	--	100.0000
	(Reese, et al.)	11.0000	6.2600	33.0000	--	100.0000
4	Strong Rock	11.0000	106.6000	--	2486.	--
	(Vuggy Limestone)	20.0000	106.6000	--	2486.	--

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	5	y = -0.975000 in	S = 0.0000 in/in	445000.	N.A.	Yes
2	4	y = -0.975000 in	M = 1728649. in-lbs	445000.	N.A.	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 2

Pile Section No. 1:

Dimensions and Properties of Steel H Weak Axis:

Length of Section = 11.000000 ft
Flange Width = 14.695000 in
Section Depth = 13.830000 in
Flange Thickness = 0.615000 in
Web Thickness = 0.615000 in
Yield Stress of Pipe = 50.000000 ksi
Elastic Modulus = 29000. ksi
Cross-sectional Area = 25.823850 sq. in.
Moment of Inertia = 325.505721 in^4
Elastic Bending Stiffness = 9439666. kip-in^2
Plastic Modulus, Z = 67.593889in^3
Plastic Moment Capacity = Fy Z = 3380.in-kip

Axial Structural Capacities:

Nom. Axial Structural Capacity = Fy As = 1291.193 kips
Nominal Axial Tensile Capacity = -1291.193 kips

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	445.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 445.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000422	39.8712137	9438779.	148.0161667	18.1232118	
0.00000845	79.7424273	9438779.	77.6818334	19.0142911	
0.00001267	119.6136410	9438779.	54.2370556	19.9053706	
0.00001690	159.4848546	9438779.	42.5146667	20.7964500	

0.00002112	199.3560683	9438779.	35.4812333	21.6875295	
0.00002535	239.2272819	9438779.	30.7922778	22.5786090	
0.00002957	279.0984956	9438779.	27.4430238	23.4696887	
0.00003379	318.9697093	9438779.	24.9310833	24.3607682	
0.00003802	358.8409229	9438779.	22.9773519	25.2518476	
0.00004224	398.7121366	9438779.	21.4143667	26.1429271	
0.00004647	438.5833502	9438779.	20.1355606	27.0340066	
0.00005069	478.4545639	9438779.	19.0698889	27.9250860	
0.00005491	518.3257775	9438779.	18.1681667	28.8161655	
0.00005914	558.1969912	9438779.	17.3952619	29.7072450	
0.00006336	598.0682049	9438779.	16.7254111	30.5983245	
0.00006759	637.9394185	9438779.	16.1392917	31.4894039	
0.00007181	677.8106322	9438779.	15.6221275	32.3804834	
0.00007604	717.6818458	9438779.	15.1624259	33.2715629	
0.00008026	757.5530595	9438779.	14.7511140	34.1626425	
0.00008448	797.4242731	9438779.	14.3809333	35.0537219	
0.00008871	837.2954868	9438779.	14.0460079	35.9448015	
0.00009293	877.1667005	9438779.	13.7415303	36.8358810	
0.00009716	917.0379141	9438779.	13.4635290	37.7269604	
0.0001014	956.9091278	9438779.	13.2086944	38.6180399	
0.0001056	996.7803414	9438779.	12.9742467	39.5091194	
0.0001098	1037.	9438779.	12.7578333	40.4001989	
0.0001141	1077.	9438779.	12.5574506	41.2912783	
0.0001183	1116.	9438779.	12.3713810	42.1823578	
0.0001225	1156.	9438779.	12.1981437	43.0734373	
0.0001267	1196.	9438779.	12.0364556	43.9645168	
0.0001309	1236.	9438779.	11.8851989	44.8555963	
0.0001352	1276.	9438779.	11.7433958	45.7466757	
0.0001394	1316.	9438779.	11.6101869	46.6377552	
0.0001436	1356.	9438779.	11.4848137	47.5288347	
0.0001478	1395.	9438779.	11.3666048	48.4199142	
0.0001521	1435.	9438779.	11.2549630	49.3109937	
0.0001563	1475.	9437067.	11.1496701	50.0000000	Y
0.0001605	1513.	9426369.	11.0515978	50.0000000	Y
0.0001647	1550.	9407830.	10.9601450	50.0000000	Y
0.0001732	1619.	9350066.	10.7952114	50.0000000	Y
0.0001816	1684.	9272173.	10.6508365	50.0000000	Y
0.0001901	1745.	9180270.	10.5237852	50.0000000	Y
0.0001985	1802.	9078703.	10.4114698	50.0000000	Y
0.0002070	1857.	8970923.	10.3117171	50.0000000	Y
0.0002154	1908.	8858170.	10.2230711	50.0000000	Y
0.0002239	1958.	8744039.	10.1436334	50.0000000	Y
0.0002323	2005.	8628493.	10.0725409	50.0000000	Y
0.0002408	2050.	8513781.	10.0084332	50.0000000	Y
0.0002492	2093.	8399743.	9.9506904	50.0000000	Y
0.0002577	2135.	8287097.	9.8985268	50.0000000	Y
0.0002661	2176.	8176587.	9.8512036	50.0000000	Y
0.0002746	2215.	8068412.	9.8081975	50.0000000	Y
0.0002830	2254.	7962730.	9.7690447	50.0000000	Y
0.0002915	2291.	7859672.	9.7333330	50.0000000	Y
0.0002999	2327.	7759339.	9.7006939	50.0000000	Y
0.0003084	2363.	7661810.	9.6707965	50.0000000	Y
0.0003168	2397.	7567143.	9.6433428	50.0000000	Y
0.0003253	2431.	7474974.	9.6182185	50.0000000	Y

0.0003337	2465.	7385342.	9.5951883	50.0000000	Y
0.0003422	2497.	7298311.	9.5738347	50.0000000	Y
0.0003506	2528.	7209946.	9.5527829	50.0000000	Y
0.0003591	2556.	7119836.	9.5323352	50.0000000	Y
0.0003675	2583.	7029282.	9.5120993	50.0000000	Y
0.0003760	2609.	6938766.	9.4921610	50.0000000	Y
0.0003844	2632.	6848188.	9.4727887	50.0000000	Y
0.0003928	2655.	6758754.	9.4535662	50.0000000	Y
0.0004013	2677.	6669692.	9.4350782	50.0000000	Y
0.0004097	2697.	6581531.	9.4164255	50.0000000	Y
0.0004182	2716.	6494008.	9.3983995	50.0000000	Y
0.0004266	2734.	6408390.	9.3806174	50.0000000	Y
0.0004351	2751.	6323609.	9.3631625	50.0000000	Y
0.0004435	2768.	6240019.	9.3459336	50.0000000	Y
0.0004520	2784.	6158627.	9.3290310	50.0000000	Y
0.0004604	2798.	6077521.	9.3124488	50.0000000	Y
0.0004689	2813.	5998574.	9.2961248	50.0000000	Y
0.0004773	2826.	5921058.	9.2799508	50.0000000	Y
0.0004858	2839.	5844660.	9.2642581	50.0000000	Y
0.0004942	2852.	5770103.	9.2487422	50.0000000	Y
0.0005027	2864.	5696955.	9.2332190	50.0000000	Y
0.0005365	2907.	5418472.	9.1745062	50.0000000	Y
0.0005703	2944.	5162039.	9.1192596	50.0000000	Y
0.0006041	2975.	4925588.	9.0672850	50.0000000	Y
0.0006379	3003.	4708046.	9.0183539	50.0000000	Y
0.0006716	3028.	4507716.	8.9720369	50.0000000	Y
0.0007054	3049.	4322082.	8.9282954	50.0000000	Y
0.0007392	3068.	4150447.	8.8866078	50.0000000	Y
0.0007730	3085.	3991130.	8.8474011	50.0000000	Y
0.0008068	3101.	3843269.	8.8099043	50.0000000	Y
0.0008406	3115.	3705157.	8.7742739	50.0000000	Y
0.0008744	3127.	3576304.	8.7403185	50.0000000	Y
0.0009082	3139.	3456004.	8.7078844	50.0000000	Y
0.0009420	3150.	3343467.	8.6771919	50.0000000	Y

Summary of Results for Nominal Moment Capacity for Section 1

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	445.0000000000	3150.

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction

factor to compute ultimate moment capacity according to the LRFD structural
design standard being followed.

Pile Section No. 2:

Dimensions and Properties of Drilled Shaft (Bored Pile) with Casing and H Weak Axis Core/Insert:

Length of Section = 2.000000 ft
Outside Diameter of Casing = 30.000000 in
Casing Wall Thickness = 0.0000 in
Moment of Inertia of Steel Casing = 0.0000 in^4
Width Flange of Core/Insert = 14.695000 in
Depth of Core/Insert = 13.830000 in
Flange Thickness of Core/Insert = 0.615000 in
Web Thickness of Core/Insert = 0.615000 in
Moment of Inertia of Steel Core/Insert = 325.505721 in^4
Yield Stress of Casing = 50000. psi
Elastic Modulus of Casing = 29000000. psi
Yield Stress of Core/Insert = 50000. psi
Elastic Modulus of Core/Insert = 29000000. psi
Number of Reinforcing Bars = 0 bars
Gross Area of Pile = 706.858347 sq. in.
Area of Concrete = 681.034497 sq. in.
Cross-sectional Area of Steel Casing = 0.0000 sq. in.
Cross-sectional Area of Steel Core/Insert = 25.823850 sq. in.
Area of All Steel (Casing, Core/Insert, and Bars) = 25.823850 sq. in.
Area Ratio of All Steel to Gross Area = 3.65 percent

Note that the core is assumed to be void of concrete.

Axial Structural Capacities:

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As = 1320.136 kips
Tensile Load for Cracking of Concrete = NaN kips
Nominal Axial Tensile Capacity = -1291.193 kips

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	445.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 445.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Max Core Stress ksi	Run Msg
0.00000422	39.5556389	9364072.	145.0568738	0.0006127	0.0004860	0.0494237	0.00000	0.00000	16.8325576	
0.00000845	79.1112779	9364072.	80.0284369	0.0006761	0.0004227	0.0495548	0.00000	0.00000	17.7329441	
0.00001267	118.6669168	9364072.	58.3522913	0.0007395	0.0003593	0.0496859	0.00000	0.00000	18.6333307	
0.00001690	158.2225557	9364072.	47.5142184	0.0008028	0.0002959	0.0498170	0.00000	0.00000	19.5337171	
0.00002112	197.7781947	9364072.	41.0113748	0.0008662	0.0002326	0.0499481	0.00000	0.00000	20.4341037	
0.00002535	237.4406843	9368288.	36.6765360	0.0009296	0.0001692	0.0499997	0.00000	0.00000	21.3347772	
0.00002957	278.8172667	9429268.	33.5858646	0.0009931	0.0001060	0.0499909	0.00000	0.00000	22.2402887	
0.00003379	324.1631864	9592461.	31.2799832	0.0010571	0.00004326	0.0499999	0.00000	0.00000	23.1576801	
0.00003802	374.7731154	9857851.	29.5015594	0.0011216	-0.00001895	0.0499917	0.00000	0.00000	24.0916528	
0.00004224	430.3800432	10188458.	28.0925868	0.0011867	-0.00008057	0.0499867	0.00000	0.00000	25.0424894	
0.00004647	488.5383174	10513863.	26.9476907	0.0012522	-0.0001418	0.0499943	0.00000	0.00000	26.0039710	
0.00005069	546.8677085	10788408.	25.9962074	0.0013178	-0.0002030	0.0499909	0.00000	0.00000	26.9692701	
0.00005491	603.5877650	10991410.	25.1899807	0.0013833	-0.0002641	0.0499771	0.00000	0.00000	27.9327769	
0.00005914	657.3777991	11115867.	24.4952668	0.0014486	-0.0003255	0.0499902	0.00000	0.00000	28.8900027	
0.00006336	707.2219898	11161456.	23.8877639	0.0015136	-0.0003873	0.0499987	0.00000	0.00000	29.8372734	
0.00006759	752.2953376	11130758.	23.3495304	0.0015781	-0.0004495	0.0499978	0.00000	0.00000	30.7714738	
0.00007181	791.8885244	11027358.	22.8670183	0.0016421	-0.0005122	0.0499977	0.00000	0.00000	31.6898472	
0.00007604	825.3473929	10854770.	22.4297659	0.0017055	-0.0005756	0.0903338	0.00000	0.00000	32.5898013	
0.00008026	852.0576038	10616264.	22.0295821	0.0017681	-0.0006397	0.1452765	0.00000	0.00000	33.4689062	
0.00008448	871.3990057	10314387.	21.6599039	0.0018299	-0.0007046	0.2101435	0.00000	0.00000	34.3247044	
0.00008871	882.7368375	9951036.	21.3154060	0.0018908	-0.0007704	0.2853885	0.00000	0.00000	35.1547073	
0.00009293	885.3938469	9527307.	20.9916778	0.0019508	-0.0008372	0.3715275	0.00000	0.00000	35.9562822	
0.00009716	878.6270864	9043428.	20.6849906	0.0020097	-0.0009050	0.4691491	0.00000	0.00000	36.7265566	
0.0001014	861.6029034	8498695.	20.3921152	0.0020674	-0.0009741	0.5789301	0.00000	0.00000	37.4622988	
0.0001056	833.3803318	7891500.	20.1102150	0.0021237	-0.0010444	0.7016488	0.00000	0.00000	38.1598973	
0.0001098	792.8747652	7219175.	19.8367191	0.0021786	-0.0011162	0.8382101	0.00000	0.00000	38.8151975	
0.0001141	738.8089343	6477758.	19.5692024	0.0022319	-0.0011897	0.9896821	0.00000	0.00000	39.4232670	
0.0001183	669.6722883	5661880.	19.3053339	0.0022834	-0.0012649	1.1573305	0.00000	0.00000	39.9783077	
0.0001225	583.6355400	4764311.	19.0427536	0.0023328	-0.0013423	1.3426835	0.00000	0.00000	40.4732756	
0.0001267	478.4345084	3775353.	18.7789415	0.0023798	-0.0014220	1.5476252	0.00000	0.00000	40.8993841	
0.0001309	351.2253597	2682134.	18.5111154	0.0024240	-0.0015045	1.7745104	0.00000	0.00000	41.2456142	
0.0001352	198.3131472	1467094.	18.2359771	0.0024650	-0.0015902	2.0263768	0.00000	0.00000	41.4975623	
0.0001394	14.7274051	105650.	17.9493606	0.0025021	-0.0016798	2.3072827	0.00000	0.00000	41.6356996	
0.0001436	-206.4922145	-1437743.	17.6456816	0.0025343	-0.0017744	2.6228681	0.00000	0.00000	41.6325487	

Summary of Results for Nominal Moment Capacity for Section 2

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips

1	445.0000000000	-206.4922145475

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	0.00	0.00	N.A.	No	0.00	94334.
2	9.5000	9.2184	Yes	No	94334.	14260.
3	10.0000	9.7183	Yes	No	108594.	31867.
4	11.0000	11.0000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Displacement and Pile-head Rotation (Loading Type 5)
Displacement of pile head = -0.975000 inches
Rotation of pile head = 0.000E+00 radians
Axial load on pile head = 445000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch

0.00	-0.9750	2859584.	-52723.	0.00	81780.	5.73E+09	0.00	0.00	0.00
0.10000	-0.9746	2796169.	-52706.	5.92E-04	80349.	5.73E+09	11.0838	13.6466	0.00
0.2000	-0.9736	2732456.	-52686.	0.00114	78911.	6.42E+09	23.0013	28.3506	0.00
0.3000	-0.9719	2668504.	-52651.	0.00163	77467.	6.70E+09	35.6710	44.0427	0.00
0.4000	-0.9697	2604348.	-52600.	0.00210	76019.	6.95E+09	49.0114	60.6543	0.00
0.5000	-0.9669	2540023.	-52533.	0.00254	74567.	7.17E+09	62.9410	78.1175	0.00
0.6000	-0.9636	2475562.	-52449.	0.00295	73112.	7.35E+09	77.3782	96.3646	0.00
0.7000	-0.9598	2410996.	-52347.	0.00334	71654.	7.53E+09	92.1329	115.1918	0.00
0.8000	-0.9555	2346357.	-52227.	0.00372	70195.	7.71E+09	107.1721	134.5901	0.00
0.9000	-0.9509	2281678.	-52090.	0.00408	68735.	7.88E+09	122.4222	154.4987	0.00
1.0000	-0.9458	2216990.	-51933.	0.00441	67275.	8.06E+09	137.7970	174.8394	0.00
1.1000	-0.9403	2152324.	-51759.	0.00474	65816.	8.24E+09	153.2103	195.5322	0.00
1.2000	-0.9344	2087711.	-51566.	0.00504	64357.	8.41E+09	168.5760	216.4942	0.00
1.3000	-0.9282	2023182.	-51354.	0.00533	62901.	8.58E+09	184.0272	237.9234	0.00
1.4000	-0.9216	1958767.	-51124.	0.00561	61447.	8.74E+09	199.3884	259.6204	0.00
1.5000	-0.9147	1894495.	-50876.	0.00587	59996.	8.89E+09	214.5141	281.4195	0.00
1.6000	-0.9075	1830396.	-50609.	0.00612	58549.	9.02E+09	229.3230	303.2333	0.00
1.7000	-0.9000	1766497.	-50326.	0.00636	57106.	9.14E+09	243.7336	324.9703	0.00
1.8000	-0.8923	1702825.	-50025.	0.00658	55669.	9.24E+09	257.6643	346.5350	0.00
1.9000	-0.8842	1639406.	-49707.	0.00680	54238.	9.33E+09	272.1682	369.3671	0.00
2.0000	-0.8759	1576266.	-49371.	0.00701	52813.	9.39E+09	286.9351	393.0914	0.00
2.1000	-0.8674	1513432.	-49018.	0.00720	51394.	9.43E+09	301.2897	416.8149	0.00
2.2000	-0.8586	1450928.	-48649.	0.00739	49983.	9.44E+09	315.1670	440.4612	0.00
2.3000	-0.8497	1388781.	-48262.	0.00757	48580.	9.44E+09	328.5016	463.9496	0.00
2.4000	-0.8405	1327011.	-47861.	0.00774	47186.	9.44E+09	341.2284	487.1950	0.00
2.5000	-0.8311	1265644.	-47444.	0.00791	45801.	9.44E+09	353.8863	510.9794	0.00
2.6000	-0.8215	1204699.	-47011.	0.00807	44425.	9.44E+09	366.5074	535.3800	0.00
2.7000	-0.8117	1144201.	-46564.	0.00822	43060.	9.44E+09	378.4867	559.5347	0.00
2.8000	-0.8018	1084170.	-46103.	0.00836	41705.	9.44E+09	389.7657	583.3573	0.00
2.9000	-0.7917	1024627.	-45629.	0.00849	40361.	9.44E+09	400.2863	606.7559	0.00
3.0000	-0.7814	965591.	-45143.	0.00862	39028.	9.44E+09	409.9903	629.6320	0.00
3.1000	-0.7710	907079.	-44645.	0.00874	37707.	9.44E+09	420.5564	654.5839	0.00
3.2000	-0.7604	849112.	-44132.	0.00885	36399.	9.44E+09	433.2981	683.7764	0.00
3.3000	-0.7497	791711.	-43605.	0.00895	35103.	9.44E+09	445.5529	713.1346	0.00
3.4000	-0.7389	734897.	-43063.	0.00905	33821.	9.44E+09	457.2811	742.6078	0.00
3.5000	-0.7280	678692.	-42508.	0.00914	32552.	9.44E+09	468.4431	772.1416	0.00
3.6000	-0.7170	623116.	-41940.	0.00922	31297.	9.44E+09	478.9993	801.6766	0.00
3.7000	-0.7059	568187.	-41358.	0.00930	30058.	9.44E+09	490.7022	834.1950	0.00
3.8000	-0.6947	513927.	-40759.	0.00937	28833.	9.44E+09	507.1552	876.0677	0.00
3.9000	-0.6834	460361.	-40141.	0.00943	27624.	9.44E+09	523.5341	919.2881	0.00
4.0000	-0.6720	407518.	-39503.	0.00948	26431.	9.44E+09	539.8200	963.8941	0.00
4.1000	-0.6606	355425.	-38845.	0.00953	25255.	9.44E+09	555.9945	1010.	0.00
4.2000	-0.6492	304109.	-38168.	0.00957	24097.	9.44E+09	572.0388	1057.	0.00
4.3000	-0.6377	253595.	-37472.	0.00961	22956.	9.44E+09	587.9343	1106.	0.00
4.4000	-0.6261	203911.	-36757.	0.00964	21835.	9.44E+09	603.6625	1157.	0.00
4.5000	-0.6145	155083.	-36024.	0.00966	20733.	9.44E+09	619.2047	1209.	0.00
4.6000	-0.6029	107135.	-35271.	0.00968	19650.	9.44E+09	634.5422	1263.	0.00
4.7000	-0.5913	60094.	-34501.	0.00969	18589.	9.44E+09	649.6564	1318.	0.00
4.8000	-0.5797	13985.	-33712.	0.00969	17548.	9.44E+09	664.5287	1376.	0.00
4.9000	-0.5680	-31169.	-32906.	0.00969	17936.	9.44E+09	679.2843	1435.	0.00
5.0000	-0.5564	-75342.	-32077.	0.00969	18933.	9.44E+09	702.5631	1515.	0.00
5.1000	-0.5448	-118499.	-31223.	0.00967	19907.	9.44E+09	720.0094	1586.	0.00
5.2000	-0.5332	-160611.	-30352.	0.00966	20858.	9.44E+09	731.9033	1647.	0.00
5.3000	-0.5216	-201658.	-29467.	0.00963	21784.	9.44E+09	743.2869	1710.	0.00

5.4000	-0.5101	-241620.	-28569.	0.00961	22686.	9.44E+09	754.1419	1774.	0.00
5.5000	-0.4985	-280481.	-27658.	0.00957	23563.	9.44E+09	764.4508	1840.	0.00
5.6000	-0.4871	-318221.	-26734.	0.00953	24415.	9.44E+09	774.1968	1907.	0.00
5.7000	-0.4757	-354826.	-25800.	0.00949	25241.	9.44E+09	783.3638	1976.	0.00
5.8000	-0.4643	-390278.	-24855.	0.00944	26042.	9.44E+09	791.9364	2047.	0.00
5.9000	-0.4530	-424563.	-23900.	0.00939	26816.	9.44E+09	799.9002	2119.	0.00
6.0000	-0.4418	-457667.	-22935.	0.00934	27563.	9.44E+09	807.2413	2193.	0.00
6.1000	-0.4306	-489578.	-21963.	0.00928	28283.	9.44E+09	813.9465	2268.	0.00
6.2000	-0.4195	-520284.	-20981.	0.00921	28976.	9.44E+09	821.7573	2351.	0.00
6.3000	-0.4085	-549771.	-19990.	0.00914	29642.	9.44E+09	829.6086	2437.	0.00
6.4000	-0.3976	-578026.	-18990.	0.00907	30280.	9.44E+09	836.9990	2526.	0.00
6.5000	-0.3867	-605036.	-17982.	0.00900	30889.	9.44E+09	843.9263	2619.	0.00
6.6000	-0.3760	-630791.	-16965.	0.00892	31471.	9.44E+09	850.3892	2714.	0.00
6.7000	-0.3653	-655277.	-15941.	0.00884	32023.	9.44E+09	856.3872	2813.	0.00
6.8000	-0.3548	-678486.	-14910.	0.00875	32547.	9.44E+09	861.9203	2916.	0.00
6.9000	-0.3443	-700408.	-13873.	0.00866	33042.	9.44E+09	866.9893	3022.	0.00
7.0000	-0.3340	-721034.	-12830.	0.00857	33508.	9.44E+09	871.5956	3132.	0.00
7.1000	-0.3237	-740356.	-11781.	0.00848	33944.	9.44E+09	875.7414	3246.	0.00
7.2000	-0.3136	-758366.	-10728.	0.00839	34350.	9.44E+09	879.4291	3365.	0.00
7.3000	-0.3036	-775059.	-9671.	0.00829	34727.	9.44E+09	882.6622	3489.	0.00
7.4000	-0.2937	-790428.	-8610.	0.00819	35074.	9.44E+09	885.4442	3617.	0.00
7.5000	-0.2840	-804468.	-7546.	0.00809	35391.	9.44E+09	887.7795	3752.	0.00
7.6000	-0.2743	-817176.	-6480.	0.00798	35678.	9.44E+09	889.6728	3892.	0.00
7.7000	-0.2648	-828546.	-5411.	0.00788	35935.	9.44E+09	891.1292	4038.	0.00
7.8000	-0.2554	-838577.	-4341.	0.00777	36161.	9.44E+09	892.1542	4192.	0.00
7.9000	-0.2461	-847267.	-3270.	0.00767	36357.	9.44E+09	892.7538	4352.	0.00
8.0000	-0.2370	-854613.	-2199.	0.00756	36523.	9.44E+09	892.8191	4521.	0.00
8.1000	-0.2280	-860616.	-1128.	0.00745	36658.	9.44E+09	892.1541	4696.	0.00
8.2000	-0.2191	-865276.	-58.1634	0.00734	36764.	9.44E+09	890.7378	4878.	0.00
8.3000	-0.2104	-868594.	1009.	0.00723	36839.	9.44E+09	888.5509	5068.	0.00
8.4000	-0.2018	-870574.	2074.	0.00712	36883.	9.44E+09	885.5733	5267.	0.00
8.5000	-0.1933	-871219.	3134.	0.00701	36898.	9.44E+09	881.7835	5474.	0.00
8.6000	-0.1850	-870536.	4190.	0.00690	36882.	9.44E+09	877.1589	5691.	0.00
8.7000	-0.1767	-868530.	5239.	0.00679	36837.	9.44E+09	871.6752	5918.	0.00
8.8000	-0.1687	-865210.	6281.	0.00668	36762.	9.44E+09	865.3062	6156.	0.00
8.9000	-0.1607	-860585.	7315.	0.00657	36658.	9.44E+09	858.0236	6406.	0.00
9.0000	-0.1529	-854667.	8340.	0.00646	36524.	9.44E+09	849.7967	6669.	0.00
9.1000	-0.1452	-847466.	9354.	0.00635	36362.	9.44E+09	840.5918	6946.	0.00
9.2000	-0.1377	-838998.	10357.	0.00624	36170.	9.44E+09	830.3719	7238.	0.00
9.3000	-0.1302	-829277.	11346.	0.00614	35951.	9.44E+09	819.0961	7547.	0.00
9.4000	-0.1229	-818320.	12322.	0.00603	35704.	9.44E+09	806.7187	7874.	0.00
9.5000	-0.1158	-806146.	13275.	0.00593	35429.	9.44E+09	781.7125	8103.	0.00
9.6000	-0.1087	-792792.	14224.	0.00583	35127.	9.44E+09	799.9853	8830.	0.00
9.7000	-0.1018	-778231.	15174.	0.00573	34799.	9.44E+09	783.9905	9243.	0.00
9.8000	-0.09498	-762489.	16105.	0.00563	34443.	9.44E+09	766.5800	9686.	0.00
9.9000	-0.08828	-745592.	17013.	0.00553	34062.	9.44E+09	747.6644	10163.	0.00
10.0000	-0.08170	-727567.	17898.	0.00544	33655.	9.44E+09	727.1296	10680.	0.00
10.1000	-0.07523	-708445.	18755.	0.00535	33224.	9.44E+09	701.2358	11186.	0.00
10.2000	-0.06886	-688266.	19580.	0.00526	32768.	9.44E+09	673.4877	11736.	0.00
10.3000	-0.06260	-667070.	20370.	0.00517	32290.	9.44E+09	643.7797	12340.	0.00
10.4000	-0.05645	-644902.	21124.	0.00509	31789.	9.44E+09	611.9777	13010.	0.00
10.5000	-0.05039	-621809.	21838.	0.00501	31268.	9.44E+09	577.9081	13763.	0.00
10.6000	-0.04443	-597841.	22509.	0.00493	30727.	9.44E+09	541.3436	14622.	0.00
10.7000	-0.03855	-573053.	23131.	0.00486	30167.	9.44E+09	495.0358	15408.	0.00

10.8000	-0.03277	-547514.	23683.	0.00479	29591.	9.44E+09	424.6930	15552.	0.00
10.9000	-0.02707	-521326.	24150.	0.00472	29000.	9.44E+09	354.0544	15696.	0.00
11.0000	-0.02145	-494592.	34291.	0.00465	28396.	9.44E+09	16547.	925868.	0.00
11.1000	-0.01590	-443997.	62409.	0.00460	0.00	1.03E+10	30316.	2287889.	0.00
11.2000	-0.01042	-349719.	96136.	0.00455	0.00	9.73E+09	25896.	2983200.	0.00
11.3000	-0.00498	-218128.	119108.	0.00451	0.00	9.37E+09	12392.	2983200.	0.00
11.4000	4.14E-04	-68679.	125926.	0.00449	0.00	9.36E+09	-1029.	2983200.	0.00
11.5000	0.00580	79293.	116654.	0.00450	0.00	9.36E+09	-14424.	2983200.	0.00
11.6000	0.01120	206489.	91290.	0.00163	0.00	-4.32E+07	-27849.	2983200.	0.00
11.7000	0.00971	296647.	60090.	-0.00122	0.00	9.50E+09	-24150.	2983200.	0.00
11.8000	0.00827	352009.	33262.	-0.00118	0.00	9.75E+09	-20563.	2983200.	0.00
11.9000	0.00688	377736.	10661.	-0.00114	0.00	9.88E+09	-17105.	2983200.	0.00
12.0000	0.00554	378808.	-7874.	-0.00109	0.00	9.88E+09	-13785.	2983200.	0.00
12.1000	0.00426	360004.	-22505.	-0.00105	0.00	9.79E+09	-10601.	2983200.	0.00
12.2000	0.00304	325912.	-33395.	-0.00100	0.00	9.60E+09	-7549.	2983200.	0.00
12.3000	0.00186	280928.	-40695.	-9.64E-04	0.00	9.44E+09	-4618.	2983200.	0.00
12.4000	7.22E-04	229273.	-44543.	-9.32E-04	0.00	9.37E+09	-1795.	2983200.	0.00
12.5000	-3.79E-04	175019.	-45055.	-9.06E-04	0.00	9.36E+09	941.7461	2983200.	0.00
12.6000	-0.00145	122110.	-42323.	-8.87E-04	0.00	9.36E+09	3611.	2983200.	0.00
12.7000	-0.00251	74391.	-36416.	-8.74E-04	0.00	9.36E+09	6234.	2983200.	0.00
12.8000	-0.00355	35645.	-27379.	-8.67E-04	0.00	9.36E+09	8828.	2983200.	0.00
12.9000	-0.00459	9608.	-15237.	-8.64E-04	0.00	9.36E+09	11409.	2983200.	0.00
13.0000	-0.00563	0.00	0.00	-8.64E-04	0.00	9.36E+09	13986.	1491600.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

Pile-head deflection = -0.97500000 inches
Computed slope at pile head = 0.000000 radians
Maximum bending moment = 2859584. inch-lbs
Maximum shear force = 125926. lbs
Depth of maximum bending moment = 0.000000 feet below pile head
Depth of maximum shear force = 11.40000000 feet below pile head
Number of iterations = 38
Number of zero deflection points = 2

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Displacement and Moment (Loading Type 4)
Displacement of pile head = -0.975000 inches
Moment at pile head = 1728649.0 in-lbs
Axial load at pile head = 445000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	-0.9750	1728649.	-38213.	0.00509	56252.	9.18E+09	0.00	0.00	0.00
0.10000	-0.9688	1680015.	-38206.	0.00531	55154.	9.18E+09	11.0838	13.7295	0.00
0.2000	-0.9623	1631281.	-38186.	0.00553	54054.	9.34E+09	23.0013	28.6843	0.00
0.3000	-0.9555	1582467.	-38151.	0.00573	52952.	9.38E+09	35.6709	44.7990	0.00
0.4000	-0.9485	1533596.	-38100.	0.00593	51849.	9.42E+09	49.0113	62.0075	0.00
0.5000	-0.9413	1484692.	-38033.	0.00612	50745.	9.43E+09	62.9410	80.2429	0.00
0.6000	-0.9338	1435777.	-37949.	0.00631	49641.	9.44E+09	77.3783	99.4371	0.00
0.7000	-0.9261	1386877.	-37847.	0.00649	48538.	9.44E+09	92.1330	119.3801	0.00
0.8000	-0.9182	1338015.	-37727.	0.00666	47435.	9.44E+09	107.1723	140.0607	0.00
0.9000	-0.9101	1289216.	-37589.	0.00683	46333.	9.44E+09	122.4224	161.4141	0.00
1.0000	-0.9018	1240507.	-37433.	0.00699	45234.	9.44E+09	137.7973	183.3567	0.00
1.1000	-0.8933	1191911.	-37259.	0.00714	44137.	9.44E+09	153.2107	205.8020	0.00
1.2000	-0.8847	1143455.	-37066.	0.00729	43043.	9.44E+09	168.5766	228.6600	0.00
1.3000	-0.8758	1095164.	-36854.	0.00744	41953.	9.44E+09	184.0279	252.1377	0.00
1.4000	-0.8668	1047064.	-36624.	0.00757	40867.	9.44E+09	199.3892	276.0225	0.00
1.5000	-0.8577	999180.	-36376.	0.00770	39786.	9.44E+09	214.5151	300.1354	0.00
1.6000	-0.8484	951537.	-36109.	0.00783	38711.	9.44E+09	229.3241	324.3795	0.00
1.7000	-0.8389	904160.	-35826.	0.00794	37641.	9.44E+09	243.7348	348.6527	0.00
1.8000	-0.8293	857072.	-35525.	0.00806	36578.	9.44E+09	257.6657	372.8476	0.00
1.9000	-0.8196	810297.	-35207.	0.00816	35523.	9.44E+09	272.1698	398.5120	0.00
2.0000	-0.8097	763859.	-34871.	0.00826	34474.	9.44E+09	286.9368	425.2478	0.00
2.1000	-0.7997	717783.	-34518.	0.00836	33434.	9.44E+09	301.2916	452.0899	0.00
2.2000	-0.7896	672091.	-34149.	0.00844	32403.	9.44E+09	315.1690	478.9510	0.00
2.3000	-0.7795	626808.	-33762.	0.00853	31381.	9.44E+09	328.5038	505.7380	0.00
2.4000	-0.7692	581955.	-33360.	0.00860	30368.	9.44E+09	341.2308	532.3524	0.00
2.5000	-0.7588	537554.	-32943.	0.00867	29366.	9.44E+09	353.8888	559.6442	0.00
2.6000	-0.7484	493626.	-32511.	0.00874	28375.	9.44E+09	366.5102	587.6978	0.00
2.7000	-0.7378	450192.	-32064.	0.00880	27394.	9.44E+09	378.4896	615.5649	0.00
2.8000	-0.7272	407273.	-31603.	0.00885	26425.	9.44E+09	389.7688	643.1441	0.00
2.9000	-0.7166	364888.	-31129.	0.00890	25469.	9.44E+09	400.2897	670.3269	0.00
3.0000	-0.7059	323054.	-30643.	0.00895	24524.	9.44E+09	409.9939	696.9973	0.00
3.1000	-0.6951	281788.	-30145.	0.00899	23593.	9.44E+09	420.5601	726.0293	0.00
3.2000	-0.6843	241109.	-29632.	0.00902	22675.	9.44E+09	433.3021	759.8371	0.00
3.3000	-0.6735	201038.	-29105.	0.00905	21770.	9.44E+09	445.5571	793.9053	0.00
3.4000	-0.6626	161595.	-28563.	0.00907	20880.	9.44E+09	457.2855	828.1731	0.00
3.5000	-0.6517	122799.	-28008.	0.00909	20004.	9.44E+09	468.4477	862.5743	0.00
3.6000	-0.6408	84669.	-27439.	0.00910	19143.	9.44E+09	479.0042	897.0374	0.00
3.7000	-0.6299	47223.	-26858.	0.00911	18298.	9.44E+09	490.7073	934.8987	0.00
3.8000	-0.6189	10481.	-26259.	0.00911	17469.	9.44E+09	507.1607	983.3185	0.00
3.9000	-0.6080	-25531.	-25640.	0.00911	17808.	9.44E+09	523.5398	1033.	0.00
4.0000	-0.5970	-60788.	-25002.	0.00911	18604.	9.44E+09	539.8261	1085.	0.00
4.1000	-0.5861	-95264.	-24345.	0.00910	19382.	9.44E+09	556.0009	1138.	0.00
4.2000	-0.5752	-128932.	-23668.	0.00908	20142.	9.44E+09	572.0455	1193.	0.00
4.3000	-0.5643	-161768.	-22972.	0.00906	20884.	9.44E+09	587.9414	1250.	0.00
4.4000	-0.5535	-193747.	-22257.	0.00904	21605.	9.44E+09	603.6700	1309.	0.00
4.5000	-0.5426	-224842.	-21527.	0.00902	22307.	9.44E+09	612.6951	1355.	0.00
4.6000	-0.5318	-255041.	-20788.	0.00898	22989.	9.44E+09	619.0423	1397.	0.00
4.7000	-0.5211	-284330.	-20042.	0.00895	23650.	9.44E+09	624.4448	1438.	0.00
4.8000	-0.5103	-312701.	-19290.	0.00891	24291.	9.44E+09	628.8643	1479.	0.00

4.9000	-0.4997	-340146.	-18533.	0.00887	24910.	9.44E+09	632.4087	1519.	0.00
5.0000	-0.4890	-366656.	-17768.	0.00883	25509.	9.44E+09	643.8258	1580.	0.00
5.1000	-0.4785	-392215.	-16989.	0.00878	26085.	9.44E+09	654.8376	1642.	0.00
5.2000	-0.4680	-416804.	-16196.	0.00873	26640.	9.44E+09	665.4287	1706.	0.00
5.3000	-0.4575	-440406.	-15392.	0.00867	27173.	9.44E+09	675.5841	1772.	0.00
5.4000	-0.4472	-463006.	-14575.	0.00861	27683.	9.44E+09	685.2891	1839.	0.00
5.5000	-0.4369	-484587.	-13747.	0.00855	28171.	9.44E+09	694.5298	1908.	0.00
5.6000	-0.4266	-505136.	-12909.	0.00849	28634.	9.44E+09	703.2925	1978.	0.00
5.7000	-0.4165	-524637.	-12060.	0.00843	29075.	9.44E+09	711.5644	2050.	0.00
5.8000	-0.4064	-543078.	-11201.	0.00836	29491.	9.44E+09	719.3327	2124.	0.00
5.9000	-0.3964	-560446.	-10334.	0.00829	29883.	9.44E+09	726.5855	2199.	0.00
6.0000	-0.3865	-576730.	-9458.	0.00822	30250.	9.44E+09	733.3110	2277.	0.00
6.1000	-0.3767	-591919.	-8574.	0.00814	30593.	9.44E+09	739.4983	2356.	0.00
6.2000	-0.3670	-606003.	-7682.	0.00807	30911.	9.44E+09	747.0140	2443.	0.00
6.3000	-0.3574	-618970.	-6781.	0.00799	31204.	9.44E+09	754.7081	2534.	0.00
6.4000	-0.3478	-630808.	-5871.	0.00791	31471.	9.44E+09	762.0426	2629.	0.00
6.5000	-0.3384	-641507.	-4952.	0.00783	31713.	9.44E+09	769.0153	2727.	0.00
6.6000	-0.3290	-651054.	-4026.	0.00775	31928.	9.44E+09	775.6244	2829.	0.00
6.7000	-0.3198	-659440.	-3091.	0.00766	32117.	9.44E+09	781.8686	2934.	0.00
6.8000	-0.3106	-666655.	-2149.	0.00758	32280.	9.44E+09	787.7467	3043.	0.00
6.9000	-0.3016	-672691.	-1201.	0.00749	32416.	9.44E+09	793.2578	3156.	0.00
7.0000	-0.2927	-677539.	-245.7466	0.00741	32526.	9.44E+09	798.4014	3274.	0.00
7.1000	-0.2838	-681191.	715.2004	0.00732	32608.	9.44E+09	803.1769	3396.	0.00
7.2000	-0.2751	-683640.	1682.	0.00723	32664.	9.44E+09	807.5843	3523.	0.00
7.3000	-0.2665	-684880.	2653.	0.00715	32692.	9.44E+09	811.6232	3655.	0.00
7.4000	-0.2579	-684905.	3629.	0.00706	32692.	9.44E+09	815.2937	3793.	0.00
7.5000	-0.2495	-683709.	4610.	0.00697	32665.	9.44E+09	818.5957	3937.	0.00
7.6000	-0.2412	-681288.	5594.	0.00689	32611.	9.44E+09	821.5064	4087.	0.00
7.7000	-0.2330	-677638.	6581.	0.00680	32528.	9.44E+09	823.8488	4243.	0.00
7.8000	-0.2249	-672755.	7571.	0.00671	32418.	9.44E+09	825.5696	4405.	0.00
7.9000	-0.2169	-666638.	8562.	0.00663	32280.	9.44E+09	826.6483	4574.	0.00
8.0000	-0.2090	-659285.	9554.	0.00654	32114.	9.44E+09	827.0629	4749.	0.00
8.1000	-0.2012	-650697.	10546.	0.00646	31920.	9.44E+09	826.7902	4932.	0.00
8.2000	-0.1935	-640874.	11538.	0.00638	31698.	9.44E+09	825.8052	5122.	0.00
8.3000	-0.1859	-629818.	12528.	0.00630	31449.	9.44E+09	824.0811	5320.	0.00
8.4000	-0.1784	-617532.	13515.	0.00622	31171.	9.44E+09	821.5890	5528.	0.00
8.5000	-0.1709	-604022.	14499.	0.00614	30866.	9.44E+09	818.2976	5744.	0.00
8.6000	-0.1636	-589292.	15479.	0.00606	30534.	9.44E+09	814.1727	5971.	0.00
8.7000	-0.1564	-573350.	16453.	0.00599	30174.	9.44E+09	809.1771	6209.	0.00
8.8000	-0.1492	-556204.	17420.	0.00592	29787.	9.44E+09	803.2701	6459.	0.00
8.9000	-0.1422	-537863.	18380.	0.00585	29373.	9.44E+09	796.4067	6722.	0.00
9.0000	-0.1352	-518339.	19331.	0.00578	28932.	9.44E+09	788.5372	6999.	0.00
9.1000	-0.1283	-497645.	20272.	0.00572	28465.	9.44E+09	779.6065	7291.	0.00
9.2000	-0.1215	-475794.	21201.	0.00566	27972.	9.44E+09	769.5532	7602.	0.00
9.3000	-0.1147	-452802.	22118.	0.00560	27453.	9.44E+09	758.3085	7931.	0.00
9.4000	-0.1080	-428688.	23021.	0.00554	26909.	9.44E+09	745.7947	8283.	0.00
9.5000	-0.1014	-403470.	23901.	0.00549	26339.	9.44E+09	721.3343	8534.	0.00
9.6000	-0.09488	-377187.	24776.	0.00544	25746.	9.44E+09	736.4216	9314.	0.00
9.7000	-0.08838	-349817.	25649.	0.00539	25128.	9.44E+09	719.4795	9769.	0.00
9.8000	-0.08194	-321388.	26501.	0.00535	24487.	9.44E+09	700.7548	10263.	0.00
9.9000	-0.07554	-291928.	27330.	0.00531	23822.	9.44E+09	680.0853	10803.	0.00
10.0000	-0.06919	-261469.	28132.	0.00528	23134.	9.44E+09	657.2689	11399.	0.00
10.1000	-0.06288	-230045.	28904.	0.00524	22425.	9.44E+09	628.8304	12001.	0.00
10.2000	-0.05660	-197700.	29640.	0.00522	21695.	9.44E+09	597.8258	12674.	0.00

10.3000	-0.05036	-164481.	30337.	0.00519	20945.	9.44E+09	563.9904	13439.	0.00
10.4000	-0.04414	-130439.	30991.	0.00518	20176.	9.44E+09	526.9779	14327.	0.00
10.5000	-0.03794	-95629.	31594.	0.00516	19391.	9.44E+09	478.0274	15120.	0.00
10.6000	-0.03175	-60124.	32124.	0.00515	18589.	9.44E+09	403.8980	15264.	0.00
10.7000	-0.02558	-24033.	32563.	0.00515	17775.	9.44E+09	328.4019	15408.	0.00
10.8000	-0.01940	12532.	32911.	0.00514	17515.	9.44E+09	251.4710	15552.	0.00
10.9000	-0.01323	49458.	33166.	0.00515	18349.	9.44E+09	173.0335	15696.	0.00
11.0000	-0.00705	86630.	42124.	0.00516	19188.	9.44E+09	14757.	2513123.	0.00
11.1000	-8.51E-04	145047.	52248.	0.00517	0.00	9.36E+09	2116.	2983200.	0.00
11.2000	0.00537	206501.	45512.	0.00229	0.00	-4.29E+07	-13342.	2983200.	0.00
11.3000	0.00465	251827.	30568.	-5.80E-04	0.00	9.39E+09	-11565.	2983200.	0.00
11.4000	0.00398	280482.	17698.	-5.46E-04	0.00	9.44E+09	-9884.	2983200.	0.00
11.5000	0.00334	294886.	6782.	-5.09E-04	0.00	9.49E+09	-8310.	2983200.	0.00
11.6000	0.00275	297303.	-2312.	-4.72E-04	0.00	9.50E+09	-6847.	2983200.	0.00
11.7000	0.00221	289840.	-9717.	-4.35E-04	0.00	9.47E+09	-5495.	2983200.	0.00
11.8000	0.00171	274445.	-15567.	-3.99E-04	0.00	9.42E+09	-4254.	2983200.	0.00
11.9000	0.00125	252906.	-19989.	-3.65E-04	0.00	9.39E+09	-3116.	2983200.	0.00
12.0000	8.35E-04	226861.	-23104.	-3.34E-04	0.00	9.37E+09	-2075.	2983200.	0.00
12.1000	4.51E-04	197813.	-25022.	-3.07E-04	0.00	9.36E+09	-1121.	2983200.	0.00
12.2000	9.76E-05	167136.	-25841.	-2.84E-04	0.00	9.36E+09	-242.5492	2983200.	0.00
12.3000	-2.30E-04	136098.	-25643.	-2.64E-04	0.00	9.36E+09	572.2190	2983200.	0.00
12.4000	-5.37E-04	105876.	-24498.	-2.49E-04	0.00	9.36E+09	1335.	2983200.	0.00
12.5000	-8.28E-04	77568.	-22463.	-2.37E-04	0.00	9.36E+09	2057.	2983200.	0.00
12.6000	-0.00111	52217.	-19579.	-2.29E-04	0.00	9.36E+09	2750.	2983200.	0.00
12.7000	-0.00138	30823.	-15876.	-2.24E-04	0.00	9.36E+09	3422.	2983200.	0.00
12.8000	-0.00164	14355.	-11372.	-2.21E-04	0.00	9.36E+09	4083.	2983200.	0.00
12.9000	-0.00191	3766.	-6079.	-2.19E-04	0.00	9.36E+09	4739.	2983200.	0.00
13.0000	-0.00217	0.00	0.00	-2.19E-04	0.00	9.36E+09	5393.	1491600.	0.00

Lateral toe displacement of the internal H-pile core within the peastone-filled shaft

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 2:

Pile-head deflection = -0.97500000 inches
Computed slope at pile head = 0.00508922 radians
Maximum bending moment = 1728649. inch-lbs
Maximum shear force = 52248. lbs
Depth of maximum bending moment = 0.000000 feet below pile head
Depth of maximum shear force = 11.10000000 feet below pile head
Number of iterations = 17
Number of zero deflection points = 2

Summary of Pile-head Responses for Conventional Analyses

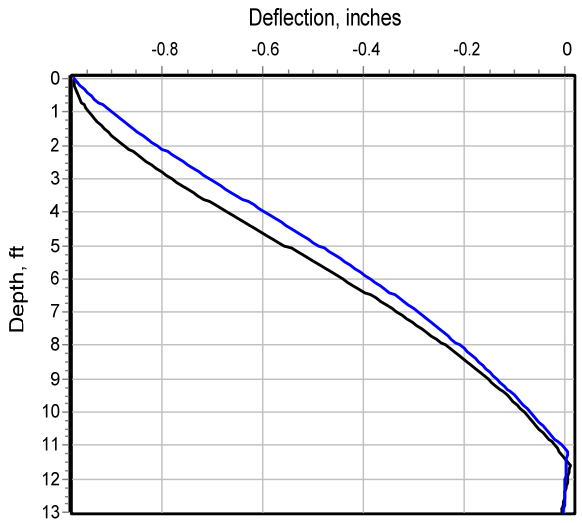
Definitions of Pile-head Loading Conditions:

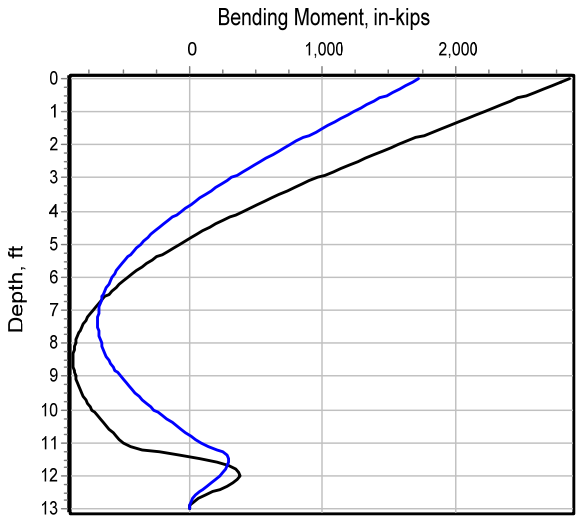
Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

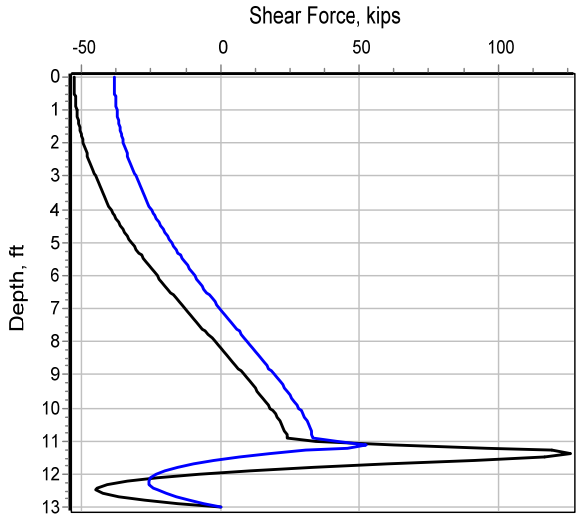
Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Pile-head Loading lbs	Pile-head Deflection inches	Max Shear Rotation radians	Max Moment in Pile lbs	in Pile in-lbs
1	y, in	-0.9750	S, rad	0.00	445000.	-0.9750	0.00	125926.	2859584.
2	y, in	-0.9750	M, in-lb	1728649.	445000.	-0.9750	0.00509	52248.	1728649.

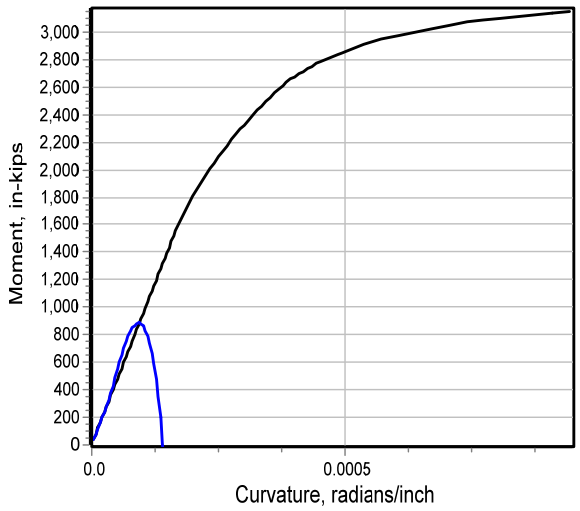
Maximum pile-head deflection = -0.9750000000 inches
Maximum pile-head rotation = 0.0050892236 radians = 0.291591 deg.

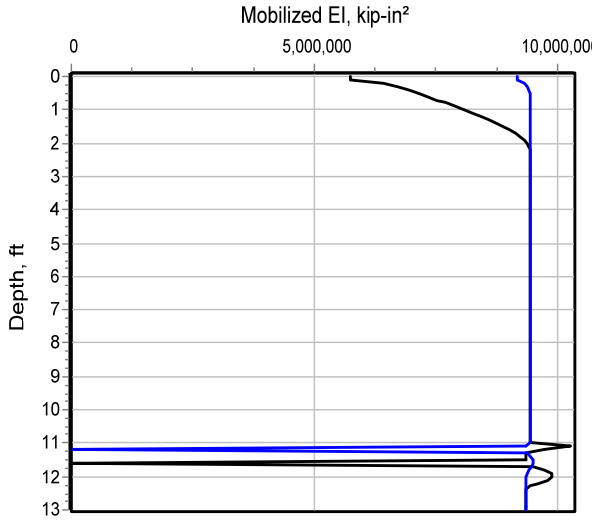
The analysis ended normally.

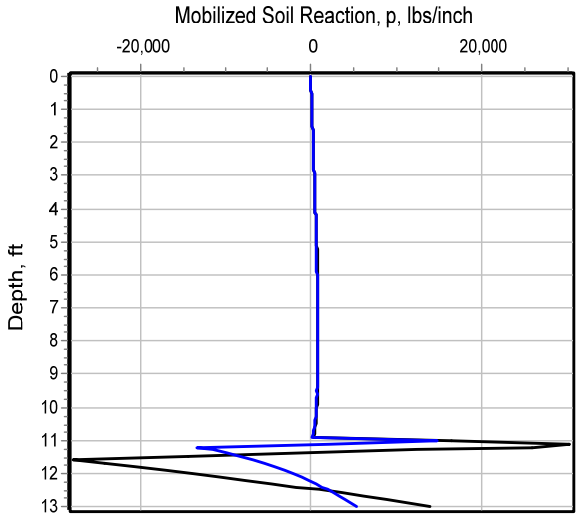












Legend:
----- First Iteration Load Case (with axial load and lateral deflection applied to pile head)
----- Second Iteration Load Case (with axial load, lateral deflection, and plastic hinge moment applied to pile head)

Attachment 3

GOLDER MEMBER OF WSP	**SUBJECT:**	MaineDOT Mallet Drive Bridge 5721 (Exit 22)		
	Job No.:	21450910	**Prepared:**	KAR
	Location:	Freeport, Maine	**Checked:**	AH
	Date:	6/29/2021	**Reviewed:**	JEL

Description:

Evaluate the downdrag load for Abutment 2 driven piles using APILE

References:

1 Golder Associates Inc.; "Preliminary Geotechnical Design Report - I-295 Mallet Drive Bridge Replacement"; December 21, 2020
2 AASHTO; "AASHTO LRFD Bridge Design Specifications - 9th Edition", 2020
3 FHWA; Design and Construction of Driven Pile Foundations - Volume 1; FHWA GEC 012; FHWA-NHI-16-009; July 2016
4 FHWA; Design and Construction of Driven Pile Foundations - Volume 2; FHWA GEC 012; FHWA-NHI-16-009; July 2016
5 FHWA; Design and Construction of Driven Pile Foundations - Comprehensive Design Examples; FHWA GEC 012; FHWA-NHI-16-064; September 2016
6 Wyllie, DA; Foundations on Rock, 2nd Edition; E&FN Spon; 1999
7 Siegel, TC et al; "Alternative Design Approach for Drag Load and Downdrag of Deep Foundations within the LRFD Framework"; Proceedings 38th Deep Foundations; 2013
8 Geotechnical Design Manual, Chapter 8 - Foundations, Oregon Department of Transportation, Geo-Environmental Section, Version 2.1, May 6, 2019.
9 Isenhower, W.M. et al. LPile v2019 Technical Manual: A Program for the Analysis of Deep Foundations Under Lateral Loading. Ensoft, Inc. Dated March 2020.
10 Golder settlement model created using Rocscience Settle3 software package, Version 5.010 64-bit, build date Mar 5, 2021
11 HNTB. May 7, 2021. Approach Road Bridge, Interstate 295, Route 136/125 (Mallett Dr.): 60% Plans.
12 HNTB. May 26, 2021. Freeport Bridges_Loads_Bottom of Footing_flat.pdf.
13 Golder's Phase II Updated Interpreted Subsurface Profile using HNTB design references.

Assumptions:

1. Settlement greater than or equal to 0.4" is needed for downdrag to fully develop (Ref 2).
2. The soil profile analyzed (Ref 1) is the interpreted profile where maximum settlement occurs along the abutment.
3. Any downdrag load that may develop along the back of the abutment due to settlement is not included in the pile downdrag analysis.
4. The FHWA automated computation method provided in APILE is used for the software computations of unit load transfers and axial pile capacity.

Calculations:

				Top Elev (ft)	Bot. Elev (ft)	Thickness (ft)
Granular Backfill Unit Weight:	γ	125	pcf	167.6	156.7	10.9
Granular Backfill Friction Angle:	φ	32	deg			
Passive Earth Pressure Coefficient	K_p	3.93				
Active Earth Pressure Coefficient	K_a	0.31				

Strength I Loads

Strength I Factored Vertical Load per pile (kips) = 402 No. piles = 8 (Ref. 12)

Starting elevation of the pile	-	156.65	ft	Ref. 11 (below the base of the abutment)
Ending elevation of the pile	-	146.4	ft	Ref. 1, Ref. 13
Box perimeter of pile	P:	57.05	in	for HP14x89
Segment Length:	L:	12	in	
Cross-sectional Area:	A_s:	26.1	in^2	for HP14x89
Elastic Modulus of Pile	E:	29000	ksi	
Nominal Weight of Pile		0.089	kips/ft	
Factored Pile Strength = ϕFyAs	P_r:	652.5	kips	Ref 3 Eq 8-35
	Fy :	50	ksi	Ref 3 Table 8-2
	ϕ :	0.5	-	Ref 2 Article 6.5.4.2 for axial resistance of H-piles in compression and subject to severe driving conditions

Non-Cohesive Soil Layers -Nordlund/Thurman Method

	Parameters						
Soil Layer	**ϕ_f (deg)**	**γ (pcf)**	**γ_{pDD}**	Top Elev (ft)	Bot. Elev (ft)	Thickness (ft)	
Soil 1	33	125	1.1	156.7	146.4	10.3	Fill, Ref. 1, Ref. 13

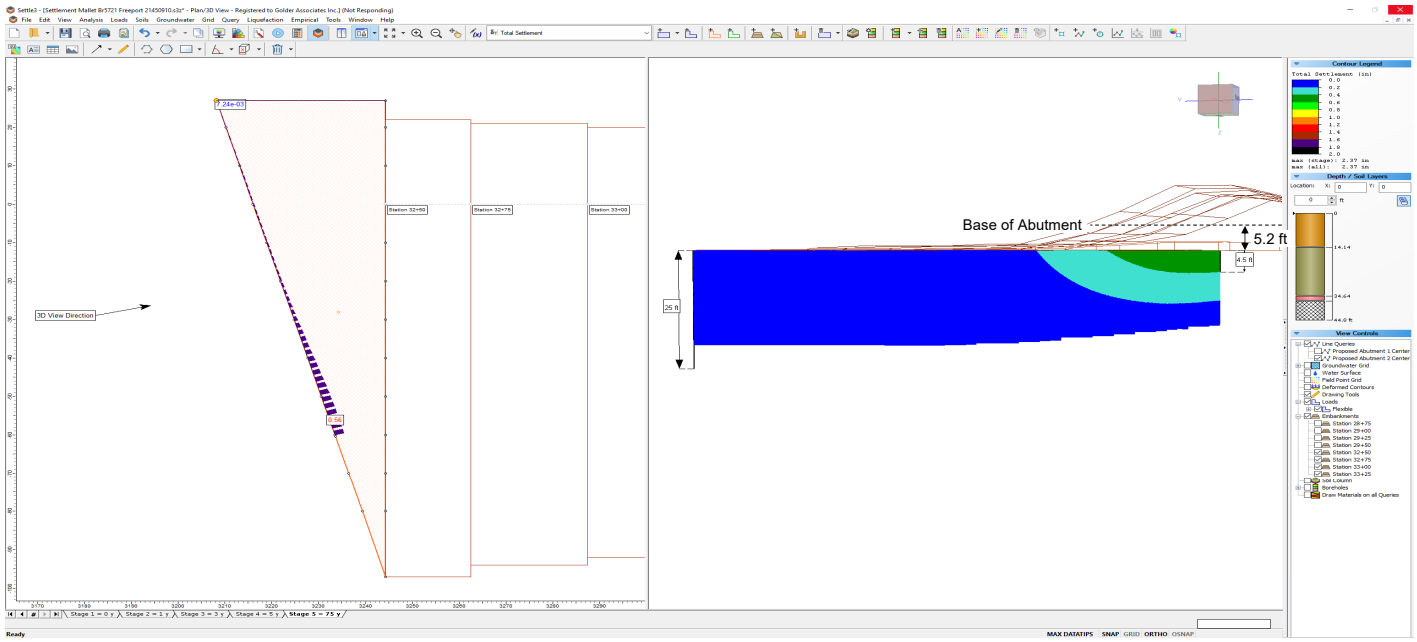
ϕ_f: Based on empirical correlation to avg of N_{60} values encountered in all borings for layer
γ: Unit Weight
γ_{pDD}: STR 1 Load Factor for Downdrag (Ref 1, Ref. 13, and Ref 8)

1. Identify deepest depth below the ground surface along the abutment centerline where settlement less than or equal to 0.4 inches.

Ref. 2 Article 3.11.8 indicates that full downdrag loading occurs where settlement is equal to or greater than 0.4 inches.
From the Settle3 model (Ref 10) image below, maximum depth to the 0.4" or less settlement contour below base of abutment (ft): **9.7**
Thus, downdrag loading below this elevation is not considered fully developed and is not included in this analysis.

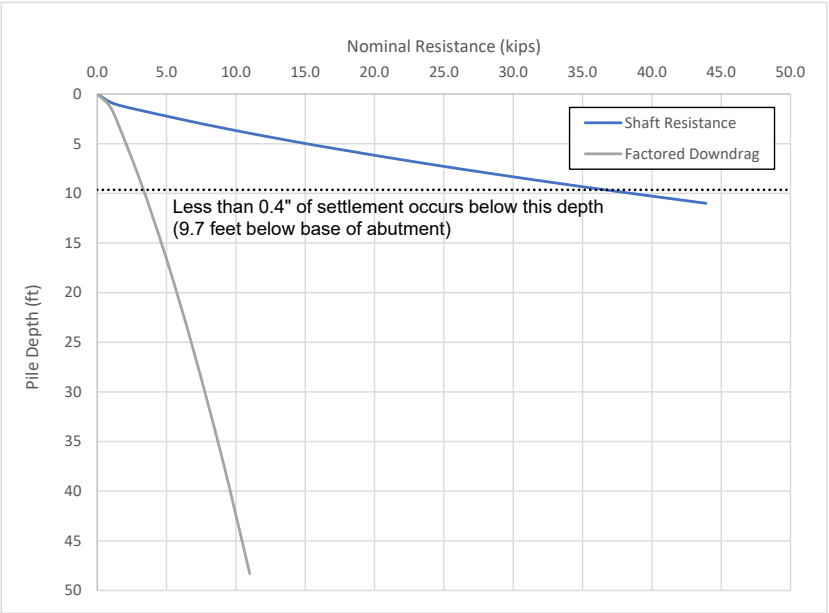
SUBJECT:	MaineDOT Mallet Drive Bridge 5721 (Exit 22)			
Job No.:	21450910	**Prepared:**	KAR	
Location:	Freeport, Maine	**Checked:**	AH	
Date:	6/29/2021	**Reviewed:**	JEL	

Settle3 Model from Abutment 2 loading.



2. Determine downdrag loading using APILE (Ensoft) Shaft Resistance

Pile Depth Below Pile Cap	Type of Soil	Shaft Resistance	Factored Downdrag Load	Total Factored Axial Load w/ Down Drag & Pile Weight
(feet)		(kips)	(kips)	(kips)
0	1	0.0	0	402.0
1	1	1.3	1	403.5
2	1	4.3	5	406.9
3	1	7.6	8	410.6
4	1	11.2	12	414.7
5	1	15.1	17	419.1
6	1	19.3	21	423.8
7	1	23.7	26	428.7
8	1	28.4	31	434.0
9	1	33.3	37	439.4
10	**1**	**38.5**	**42**	**445.2**
11	1	43.9	48	451.3



Type of Soil	g_{pDD}	Downdrag Load Factor
1	1.1	Strength I Load Factor for Down Drag (Ref 1, Ref 8 Table 8.2)
1	1.0	Service and Extreme Load Factor for Down Drag (Ref 2, Ref 8)

Total Factored Downdrag Load,	**42 kips**	(per pile)
Strength I Limit State	**339 kips**	(per abutment - 9 piles/abutment)
Total Factored Downdrag Load,	**39 kips**	(per pile)
Extreme & Service Limit States	**308 kips**	(per abutment - 9 piles/abutment)

Conclusions:

Based on the Settle3 model, downdrag is estimated to develop along the upper 9.7 feet of the pile. A total factored downdrag load of 42 kips per pile was calculated for the Strength I load case and a total factored downdrag load of 39 kips per pile was calculated for the Extreme and Service limit load cases. The total factored downdrag load will be conservatively applied to the top of the pile in the lateral response analysis.

==========

APILE for Windows, Version 2019.9.3

Serial Number : 156241926

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

==========

This program is licensed to :

Golder Associates
Houston, Texas

Path to file locations : C:\Users\MGore\Golder Associates\21450910 MaineDOT Mallet Dr. Bridge5721 p2 Freeport - 5 Technical Work\06 Analysis\Phase II - Pile Design\Downdrag\HP14x89\
Name of input data file : HP14x89_Abutment 2_MSG.ap9d
Name of output file : HP14x89_Abutment 2_MSG.ap9o
Name of plot output file : HP14x89_Abutment 2_MSG.ap9p

Time and Date of Analysis

Date: June 29, 2021 Time: 10:02:31

1

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

New Pile

DESIGNER :

JOB NUMBER :

METHOD FOR UNIT LOAD TRANSFERS :

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

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 26.10 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 21.20 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 0.00 FT.
- ZERO FRICTION LENGTH, ZFL = 10.90 FT.
- PERIMETER OF PILE = 57.05 IN.
- TIP AREA OF PILE = 26.10 IN2
- INCREMENT OF PILE LENGTH
  USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	SAND	0.80*	125.00	32.00	28.00**
10.90	SAND	0.80*	125.00	32.00	28.00**
10.90	SAND	0.80*	125.00	33.00	32.00**
19.80	SAND	0.80*	125.00	33.00	32.00**
19.80	SAND	0.80*	62.60	33.00	32.00**
21.20	SAND	0.80*	62.60	33.00	32.00**
21.20	SAND	0.80*	145.00	50.00	50.00**
40.00	SAND	0.80*	145.00	50.00	50.00**

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

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

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

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
10.90	1.000	1.000
10.90	1.000	1.000
19.80	1.000	1.000
19.80	1.000	1.000
21.20	1.000	1.000
21.20	1.000	1.000
40.00	1.000	1.000

DEPTH FT.	PLASTIC INDEX PI %	YIELD STRESS RATIO	Qc FROM CPT KSF
0.00	0.00	0.00	0.000E+00
10.90	0.00	0.00	0.000E+00
10.90	0.00	0.00	0.000E+00
19.80	0.00	0.00	0.000E+00
19.80	0.00	0.00	0.000E+00
21.20	0.00	0.00	0.000E+00
21.20	0.00	0.00	0.000E+00
40.00	0.00	0.00	0.000E+00

1

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

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

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.3	0.3
1.00	0.0	0.6	0.6
2.00	0.0	1.1	1.1
3.00	0.0	1.7	1.7
4.00	0.0	2.3	2.3
5.00	0.0	2.9	2.9
6.00	0.0	3.4	3.4
7.00	0.0	4.0	4.0
8.00	0.0	4.6	4.6
9.00	0.0	5.2	5.2
10.00	0.0	6.1	6.1
11.00	1.3	7.0	8.3
12.00	4.3	7.8	12.1
13.00	7.6	8.5	16.2
14.00	11.2	8.9	20.2
15.00	15.1	9.0	24.2
16.00	19.3	9.1	28.3
17.00	23.7	9.1	32.7
18.00	28.4	9.1	37.4
19.00	33.3	9.1	42.4
20.00	38.5	16.5	55.0
21.00	43.9	43.9	87.8

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

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

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.0000E+00		

0.0000E+00 0.0000E+00
0.0000E+00 0.2906E-01
0.0000E+00 0.5629E-01
0.0000E+00 0.1035E+00
0.0000E+00 0.1453E+00
0.0000E+00 0.1816E+00
0.0000E+00 0.3632E+00
0.0000E+00 0.5448E+00
0.0000E+00 0.9080E+00
0.0000E+00 0.3632E+01
2 10 0.5475E+01
0.0000E+00 0.0000E+00
0.0000E+00 0.2906E-01
0.0000E+00 0.5629E-01
0.0000E+00 0.1035E+00
0.0000E+00 0.1453E+00
0.0000E+00 0.1816E+00
0.0000E+00 0.3632E+00
0.0000E+00 0.5448E+00
0.0000E+00 0.9080E+00
0.0000E+00 0.3632E+01
3 10 0.1086E+02
0.0000E+00 0.0000E+00
0.1014E+01 0.2906E-01
0.1691E+01 0.5629E-01
0.2536E+01 0.1035E+00
0.3043E+01 0.1453E+00
0.3381E+01 0.1816E+00
0.3381E+01 0.3632E+00
0.3381E+01 0.5448E+00
0.3381E+01 0.9080E+00
0.3381E+01 0.3632E+01
4 10 0.1090E+02
0.0000E+00 0.0000E+00
0.1064E+01 0.2906E-01
0.1773E+01 0.5629E-01
0.2659E+01 0.1035E+00
0.3191E+01 0.1453E+00
0.3545E+01 0.1816E+00
0.3545E+01 0.3632E+00
0.3545E+01 0.5448E+00
0.3545E+01 0.9080E+00
0.3545E+01 0.3632E+01
5 10 0.1538E+02
0.0000E+00 0.0000E+00
0.1801E+01 0.2906E-01
0.3001E+01 0.5629E-01
0.4502E+01 0.1035E+00
0.5402E+01 0.1453E+00
0.6003E+01 0.1816E+00
0.6003E+01 0.3632E+00
0.6003E+01 0.5448E+00
0.6003E+01 0.9080E+00
0.6003E+01 0.3632E+01

6	10	0.1976E+02	
		0.0000E+00	0.0000E+00
		0.2314E+01	0.2906E-01
		0.3857E+01	0.5629E-01
		0.5786E+01	0.1035E+00
		0.6943E+01	0.1453E+00
		0.7714E+01	0.1816E+00
		0.7714E+01	0.3632E+00
		0.7714E+01	0.5448E+00
		0.7714E+01	0.9080E+00
		0.7714E+01	0.3632E+01
7	10	0.1980E+02	
		0.0000E+00	0.0000E+00
		0.2319E+01	0.2906E-01
		0.3865E+01	0.5629E-01
		0.5798E+01	0.1035E+00
		0.6957E+01	0.1453E+00
		0.7730E+01	0.1816E+00
		0.7730E+01	0.3632E+00
		0.7730E+01	0.5448E+00
		0.7730E+01	0.9080E+00
		0.7730E+01	0.3632E+01
8	10	0.2053E+02	
		0.0000E+00	0.0000E+00
		0.2373E+01	0.2906E-01
		0.3956E+01	0.5629E-01
		0.5933E+01	0.1035E+00
		0.7120E+01	0.1453E+00
		0.7911E+01	0.1816E+00
		0.7911E+01	0.3632E+00
		0.7911E+01	0.5448E+00
		0.7911E+01	0.9080E+00
		0.7911E+01	0.3632E+01
9	10	0.2116E+02	
		0.0000E+00	0.0000E+00
		0.2401E+01	0.2906E-01
		0.4002E+01	0.5629E-01
		0.6003E+01	0.1035E+00
		0.7203E+01	0.1453E+00
		0.8004E+01	0.1816E+00
		0.8004E+01	0.3632E+00
		0.8004E+01	0.5448E+00
		0.8004E+01	0.9080E+00
		0.8004E+01	0.3632E+01
10	10	0.2120E+02	
		0.0000E+00	0.0000E+00
		0.2401E+01	0.2906E-01
		0.4002E+01	0.5629E-01
		0.6003E+01	0.1035E+00
		0.7203E+01	0.1453E+00
		0.8004E+01	0.1816E+00
		0.8004E+01	0.3632E+00
		0.8004E+01	0.5448E+00
		0.8004E+01	0.9080E+00

		0.8004E+01	0.3632E+01
11	10	0.3063E+02	
		0.0000E+00	0.0000E+00
		0.2401E+01	0.2906E-01
		0.4002E+01	0.5629E-01
		0.6003E+01	0.1035E+00
		0.7203E+01	0.1453E+00
		0.8004E+01	0.1816E+00
		0.8004E+01	0.3632E+00
		0.8004E+01	0.5448E+00
		0.8004E+01	0.9080E+00
		0.8004E+01	0.3632E+01
12	10	0.3996E+02	
		0.0000E+00	0.0000E+00
		0.2401E+01	0.2906E-01
		0.4002E+01	0.5629E-01
		0.6003E+01	0.1035E+00
		0.7203E+01	0.1453E+00
		0.8004E+01	0.1816E+00
		0.8004E+01	0.3632E+00
		0.8004E+01	0.5448E+00
		0.8004E+01	0.9080E+00
		0.8004E+01	0.3632E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.2745E+01	0.9080E-02
0.5491E+01	0.1816E-01
0.1098E+02	0.3632E-01
0.2196E+02	0.2361E+00
0.3294E+02	0.7627E+00
0.3953E+02	0.1326E+01
0.4392E+02	0.1816E+01
0.4392E+02	0.2724E+01
0.4392E+02	0.3632E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.7772E-01	0.1225E-03	0.3024E-01	0.1000E-03
0.7772E+00	0.1225E-02	0.3024E+00	0.1000E-02
0.3886E+01	0.6126E-02	0.1512E+01	0.5000E-02
0.7772E+01	0.1225E-01	0.3024E+01	0.1000E-01
0.1555E+02	0.2451E-01	0.6047E+01	0.2000E-01

0.3244E+02	0.5934E-01	0.1173E+02	0.5000E-01
0.4170E+02	0.9189E-01	0.1338E+02	0.8000E-01
0.4755E+02	0.1135E+00	0.1448E+02	0.1000E+00
0.6458E+02	0.2184E+00	0.1998E+02	0.2000E+00
0.7207E+02	0.5209E+00	0.2747E+02	0.5000E+00
0.7798E+02	0.8229E+00	0.3338E+02	0.8000E+00
0.8032E+02	0.1024E+01	0.3572E+02	0.1000E+01
0.8852E+02	0.2026E+01	0.4392E+02	0.2000E+01

APPENDIX F2

Abutment 2 Pile Design – Shorter Pile

GOLDER
MEMBER OF WSP

CALCULATIONS

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Minimum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

OBJECTIVE

Determine if the proposed HP 14x89 piles will provide adequate support for Abutment 2 (the southeastern integral abutment) based on the anticipated thermal movement and final design loads. This analysis is performed at the location along the abutment where bedrock depth (and thus pile soil embedment) is anticipated to be shallowest.

METHOD

Use the procedure outlined in AASHTO LRFD (Ref. 1) and the design method provided in the MaineDOT Bridge Design Guide (Ref. 2).

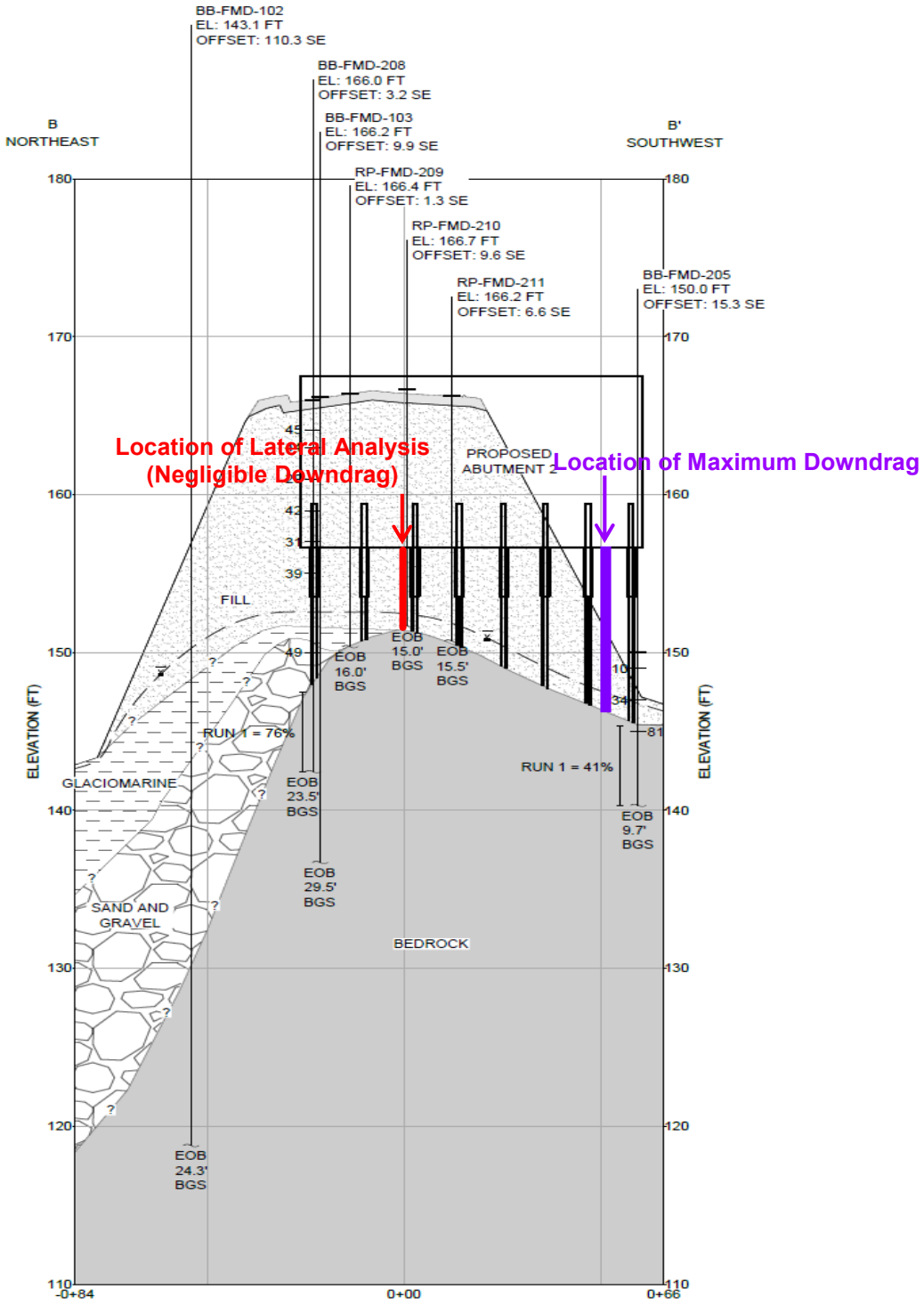
REFERENCES

1. AASHTO LRFD Bridge Design Specifications, 9th Ed. 2020.
2. Guertin Elkerton & Associates for Maine Department of Transportation. Bridge Design Guide. Dated August 2003 with 2018 updates.
3. Email communication between Golder and HNTB, subject "RE: Freeport I-295 Exit 20 and Exit 22 - Request for Sections and Design Info", dated June 23, 2020.
4. Isenhower, W.M. et al. LPile v2019 Technical Manual: A Program for the Analysis of Deep Foundations Under Lateral Loading. Ensoft, Inc. Dated March 2020.
5. Updated Golder interpreted subsurface profiles A-A' and B-B', dated June 2021.
6. Golder geotechnical test boring logs (Appendix A, Preliminary Geotechnical Design Report, dated December 2020).
7. Bridge Software Institute. FB-MultiPier Soil Parameter Table (US Customary Units). Accessed July 2020. https://bsi.ce.ufl.edu/downloads/files/MultiPier_Soil_Table.pdf
8. VTrans Integral Abutment Committee. Integral Abutment Bridge Design Guidelines, 2nd Ed. 2008.
9. AISC Steel Construction Manual, 13th Ed.
10. HNTB calculation titled "Freeport Bridges_Loads_Bottom of Footing_flat.pdf", dated May 26, 2021.
11. Oregon Department of Transportation, Geo-Environmental Section. Geotechnical Design Manual: Chapter 8 - Foundations, Version 2.1. Dated May 6, 2019.
12. HNTB for State of Maine Department of Transportation. Approach Road Bridge over Interstate 295 and Signalized Intersections, Exit 22 Interchange: 60% Plans, dated May 7, 2021.
13. Golder calculation titled "21450910 Freeport Exit 22 APILE Downdrag - Abutment 2", dated June 29, 2021.
14. Golder settlement model created using Rocscience Settle3 software package, Version 5.010 64-bit, build date Mar 5, 2021.
15. HNTB for State of Maine Department of Transportation. Merrill Road Bridge over Interstate 295, Freeport, Cumberland: Abutment 1 Reinforcement Sections, Sheet 94, dated May 7, 2021.

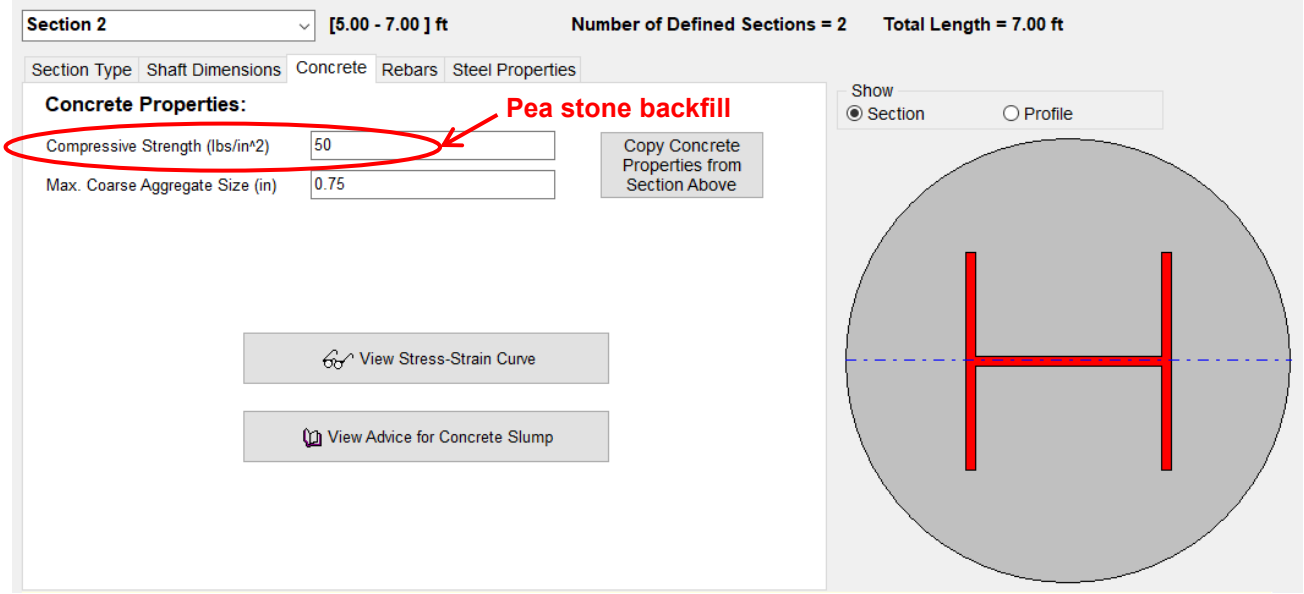
ASSUMPTIONS

1. The selected pile orientation is weak axis bending (Ref. 2, page 5-42).
2. The vertical load is assumed to be evenly distributed.
3. A rock socket diameter of 30 inches (approximately twice the pile flange width) is assumed in order to permit pile rotation.
4. Since LPile capability for modeling round shafts is limited to concrete backfill, a low compressive strength of 50 psi is assumed in order to represent pea stone backfill in the annular space between the pile and the rock socket wall. The compressive strength input is illustrated in the LPile image below.
5. For the lateral analysis, the soil profile is analyzed at the location along the abutment where bedrock depth (and thus pile soil embedment) is anticipated to be shallowest. At this location, settlement due to the proposed site improvements is anticipated to be approximately 0.05 inches (Ref. 14). Since Ref. 1 Article 3.11.8 indicates that full downdrag loading occurs where settlement is equal to or greater than 0.4 inches, downdrag is considered negligible at the lateral analysis location and is not analyzed. This location is illustrated in the interpreted subsurface profile below.

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Minimum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		



Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Minimum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		



ATTACHMENTS

1. LPile analysis output for Strength I
2. LPile analysis output for Strength I with Plastic Hinge

CALCULATION

1. Select the preliminary pile size.

Determine the factored applied superstructure vertical dead and live load (P_u) distributed to each pile.

Strength I factored vertical load per abutment =	3216	kips	(Ref. 10, page 2)
divided by	8	piles at Abutment 2 (Ref. 12, Sheet 95) =	
Strength I factored vertical load per pile =	402	kips	

Pile weight =	0.089	kip/ft	x	7.0	ft	=	1	kips

P_u = 403 kips (Total factored axial load including pile weight)

Select the steel pile strength.

F_y = 50 ksi
E = 29,000 ksi

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Minimum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

Determine resistance factors (Φ_c and Φ_f) for the structural strength in the upper and lower zones of the pile.

ϕ_{cl} = 0.50 for axial resistance in the lower zone of the pile (Ref. 2, page 5-41)
ϕ_{cu} = 0.70 for axial resistance in the upper zone of the pile (Ref. 2, page 5-42)
ϕ_f = 1.00 for flexural resistance in the upper zone of the pile (Ref. 2, page 5-42)

Determine the maximum required nominal axial pile resistance (Ref. 1, Article 6.9.2.1).

$$R_{n.upper} = \frac{P_u}{\phi_{cu}}$$

$R_{n.upper}$ = 576 kips

$$R_{n.lower} = \frac{P_u}{\phi_{cl}}$$

$R_{n.lower}$ = 806 kips

$$R_n = \max\left(R_{n.upper}, R_{n.lower}\right)$$

R_n = 806 kips

Use the required nominal axial pile resistance to estimate the required pile area.

$$A_{s.req} = \frac{R_n}{0.80\ Fy}$$ (Ref. 2, page 5-42)

$A_{s.req}$ = 20.2 in^2

Select a pile size with an area of $A_{s.req}$ or greater.

Preferred selection is HP 14x89 based on June 16, 2020 meeting with MaineDOT and HNTB.
Check that preferred selection satisfies pile area requirement:

HP 14x89 A_s = 26.1 in^2 (Ref. 4, Table 5.6.3)
A_s > $A_{s.req}$ OK

2. Use LPile analysis to determine the pile unbraced length and maximum moment at the top of the pile.

The following input parameters were used in the LPile analysis:

GOLDER
MEMBER OF WSP

CALCULATIONS

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Minimum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

Pile Properties

Section type:	Steel H Section Weak Axis		(Assumption 1)
Length of section:	7	ft	(2-foot embedment into a 2-foot rock socket)
Flange width, b:	14.695	in	(Ref. 4, Table 5.6.3)
Section depth, d:	13.83	in	(Ref. 4, Table 5.6.3)
Flange thickness, t_f:	0.615	in	(Ref. 4, Table 5.6.3)
Web thickness, t_w:	0.615	in	(Ref. 4, Table 5.6.3)
Pile batter:	Vertical		(pile battering not required)

Rock Socket Properties

Socket length:	2	ft	
Socket diameter:	30	in	(Assumption 3)
Socket fill material:	Pea stone with compressive strength of 50 psi		(Assumption 4)

Pile Loading

Lateral deflection due to abutment thermal expansion or contraction:	0.795	in	(Ref. 10, page 2)
Lateral deflection due to girder rotation:	0.18	in	(Ref. 14)
Total lateral deflection at pile head:	0.975	in	
Axial load:	403,000	lbs	(from Step 1)

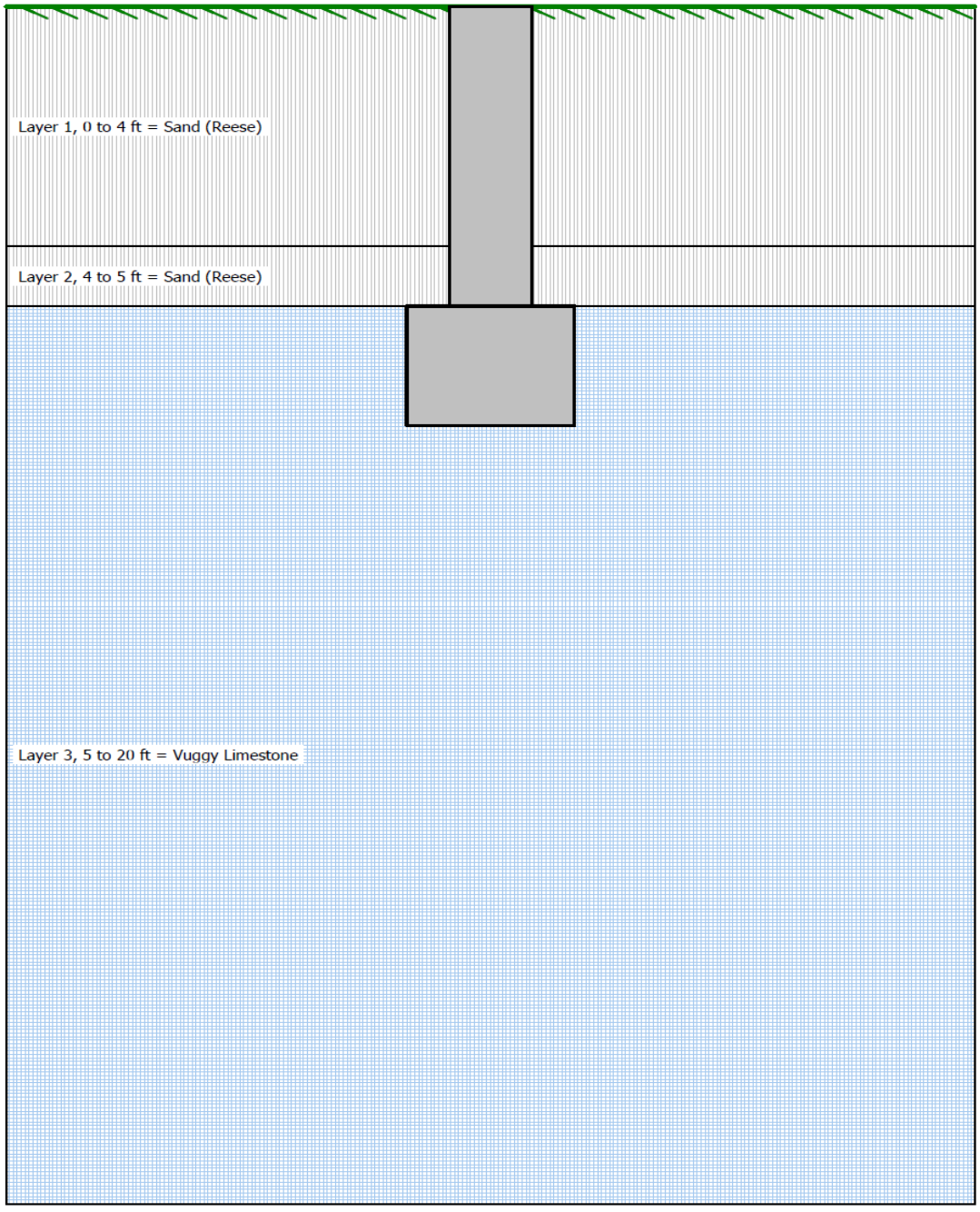
Soil Layers

Layer	Depth below base of abutment[1]	Lateral Model	Effective Unit Weight (pcf)	Undrained Shear Strength (psf)	Friction Angle (°)	Subgrade Modulus (pci)[3]	Major Principal Strain at 50%	UCS (psi)[2]
Existing Fill (above water table)	0 - 4 ft	Sand (Reese)	125	-	33	165	-	-
Existing Fill (below water table)	4 - 5 ft	Sand (Reese)	62.6	-	33	100	-	-
Bedrock	> 5 ft	Strong Rock (Vuggy Limestone)	106.6	-	-	-	-	2486

1) Ref. 5
2) Ref. 6. Using lowest UCS value from laboratory test results due to low RQD encountered in boring BB-FMD-103 closest to southeastern abutment.
3) Ref. 7. Interpolation based on average N_{60} value for existing fill.

An image of the LPile model setup is provided below. The full LPile output is provided in Attachments 1 and 2.

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Minimum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		



From the LPile output:
Obtain the maximum moment at the top of the pile.

$M_{u.Top}$ = 3174 in-kips (LPile)

Obtain the unbraced lengths of the top segment and the second segment of the upper zone of the pile.

$l_{b.top}$ = 5.2 ft (LPile)
$l_{b.top}$ = 62.4 in

$l_{b.2nd}$ = 1.8 ft (LPile)
$l_{b.2nd}$ = 21.3 in

3. Determine if the applied moment on the pile will cause pile head plastic deformation by using the interaction

Determine K values for the top and bottom of the pile and calculate the column slenderness factor (λ) for each segment.

For the top segment (fixed at top and pinned at bottom):

$$\lambda_{top} = \frac{K_{top} l_{b.top}}{r_y} \leq 120 \quad \text{(Ref. 1, Article 6.9.3)}$$

$$r_y = \sqrt{I_{yy} / A_s}$$

where:

K_{top} = 1.2 (Ref. 1, Table C4.6.2.5-1)
I_{yy} = 326 in^4 (Ref. 4, Table 5.6.3)
r_y = 3.53 in

λ_{top} = 21.19 OK

For the second segment (pinned at top and bottom):

$$\lambda_{2nd} = \frac{K_{2nd} l_{b.2nd}}{r_y} \leq 120 \quad \text{(Ref. 1, Article 6.9.3)}$$

where:

K_{2nd} = 1.0 (Ref. 1, Table C4.6.2.5-1)

λ_{2nd} = 6.02 OK

Calculate the critical elastic buckling resistance, P_e, and the nominal yield resistance, P_o.

Use Ref. 1 Table 6.9.4.1.1-1 to select equation for P_e based on cross-section shape and potential buckling mode.

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Minimum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

$$P_e = \frac{\pi^2 E}{\left(\frac{K l_b}{r_y}\right)^2} A_s \qquad \text{(Ref. 1, Eqn 6.9.4.1.2-1)}$$

$P_{e.top}$ = 16644 kips
$P_{e.2nd}$ = 205864 kips

$$P_o = F_y A_s \qquad \text{(Ref. 1, Article 6.9.4.1)}$$

P_o = 1305 kips

Calculate the nominal structural pile resistance, P_n, for both segments of the upper zone of the pile as well as the lower zone of the pile.

Determine P_o/P_e to select equation for P_n as per Ref. 1 Article 6.9.4.1.

$P_o/P_{e.top}$ = 0.08 ≤ 2.25
$P_o/P_{e.2nd}$ = 0.01 ≤ 2.25

thus use Ref. 1 Eqn 6.9.4.1.1-1:

$$P_n = \left[0.658^{\left(\frac{P_o}{P_e}\right)}\right] P_o$$

$P_{n.top}$ = 1263 kips
$P_{n.2nd}$ = 1302 kips

$$P_{n.bottom} = (0.658^{(0)}) \times F_y A_s \qquad \text{(0 for a fully braced pile - Ref. 8, Appendix B, Eqn 6-9)}$$

$P_{n.bottom}$ = 1305 kips

Calculate the factored structural pile resistance, P_r, for both segments of the upper zone of the pile as well as the lower zone of the pile.

$$P_{r.top} = \phi_{cu} P_{n.top}$$
$P_{r.top}$ = 884 kips

$$P_{r.2nd} = \phi_{cu} P_{n.2nd}$$
$P_{r.2nd}$ = 911 kips

$$P_{r.bottom} = \phi_{cl} P_{n.bottom}$$
$P_{r.bottom}$ = 653 kips

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Minimum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

Compare the ratio of P_u to the structural resistance in the upper portion of the pile – the pile size should be such that the ratio is not less than 0.20.

$$\frac{P_u}{P_{r.top}} = \quad 0.46 \quad \text{OK}$$

$$\frac{P_u}{P_{r.2nd}} = \quad 0.44 \quad \text{OK}$$

Since the lower zone of the pile will have virtually no moment, the entire section can carry the required vertical loads. Make sure the applied load will not exceed the resistance of the lower zone.

$$\text{Check}\left(\frac{P_u}{P_{r.bottom}} < 1\right)$$

$$\frac{P_u}{P_{r.bottom}} = \quad 0.62 \quad \text{OK}$$

Determine the nominal and factored flexural resistance about H-Pile weak axis (LRFD 6.12.2.2).

Slenderness ratio for the flange:

$$\lambda_f = \frac{b_f}{2t_f} \qquad \text{(Ref. 1, Eqn 6.12.2.2.1-3)}$$

$\lambda_f =$ 11.95

Limiting slenderness ratio for a compact flange:

$$\lambda_{pf} = 0.38\sqrt{\frac{E}{F_y}} \qquad \text{(Ref. 1, Eqn 6.12.2.2.1-4)}$$

$\lambda_{pf} =$ 9.15

Limiting slenderness ratio for a noncompact flange:

$$\lambda_{rf} = 0.83\sqrt{\frac{E}{F_y}} \qquad \text{(Ref. 1, Eqn 6.12.2.2.1-5)}$$

$\lambda r_f =$ 19.99

Elastic and plastic section moduli about the weak axis:

$$S_y = \frac{I_{yy}}{b/2}$$

$$Z_y = (b^2 t_f)/2 + 0.25 t_w^2 (d - 2t_f)$$

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Minimum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

S_y = 44.4 in^3
Z_y = 67.6 in^3

Nominal flexural resistance:

$$M_n = M_p = (F_y Z_y) \quad \text{if } \lambda_f \le \lambda_{pf}$$ (Ref. 1, Eqn 6.12.2.2.1-1)

$$M_n = \left[1 - \left(1 - \frac{S_y}{Z_y}\right)\left(\frac{\lambda_f - \lambda_{pf}}{0.45\sqrt{\frac{E}{F_y}}}\right)\right] F_y Z_y \quad \text{if } \lambda_{pf} < \lambda_f \le \lambda_{rf}$$ (Ref. 1, Eqn 6.12.2.2.1-2)

Since $\lambda_{pf} < \lambda_f \le \lambda_{rf}$,
M_n = 3080 in-kips

Factored flexural resistance:
ϕ_f = 1.00 (Ref. 2, page 5-42)
$M_r = \phi_f M_n$
M_r = 3080 in-kips

Calculate the moment that will cause a plastic hinge at the top of the pile, M_p'(Ref. 2, Article 6.9.2.2).

$$M_p' = \frac{9}{8}\left(1 - \frac{P_u}{P_{r.top}}\right) M_r$$ (Ref. 8, Appendix B, Eqn 6-24)

M_p' = 1885 in-kips = 1885472.6 inch-lb

If the applied moment exceeds the moment that would cause a plastic hinge, it can be assumed that the pile head has entered plastic deformation and therefore the moment that can be applied to the pile head cannot exceed M_p'.

$M_{u.Top}$ = 3174 in-kips (From Step 2)
$M_{u.Top}$ > M_p' Plastic Hinge Forms

4. Run a second LPile analysis with displacement, plastic moment (M_p'), and P_u as load conditions, and calculate new unbraced lengths from the moment vs. depth curve. Then repeat Step 4 with the new unbraced lengths.

$l_{b.top}$ = 3.7 ft (LPile)
$l_{b.top}$ = 44.4 in

$l_{b.2nd}$ = 2.2 ft (LPile)
$l_{b.2nd}$ = 26.8 in

$M_{u.2nd}$ = 629 in-kips (LPile)

Since a plastic hinge developed at the pile head, the value of K for the top segment becomes 2.1 (Ref. 2, page 5-43).

K_{top} = 2.1 (Ref. 1, Table C4.6.2.5-1)
K_{2nd} = 1.0 (Ref. 1, Table C4.6.2.5-1)

λ_{top} = 26.39 < 120 OK
λ_{2nd} = 7.57 < 120 OK

$P_{e.top}$ = 10728 kips
$P_{e.2nd}$ = 130259 kips

$P_o/P_{e.top}$ = 0.12 ≤ 2.25 (to select P_n equation)
$P_o/P_{e.2nd}$ = 0.01 ≤ 2.25 (to select P_n equation)

$P_{n.top}$ = 1240 kips
$P_{n.2nd}$ = 1300 kips

$P_{r.top}$ = 868 kips
$P_{r.2nd}$ = 910 kips

$\frac{P_u}{P_{r.top}}$ = 0.46 > 0.20 OK

$\frac{P_u}{P_{r.2nd}}$ = 0.44 > 0.20 OK

Since the pile is appropriately sized, the second segment of the upper zone of the pile needs to be checked with the interaction equation of LRFD Section 6.9.2.2. It is important that this segment of the pile does not form a plastic hinge. A plastic hinge in this segment will cause the pile to fail.

Check: $\frac{P_u}{P_{r.2nd}} + \frac{8}{9}\left(\frac{M_{u.2nd}}{M_r}\right) < 1$ (Ref. 8, Appendix B, Eqn 7-13)

Check: 0.62 < 1 OK

5. Because the piles have weak axis orientation and the flanges resist the shear as opposed to the web, check the maximum shear from the LPile output against the structural shear resistance per AISC G7.

V_u = 158.1 kips (LPile)

AASHTO LRFD does not directly address weak axis shear. This analysis will use the AISC Steel Construction Manual 13th edition (G7) to ensure the pile will not shear under the longitudinal load.

k_v = 1.2 (Ref. 9, Section G2.1)

$$C_v = 1.0 \quad \text{if} \quad b/t_f \leq 1.1\sqrt{k_v E/F_y}$$ (Ref. 9, Eqn. G2-3)

C_v = 1.0

Both flanges will resist shear forces:

$$A_w = 2b_f t_f$$ (Ref. 8, Appendix B, Eqn 7-17)

A_w = 18.07 in^2

$$V_n = 0.6F_y A_w C_V$$ (Ref. 9, Eqn G2-1)

V_n = 542 kips

$$V_r = \Phi_v V_n$$

ϕ_v = 1.00 (Ref. 1, Article 6.5.4.2)

V_r = 542 kips

Check that the shear resistance is sufficient:

V_u < V_r OK

6. Check that the maximum factored applied pile load does not exceed the factored pile drivability resistance.

While driving the pile, the maximum stress that is permitted in the pile is:

$$\sigma_{dr} = 0.9\Phi_{da}F_y$$ (Ref. 8, Appendix B, Eqn 7-22)

ϕ_{da} = 1.00 (Ref. 1, Article 6.5.4.2)

σ_{dr} = 45 ksi

This translates into an ultimate maximum driving force that can be applied to the pile of:

$$P_0 = \sigma_{dr}A_s$$ (Ref. 8, Appendix B, Eqn 7-23)

P_0 = 1175 kips

Calculate the nominal pile driving resistance (R_{ndr}) from the applied load divided by the resistance factor associated with the pile monitoring method. In this design, the pile will be bearing on rock. The driving criteria will be established by dynamic testing.

ϕ_{mon} = 0.65 (Ref. 1, Table 10.5.5.2.3-1)

$$R_{ndr} = \frac{P_u}{\phi_{mon}}$$ (Ref. 8, Appendix B, Eqn 7-25)

R_{ndr} = 620 kips

The nominal pile driving resistance (R_{ndr}) should exceed neither the nominal structural pile resistance (P_n) nor the maximum driving force (P_0) calculated above.

$P_{n.top}$ = 1240 kips (From Step 4)
$P_{n.2nd}$ = 1300 kips (From Step 4)

Check $R_{ndr} < P_n$: OK
Check $R_{ndr} < P_0$: OK

7. Verify the assumption of a pinned support at the base of the pile by comparing the ratio of the shear and axial forces acting at the pile tip to the factored friction coefficient at the bedrock/pile interface.

V_u at pile tip = 3.87 kips (LPile)
ϕ_v = 1.00 (Ref. 1, Article 6.5.4.2)
$V_{factored}$ at pile tip = 3.87 kips

	Unfactored Vertical Dead Load per Abut. (Ref. 10, pg. 2)	Load Factor (Ref. 1, Table 3.4.1-1)
	kips	-
DC_{super}	633	1.25
DC_{sub}	636	1.25
DW	86	1.50

Strength I factored dead load per abutment = 1715 kips
divided by 8 piles at Abutment 2 (Ref. 12, Sheet 95) =
P = 214 kips

V / P = 0.018

Friction coefficient, μ = 0.40 (Ref. 1, Table C3.11.5.3-1: steel sheet piles against clean gravel, gravel-sand mixtures, well-graded rock fill with spalls)

Date:	7/14/2021	**Made by:**	KAR
Project No.:	21450910	**Checked by:**	DAF
Subject:	Pile Design at Abutment 2 - Minimum Anticipated Pile Length	**Reviewed by:**	JEL
Project Title:	MaineDOT Mallet Drive Bridge 5721 Freeport (Exit 22) Phase 2		

Resistance factor = 0.5 (per discussion with MaineDOT)
μ * resistance factor = 0.2

If the shear/axial ratio is less than μ multiplied by the resistance factor, then the chosen pile section can be considered pinned.

V / P	<	μ * resistance factor
0.018	<	0.2

The chosen pile section can be considered pinned.

8. Check the pile toe displacement.

The target pile toe displacement (as computed with LPile) is under 1/4 inch (0.25 inches) and preferably under 1/8 inch (0.125 inches), based on engineering judgement.

Lateral Pile Deflection at pile tip = 0.013 inches < 0.125 inches OK

CONCLUSIONS

The results of the analysis indicate that, at the location along the abutment where bedrock depth (and thus pile soil embedment) is anticipated to be shallowest, a maximum moment of 3174 in-kips (265 ft-kips) occurs at the top of the pile under the Strength I load case with a maximum bridge expansion or contraction of 0.8 inches and a maximum lateral deflection due to girder rotation of 0.2 inches. The results indicate that 2-foot pile embedment into a 2-foot rock socket backfilled with pea stone is sufficient to limit translation of the pile tip to a negligible amount (i.e., less than 1/8 inch). HP 14x89 piles will provide adequate support for Abutment 2 based on the anticipated thermal movement, girder rotation, and final design loads.

The socket provides sufficient toe restraint when using a rounded pea stone fill around the pile to achieve fixity such that the pile tip is restrained from sliding but allows rotation with the 1.0 inches of potential abutment horizontal displacement, to avoid creating an unacceptable double hinge case at the two ends of the pile. Analyses indicate that longer than a 2-foot socket would restrain the tip to create high bending moments associated with the abutment horizontal displacement and create an unacceptable plastic hinge at the bottom of the pile.

Attachment 1

==========

LPile for Windows, Version 2019-11.005

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

==========

This copy of LPile is being used by:

KAR
Golder Associates, Inc.

Serial Number of Security Device: 239146533

This copy of LPile is licensed for exclusive use by:

GOLDER, Manchester, NH

Use of this program by any entity other than GOLDER, Manchester, NH
is a violation of the software license agreement.

Files Used for Analysis

Path to file locations:
\\golderassociates.sharepoint.com@SSL\DavWWWRoot\sites\139982\Project Files\5 Technical Work\06 Analysis\Phase II - Pile Design\LPILE\Abutment 2 Strength I\

Name of input data file:
Freeport Exit 22 Abutment 2 with Socket MinSoil 2ftPile GirderRotation.lp11d

Name of output report file:
Freeport Exit 22 Abutment 2 with Socket MinSoil 2ftPile GirderRotation.lp11o

Name of plot output file:
Freeport Exit 22 Abutment 2 with Socket MinSoil 2ftPile GirderRotation.lp11p

Name of runtime message file:
Freeport Exit 22 Abutment 2 with Socket MinSoil 2ftPile GirderRotation.lp11r

---

Date and Time of Analysis

Date: July 14, 2021 Time: 16:31:04

Problem Title

Project Name: MaineDOT I-295 Exit 22 Mallet Drive Bridge No. 5721
Job Number: 21450910
Client: MaineDOT
Engineer: KAR
Description: Abutment 2 Pile Design - Strength I (Rock Socket)

Program Options and Settings

Computational Options:
- Conventional Analysis

Engineering Units Used for Data Input and Computations:
- US Customary System Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 1000
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 500

Loading Type and Number of Cycles of Loading:
- Static loading specified

- Use of p-y modification factors for p-y curves not selected
- Analysis uses layering correction (Method of Georgiadis)
- No distributed lateral loads are entered
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Input of moment resistance at the pile tip not selected
- Input of side resistance moment along pile not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- Output files use decimal points to denote decimal symbols.
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 2
Total length of pile = 7.000 ft
Depth of ground surface below top of pile = 0.0000 ft

Pile diameters used for p-y curve computations are defined using 4 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	14.6950
2	5.000	14.6950
3	5.000	30.0000
4	7.000	30.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is a H weak axis steel pile
Length of section = 5.000000 ft
Pile width = 13.830000 in
Shear capacity of section = 0.0000 lbs

Pile Section No. 2:

Section 2 is a drilled shaft with casing and H section core/insert
Length of section = 2.000000 ft
Section Diameter = 30.000000 in
Shear capacity of section = 0.0000 lbs

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 0.0000 ft
Distance from top of pile to bottom of layer = 4.000000 ft
Effective unit weight at top of layer = 125.000000 pcf
Effective unit weight at bottom of layer = 125.000000 pcf
Friction angle at top of layer = 33.000000 deg.
Friction angle at bottom of layer = 33.000000 deg.
Subgrade k at top of layer = 165.000000 pci
Subgrade k at bottom of layer = 165.000000 pci

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 4.000000 ft
Distance from top of pile to bottom of layer = 5.000000 ft
Effective unit weight at top of layer = 62.600000 pcf
Effective unit weight at bottom of layer = 6.260000 pcf
Friction angle at top of layer = 33.000000 deg.
Friction angle at bottom of layer = 33.000000 deg.
Subgrade k at top of layer = 100.000000 pci
Subgrade k at bottom of layer = 100.000000 pci

Layer 3 is strong rock (vuggy limestone)

Distance from top of pile to top of layer = 5.000000 ft
Distance from top of pile to bottom of layer = 20.000000 ft
Effective unit weight at top of layer = 106.600000 pcf
Effective unit weight at bottom of layer = 106.600000 pcf
Uniaxial compressive strength at top of layer = 2486. psi
Uniaxial compressive strength at bottom of layer = 2486. psi

(Depth of the lowest soil layer extends 13.000 ft below the pile tip)

Summary of Input Soil Properties

Layer Num.	Soil Type Layer Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	Uniaxial qu psi	kpy pci
1	Sand	0.00	125.0000	33.0000	--	165.0000
	(Reese, et al.)	4.0000	125.0000	33.0000	--	165.0000
2	Sand	4.0000	62.6000	33.0000	--	100.0000

	(Reese, et al.)	5.0000	6.2600	33.0000	--	100.0000
3	Strong Rock	5.0000	106.6000	--	2486.	--
	(Vuggy Limestone)	20.0000	106.6000	--	2486.	--

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	5	y = -0.975000 in	S = 0.0000 in/in	403000.	N.A.	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 2

Pile Section No. 1:

Dimensions and Properties of Steel H Weak Axis:

Length of Section = 5.000000 ft
Flange Width = 14.695000 in
Section Depth = 13.830000 in
Flange Thickness = 0.615000 in
Web Thickness = 0.615000 in

Yield Stress of Pipe = 50.000000 ksi
Elastic Modulus = 29000. ksi
Cross-sectional Area = 25.823850 sq. in.
Moment of Inertia = 325.505721 in^4
Elastic Bending Stiffness = 9439666. kip-in^2
Plastic Modulus, Z = 67.593889in^3
Plastic Moment Capacity = Fy Z = 3380.in-kip

Axial Structural Capacities:

Nom. Axial Structural Capacity = Fy As = 1291.193 kips
Nominal Axial Tensile Capacity = -1291.193 kips

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	403.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 403.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000433	40.8281079	9438779.	131.7538671	16.5181939	
0.00000865	81.6562158	9438779.	69.5506836	17.4306589	
0.00001298	122.4843237	9438779.	48.8162890	18.3431240	
0.00001730	163.3124315	9438779.	38.4490918	19.2555888	
0.00002163	204.1405394	9438779.	32.2287734	20.1680540	
0.00002595	244.9686473	9438779.	28.0818945	21.0805192	
0.00003028	285.7967552	9438779.	25.1198382	21.9929841	
0.00003460	326.6248631	9438779.	22.8982959	22.9054492	
0.00003893	367.4529710	9438779.	21.1704297	23.8179143	
0.00004326	408.2810788	9438779.	19.7881367	24.7303794	
0.00004758	449.1091867	9438779.	18.6571697	25.6428444	
0.00005191	489.9372946	9438779.	17.7146973	26.5553094	
0.00005623	530.7654025	9438779.	16.9172205	27.4677745	
0.00006056	571.5935104	9438779.	16.2336691	28.3802396	
0.00006488	612.4216183	9438779.	15.6412578	29.2927047	
0.00006921	653.2497262	9438779.	15.1228979	30.2051698	
0.00007353	694.0778340	9438779.	14.6655216	31.1176348	
0.00007786	734.9059419	9438779.	14.2589648	32.0300998	
0.00008219	775.7340498	9438779.	13.8952035	32.9425649	

0.00008651	816.5621577	9438779.	13.5678184	33.8550300	
0.00009084	857.3902656	9438779.	13.2716127	34.7674950	
0.00009516	898.2183735	9438779.	13.0023349	35.6799601	
0.00009949	939.0464813	9438779.	12.7564725	36.5924251	
0.0001038	979.8745892	9438779.	12.5310986	37.5048902	
0.0001081	1021.	9438779.	12.3237547	38.4173552	
0.0001125	1062.	9438779.	12.1323603	39.3298203	
0.0001168	1102.	9438779.	11.9551432	40.2422853	
0.0001211	1143.	9438779.	11.7905845	41.1547504	
0.0001254	1184.	9438779.	11.6373747	42.0672155	
0.0001298	1225.	9438779.	11.4943789	42.9796805	
0.0001341	1266.	9438779.	11.3606086	43.8921456	
0.0001384	1306.	9438779.	11.2351990	44.8046106	
0.0001427	1347.	9438779.	11.1173899	45.7170757	
0.0001471	1388.	9438779.	11.0065108	46.6295408	
0.0001514	1429.	9438779.	10.9019676	47.5420058	
0.0001557	1470.	9438779.	10.8032324	48.4544709	
0.0001600	1511.	9438779.	10.7098342	49.3669360	
0.0001644	1551.	9436528.	10.6217649	50.0000000	Y
0.0001687	1590.	9425696.	10.5398225	50.0000000	Y
0.0001773	1664.	9382164.	10.3924155	50.0000000	Y
0.0001860	1733.	9315188.	10.2642035	50.0000000	Y
0.0001947	1797.	9232294.	10.1519667	50.0000000	Y
0.0002033	1858.	9138117.	10.0532961	50.0000000	Y
0.0002120	1915.	9036240.	9.9661943	50.0000000	Y
0.0002206	1970.	8928428.	9.8892467	50.0000000	Y
0.0002293	2022.	8818219.	9.8207233	50.0000000	Y
0.0002379	2071.	8705935.	9.7597850	50.0000000	Y
0.0002466	2119.	8593912.	9.7051609	50.0000000	Y
0.0002552	2165.	8481627.	9.6564193	50.0000000	Y
0.0002639	2209.	8370626.	9.6126225	50.0000000	Y
0.0002725	2251.	8261381.	9.5731789	50.0000000	Y
0.0002812	2293.	8154131.	9.5376118	50.0000000	Y
0.0002898	2333.	8049078.	9.5054988	50.0000000	Y
0.0002985	2372.	7946385.	9.4764639	50.0000000	Y
0.0003071	2410.	7846185.	9.4501712	50.0000000	Y
0.0003158	2447.	7748585.	9.4263189	50.0000000	Y
0.0003244	2483.	7653669.	9.4046348	50.0000000	Y
0.0003331	2518.	7559608.	9.3843397	50.0000000	Y
0.0003417	2550.	7463250.	9.3645026	50.0000000	Y
0.0003504	2581.	7365272.	9.3451592	50.0000000	Y
0.0003590	2609.	7266875.	9.3260777	50.0000000	Y
0.0003677	2636.	7168465.	9.3073057	50.0000000	Y
0.0003763	2661.	7069908.	9.2891374	50.0000000	Y
0.0003850	2684.	6972272.	9.2710431	50.0000000	Y
0.0003936	2706.	6874736.	9.2533486	50.0000000	Y
0.0004023	2727.	6778722.	9.2358974	50.0000000	Y
0.0004109	2747.	6684004.	9.2189565	50.0000000	Y
0.0004196	2765.	6590860.	9.2022183	50.0000000	Y
0.0004282	2783.	6498472.	9.1857273	50.0000000	Y
0.0004369	2800.	6408426.	9.1694626	50.0000000	Y
0.0004455	2816.	6319527.	9.1538025	50.0000000	Y
0.0004542	2831.	6232287.	9.1379987	50.0000000	Y
0.0004628	2845.	6147103.	9.1228494	50.0000000	Y

0.0004715	2859.	6062972.	9.1076939	50.0000000	Y
0.0004801	2872.	5981237.	9.0927888	50.0000000	Y
0.0004888	2884.	5900613.	9.0782901	50.0000000	Y
0.0004974	2896.	5821904.	9.0640123	50.0000000	Y
0.0005061	2907.	5744976.	9.0497775	50.0000000	Y
0.0005147	2918.	5669547.	9.0359892	50.0000000	Y
0.0005493	2958.	5383970.	8.9828789	50.0000000	Y
0.0005840	2991.	5121790.	8.9326324	50.0000000	Y
0.0006186	3020.	4882047.	8.8855980	50.0000000	Y
0.0006532	3045.	4661207.	8.8412923	50.0000000	Y
0.0006878	3066.	4458417.	8.7994352	50.0000000	Y
0.0007224	3086.	4271591.	8.7597796	50.0000000	Y
0.0007570	3103.	4098848.	8.7224193	50.0000000	Y
0.0007916	3118.	3938972.	8.6868020	50.0000000	Y
0.0008262	3132.	3790601.	8.6530439	50.0000000	Y
0.0008608	3144.	3652625.	8.6211454	50.0000000	Y
0.0008954	3155.	3524138.	8.5905763	50.0000000	Y
0.0009300	3166.	3403799.	8.5612716	50.0000000	Y
0.0009646	3175.	3291337.	8.5336604	50.0000000	Y

Summary of Results for Nominal Moment Capacity for Section 1

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	403.0000000000	3175.

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Pile Section No. 2:

Dimensions and Properties of Drilled Shaft (Bored Pile) with Casing and H Weak Axis Core/Insert:

Length of Section = 2.000000 ft
Outside Diameter of Casing = 30.000000 in
Casing Wall Thickness = 0.0000 in

Moment of Inertia of Steel Casing = 0.0000 in^4
Width Flange of Core/Insert = 14.695000 in
Depth of Core/Insert = 13.830000 in
Flange Thickness of Core/Insert = 0.615000 in
Web Thickness of Core/Insert = 0.615000 in
Moment of Inertia of Steel Core/Insert = 325.505721 in^4
Yield Stress of Casing = 50000. psi
Elastic Modulus of Casing = 29000000. psi
Yield Stress of Core/Insert = 50000. psi
Elastic Modulus of Core/Insert = 29000000. psi
Number of Reinforcing Bars = 0 bars
Gross Area of Pile = 706.858347 sq. in.
Area of Concrete = 681.034497 sq. in.
Cross-sectional Area of Steel Casing = 0.0000 sq. in.
Cross-sectional Area of Steel Core/Insert = 25.823850 sq. in.
Area of All Steel (Casing, Core/Insert, and Bars) = 25.823850 sq. in.
Area Ratio of All Steel to Gross Area = 3.65 percent

Note that the core is assumed to be void of concrete.

Axial Structural Capacities:

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As = 1320.136 kips
Tensile Load for Cracking of Concrete = NaN kips
Nominal Axial Tensile Capacity = -1291.193 kips

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	403.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 403.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Max Core Stress	Run Msg
0.00000433	40.5049595	9364072.	129.0185990	0.0005581	0.0004283	0.0495443	0.00000	0.00000	15.2246666	
0.00000865	81.0099190	9364072.	72.0092995	0.0006230	0.0003634	0.0496785	0.00000	0.00000	16.1466619	
0.00001298	121.5148785	9364072.	53.0061997	0.0006878	0.0002985	0.0498128	0.00000	0.00000	17.0686574	
0.00001730	162.0198379	9364072.	43.5046498	0.0007527	0.0002337	0.0499470	0.00000	0.00000	17.9906529	
0.00002163	202.6636425	9370492.	37.8043185	0.0008176	0.0001688	0.0499998	0.00000	0.00000	18.9130239	
0.00002595	245.4812957	9458531.	34.0123697	0.0008827	0.0001041	0.0499970	0.00000	0.00000	19.8416208	

0.00003028	293.0641527	9678793.	31.3204289	0.0009484	0.00003998	0.0499908	0.00000	0.00000	20.7847889
0.00003460	346.6528344	10017545.	29.3207969	0.0010146	-0.00002350	0.0499993	0.00000	0.00000	21.7473487
0.00003893	405.4953474	10415975.	27.7818331	0.0010816	-0.00008635	0.0499988	0.00000	0.00000	22.7283171
0.00004326	466.5264376	10785314.	26.5588534	0.0011488	-0.0001488	0.0499907	0.00000	0.00000	23.7195608
0.00004758	527.0921690	11077721.	25.5599338	0.0012162	-0.0002113	0.0499987	0.00000	0.00000	24.7131505
0.00005191	585.3209898	11276372.	24.7249687	0.0012834	-0.0002738	0.0499878	0.00000	0.00000	25.7029288
0.00005623	639.8717401	11379053.	24.0131953	0.0013503	-0.0003367	0.0499985	0.00000	0.00000	26.6841219
0.00006056	689.7271125	11389530.	23.3960306	0.0014168	-0.0003999	0.0499945	0.00000	0.00000	27.6528933
0.00006488	734.0593162	11313486.	22.8528277	0.0014828	-0.0004637	0.0499893	0.00000	0.00000	28.6059967
0.00006921	772.1407621	11156630.	22.3682638	0.0015481	-0.0005282	0.0558967	0.00000	0.00000	29.5405125
0.00007353	803.3029063	10924133.	21.9307290	0.0016127	-0.0005934	0.1051144	0.00000	0.00000	30.4537480
0.00007786	826.8888945	10620164.	21.5312171	0.0016764	-0.0006594	0.1645060	0.00000	0.00000	31.3430679
0.00008219	842.2349056	10247931.	21.1626199	0.0017393	-0.0007263	0.2345379	0.00000	0.00000	32.2058387
0.00008651	848.6290328	9809445.	20.8191828	0.0018011	-0.0007942	0.3157433	0.00000	0.00000	33.0392569
0.00009084	845.2931767	9305605.	20.4961583	0.0018618	-0.0008633	0.4087320	0.00000	0.00000	33.8402852
0.00009516	831.3579216	8736187.	20.1895357	0.0019213	-0.0009336	0.5142054	0.00000	0.00000	34.6055367
0.00009949	805.8354947	8099815.	19.8958494	0.0019794	-0.0010052	0.6329742	0.00000	0.00000	35.3311849
0.0001038	767.5868770	7393888.	19.6120263	0.0020360	-0.0010784	0.7659820	0.00000	0.00000	36.0128462
0.0001081	715.2671275	6614314.	19.3352205	0.0020909	-0.0011533	0.9143451	0.00000	0.00000	36.6453077
0.0001125	647.2735723	5755341.	19.0627219	0.0021439	-0.0012301	1.0793945	0.00000	0.00000	37.2223710
0.0001168	561.6627290	4809151.	18.7918356	0.0021947	-0.0013090	1.2627399	0.00000	0.00000	37.7365298
0.0001211	456.0104678	3765072.	18.5196977	0.0022430	-0.0013904	1.4663780	0.00000	0.00000	38.1783320
0.0001254	327.2391365	2608698.	18.2431333	0.0022884	-0.0014748	1.6928288	0.00000	0.00000	38.5357563
0.0001298	171.3206591	1320216.	17.9583856	0.0023304	-0.0015626	1.9453670	0.00000	0.00000	38.7929998
0.0001341	-17.2212589	-128428.	17.6606840	0.0023682	-0.0016546	2.2284106	0.00000	0.00000	38.9284308

Summary of Results for Nominal Moment Capacity for Section 2

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	403.0000000000	-17.2212588659

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or Rock Layer	F0 Integral is Below for Layer lbs	F1 Integral for Layer lbs
1	0.00	0.00	N.A.	No	0.00	14017.
2	4.0000	4.0000	Yes	No	14017.	7137.
3	5.0000	5.0000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Displacement and Pile-head Rotation (Loading Type 5)
Displacement of pile head = -0.975000 inches
Rotation of pile head = 0.000E+00 radians
Axial load on pile head = 403000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	-0.9750	3174431.	-53957.	0.00	87261.	3.50E+08	0.00	0.00	0.00
0.01400	-0.9749	3165314.	-53956.	0.00152	87055.	3.50E+08	1.5753	0.2715	0.00
0.02800	-0.9745	3156095.	-53955.	0.00242	86847.	1.92E+09	3.1703	0.5466	0.00
0.04200	-0.9741	3146858.	-53954.	0.00263	86638.	3.63E+09	4.7847	0.8252	0.00
0.05600	-0.9736	3137610.	-53954.	0.00277	86430.	3.75E+09	6.4184	1.1075	0.00
0.07000	-0.9731	3128354.	-53952.	0.00291	86221.	3.85E+09	8.0710	1.3934	0.00
0.08400	-0.9726	3119088.	-53951.	0.00305	86012.	3.95E+09	9.7423	1.6828	0.00
0.09800	-0.9721	3109814.	-53949.	0.00318	85802.	4.05E+09	11.4321	1.9757	0.00
0.1120	-0.9716	3100531.	-53947.	0.00331	85593.	4.14E+09	13.1401	2.2722	0.00
0.1260	-0.9710	3091240.	-53945.	0.00343	85383.	4.23E+09	14.8661	2.5721	0.00
0.1400	-0.9704	3081941.	-53942.	0.00355	85173.	4.32E+09	16.6099	2.8756	0.00
0.1540	-0.9698	3072635.	-53939.	0.00367	84963.	4.41E+09	18.3711	3.1825	0.00
0.1680	-0.9692	3063321.	-53936.	0.00379	84753.	4.50E+09	20.1496	3.4928	0.00
0.1820	-0.9685	3054000.	-53932.	0.00390	84542.	4.58E+09	21.9451	3.8066	0.00
0.1960	-0.9679	3044672.	-53928.	0.00401	84332.	4.67E+09	23.7573	4.1238	0.00
0.2100	-0.9672	3035337.	-53924.	0.00412	84121.	4.75E+09	25.5861	4.4443	0.00
0.2240	-0.9665	3025995.	-53920.	0.00422	83910.	4.84E+09	27.4311	4.7683	0.00
0.2380	-0.9658	3016648.	-53915.	0.00433	83699.	4.92E+09	29.2922	5.0956	0.00
0.2520	-0.9650	3007294.	-53910.	0.00443	83488.	4.99E+09	31.1691	5.4262	0.00

0.2660	-0.9643	2997934.	-53905.	0.00453	83277.	5.07E+09	33.0615	5.7601	0.00
0.2800	-0.9635	2988569.	-53899.	0.00463	83065.	5.15E+09	34.9692	6.0974	0.00
0.2940	-0.9627	2979197.	-53893.	0.00473	82854.	5.22E+09	36.8919	6.4379	0.00
0.3080	-0.9619	2969821.	-53886.	0.00482	82642.	5.29E+09	38.8295	6.7816	0.00
0.3220	-0.9611	2960439.	-53880.	0.00491	82430.	5.37E+09	40.7816	7.1286	0.00
0.3360	-0.9603	2951052.	-53873.	0.00501	82219.	5.43E+09	42.7480	7.4788	0.00
0.3500	-0.9594	2941660.	-53865.	0.00510	82007.	5.50E+09	44.7285	7.8323	0.00
0.3640	-0.9586	2932263.	-53858.	0.00519	81794.	5.57E+09	46.7229	8.1889	0.00
0.3780	-0.9577	2922861.	-53850.	0.00527	81582.	5.64E+09	48.7308	8.5486	0.00
0.3920	-0.9568	2913455.	-53841.	0.00536	81370.	5.71E+09	50.7521	8.9115	0.00
0.4060	-0.9559	2904045.	-53833.	0.00544	81157.	5.77E+09	52.7865	9.2775	0.00
0.4200	-0.9550	2894630.	-53824.	0.00553	80945.	5.84E+09	54.8337	9.6466	0.00
0.4340	-0.9540	2885211.	-53814.	0.00561	80732.	5.90E+09	56.8935	10.0188	0.00
0.4480	-0.9531	2875789.	-53805.	0.00569	80520.	5.96E+09	58.9657	10.3941	0.00
0.4620	-0.9521	2866362.	-53794.	0.00577	80307.	6.02E+09	61.0500	10.7724	0.00
0.4760	-0.9511	2856932.	-53784.	0.00585	80094.	6.08E+09	63.1462	11.1537	0.00
0.4900	-0.9501	2847498.	-53773.	0.00593	79881.	6.14E+09	65.2541	11.5380	0.00
0.5040	-0.9491	2838061.	-53762.	0.00601	79668.	6.19E+09	67.3733	11.9253	0.00
0.5180	-0.9481	2828620.	-53751.	0.00609	79455.	6.25E+09	69.5037	12.3156	0.00
0.5320	-0.9471	2819177.	-53739.	0.00616	79242.	6.30E+09	71.6449	12.7088	0.00
0.5460	-0.9460	2809730.	-53727.	0.00624	79029.	6.35E+09	73.7968	13.1049	0.00
0.5600	-0.9450	2800280.	-53714.	0.00631	78815.	6.41E+09	75.9592	13.5040	0.00
0.5740	-0.9439	2790828.	-53701.	0.00638	78602.	6.46E+09	78.1317	13.9059	0.00
0.5880	-0.9428	2781372.	-53688.	0.00646	78388.	6.51E+09	80.3141	14.3107	0.00
0.6020	-0.9418	2771915.	-53674.	0.00653	78175.	6.56E+09	82.5062	14.7183	0.00
0.6160	-0.9407	2762454.	-53660.	0.00660	77961.	6.61E+09	84.7036	15.1280	0.00
0.6300	-0.9395	2752991.	-53646.	0.00667	77748.	6.65E+09	86.8981	15.5383	0.00
0.6440	-0.9384	2743526.	-53631.	0.00674	77534.	6.70E+09	89.1006	15.9513	0.00
0.6580	-0.9373	2734059.	-53616.	0.00680	77320.	6.75E+09	91.3109	16.3668	0.00
0.6720	-0.9361	2724590.	-53600.	0.00687	77107.	6.79E+09	93.5287	16.7849	0.00
0.6860	-0.9350	2715119.	-53584.	0.00694	76893.	6.83E+09	95.7537	17.2055	0.00
0.7000	-0.9338	2705646.	-53568.	0.00701	76679.	6.88E+09	97.9857	17.6287	0.00
0.7140	-0.9326	2696172.	-53551.	0.00707	76465.	6.92E+09	100.2244	18.0543	0.00
0.7280	-0.9314	2686695.	-53534.	0.00714	76251.	6.96E+09	102.4696	18.4824	0.00
0.7420	-0.9302	2677218.	-53517.	0.00720	76037.	7.00E+09	104.7210	18.9130	0.00
0.7560	-0.9290	2667739.	-53499.	0.00727	75823.	7.04E+09	106.9784	19.3459	0.00
0.7700	-0.9278	2658258.	-53481.	0.00733	75609.	7.08E+09	109.2414	19.7813	0.00
0.7840	-0.9265	2648777.	-53462.	0.00739	75395.	7.12E+09	111.5099	20.2190	0.00
0.7980	-0.9253	2639294.	-53443.	0.00745	75181.	7.15E+09	113.7835	20.6591	0.00
0.8120	-0.9240	2629811.	-53424.	0.00752	74967.	7.19E+09	116.0621	21.1014	0.00
0.8260	-0.9228	2620326.	-53404.	0.00758	74753.	7.23E+09	118.3454	21.5461	0.00
0.8400	-0.9215	2610841.	-53384.	0.00764	74539.	7.26E+09	120.6330	21.9931	0.00
0.8540	-0.9202	2601355.	-53364.	0.00770	74325.	7.29E+09	122.9248	22.4423	0.00
0.8680	-0.9189	2591868.	-53343.	0.00776	74111.	7.33E+09	125.2204	22.8937	0.00
0.8820	-0.9176	2582381.	-53322.	0.00782	73897.	7.36E+09	127.5197	23.3473	0.00
0.8960	-0.9163	2572894.	-53300.	0.00788	73683.	7.39E+09	129.8224	23.8031	0.00
0.9100	-0.9149	2563406.	-53278.	0.00793	73468.	7.42E+09	132.1281	24.2610	0.00
0.9240	-0.9136	2553918.	-53256.	0.00799	73254.	7.45E+09	134.4367	24.7210	0.00
0.9380	-0.9123	2544430.	-53233.	0.00805	73040.	7.48E+09	136.7479	25.1832	0.00
0.9520	-0.9109	2534942.	-53210.	0.00811	72826.	7.51E+09	139.0615	25.6474	0.00
0.9660	-0.9095	2525454.	-53186.	0.00816	72612.	7.54E+09	141.3771	26.1136	0.00
0.9800	-0.9082	2515966.	-53162.	0.00822	72398.	7.57E+09	143.6945	26.5819	0.00
0.9940	-0.9068	2506478.	-53138.	0.00827	72183.	7.59E+09	146.0135	27.0521	0.00
1.0080	-0.9054	2496991.	-53113.	0.00833	71969.	7.62E+09	148.3338	27.5244	0.00

1.0220	-0.9040	2487505.	-53088.	0.00838	71755.	7.64E+09	150.6552	27.9985	0.00
1.0360	-0.9026	2478018.	-53063.	0.00844	71541.	7.67E+09	152.9773	28.4746	0.00
1.0500	-0.9011	2468533.	-53037.	0.00849	71327.	7.69E+09	155.3000	28.9525	0.00
1.0640	-0.8997	2459048.	-53010.	0.00855	71113.	7.72E+09	157.6229	29.4323	0.00
1.0780	-0.8983	2449564.	-52984.	0.00860	70899.	7.74E+09	159.9458	29.9140	0.00
1.0920	-0.8968	2440081.	-52957.	0.00865	70685.	7.77E+09	162.2685	30.3974	0.00
1.1060	-0.8954	2430599.	-52929.	0.00871	70471.	7.79E+09	164.5907	30.8826	0.00
1.1200	-0.8939	2421118.	-52901.	0.00876	70257.	7.82E+09	166.9122	31.3696	0.00
1.1340	-0.8924	2411638.	-52873.	0.00881	70043.	7.84E+09	169.2326	31.8583	0.00
1.1480	-0.8909	2402160.	-52845.	0.00886	69829.	7.87E+09	171.5517	32.3487	0.00
1.1620	-0.8894	2392683.	-52816.	0.00891	69615.	7.89E+09	173.8693	32.8407	0.00
1.1760	-0.8879	2383207.	-52786.	0.00896	69401.	7.92E+09	176.1851	33.3344	0.00
1.1900	-0.8864	2373733.	-52756.	0.00901	69187.	7.94E+09	178.4988	33.8297	0.00
1.2040	-0.8849	2364261.	-52726.	0.00906	68973.	7.97E+09	180.8102	34.3266	0.00
1.2180	-0.8834	2354790.	-52696.	0.00911	68759.	7.99E+09	183.1191	34.8250	0.00
1.2320	-0.8819	2345321.	-52665.	0.00916	68546.	8.02E+09	185.4465	35.3290	0.00
1.2460	-0.8803	2335854.	-52633.	0.00921	68332.	8.04E+09	187.7907	35.8383	0.00
1.2600	-0.8788	2326389.	-52602.	0.00926	68118.	8.07E+09	190.1329	36.3494	0.00
1.2740	-0.8772	2316926.	-52569.	0.00931	67905.	8.09E+09	192.4729	36.8621	0.00
1.2880	-0.8756	2307465.	-52537.	0.00936	67691.	8.12E+09	194.8104	37.3766	0.00
1.3020	-0.8741	2298007.	-52504.	0.00940	67478.	8.14E+09	197.1451	37.8928	0.00
1.3160	-0.8725	2288551.	-52471.	0.00945	67264.	8.16E+09	199.4769	38.4105	0.00
1.3300	-0.8709	2279097.	-52437.	0.00950	67051.	8.19E+09	201.8054	38.9299	0.00
1.3440	-0.8693	2269646.	-52403.	0.00954	66837.	8.21E+09	204.1305	39.4509	0.00
1.3580	-0.8677	2260197.	-52368.	0.00959	66624.	8.24E+09	206.4519	39.9735	0.00
1.3720	-0.8661	2250751.	-52333.	0.00964	66411.	8.26E+09	208.7693	40.4975	0.00
1.3860	-0.8644	2241308.	-52298.	0.00968	66198.	8.29E+09	211.0825	41.0231	0.00
1.4000	-0.8628	2231868.	-52263.	0.00973	65985.	8.31E+09	213.3912	41.5502	0.00
1.4140	-0.8612	2222431.	-52227.	0.00977	65772.	8.34E+09	215.6953	42.0787	0.00
1.4280	-0.8595	2212997.	-52190.	0.00982	65559.	8.36E+09	217.9944	42.6086	0.00
1.4420	-0.8579	2203566.	-52153.	0.00986	65346.	8.38E+09	220.2884	43.1400	0.00
1.4560	-0.8562	2194138.	-52116.	0.00991	65133.	8.41E+09	222.5769	43.6727	0.00
1.4700	-0.8545	2184714.	-52078.	0.00995	64920.	8.43E+09	224.8598	44.2067	0.00
1.4840	-0.8529	2175293.	-52041.	0.00999	64708.	8.45E+09	227.1367	44.7421	0.00
1.4980	-0.8512	2165875.	-52002.	0.01004	64495.	8.48E+09	229.4075	45.2787	0.00
1.5120	-0.8495	2156461.	-51963.	0.01008	64283.	8.50E+09	231.6719	45.8165	0.00
1.5260	-0.8478	2147051.	-51924.	0.01012	64070.	8.52E+09	233.9296	46.3556	0.00
1.5400	-0.8461	2137644.	-51885.	0.01016	63858.	8.55E+09	236.1805	46.8959	0.00
1.5540	-0.8444	2128241.	-51845.	0.01020	63646.	8.57E+09	238.4242	47.4373	0.00
1.5680	-0.8427	2118842.	-51805.	0.01025	63433.	8.59E+09	240.6606	47.9799	0.00
1.5820	-0.8409	2109447.	-51764.	0.01029	63221.	8.62E+09	242.8893	48.5236	0.00
1.5960	-0.8392	2100057.	-51723.	0.01033	63009.	8.64E+09	245.1102	49.0683	0.00
1.6100	-0.8375	2090670.	-51682.	0.01037	62798.	8.66E+09	247.3229	49.6140	0.00
1.6240	-0.8357	2081288.	-51640.	0.01041	62586.	8.68E+09	249.5273	50.1608	0.00
1.6380	-0.8340	2071909.	-51598.	0.01045	62374.	8.70E+09	251.7231	50.7085	0.00
1.6520	-0.8322	2062536.	-51555.	0.01049	62162.	8.73E+09	253.9101	51.2572	0.00
1.6660	-0.8304	2053166.	-51513.	0.01053	61951.	8.75E+09	256.0879	51.8067	0.00
1.6800	-0.8287	2043802.	-51469.	0.01057	61740.	8.77E+09	258.2565	52.3572	0.00
1.6940	-0.8269	2034442.	-51426.	0.01061	61528.	8.79E+09	260.4154	52.9084	0.00
1.7080	-0.8251	2025086.	-51382.	0.01065	61317.	8.81E+09	262.5646	53.4605	0.00
1.7220	-0.8233	2015736.	-51338.	0.01068	61106.	8.83E+09	264.7037	54.0133	0.00
1.7360	-0.8215	2006390.	-51293.	0.01072	60895.	8.85E+09	266.8324	54.5669	0.00
1.7500	-0.8197	1997049.	-51248.	0.01076	60684.	8.87E+09	268.9507	55.1211	0.00
1.7640	-0.8179	1987714.	-51203.	0.01080	60474.	8.89E+09	271.0581	55.6761	0.00

1.7780	-0.8161	1978383.	-51157.	0.01084	60263.	8.91E+09	273.1545	56.2316	0.00
1.7920	-0.8143	1969058.	-51111.	0.01087	60052.	8.93E+09	275.2396	56.7877	0.00
1.8060	-0.8124	1959738.	-51064.	0.01091	59842.	8.95E+09	277.3131	57.3444	0.00
1.8200	-0.8106	1950423.	-51018.	0.01095	59632.	8.97E+09	279.3749	57.9016	0.00
1.8340	-0.8088	1941113.	-50971.	0.01098	59422.	8.98E+09	281.4247	58.4593	0.00
1.8480	-0.8069	1931809.	-50923.	0.01102	59212.	9.00E+09	283.6678	59.0602	0.00
1.8620	-0.8051	1922511.	-50875.	0.01106	59002.	9.02E+09	285.9570	59.6739	0.00
1.8760	-0.8032	1913218.	-50827.	0.01109	58792.	9.04E+09	288.2396	60.2896	0.00
1.8900	-0.8013	1903931.	-50778.	0.01113	58582.	9.06E+09	290.5153	60.9071	0.00
1.9040	-0.7995	1894650.	-50729.	0.01116	58373.	9.07E+09	292.7841	61.5265	0.00
1.9180	-0.7976	1885375.	-50680.	0.01120	58163.	9.09E+09	295.0456	62.1478	0.00
1.9320	-0.7957	1876106.	-50630.	0.01123	57954.	9.10E+09	297.2997	62.7708	0.00
1.9460	-0.7938	1866843.	-50580.	0.01127	57745.	9.12E+09	299.5463	63.3957	0.00
1.9600	-0.7919	1857585.	-50530.	0.01130	57536.	9.14E+09	301.7850	64.0224	0.00
1.9740	-0.7900	1848334.	-50479.	0.01133	57327.	9.15E+09	304.0158	64.6509	0.00
1.9880	-0.7881	1839090.	-50427.	0.01137	57119.	9.17E+09	306.2384	65.2811	0.00
2.0020	-0.7862	1829852.	-50376.	0.01140	56910.	9.18E+09	308.4526	65.9131	0.00
2.0160	-0.7843	1820620.	-50324.	0.01143	56702.	9.19E+09	310.6582	66.5467	0.00
2.0300	-0.7823	1811394.	-50271.	0.01147	56494.	9.21E+09	312.8550	67.1821	0.00
2.0440	-0.7804	1802176.	-50219.	0.01150	56285.	9.22E+09	315.0429	67.8192	0.00
2.0580	-0.7785	1792964.	-50166.	0.01153	56078.	9.24E+09	317.2217	68.4580	0.00
2.0720	-0.7765	1783758.	-50112.	0.01157	55870.	9.25E+09	319.3910	69.0984	0.00
2.0860	-0.7746	1774560.	-50058.	0.01160	55662.	9.26E+09	321.5509	69.7404	0.00
2.1000	-0.7726	1765368.	-50004.	0.01163	55455.	9.27E+09	323.7010	70.3840	0.00
2.1140	-0.7707	1756184.	-49949.	0.01166	55247.	9.28E+09	325.8411	71.0292	0.00
2.1280	-0.7687	1747006.	-49895.	0.01169	55040.	9.30E+09	327.9711	71.6760	0.00
2.1420	-0.7668	1737836.	-49839.	0.01173	54833.	9.31E+09	330.0908	72.3243	0.00
2.1560	-0.7648	1728672.	-49784.	0.01176	54626.	9.32E+09	332.1999	72.9742	0.00
2.1700	-0.7628	1719516.	-49728.	0.01179	54420.	9.33E+09	334.2984	73.6255	0.00
2.1840	-0.7608	1710368.	-49671.	0.01182	54213.	9.34E+09	336.3859	74.2784	0.00
2.1980	-0.7588	1701226.	-49615.	0.01185	54007.	9.35E+09	338.4623	74.9327	0.00
2.2120	-0.7568	1692093.	-49558.	0.01188	53801.	9.35E+09	340.5273	75.5884	0.00
2.2260	-0.7548	1682966.	-49500.	0.01191	53595.	9.36E+09	342.5809	76.2456	0.00
2.2400	-0.7528	1673848.	-49443.	0.01194	53389.	9.37E+09	344.6228	76.9041	0.00
2.2540	-0.7508	1664737.	-49384.	0.01197	53183.	9.38E+09	346.6528	77.5641	0.00
2.2680	-0.7488	1655634.	-49326.	0.01200	52978.	9.39E+09	348.6707	78.2254	0.00
2.2820	-0.7468	1646538.	-49267.	0.01203	52772.	9.39E+09	350.6763	78.8880	0.00
2.2960	-0.7448	1637451.	-49208.	0.01206	52567.	9.40E+09	352.6694	79.5519	0.00
2.3100	-0.7427	1628372.	-49149.	0.01209	52362.	9.40E+09	354.6499	80.2171	0.00
2.3240	-0.7407	1619300.	-49089.	0.01212	52157.	9.41E+09	356.6175	80.8835	0.00
2.3380	-0.7387	1610237.	-49029.	0.01215	51953.	9.41E+09	358.5720	81.5512	0.00
2.3520	-0.7366	1601182.	-48969.	0.01217	51749.	9.42E+09	360.5132	82.2201	0.00
2.3660	-0.7346	1592135.	-48908.	0.01220	51544.	9.42E+09	362.4410	82.8902	0.00
2.3800	-0.7325	1583096.	-48847.	0.01223	51340.	9.43E+09	364.3552	83.5614	0.00
2.3940	-0.7305	1574066.	-48785.	0.01226	51136.	9.43E+09	366.2555	84.2338	0.00
2.4080	-0.7284	1565045.	-48724.	0.01229	50933.	9.43E+09	368.1417	84.9073	0.00
2.4220	-0.7263	1556031.	-48662.	0.01232	50729.	9.44E+09	370.0137	85.5819	0.00
2.4360	-0.7243	1547027.	-48599.	0.01234	50526.	9.44E+09	371.8713	86.2575	0.00
2.4500	-0.7222	1538031.	-48537.	0.01237	50323.	9.44E+09	373.7246	86.9365	0.00
2.4640	-0.7201	1529043.	-48474.	0.01240	50120.	9.44E+09	375.7276	87.6550	0.00
2.4780	-0.7180	1520065.	-48411.	0.01242	49917.	9.44E+09	377.7189	88.3754	0.00
2.4920	-0.7159	1511095.	-48347.	0.01245	49715.	9.44E+09	379.6982	89.0978	0.00
2.5060	-0.7139	1502134.	-48283.	0.01248	49513.	9.44E+09	381.6653	89.8222	0.00
2.5200	-0.7118	1493182.	-48219.	0.01251	49311.	9.44E+09	383.6202	90.5484	0.00

2.5340	-0.7097	1484239.	-48154.	0.01253	49109.	9.44E+09	385.5625	91.2766	0.00
2.5480	-0.7075	1475306.	-48089.	0.01256	48907.	9.44E+09	387.4922	92.0066	0.00
2.5620	-0.7054	1466381.	-48024.	0.01258	48706.	9.44E+09	389.4090	92.7386	0.00
2.5760	-0.7033	1457465.	-47958.	0.01261	48504.	9.44E+09	391.3128	93.4724	0.00
2.5900	-0.7012	1448559.	-47892.	0.01264	48303.	9.44E+09	393.2034	94.2081	0.00
2.6040	-0.6991	1439663.	-47826.	0.01266	48103.	9.44E+09	395.0806	94.9456	0.00
2.6180	-0.6969	1430775.	-47760.	0.01269	47902.	9.44E+09	396.9443	95.6849	0.00
2.6320	-0.6948	1421897.	-47693.	0.01271	47702.	9.44E+09	398.7943	96.4260	0.00
2.6460	-0.6927	1413029.	-47626.	0.01274	47501.	9.44E+09	400.6304	97.1690	0.00
2.6600	-0.6905	1404170.	-47558.	0.01276	47301.	9.44E+09	402.4524	97.9137	0.00
2.6740	-0.6884	1395321.	-47490.	0.01279	47102.	9.44E+09	404.2602	98.6602	0.00
2.6880	-0.6862	1386482.	-47422.	0.01281	46902.	9.44E+09	406.0535	99.4084	0.00
2.7020	-0.6841	1377653.	-47354.	0.01284	46703.	9.44E+09	407.8323	100.1583	0.00
2.7160	-0.6819	1368833.	-47285.	0.01286	46504.	9.44E+09	409.5963	100.9100	0.00
2.7300	-0.6798	1360023.	-47216.	0.01289	46305.	9.44E+09	411.3454	101.6633	0.00
2.7440	-0.6776	1351223.	-47147.	0.01291	46106.	9.44E+09	413.0793	102.4183	0.00
2.7580	-0.6754	1342434.	-47078.	0.01293	45908.	9.44E+09	414.7980	103.1750	0.00
2.7720	-0.6732	1333654.	-47008.	0.01296	45710.	9.44E+09	416.5012	103.9334	0.00
2.7860	-0.6711	1324884.	-46938.	0.01298	45512.	9.44E+09	418.1887	104.6933	0.00
2.8000	-0.6689	1316125.	-46867.	0.01301	45314.	9.44E+09	419.8605	105.4549	0.00
2.8140	-0.6667	1307376.	-46797.	0.01303	45117.	9.44E+09	421.5163	106.2180	0.00
2.8280	-0.6645	1298637.	-46726.	0.01305	44919.	9.44E+09	423.1559	106.9827	0.00
2.8420	-0.6623	1289909.	-46654.	0.01307	44722.	9.44E+09	424.7792	107.7490	0.00
2.8560	-0.6601	1281191.	-46583.	0.01310	44525.	9.44E+09	426.3859	108.5167	0.00
2.8700	-0.6579	1272484.	-46511.	0.01312	44329.	9.44E+09	427.9760	109.2860	0.00
2.8840	-0.6557	1263787.	-46439.	0.01314	44133.	9.44E+09	429.5492	110.0568	0.00
2.8980	-0.6535	1255100.	-46367.	0.01317	43937.	9.44E+09	431.1054	110.8290	0.00
2.9120	-0.6513	1246425.	-46294.	0.01319	43741.	9.44E+09	432.6444	111.6027	0.00
2.9260	-0.6491	1237760.	-46221.	0.01321	43545.	9.44E+09	434.1660	112.3778	0.00
2.9400	-0.6468	1229106.	-46148.	0.01323	43350.	9.44E+09	435.6701	113.1543	0.00
2.9540	-0.6446	1220462.	-46075.	0.01325	43155.	9.44E+09	437.1564	113.9322	0.00
2.9680	-0.6424	1211830.	-46001.	0.01327	42960.	9.44E+09	438.6248	114.7115	0.00
2.9820	-0.6402	1203208.	-45928.	0.01330	42765.	9.44E+09	440.0751	115.4921	0.00
2.9960	-0.6379	1194598.	-45854.	0.01332	42571.	9.44E+09	441.5072	116.2740	0.00
3.0100	-0.6357	1185998.	-45779.	0.01334	42377.	9.44E+09	442.9209	117.0571	0.00
3.0240	-0.6334	1177410.	-45705.	0.01336	42183.	9.44E+09	444.3159	117.8416	0.00
3.0380	-0.6312	1168832.	-45630.	0.01338	41989.	9.44E+09	445.6922	118.6273	0.00
3.0520	-0.6289	1160266.	-45555.	0.01340	41796.	9.44E+09	447.0495	119.4142	0.00
3.0660	-0.6267	1151711.	-45480.	0.01342	41603.	9.44E+09	448.6044	120.2603	0.00
3.0800	-0.6244	1143167.	-45404.	0.01344	41410.	9.44E+09	450.5979	121.2313	0.00
3.0940	-0.6222	1134635.	-45328.	0.01346	41217.	9.44E+09	452.5821	122.2075	0.00
3.1080	-0.6199	1126114.	-45252.	0.01348	41025.	9.44E+09	454.5570	123.1889	0.00
3.1220	-0.6176	1117605.	-45176.	0.01350	40833.	9.44E+09	456.5224	124.1756	0.00
3.1360	-0.6154	1109107.	-45099.	0.01352	40641.	9.44E+09	458.4782	125.1676	0.00
3.1500	-0.6131	1100620.	-45022.	0.01354	40450.	9.44E+09	460.4243	126.1651	0.00
3.1640	-0.6108	1092146.	-44944.	0.01356	40258.	9.44E+09	462.3606	127.1679	0.00
3.1780	-0.6085	1083683.	-44866.	0.01358	40067.	9.44E+09	464.2869	128.1761	0.00
3.1920	-0.6063	1075232.	-44788.	0.01360	39876.	9.44E+09	466.2031	129.1899	0.00
3.2060	-0.6040	1066792.	-44710.	0.01362	39686.	9.44E+09	468.1092	130.2092	0.00
3.2200	-0.6017	1058365.	-44631.	0.01364	39496.	9.44E+09	470.0049	131.2340	0.00
3.2340	-0.5994	1049950.	-44552.	0.01366	39306.	9.44E+09	471.8903	132.2645	0.00
3.2480	-0.5971	1041546.	-44472.	0.01368	39116.	9.44E+09	473.7650	133.3005	0.00
3.2620	-0.5948	1033155.	-44393.	0.01369	38927.	9.44E+09	475.6292	134.3423	0.00
3.2760	-0.5925	1024776.	-44312.	0.01371	38738.	9.44E+09	477.4825	135.3898	0.00

3.2900	-0.5902	1016409.	-44232.	0.01373	38549.	9.44E+09	479.3249	136.4431	0.00
3.3040	-0.5879	1008055.	-44151.	0.01375	38360.	9.44E+09	481.1564	137.5023	0.00
3.3180	-0.5856	999713.	-44070.	0.01377	38172.	9.44E+09	482.9767	138.5673	0.00
3.3320	-0.5833	991383.	-43989.	0.01378	37984.	9.44E+09	484.7857	139.6382	0.00
3.3460	-0.5809	983066.	-43908.	0.01380	37796.	9.44E+09	486.5833	140.7150	0.00
3.3600	-0.5786	974761.	-43826.	0.01382	37609.	9.44E+09	488.3695	141.7979	0.00
3.3740	-0.5763	966469.	-43743.	0.01384	37421.	9.44E+09	490.1441	142.8868	0.00
3.3880	-0.5740	958190.	-43661.	0.01385	37235.	9.44E+09	491.9069	143.9819	0.00
3.4020	-0.5716	949923.	-43578.	0.01387	37048.	9.44E+09	493.6579	145.0830	0.00
3.4160	-0.5693	941669.	-43495.	0.01389	36862.	9.44E+09	495.3969	146.1904	0.00
3.4300	-0.5670	933428.	-43412.	0.01390	36676.	9.44E+09	497.1238	147.3041	0.00
3.4440	-0.5646	925200.	-43328.	0.01392	36490.	9.44E+09	498.8385	148.4241	0.00
3.4580	-0.5623	916985.	-43244.	0.01394	36304.	9.44E+09	500.5409	149.5504	0.00
3.4720	-0.5599	908783.	-43160.	0.01395	36119.	9.44E+09	502.2309	150.6832	0.00
3.4860	-0.5576	900594.	-43075.	0.01397	35934.	9.44E+09	503.9083	151.8224	0.00
3.5000	-0.5553	892418.	-42991.	0.01399	35750.	9.44E+09	505.5730	152.9682	0.00
3.5140	-0.5529	884255.	-42905.	0.01400	35566.	9.44E+09	507.2249	154.1205	0.00
3.5280	-0.5506	876106.	-42820.	0.01402	35382.	9.44E+09	508.5848	155.1943	0.00
3.5420	-0.5482	867970.	-42735.	0.01403	35198.	9.44E+09	508.9399	155.9702	0.00
3.5560	-0.5458	859847.	-42649.	0.01405	35015.	9.44E+09	509.2666	156.7448	0.00
3.5700	-0.5435	851737.	-42564.	0.01406	34832.	9.44E+09	509.5648	157.5180	0.00
3.5840	-0.5411	843641.	-42478.	0.01408	34649.	9.44E+09	509.8344	158.2898	0.00
3.5980	-0.5387	835559.	-42392.	0.01409	34466.	9.44E+09	510.0752	159.0602	0.00
3.6120	-0.5364	827489.	-42307.	0.01411	34284.	9.44E+09	510.2871	159.8290	0.00
3.6260	-0.5340	819433.	-42221.	0.01412	34102.	9.44E+09	510.4699	160.5963	0.00
3.6400	-0.5316	811391.	-42135.	0.01414	33921.	9.44E+09	510.6236	161.3620	0.00
3.6540	-0.5293	803362.	-42049.	0.01415	33740.	9.44E+09	510.7478	162.1259	0.00
3.6680	-0.5269	795346.	-41963.	0.01417	33559.	9.44E+09	510.8426	162.8881	0.00
3.6820	-0.5245	787344.	-41878.	0.01418	33378.	9.44E+09	511.4934	163.8360	0.00
3.6960	-0.5221	779355.	-41792.	0.01419	33198.	9.44E+09	512.5286	164.9170	0.00
3.7100	-0.5197	771380.	-41705.	0.01421	33018.	9.44E+09	513.5415	166.0014	0.00
3.7240	-0.5173	763418.	-41619.	0.01422	32838.	9.44E+09	514.5318	167.0893	0.00
3.7380	-0.5149	755470.	-41532.	0.01423	32659.	9.44E+09	515.4993	168.1805	0.00
3.7520	-0.5126	747536.	-41446.	0.01425	32480.	9.44E+09	516.4439	169.2752	0.00
3.7660	-0.5102	739615.	-41359.	0.01426	32301.	9.44E+09	517.3654	170.3733	0.00
3.7800	-0.5078	731708.	-41272.	0.01427	32122.	9.44E+09	518.2635	171.4747	0.00
3.7940	-0.5054	723815.	-41185.	0.01429	31944.	9.44E+09	519.1382	172.5796	0.00
3.8080	-0.5030	715935.	-41098.	0.01430	31766.	9.44E+09	519.9891	173.6878	0.00
3.8220	-0.5006	708070.	-41010.	0.01431	31589.	9.44E+09	520.8162	174.7994	0.00
3.8360	-0.4982	700218.	-40923.	0.01433	31411.	9.44E+09	521.6192	175.9143	0.00
3.8500	-0.4957	692380.	-40835.	0.01434	31235.	9.44E+09	522.3980	177.0326	0.00
3.8640	-0.4933	684556.	-40747.	0.01435	31058.	9.44E+09	523.1522	178.1542	0.00
3.8780	-0.4909	676746.	-40659.	0.01436	30882.	9.44E+09	523.8819	179.2792	0.00
3.8920	-0.4885	668950.	-40571.	0.01437	30706.	9.44E+09	524.5867	180.4074	0.00
3.9060	-0.4861	661167.	-40483.	0.01439	30530.	9.44E+09	525.2665	181.5390	0.00
3.9200	-0.4837	653399.	-40395.	0.01440	30355.	9.44E+09	525.9211	182.6739	0.00
3.9340	-0.4813	645645.	-40306.	0.01441	30180.	9.44E+09	526.5502	183.8120	0.00
3.9480	-0.4788	637905.	-40218.	0.01442	30005.	9.44E+09	527.1538	184.9534	0.00
3.9620	-0.4764	630180.	-40129.	0.01443	29830.	9.44E+09	527.7316	186.0981	0.00
3.9760	-0.4740	622468.	-40040.	0.01444	29656.	9.44E+09	528.2834	187.2460	0.00
3.9900	-0.4716	614770.	-39951.	0.01445	29483.	9.44E+09	528.8091	188.3971	0.00
4.0040	-0.4691	607087.	-39863.	0.01447	29309.	9.44E+09	529.0421	189.4561	0.00
4.0180	-0.4667	599418.	-39774.	0.01448	29136.	9.44E+09	528.5849	190.2784	0.00
4.0320	-0.4643	591763.	-39685.	0.01449	28963.	9.44E+09	528.0942	191.0980	0.00

4.0460	-0.4618	584122.	-39596.	0.01450	28791.	9.44E+09	527.5702	191.9147	0.00
4.0600	-0.4594	576495.	-39508.	0.01451	28619.	9.44E+09	527.0126	192.7286	0.00
4.0740	-0.4570	568883.	-39419.	0.01452	28447.	9.44E+09	526.4216	193.5396	0.00
4.0880	-0.4545	561285.	-39331.	0.01453	28275.	9.44E+09	525.7972	194.3477	0.00
4.1020	-0.4521	553701.	-39243.	0.01454	28104.	9.44E+09	525.1393	195.1528	0.00
4.1160	-0.4496	546131.	-39154.	0.01455	27933.	9.44E+09	524.4479	195.9549	0.00
4.1300	-0.4472	538575.	-39066.	0.01456	27763.	9.44E+09	523.7231	196.7538	0.00
4.1440	-0.4447	531033.	-38978.	0.01457	27593.	9.44E+09	522.9649	197.5497	0.00
4.1580	-0.4423	523506.	-38891.	0.01458	27423.	9.44E+09	522.1732	198.3424	0.00
4.1720	-0.4398	515992.	-38803.	0.01458	27253.	9.44E+09	521.3481	199.1318	0.00
4.1860	-0.4374	508493.	-38715.	0.01459	27084.	9.44E+09	520.4896	199.9179	0.00
4.2000	-0.4349	501008.	-38628.	0.01460	26915.	9.44E+09	519.5978	200.7008	0.00
4.2140	-0.4325	493537.	-38541.	0.01461	26746.	9.44E+09	518.6726	201.4802	0.00
4.2280	-0.4300	486080.	-38454.	0.01462	26578.	9.44E+09	517.7140	202.2562	0.00
4.2420	-0.4276	478636.	-38367.	0.01463	26410.	9.44E+09	516.7222	203.0288	0.00
4.2560	-0.4251	471207.	-38280.	0.01464	26242.	9.44E+09	515.6971	203.7977	0.00
4.2700	-0.4227	463792.	-38194.	0.01465	26075.	9.44E+09	514.6387	204.5632	0.00
4.2840	-0.4202	456391.	-38107.	0.01465	25908.	9.44E+09	513.5471	205.3249	0.00
4.2980	-0.4177	449004.	-38021.	0.01466	25741.	9.44E+09	512.4223	206.0830	0.00
4.3120	-0.4153	441631.	-37935.	0.01467	25574.	9.44E+09	511.2644	206.8373	0.00
4.3260	-0.4128	434271.	-37849.	0.01468	25408.	9.44E+09	510.0734	207.5878	0.00
4.3400	-0.4103	426926.	-37764.	0.01469	25243.	9.44E+09	508.8493	208.3345	0.00
4.3540	-0.4079	419594.	-37678.	0.01469	25077.	9.44E+09	507.5922	209.0772	0.00
4.3680	-0.4054	412276.	-37593.	0.01470	24912.	9.44E+09	506.3021	209.8160	0.00
4.3820	-0.4029	404972.	-37508.	0.01471	24747.	9.44E+09	504.9791	210.5507	0.00
4.3960	-0.4005	397682.	-37424.	0.01471	24582.	9.44E+09	503.6232	211.2814	0.00
4.4100	-0.3980	390405.	-37339.	0.01472	24418.	9.44E+09	502.2345	212.0079	0.00
4.4240	-0.3955	383142.	-37255.	0.01473	24254.	9.44E+09	500.8131	212.7302	0.00
4.4380	-0.3930	375893.	-37171.	0.01474	24091.	9.44E+09	499.3590	213.4482	0.00
4.4520	-0.3906	368658.	-37087.	0.01474	23927.	9.44E+09	497.8722	214.1620	0.00
4.4660	-0.3881	361436.	-37004.	0.01475	23764.	9.44E+09	496.3528	214.8713	0.00
4.4800	-0.3856	354228.	-36920.	0.01476	23602.	9.44E+09	494.8009	215.5762	0.00
4.4940	-0.3831	347033.	-36837.	0.01476	23439.	9.44E+09	493.2166	216.2766	0.00
4.5080	-0.3806	339851.	-36755.	0.01477	23277.	9.44E+09	491.5999	216.9724	0.00
4.5220	-0.3782	332684.	-36672.	0.01477	23115.	9.44E+09	489.9510	217.6636	0.00
4.5360	-0.3757	325529.	-36590.	0.01478	22954.	9.44E+09	488.2698	218.3500	0.00
4.5500	-0.3732	318388.	-36508.	0.01479	22793.	9.44E+09	486.5564	219.0317	0.00
4.5640	-0.3707	311260.	-36426.	0.01479	22632.	9.44E+09	484.8110	219.7086	0.00
4.5780	-0.3682	304146.	-36345.	0.01480	22471.	9.44E+09	483.0336	220.3806	0.00
4.5920	-0.3657	297045.	-36264.	0.01480	22311.	9.44E+09	481.2244	221.0476	0.00
4.6060	-0.3633	289957.	-36183.	0.01481	22151.	9.44E+09	479.3833	221.7096	0.00
4.6200	-0.3608	282882.	-36103.	0.01481	21991.	9.44E+09	477.5105	222.3665	0.00
4.6340	-0.3583	275821.	-36023.	0.01482	21832.	9.44E+09	475.6061	223.0182	0.00
4.6480	-0.3558	268772.	-35943.	0.01482	21673.	9.44E+09	473.6701	223.6646	0.00
4.6620	-0.3533	261737.	-35864.	0.01483	21514.	9.44E+09	471.7027	224.3057	0.00
4.6760	-0.3508	254714.	-35785.	0.01483	21355.	9.44E+09	469.7040	224.9414	0.00
4.6900	-0.3483	247705.	-35706.	0.01484	21197.	9.44E+09	467.6741	225.5717	0.00
4.7040	-0.3458	240708.	-35628.	0.01484	21039.	9.44E+09	465.6130	226.1964	0.00
4.7180	-0.3433	233725.	-35550.	0.01484	20881.	9.44E+09	463.5210	226.8154	0.00
4.7320	-0.3408	226754.	-35472.	0.01485	20724.	9.44E+09	461.3980	227.4288	0.00
4.7460	-0.3383	219796.	-35395.	0.01485	20567.	9.44E+09	459.2443	228.0363	0.00
4.7600	-0.3358	212850.	-35318.	0.01486	20410.	9.44E+09	457.0598	228.6380	0.00
4.7740	-0.3333	205917.	-35241.	0.01486	20254.	9.44E+09	454.8448	229.2337	0.00
4.7880	-0.3308	198997.	-35165.	0.01486	20098.	9.44E+09	452.5994	229.8234	0.00

4.8020	-0.3284	192089.	-35089.	0.01487	19942.	9.44E+09	450.3236	230.4070	0.00
4.8160	-0.3259	185194.	-35013.	0.01487	19786.	9.44E+09	448.0177	230.9844	0.00
4.8300	-0.3234	178311.	-34938.	0.01487	19631.	9.44E+09	445.6817	231.5554	0.00
4.8440	-0.3209	171441.	-34864.	0.01488	19476.	9.44E+09	443.3157	232.1201	0.00
4.8580	-0.3184	164583.	-34789.	0.01488	19321.	9.44E+09	440.9200	232.6782	0.00
4.8720	-0.3159	157737.	-34716.	0.01488	19166.	9.44E+09	438.4945	233.2298	0.00
4.8860	-0.3134	150903.	-34642.	0.01489	19012.	9.44E+09	436.0396	233.7747	0.00
4.9000	-0.3109	144081.	-34569.	0.01489	18858.	9.44E+09	433.6973	234.3896	0.00
4.9140	-0.3084	137272.	-34496.	0.01489	18704.	9.44E+09	432.3902	235.5788	0.00
4.9280	-0.3059	130474.	-34424.	0.01489	18551.	9.44E+09	431.0613	236.7758	0.00
4.9420	-0.3033	123689.	-34351.	0.01489	18398.	9.44E+09	429.7106	237.9808	0.00
4.9560	-0.3008	116915.	-34279.	0.01490	18245.	9.44E+09	428.3382	239.1940	0.00
4.9700	-0.2983	110154.	-34208.	0.01490	18092.	9.44E+09	426.9442	240.4157	0.00
4.9840	-0.2958	103404.	-34136.	0.01490	17940.	9.44E+09	425.5288	241.6461	0.00
4.9980	-0.2933	96667.	-34065.	0.01490	17788.	9.44E+09	424.0919	242.8855	0.00
5.0120	-0.2908	89941.	-34024.	0.01490	0.00	9.36E+09	55.8040	32.2352	0.00
5.0260	-0.2883	83216.	-34015.	0.01491	0.00	9.36E+09	55.9595	32.6057	0.00
5.0400	-0.2858	76493.	-34005.	0.01491	0.00	9.36E+09	56.1149	32.9828	0.00
5.0540	-0.2833	69772.	-33996.	0.01491	0.00	9.36E+09	56.2704	33.3665	0.00
5.0680	-0.2808	63052.	-33987.	0.01491	0.00	9.36E+09	56.4259	33.7571	0.00
5.0820	-0.2783	56333.	-33977.	0.01491	0.00	9.36E+09	56.5813	34.1548	0.00
5.0960	-0.2758	49617.	-33968.	0.01491	0.00	9.36E+09	56.7368	34.5597	0.00
5.1100	-0.2733	42901.	-33958.	0.01491	0.00	9.36E+09	56.8922	34.9721	0.00
5.1240	-0.2708	36187.	-33948.	0.01491	0.00	9.36E+09	57.0477	35.3921	0.00
5.1380	-0.2683	29475.	-33939.	0.01491	0.00	9.36E+09	57.2032	35.8200	0.00
5.1520	-0.2658	22764.	-33929.	0.01491	0.00	9.36E+09	57.3586	36.2559	0.00
5.1660	-0.2633	16055.	-33920.	0.01491	0.00	9.36E+09	57.5141	36.7002	0.00
5.1800	-0.2608	9348.	-33910.	0.01491	0.00	9.36E+09	57.6696	37.1530	0.00
5.1940	-0.2583	2642.	-33900.	0.01492	0.00	9.36E+09	57.8250	37.6145	0.00
5.2080	-0.2558	-4062.	-33890.	0.01492	0.00	9.36E+09	57.9805	38.0852	0.00
5.2220	-0.2533	-10765.	-33881.	0.01491	0.00	9.36E+09	58.1359	38.5651	0.00
5.2360	-0.2508	-17466.	-33871.	0.01491	0.00	9.36E+09	58.2914	39.0547	0.00
5.2500	-0.2482	-24165.	-33861.	0.01491	0.00	9.36E+09	58.4469	39.5541	0.00
5.2640	-0.2457	-30863.	-33851.	0.01491	0.00	9.36E+09	58.6023	40.0636	0.00
5.2780	-0.2432	-37558.	-33841.	0.01491	0.00	9.36E+09	58.7578	40.5837	0.00
5.2920	-0.2407	-44253.	-33832.	0.01491	0.00	9.36E+09	58.9133	41.1146	0.00
5.3060	-0.2382	-50945.	-33822.	0.01491	0.00	9.36E+09	59.0687	41.6566	0.00
5.3200	-0.2357	-57636.	-33812.	0.01491	0.00	9.36E+09	59.2242	42.2101	0.00
5.3340	-0.2332	-64325.	-33802.	0.01491	0.00	9.36E+09	59.3796	42.7754	0.00
5.3480	-0.2307	-71012.	-33792.	0.01491	0.00	9.36E+09	59.5351	43.3530	0.00
5.3620	-0.2282	-77698.	-33782.	0.01491	0.00	9.36E+09	59.6906	43.9433	0.00
5.3760	-0.2257	-84381.	-33772.	0.01491	0.00	9.36E+09	59.8460	44.5466	0.00
5.3900	-0.2232	-91063.	-33762.	0.01490	0.00	9.36E+09	60.0015	45.1634	0.00
5.4040	-0.2207	-97743.	-33752.	0.01490	0.00	9.36E+09	60.1570	45.7941	0.00
5.4180	-0.2182	-104422.	-33741.	0.01490	0.00	9.36E+09	60.3124	46.4392	0.00
5.4320	-0.2157	-111098.	-33731.	0.01490	0.00	9.36E+09	60.4679	47.0992	0.00
5.4460	-0.2132	-117773.	-33721.	0.01490	0.00	9.36E+09	60.6233	47.7747	0.00
5.4600	-0.2107	-124445.	-33711.	0.01489	0.00	9.36E+09	60.7788	48.4661	0.00
5.4740	-0.2082	-131116.	-33701.	0.01489	0.00	9.36E+09	60.9343	49.1741	0.00
5.4880	-0.2057	-137785.	-33690.	0.01489	0.00	9.36E+09	61.0897	49.8992	0.00
5.5020	-0.2032	-144453.	-33680.	0.01489	0.00	9.36E+09	61.2452	50.6421	0.00
5.5160	-0.2007	-151118.	-33670.	0.01488	0.00	9.36E+09	61.4007	51.4033	0.00
5.5300	-0.1982	-157781.	-33660.	0.01488	0.00	9.36E+09	61.5561	52.1837	0.00
5.5440	-0.1957	-164442.	-33649.	0.01488	0.00	9.36E+09	61.7116	52.9838	0.00

5.5580	-0.1932	-171102.	-33639.	0.01488	0.00	9.37E+09	61.8671	53.8045	0.00
5.5720	-0.1907	-177759.	-33628.	0.01487	0.00	9.37E+09	62.0225	54.6466	0.00
5.5860	-0.1882	-184415.	-33618.	0.01487	0.00	9.37E+09	62.1780	55.5110	0.00
5.6000	-0.1857	-191068.	-33607.	0.01487	0.00	9.37E+09	62.3334	56.3984	0.00
5.6140	-0.1832	-197720.	-33597.	0.01486	0.00	9.37E+09	62.4889	57.3098	0.00
5.6280	-0.1807	-204370.	-33586.	0.01486	0.00	9.37E+09	62.6444	58.2462	0.00
5.6420	-0.1782	-211017.	-33576.	0.01486	0.00	9.39E+09	62.7998	59.2087	0.00
5.6560	-0.1757	-217663.	-33565.	0.01485	0.00	9.41E+09	62.9553	60.1982	0.00
5.6700	-0.1732	-224306.	-33555.	0.01485	0.00	9.42E+09	63.1108	61.2161	0.00
5.6840	-0.1707	-230947.	-33544.	0.01484	0.00	9.43E+09	63.2662	62.2635	0.00
5.6980	-0.1682	-237587.	-33534.	0.01484	0.00	9.44E+09	63.4217	63.3417	0.00
5.7120	-0.1657	-244224.	-33523.	0.01483	0.00	9.46E+09	63.5771	64.4520	0.00
5.7260	-0.1632	-250859.	-33512.	0.01483	0.00	9.49E+09	63.7326	65.5960	0.00
5.7400	-0.1607	-257492.	-33501.	0.01483	0.00	9.52E+09	63.8881	66.7751	0.00
5.7540	-0.1582	-264123.	-33491.	0.01482	0.00	9.55E+09	64.0435	67.9910	0.00
5.7680	-0.1558	-270752.	-33480.	0.01482	0.00	9.58E+09	64.1990	69.2454	0.00
5.7820	-0.1533	-277379.	-33469.	0.01481	0.00	9.61E+09	64.3545	70.5403	0.00
5.7960	-0.1508	-284003.	-33458.	0.01481	0.00	9.64E+09	64.5099	71.8775	0.00
5.8100	-0.1483	-290626.	-33447.	0.01480	0.00	9.67E+09	64.6654	73.2591	0.00
5.8240	-0.1458	-297246.	-33437.	0.01480	0.00	9.71E+09	64.8209	74.6875	0.00
5.8380	-0.1433	-303864.	-33426.	0.01479	0.00	9.75E+09	64.9763	76.1649	0.00
5.8520	-0.1408	-310480.	-33415.	0.01479	0.00	9.80E+09	65.1318	77.6941	0.00
5.8660	-0.1384	-317094.	-33404.	0.01478	0.00	9.84E+09	65.2873	79.2776	0.00
5.8800	-0.1359	-323705.	-33393.	0.01478	0.00	9.88E+09	65.4427	80.9185	0.00
5.8940	-0.1334	-330314.	-33382.	0.01477	0.00	9.92E+09	65.5982	82.6199	0.00
5.9080	-0.1309	-336921.	-33371.	0.01476	0.00	9.96E+09	65.7536	84.3852	0.00
5.9220	-0.1284	-343526.	-33360.	0.01476	0.00	1.00E+10	65.9091	86.2180	0.00
5.9360	-0.1259	-350129.	-33349.	0.01475	0.00	1.00E+10	66.0646	88.1224	0.00
5.9500	-0.1235	-356729.	-33338.	0.01475	0.00	1.01E+10	66.2200	90.1025	0.00
5.9640	-0.1210	-363327.	-33326.	0.01474	0.00	1.01E+10	66.3755	92.1630	0.00
5.9780	-0.1185	-369923.	-33315.	0.01473	0.00	1.02E+10	66.5310	94.3088	0.00
5.9920	-0.1160	-376516.	-33304.	0.01473	0.00	1.02E+10	66.6864	96.5453	0.00
6.0060	-0.1136	-383107.	-33293.	0.01472	0.00	1.03E+10	66.8419	98.8784	0.00
6.0200	-0.1111	-389696.	-33282.	0.01472	0.00	1.03E+10	66.9974	101.3144	0.00
6.0340	-0.1086	-396283.	-33270.	0.01471	0.00	1.04E+10	67.1528	103.8603	0.00
6.0480	-0.1062	-402867.	-33259.	0.01470	0.00	1.04E+10	67.3083	106.5238	0.00
6.0620	-0.1037	-409449.	-33248.	0.01470	0.00	1.04E+10	67.4638	109.3130	0.00
6.0760	-0.1012	-416028.	-33236.	0.01469	0.00	1.05E+10	67.6192	112.2371	0.00
6.0900	-0.09875	-422605.	-33225.	0.01468	0.00	1.05E+10	67.7747	115.3060	0.00
6.1040	-0.09628	-429180.	-33214.	0.01468	0.00	1.06E+10	67.9302	118.5309	0.00
6.1180	-0.09382	-435752.	-33202.	0.01467	0.00	1.06E+10	68.0856	121.9239	0.00
6.1320	-0.09135	-442322.	-33191.	0.01466	0.00	1.06E+10	68.2411	125.4984	0.00
6.1460	-0.08889	-448890.	-33179.	0.01466	0.00	1.07E+10	68.3966	129.2693	0.00
6.1600	-0.08643	-455455.	-33168.	0.01465	0.00	1.07E+10	68.5520	133.2534	0.00
6.1740	-0.08397	-462018.	-33156.	0.01464	0.00	1.08E+10	68.7075	137.4690	0.00
6.1880	-0.08151	-468578.	-33145.	0.01463	0.00	1.08E+10	68.8630	141.9371	0.00
6.2020	-0.07905	-475136.	-33133.	0.01463	0.00	1.08E+10	69.0184	146.6809	0.00
6.2160	-0.07659	-481691.	-33121.	0.01462	0.00	1.09E+10	69.1739	151.7268	0.00
6.2300	-0.07414	-488244.	-33110.	0.01461	0.00	1.09E+10	69.3294	157.1044	0.00
6.2440	-0.07168	-494795.	-29975.	0.01460	0.00	1.09E+10	37251.	87304.	0.00
6.2580	-0.06923	-500294.	-23742.	0.01460	0.00	1.10E+10	36946.	89657.	0.00
6.2720	-0.06678	-504749.	-17561.	0.01459	0.00	1.10E+10	36642.	92182.	0.00
6.2860	-0.06433	-508170.	-11431.	0.01458	0.00	1.10E+10	36337.	94898.	0.00
6.3000	-0.06188	-510564.	-5352.	0.01457	0.00	1.10E+10	36033.	97827.	0.00

6.3140	-0.05943	-511941.	676.3053	0.01457	0.00	1.10E+10	35728.	100996.	0.00
6.3280	-0.05699	-512309.	6653.	0.01456	0.00	1.10E+10	35424.	104436.	0.00
6.3420	-0.05454	-511677.	12579.	0.01455	0.00	1.10E+10	35120.	108181.	0.00
6.3560	-0.05210	-510053.	18454.	0.01454	0.00	1.10E+10	34817.	112277.	0.00
6.3700	-0.04965	-507446.	24277.	0.01453	0.00	1.10E+10	34513.	116772.	0.00
6.3840	-0.04721	-503864.	30050.	0.01453	0.00	1.10E+10	34210.	121731.	0.00
6.3980	-0.04477	-499316.	35772.	0.01452	0.00	1.10E+10	33906.	127226.	0.00
6.4120	-0.04233	-493811.	41443.	0.01451	0.00	1.09E+10	33603.	133352.	0.00
6.4260	-0.03990	-487356.	47062.	0.01450	0.00	1.09E+10	33300.	140223.	0.00
6.4400	-0.03746	-479962.	52631.	0.01450	0.00	1.09E+10	32997.	147984.	0.00
6.4540	-0.03503	-471635.	58150.	0.01449	0.00	1.08E+10	32695.	156820.	0.00
6.4680	-0.03259	-462385.	63617.	0.01448	0.00	1.08E+10	32392.	166970.	0.00
6.4820	-0.03016	-452221.	69033.	0.01447	0.00	1.07E+10	32090.	178752.	0.00
6.4960	-0.02773	-441150.	74399.	0.01447	0.00	1.06E+10	31788.	192594.	0.00
6.5100	-0.02530	-429182.	79714.	0.01446	0.00	1.06E+10	31486.	209088.	0.00
6.5240	-0.02287	-416324.	84978.	0.01445	0.00	1.05E+10	31184.	229076.	0.00
6.5380	-0.02044	-402586.	90192.	0.01445	0.00	1.04E+10	30882.	253802.	0.00
6.5520	-0.01802	-387976.	95355.	0.01444	0.00	1.03E+10	30581.	285177.	0.00
6.5660	-0.01559	-372503.	100467.	0.01444	0.00	1.02E+10	30279.	326299.	0.00
6.5800	-0.01317	-356174.	105529.	0.01443	0.00	1.01E+10	29978.	382548.	0.00
6.5940	-0.01074	-338999.	110290.	0.01442	0.00	9.97E+09	26704.	417648.	0.00
6.6080	-0.00832	-321069.	114270.	0.01442	0.00	9.87E+09	20681.	417648.	0.00
6.6220	-0.00590	-302556.	117239.	0.01441	0.00	9.75E+09	14661.	417648.	0.00
6.6360	-0.00348	-283629.	119196.	0.01441	0.00	9.64E+09	8642.	417648.	0.00
6.6500	-0.00106	-264457.	120143.	0.01440	0.00	9.55E+09	2626.	417648.	0.00
6.6640	0.00136	-245211.	120079.	0.01440	0.00	9.46E+09	-3388.	417648.	0.00
6.6780	0.00378	-226060.	119005.	0.01439	0.00	9.42E+09	-9400.	417648.	0.00
6.6920	0.00620	-207174.	116921.	0.01439	0.00	9.38E+09	-15411.	417648.	0.00
6.7060	0.00862	-188723.	113827.	0.01439	0.00	9.37E+09	-21420.	417648.	0.00
6.7200	0.01103	-170876.	109724.	0.01438	0.00	9.37E+09	-27428.	417648.	0.00
6.7340	0.01345	-153804.	104899.	0.01438	0.00	9.36E+09	-30012.	374901.	0.00
6.7480	0.01586	-137578.	99832.	0.01438	0.00	9.36E+09	-30312.	320997.	0.00
6.7620	0.01828	-122207.	94714.	0.01438	0.00	9.36E+09	-30613.	281345.	0.00
6.7760	0.02069	-107700.	89546.	0.01437	0.00	9.36E+09	-30913.	250952.	0.00
6.7900	0.02311	-94066.	84327.	0.01437	0.00	9.36E+09	-31213.	226914.	0.00
6.8040	0.02552	-81312.	79058.	0.01437	0.00	9.36E+09	-31513.	207426.	0.00
6.8180	0.02794	-69448.	73739.	0.01437	0.00	9.36E+09	-31813.	191307.	0.00
6.8320	0.03035	-58482.	68369.	0.01437	0.00	9.36E+09	-32113.	177754.	0.00
6.8460	0.03276	-48422.	62949.	0.01437	0.00	9.36E+09	-32413.	166198.	0.00
6.8600	0.03518	-39276.	57478.	0.01437	0.00	9.36E+09	-32713.	156228.	0.00
6.8740	0.03759	-31054.	51957.	0.01436	0.00	9.36E+09	-33013.	147539.	0.00
6.8880	0.04000	-23764.	46386.	0.01436	0.00	9.36E+09	-33313.	139899.	0.00
6.9020	0.04242	-17414.	40764.	0.01436	0.00	9.36E+09	-33613.	133128.	0.00
6.9160	0.04483	-12012.	35092.	0.01436	0.00	9.36E+09	-33913.	127086.	0.00
6.9300	0.04724	-7568.	29369.	0.01436	0.00	9.36E+09	-34213.	121662.	0.00
6.9440	0.04966	-4089.	23596.	0.01436	0.00	9.36E+09	-34513.	116765.	0.00
6.9580	0.05207	-1585.	17773.	0.01436	0.00	9.36E+09	-34813.	112321.	0.00
6.9720	0.05448	-62.5398	11899.	0.01436	0.00	9.36E+09	-35113.	108271.	0.00
6.9860	0.05690	468.4781	5975.	0.01436	0.00	9.36E+09	-35413.	104565.	0.00
7.0000	0.05931	0.00	0.00	0.01436	0.00	9.36E+09	-35713.	50580.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual

stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

Pile-head deflection = -0.97500000 inches
Computed slope at pile head = 0.000000 radians
Maximum bending moment = 3174431. inch-lbs
Maximum shear force = 120143. lbs
Depth of maximum bending moment = 0.000000 feet below pile head
Depth of maximum shear force = 6.65000000 feet below pile head
Number of iterations = 242
Number of zero deflection points = 1

Summary of Pile-head Responses for Conventional Analyses

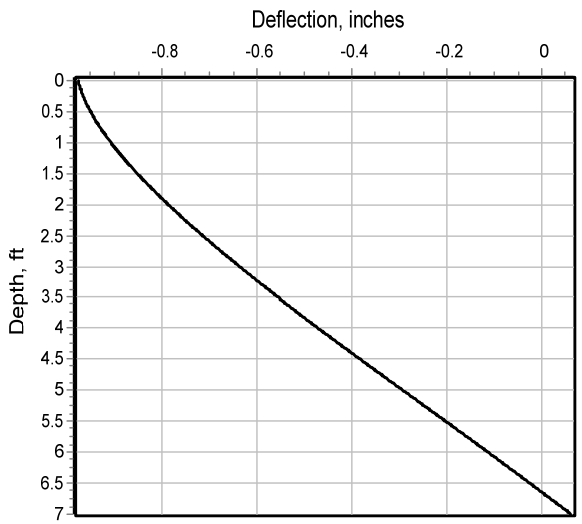
Definitions of Pile-head Loading Conditions:

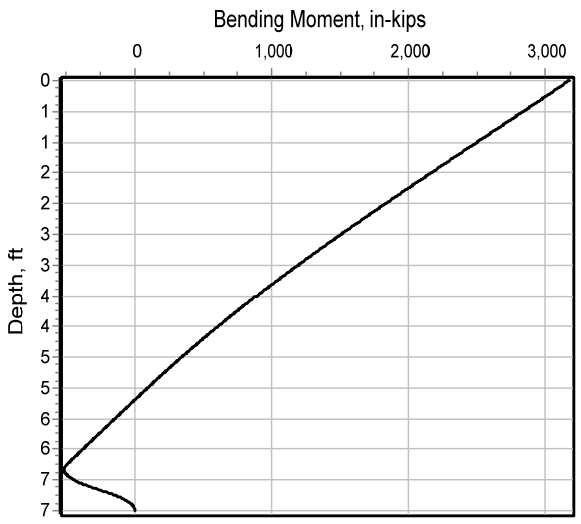
Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

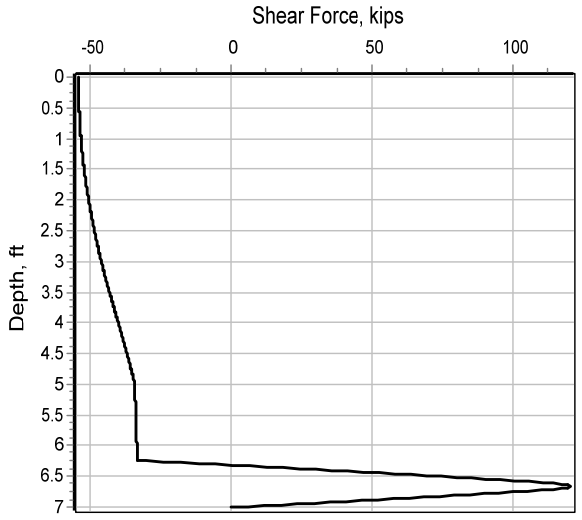
Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	y, in	-0.9750	S, rad	0.00	403000.	-0.9750	0.00	120143.	3174431.

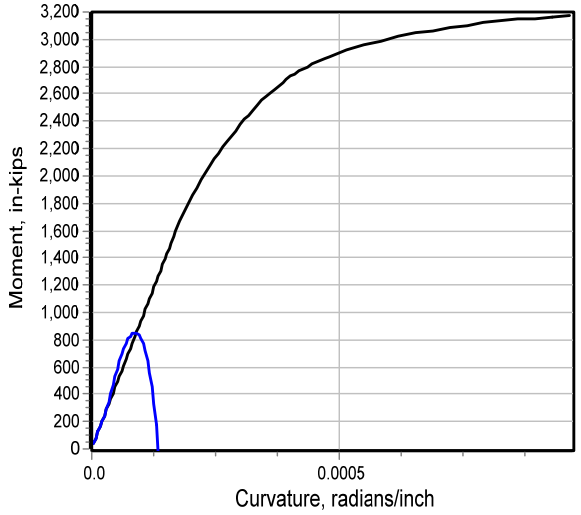
Maximum pile-head deflection = -0.9750000000 inches
Maximum pile-head rotation = 0.0000000000 radians = 0.000000 deg.

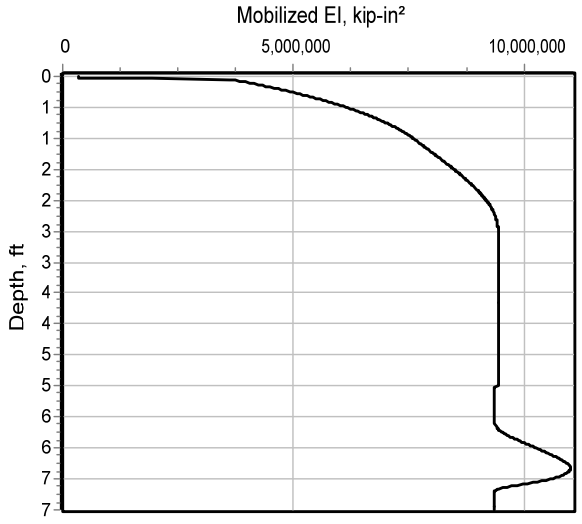
The analysis ended normally.

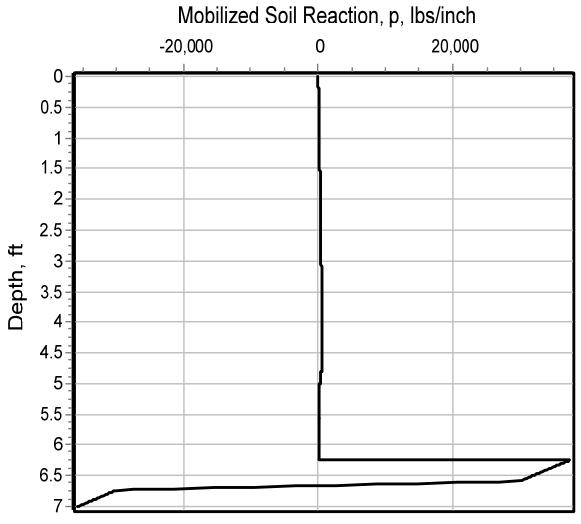

Deflection, inches
-0.8
-0.6
-0.4
-0.2
0
Depth, ft
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7


Bending Moment, in-kips
0
1,000
2,000
3,000
Depth, ft
0
1
1
2
2
3
3
4
4
5
5
6
6
7
7


Shear Force, kips
-50
0
50
100
Depth, ft
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7


Moment, in-kips
3,200
3,000
2,800
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
0.0
0.0005
Curvature, radians/inch


Mobilized EI, kip-in²
0
5,000,000
10,000,000
Depth, ft
0
1
1
2
2
3
3
4
4
5
5
6
6
7
7


Mobilized Soil Reaction, p, lbs/inch
-20,000
0
20,000
Depth, ft
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7

Attachment 2

==========

LPile for Windows, Version 2019-11.005

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

==========

This copy of LPile is being used by:

KAR
Golder Associates, Inc.

Serial Number of Security Device: 239146533

This copy of LPile is licensed for exclusive use by:

GOLDER, Manchester, NH

Use of this program by any entity other than GOLDER, Manchester, NH
is a violation of the software license agreement.

Files Used for Analysis

Path to file locations:
\\golderassociates.sharepoint.com@SSL\DavWWWRoot\sites\139982\Project Files\5 Technical Work\06 Analysis\Phase II - Pile Design\LPILE\Abutment 2 Strength I\

Name of input data file:
Freeport Exit 22 Abutment 2 with Socket MinSoil 2ftPile GirderRotation PlasticHinge.lp11d

Name of output report file:
Freeport Exit 22 Abutment 2 with Socket MinSoil 2ftPile GirderRotation PlasticHinge.lp11o

Name of plot output file:
Freeport Exit 22 Abutment 2 with Socket MinSoil 2ftPile GirderRotation PlasticHinge.lp11p

Name of runtime message file:
Freeport Exit 22 Abutment 2 with Socket MinSoil 2ftPile GirderRotation PlasticHinge.lp11r

---

Date and Time of Analysis

Date: July 14, 2021 Time: 16:36:12

Problem Title

Project Name: MaineDOT I-295 Exit 22 Mallet Drive Bridge No. 5721
Job Number: 21450910
Client: MaineDOT
Engineer: KAR
Description: Abutment 2 Pile Design - Strength I (Rock Socket)

Program Options and Settings

Computational Options:
- Conventional Analysis

Engineering Units Used for Data Input and Computations:
- US Customary System Units (pounds, feet, inches)

Analysis Control Options:
- Maximum number of iterations allowed = 1000
- Deflection tolerance for convergence = 1.0000E-02 in
- Maximum allowable deflection = 100.0000 in
- Number of pile increments = 500

Loading Type and Number of Cycles of Loading:
- Static loading specified

- Use of p-y modification factors for p-y curves not selected
- Analysis uses layering correction (Method of Georgiadis)
- No distributed lateral loads are entered
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Input of moment resistance at the pile tip not selected
- Input of side resistance moment along pile not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- Output files use decimal points to denote decimal symbols.
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 2
Total length of pile = 7.000 ft
Depth of ground surface below top of pile = 0.0000 ft

Pile diameters used for p-y curve computations are defined using 4 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	14.6950
2	5.000	14.6950
3	5.000	30.0000
4	7.000	30.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is a H weak axis steel pile
Length of section = 5.000000 ft
Pile width = 13.830000 in
Shear capacity of section = 0.0000 lbs

Pile Section No. 2:

Section 2 is a drilled shaft with casing and H section core/insert
Length of section = 2.000000 ft
Section Diameter = 30.000000 in
Shear capacity of section = 0.0000 lbs

Ground Slope and Pile Batter Angles

Ground Slope Angle = 0.000 degrees
= 0.000 radians

Pile Batter Angle = 0.000 degrees
= 0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 3 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 0.0000 ft
Distance from top of pile to bottom of layer = 4.000000 ft
Effective unit weight at top of layer = 125.000000 pcf
Effective unit weight at bottom of layer = 125.000000 pcf
Friction angle at top of layer = 33.000000 deg.
Friction angle at bottom of layer = 33.000000 deg.
Subgrade k at top of layer = 165.000000 pci
Subgrade k at bottom of layer = 165.000000 pci

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 4.000000 ft
Distance from top of pile to bottom of layer = 5.000000 ft
Effective unit weight at top of layer = 62.600000 pcf
Effective unit weight at bottom of layer = 6.260000 pcf
Friction angle at top of layer = 33.000000 deg.
Friction angle at bottom of layer = 33.000000 deg.
Subgrade k at top of layer = 100.000000 pci
Subgrade k at bottom of layer = 100.000000 pci

Layer 3 is strong rock (vuggy limestone)

Distance from top of pile to top of layer = 5.000000 ft
Distance from top of pile to bottom of layer = 20.000000 ft
Effective unit weight at top of layer = 106.600000 pcf
Effective unit weight at bottom of layer = 106.600000 pcf
Uniaxial compressive strength at top of layer = 2486. psi
Uniaxial compressive strength at bottom of layer = 2486. psi

(Depth of the lowest soil layer extends 13.000 ft below the pile tip)

Summary of Input Soil Properties

Layer Num.	Soil Type Layer Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	Uniaxial qu psi	kpy pci
1	Sand	0.00	125.0000	33.0000	--	165.0000
	(Reese, et al.)	4.0000	125.0000	33.0000	--	165.0000
2	Sand	4.0000	62.6000	33.0000	--	100.0000

	(Reese, et al.)	5.0000	6.2600	33.0000	--	100.0000
3	Strong Rock	5.0000	106.6000	--	2486.	--
	(Vuggy Limestone)	20.0000	106.6000	--	2486.	--

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 2

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	5	y = -0.975000 in	S = 0.0000 in/in	403000.	N.A.	Yes
2	4	y = -0.975000 in	M = 1885473. in-lbs	403000.	N.A.	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 2

Pile Section No. 1:

Dimensions and Properties of Steel H Weak Axis:

Length of Section = 5.000000 ft
Flange Width = 14.695000 in
Section Depth = 13.830000 in
Flange Thickness = 0.615000 in

Web Thickness = 0.615000 in
Yield Stress of Pipe = 50.000000 ksi
Elastic Modulus = 29000. ksi
Cross-sectional Area = 25.823850 sq. in.
Moment of Inertia = 325.505721 in^4
Elastic Bending Stiffness = 9439666. kip-in^2
Plastic Modulus, Z = 67.593889in^3
Plastic Moment Capacity = Fy Z = 3380.in-kip

Axial Structural Capacities:

Nom. Axial Structural Capacity = Fy As = 1291.193 kips
Nominal Axial Tensile Capacity = -1291.193 kips

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	403.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 403.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000433	40.8281079	9438779.	131.7538671	16.5181939	
0.00000865	81.6562158	9438779.	69.5506836	17.4306589	
0.00001298	122.4843237	9438779.	48.8162890	18.3431240	
0.00001730	163.3124315	9438779.	38.4490918	19.2555888	
0.00002163	204.1405394	9438779.	32.2287734	20.1680540	
0.00002595	244.9686473	9438779.	28.0818945	21.0805192	
0.00003028	285.7967552	9438779.	25.1198382	21.9929841	
0.00003460	326.6248631	9438779.	22.8982959	22.9054492	
0.00003893	367.4529710	9438779.	21.1704297	23.8179143	
0.00004326	408.2810788	9438779.	19.7881367	24.7303794	
0.00004758	449.1091867	9438779.	18.6571697	25.6428444	
0.00005191	489.9372946	9438779.	17.7146973	26.5553094	
0.00005623	530.7654025	9438779.	16.9172205	27.4677745	
0.00006056	571.5935104	9438779.	16.2336691	28.3802396	
0.00006488	612.4216183	9438779.	15.6412578	29.2927047	
0.00006921	653.2497262	9438779.	15.1228979	30.2051698	
0.00007353	694.0778340	9438779.	14.6655216	31.1176348	
0.00007786	734.9059419	9438779.	14.2589648	32.0300998	

0.00008219	775.7340498	9438779.	13.8952035	32.9425649	
0.00008651	816.5621577	9438779.	13.5678184	33.8550300	
0.00009084	857.3902656	9438779.	13.2716127	34.7674950	
0.00009516	898.2183735	9438779.	13.0023349	35.6799601	
0.00009949	939.0464813	9438779.	12.7564725	36.5924251	
0.0001038	979.8745892	9438779.	12.5310986	37.5048902	
0.0001081	1021.	9438779.	12.3237547	38.4173552	
0.0001125	1062.	9438779.	12.1323603	39.3298203	
0.0001168	1102.	9438779.	11.9551432	40.2422853	
0.0001211	1143.	9438779.	11.7905845	41.1547504	
0.0001254	1184.	9438779.	11.6373747	42.0672155	
0.0001298	1225.	9438779.	11.4943789	42.9796805	
0.0001341	1266.	9438779.	11.3606086	43.8921456	
0.0001384	1306.	9438779.	11.2351990	44.8046106	
0.0001427	1347.	9438779.	11.1173899	45.7170757	
0.0001471	1388.	9438779.	11.0065108	46.6295408	
0.0001514	1429.	9438779.	10.9019676	47.5420058	
0.0001557	1470.	9438779.	10.8032324	48.4544709	
0.0001600	1511.	9438779.	10.7098342	49.3669360	
0.0001644	1551.	9436528.	10.6217649	50.0000000	Y
0.0001687	1590.	9425696.	10.5398225	50.0000000	Y
0.0001773	1664.	9382164.	10.3924155	50.0000000	Y
0.0001860	1733.	9315188.	10.2642035	50.0000000	Y
0.0001947	1797.	9232294.	10.1519667	50.0000000	Y
0.0002033	1858.	9138117.	10.0532961	50.0000000	Y
0.0002120	1915.	9036240.	9.9661943	50.0000000	Y
0.0002206	1970.	8928428.	9.8892467	50.0000000	Y
0.0002293	2022.	8818219.	9.8207233	50.0000000	Y
0.0002379	2071.	8705935.	9.7597850	50.0000000	Y
0.0002466	2119.	8593912.	9.7051609	50.0000000	Y
0.0002552	2165.	8481627.	9.6564193	50.0000000	Y
0.0002639	2209.	8370626.	9.6126225	50.0000000	Y
0.0002725	2251.	8261381.	9.5731789	50.0000000	Y
0.0002812	2293.	8154131.	9.5376118	50.0000000	Y
0.0002898	2333.	8049078.	9.5054988	50.0000000	Y
0.0002985	2372.	7946385.	9.4764639	50.0000000	Y
0.0003071	2410.	7846185.	9.4501712	50.0000000	Y
0.0003158	2447.	7748585.	9.4263189	50.0000000	Y
0.0003244	2483.	7653669.	9.4046348	50.0000000	Y
0.0003331	2518.	7559608.	9.3843397	50.0000000	Y
0.0003417	2550.	7463250.	9.3645026	50.0000000	Y
0.0003504	2581.	7365272.	9.3451592	50.0000000	Y
0.0003590	2609.	7266875.	9.3260777	50.0000000	Y
0.0003677	2636.	7168465.	9.3073057	50.0000000	Y
0.0003763	2661.	7069908.	9.2891374	50.0000000	Y
0.0003850	2684.	6972272.	9.2710431	50.0000000	Y
0.0003936	2706.	6874736.	9.2533486	50.0000000	Y
0.0004023	2727.	6778722.	9.2358974	50.0000000	Y
0.0004109	2747.	6684004.	9.2189565	50.0000000	Y
0.0004196	2765.	6590860.	9.2022183	50.0000000	Y
0.0004282	2783.	6498472.	9.1857273	50.0000000	Y
0.0004369	2800.	6408426.	9.1694626	50.0000000	Y
0.0004455	2816.	6319527.	9.1538025	50.0000000	Y
0.0004542	2831.	6232287.	9.1379987	50.0000000	Y

0.0004628	2845.	6147103.	9.1228494	50.0000000	Y
0.0004715	2859.	6062972.	9.1076939	50.0000000	Y
0.0004801	2872.	5981237.	9.0927888	50.0000000	Y
0.0004888	2884.	5900613.	9.0782901	50.0000000	Y
0.0004974	2896.	5821904.	9.0640123	50.0000000	Y
0.0005061	2907.	5744976.	9.0497775	50.0000000	Y
0.0005147	2918.	5669547.	9.0359892	50.0000000	Y
0.0005493	2958.	5383970.	8.9828789	50.0000000	Y
0.0005840	2991.	5121790.	8.9326324	50.0000000	Y
0.0006186	3020.	4882047.	8.8855980	50.0000000	Y
0.0006532	3045.	4661207.	8.8412923	50.0000000	Y
0.0006878	3066.	4458417.	8.7994352	50.0000000	Y
0.0007224	3086.	4271591.	8.7597796	50.0000000	Y
0.0007570	3103.	4098848.	8.7224193	50.0000000	Y
0.0007916	3118.	3938972.	8.6868020	50.0000000	Y
0.0008262	3132.	3790601.	8.6530439	50.0000000	Y
0.0008608	3144.	3652625.	8.6211454	50.0000000	Y
0.0008954	3155.	3524138.	8.5905763	50.0000000	Y
0.0009300	3166.	3403799.	8.5612716	50.0000000	Y
0.0009646	3175.	3291337.	8.5336604	50.0000000	Y

Summary of Results for Nominal Moment Capacity for Section 1

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	403.0000000000	3175.

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Pile Section No. 2:

Dimensions and Properties of Drilled Shaft (Bored Pile) with Casing and H Weak Axis Core/Insert:

Length of Section = 2.000000 ft

Outside Diameter of Casing = 30.000000 in

Casing Wall Thickness = 0.0000 in
Moment of Inertia of Steel Casing = 0.0000 in^4
Width Flange of Core/Insert = 14.695000 in
Depth of Core/Insert = 13.830000 in
Flange Thickness of Core/Insert = 0.615000 in
Web Thickness of Core/Insert = 0.615000 in
Moment of Inertia of Steel Core/Insert = 325.505721 in^4
Yield Stress of Casing = 50000. psi
Elastic Modulus of Casing = 29000000. psi
Yield Stress of Core/Insert = 50000. psi
Elastic Modulus of Core/Insert = 29000000. psi
Number of Reinforcing Bars = 0 bars
Gross Area of Pile = 706.858347 sq. in.
Area of Concrete = 681.034497 sq. in.
Cross-sectional Area of Steel Casing = 0.0000 sq. in.
Cross-sectional Area of Steel Core/Insert = 25.823850 sq. in.
Area of All Steel (Casing, Core/Insert, and Bars) = 25.823850 sq. in.
Area Ratio of All Steel to Gross Area = 3.65 percent

Note that the core is assumed to be void of concrete.

Axial Structural Capacities:

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As = 1320.136 kips
Tensile Load for Cracking of Concrete = NaN kips
Nominal Axial Tensile Capacity = -1291.193 kips

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	403.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 403.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Max Core Stress	Run Msg
0.00000433	40.5049595	9364072.	129.0185990	0.0005581	0.0004283	0.0495443	0.00000	0.00000	15.2246666	
0.00000865	81.0099190	9364072.	72.0092995	0.0006230	0.0003634	0.0496785	0.00000	0.00000	16.1466619	
0.00001298	121.5148785	9364072.	53.0061997	0.0006878	0.0002985	0.0498128	0.00000	0.00000	17.0686574	
0.00001730	162.0198379	9364072.	43.5046498	0.0007527	0.0002337	0.0499470	0.00000	0.00000	17.9906529	
0.00002163	202.6636425	9370492.	37.8043185	0.0008176	0.0001688	0.0499998	0.00000	0.00000	18.9130239	

0.00002595	245.4812957	9458531.	34.0123697	0.0008827	0.0001041	0.0499970	0.00000	0.00000	19.8416208
0.00003028	293.0641527	9678793.	31.3204289	0.0009484	0.00003998	0.0499908	0.00000	0.00000	20.7847889
0.00003460	346.6528344	10017545.	29.3207969	0.0010146	-0.00002350	0.0499993	0.00000	0.00000	21.7473487
0.00003893	405.4953474	10415975.	27.7818331	0.0010816	-0.00008635	0.0499988	0.00000	0.00000	22.7283171
0.00004326	466.5264376	10785314.	26.5588534	0.0011488	-0.0001488	0.0499907	0.00000	0.00000	23.7195608
0.00004758	527.0921690	11077721.	25.5599338	0.0012162	-0.0002113	0.0499987	0.00000	0.00000	24.7131505
0.00005191	585.3209898	11276372.	24.7249687	0.0012834	-0.0002738	0.0499878	0.00000	0.00000	25.7029288
0.00005623	639.8717401	11379053.	24.0131953	0.0013503	-0.0003367	0.0499985	0.00000	0.00000	26.6841219
0.00006056	689.7271125	11389530.	23.3960306	0.0014168	-0.0003999	0.0499945	0.00000	0.00000	27.6528933
0.00006488	734.0593162	11313486.	22.8528277	0.0014828	-0.0004637	0.0499893	0.00000	0.00000	28.6059967
0.00006921	772.1407621	11156630.	22.3682638	0.0015481	-0.0005282	0.0558967	0.00000	0.00000	29.5405125
0.00007353	803.3029063	10924133.	21.9307290	0.0016127	-0.0005934	0.1051144	0.00000	0.00000	30.4537480
0.00007786	826.8888945	10620164.	21.5312171	0.0016764	-0.0006594	0.1645060	0.00000	0.00000	31.3430679
0.00008219	842.2349056	10247931.	21.1626199	0.0017393	-0.0007263	0.2345379	0.00000	0.00000	32.2058387
0.00008651	848.6290328	9809445.	20.8191828	0.0018011	-0.0007942	0.3157433	0.00000	0.00000	33.0392569
0.00009084	845.2931767	9305605.	20.4961583	0.0018618	-0.0008633	0.4087320	0.00000	0.00000	33.8402852
0.00009516	831.3579216	8736187.	20.1895357	0.0019213	-0.0009336	0.5142054	0.00000	0.00000	34.6055367
0.00009949	805.8354947	8099815.	19.8958494	0.0019794	-0.0010052	0.6329742	0.00000	0.00000	35.3311849
0.0001038	767.5868770	7393888.	19.6120263	0.0020360	-0.0010784	0.7659820	0.00000	0.00000	36.0128462
0.0001081	715.2671275	6614314.	19.3352205	0.0020909	-0.0011533	0.9143451	0.00000	0.00000	36.6453077
0.0001125	647.2735723	5755341.	19.0627219	0.0021439	-0.0012301	1.0793945	0.00000	0.00000	37.2223710
0.0001168	561.6627290	4809151.	18.7918356	0.0021947	-0.0013090	1.2627399	0.00000	0.00000	37.7365298
0.0001211	456.0104678	3765072.	18.5196977	0.0022430	-0.0013904	1.4663780	0.00000	0.00000	38.1783320
0.0001254	327.2391365	2608698.	18.2431333	0.0022884	-0.0014748	1.6928288	0.00000	0.00000	38.5357563
0.0001298	171.3206591	1320216.	17.9583856	0.0023304	-0.0015626	1.9453670	0.00000	0.00000	38.7929998
0.0001341	-17.2212589	-128428.	17.6606840	0.0023682	-0.0016546	2.2284106	0.00000	0.00000	38.9284308

Summary of Results for Nominal Moment Capacity for Section 2

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	403.0000000000	-17.2212588659

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf Above ft	Same Layer Type As Layer Above Rock Layer	Layer is Rock or is Below lbs	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	0.00	0.00	N.A.	No	0.00	14017.
2	4.0000	4.0000	Yes	No	14017.	7137.
3	5.0000	5.0000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Displacement and Pile-head Rotation (Loading Type 5)
Displacement of pile head = -0.975000 inches
Rotation of pile head = 0.000E+00 radians
Axial load on pile head = 403000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	-0.9750	3006528.	-55145.	0.00	83471.	1.66E+08	0.00	0.00	0.00
0.01400	-0.9747	2997160.	-55143.	0.00305	83259.	1.66E+08	1.5753	0.2715	0.00
0.02800	-0.9740	2987587.	-55143.	0.00502	83043.	5.58E+08	3.1705	0.5469	0.00
0.04200	-0.9731	2977953.	-55142.	0.00571	82826.	1.04E+09	4.7853	0.8262	0.00
0.05600	-0.9721	2968287.	-55141.	0.00607	82608.	1.95E+09	6.4195	1.1095	0.00
0.07000	-0.9710	2958603.	-55140.	0.00627	82389.	3.65E+09	8.0729	1.3967	0.00
0.08400	-0.9700	2948911.	-55138.	0.00639	82170.	4.90E+09	9.7452	1.6879	0.00
0.09800	-0.9689	2939211.	-55137.	0.00649	81951.	5.15E+09	11.4362	1.9830	0.00
0.1120	-0.9678	2929506.	-55135.	0.00658	81732.	5.28E+09	13.1457	2.2820	0.00
0.1260	-0.9667	2919795.	-55132.	0.00667	81513.	5.40E+09	14.8735	2.5849	0.00
0.1400	-0.9655	2910078.	-55130.	0.00676	81294.	5.51E+09	16.6192	2.8917	0.00
0.1540	-0.9644	2900356.	-55127.	0.00685	81074.	5.62E+09	18.3826	3.2023	0.00
0.1680	-0.9632	2890628.	-55123.	0.00694	80855.	5.73E+09	20.1635	3.5168	0.00
0.1820	-0.9621	2880895.	-55120.	0.00702	80635.	5.83E+09	21.9617	3.8351	0.00
0.1960	-0.9609	2871157.	-55116.	0.00710	80415.	5.93E+09	23.7770	4.1572	0.00
0.2100	-0.9597	2861414.	-55112.	0.00718	80195.	6.02E+09	25.6090	4.4831	0.00
0.2240	-0.9585	2851666.	-55107.	0.00726	79975.	6.12E+09	27.4575	4.8128	0.00
0.2380	-0.9572	2841914.	-55103.	0.00734	79755.	6.21E+09	29.3224	5.1463	0.00

0.2520	-0.9560	2832158.	-55098.	0.00742	79535.	6.29E+09	31.2033	5.4835	0.00
0.2660	-0.9547	2822397.	-55092.	0.00749	79314.	6.37E+09	33.1000	5.8244	0.00
0.2800	-0.9535	2812632.	-55086.	0.00757	79094.	6.45E+09	35.0123	6.1691	0.00
0.2940	-0.9522	2802864.	-55080.	0.00764	78874.	6.52E+09	36.9399	6.5175	0.00
0.3080	-0.9509	2793091.	-55074.	0.00771	78653.	6.59E+09	38.8827	6.8695	0.00
0.3220	-0.9496	2783315.	-55067.	0.00778	78432.	6.66E+09	40.8403	7.2253	0.00
0.3360	-0.9483	2773535.	-55060.	0.00785	78212.	6.73E+09	42.8125	7.5847	0.00
0.3500	-0.9470	2763751.	-55053.	0.00792	77991.	6.80E+09	44.7990	7.9477	0.00
0.3640	-0.9456	2753965.	-55045.	0.00799	77770.	6.86E+09	46.7997	8.3144	0.00
0.3780	-0.9443	2744175.	-55037.	0.00805	77549.	6.92E+09	48.8143	8.6847	0.00
0.3920	-0.9429	2734382.	-55029.	0.00812	77328.	6.98E+09	50.8425	9.0586	0.00
0.4060	-0.9416	2724585.	-55020.	0.00819	77107.	7.04E+09	52.8842	9.4360	0.00
0.4200	-0.9402	2714786.	-55011.	0.00825	76885.	7.10E+09	54.9390	9.8171	0.00
0.4340	-0.9388	2704984.	-55002.	0.00831	76664.	7.15E+09	57.0067	10.2016	0.00
0.4480	-0.9374	2695180.	-54992.	0.00838	76443.	7.21E+09	59.0870	10.5898	0.00
0.4620	-0.9360	2685373.	-54982.	0.00844	76221.	7.26E+09	61.1798	10.9814	0.00
0.4760	-0.9345	2675563.	-54971.	0.00850	76000.	7.31E+09	63.2848	11.3765	0.00
0.4900	-0.9331	2665751.	-54961.	0.00856	75779.	7.36E+09	65.4017	11.7751	0.00
0.5040	-0.9317	2655937.	-54949.	0.00862	75557.	7.40E+09	67.5304	12.1772	0.00
0.5180	-0.9302	2646120.	-54938.	0.00868	75335.	7.45E+09	69.6704	12.5828	0.00
0.5320	-0.9287	2636302.	-54926.	0.00874	75114.	7.49E+09	71.8217	12.9917	0.00
0.5460	-0.9273	2626481.	-54914.	0.00880	74892.	7.53E+09	73.9840	13.4041	0.00
0.5600	-0.9258	2616659.	-54901.	0.00886	74670.	7.57E+09	76.1570	13.8199	0.00
0.5740	-0.9243	2606835.	-54888.	0.00892	74449.	7.61E+09	78.3404	14.2391	0.00
0.5880	-0.9228	2597009.	-54875.	0.00898	74227.	7.64E+09	80.5341	14.6617	0.00
0.6020	-0.9213	2587182.	-54861.	0.00903	74005.	7.68E+09	82.7377	15.0876	0.00
0.6160	-0.9198	2577353.	-54847.	0.00909	73783.	7.71E+09	84.9470	15.5161	0.00
0.6300	-0.9182	2567522.	-54833.	0.00914	73561.	7.75E+09	87.1536	15.9457	0.00
0.6440	-0.9167	2557691.	-54818.	0.00920	73339.	7.78E+09	89.3686	16.3785	0.00
0.6580	-0.9151	2547858.	-54803.	0.00926	73117.	7.82E+09	91.5916	16.8143	0.00
0.6720	-0.9136	2538024.	-54787.	0.00931	72895.	7.85E+09	93.8224	17.2532	0.00
0.6860	-0.9120	2528189.	-54771.	0.00936	72673.	7.89E+09	96.0607	17.6952	0.00
0.7000	-0.9104	2518353.	-54755.	0.00942	72451.	7.92E+09	98.3063	18.1403	0.00
0.7140	-0.9088	2508516.	-54738.	0.00947	72229.	7.95E+09	100.5590	18.5883	0.00
0.7280	-0.9072	2498678.	-54721.	0.00952	72007.	7.99E+09	102.8183	19.0394	0.00
0.7420	-0.9056	2488840.	-54703.	0.00958	71785.	8.02E+09	105.0842	19.4935	0.00
0.7560	-0.9040	2479001.	-54686.	0.00963	71563.	8.05E+09	107.3563	19.9505	0.00
0.7700	-0.9024	2469162.	-54667.	0.00968	71341.	8.08E+09	109.6344	20.4104	0.00
0.7840	-0.9008	2459323.	-54649.	0.00973	71119.	8.12E+09	111.9182	20.8733	0.00
0.7980	-0.8991	2449483.	-54630.	0.00978	70897.	8.15E+09	114.2074	21.3391	0.00
0.8120	-0.8975	2439643.	-54610.	0.00983	70675.	8.18E+09	116.5018	21.8078	0.00
0.8260	-0.8958	2429802.	-54591.	0.00988	70453.	8.21E+09	118.8012	22.2793	0.00
0.8400	-0.8942	2419962.	-54570.	0.00993	70230.	8.24E+09	121.1052	22.7536	0.00
0.8540	-0.8925	2410122.	-54550.	0.00998	70008.	8.27E+09	123.4136	23.2308	0.00
0.8680	-0.8908	2400282.	-54529.	0.01003	69786.	8.30E+09	125.7262	23.7107	0.00
0.8820	-0.8891	2390442.	-54508.	0.01008	69564.	8.33E+09	128.0426	24.1935	0.00
0.8960	-0.8874	2380603.	-54486.	0.01012	69342.	8.36E+09	130.3627	24.6789	0.00
0.9100	-0.8857	2370764.	-54464.	0.01017	69120.	8.39E+09	132.6861	25.1671	0.00
0.9240	-0.8840	2360926.	-54441.	0.01022	68898.	8.41E+09	135.0126	25.6580	0.00
0.9380	-0.8823	2351088.	-54419.	0.01027	68676.	8.44E+09	137.3419	26.1516	0.00
0.9520	-0.8806	2341251.	-54395.	0.01031	68454.	8.47E+09	139.6739	26.6479	0.00
0.9660	-0.8788	2331415.	-54372.	0.01036	68232.	8.50E+09	142.0081	27.1467	0.00
0.9800	-0.8771	2321579.	-54348.	0.01041	68010.	8.52E+09	144.3444	27.6482	0.00
0.9940	-0.8753	2311745.	-54323.	0.01045	67788.	8.55E+09	146.6825	28.1523	0.00

1.0080	-0.8736	2301911.	-54298.	0.01050	67566.	8.58E+09	149.0220	28.6590	0.00
1.0220	-0.8718	2292079.	-54273.	0.01054	67344.	8.60E+09	151.3629	29.1681	0.00
1.0360	-0.8700	2282248.	-54247.	0.01059	67122.	8.63E+09	153.7048	29.6798	0.00
1.0500	-0.8682	2272419.	-54221.	0.01063	66900.	8.65E+09	156.0473	30.1940	0.00
1.0640	-0.8665	2262590.	-54195.	0.01067	66678.	8.68E+09	158.3904	30.7107	0.00
1.0780	-0.8647	2252764.	-54168.	0.01072	66456.	8.71E+09	160.7337	31.2298	0.00
1.0920	-0.8629	2242939.	-54141.	0.01076	66235.	8.73E+09	163.0769	31.7513	0.00
1.1060	-0.8610	2233115.	-54113.	0.01080	66013.	8.75E+09	165.4198	32.2753	0.00
1.1200	-0.8592	2223294.	-54085.	0.01085	65791.	8.77E+09	167.7621	32.8016	0.00
1.1340	-0.8574	2213474.	-54057.	0.01089	65570.	8.80E+09	170.1036	33.3302	0.00
1.1480	-0.8556	2203656.	-54028.	0.01093	65348.	8.82E+09	172.4440	33.8612	0.00
1.1620	-0.8537	2193840.	-53999.	0.01097	65126.	8.84E+09	174.7830	34.3944	0.00
1.1760	-0.8519	2184026.	-53969.	0.01101	64905.	8.86E+09	177.1204	34.9300	0.00
1.1900	-0.8500	2174215.	-53940.	0.01106	64683.	8.88E+09	179.4560	35.4678	0.00
1.2040	-0.8482	2164406.	-53909.	0.01110	64462.	8.90E+09	181.7893	36.0077	0.00
1.2180	-0.8463	2154599.	-53878.	0.01114	64241.	8.92E+09	184.1202	36.5499	0.00
1.2320	-0.8444	2144794.	-53847.	0.01118	64019.	8.94E+09	186.4700	37.0985	0.00
1.2460	-0.8425	2134992.	-53816.	0.01122	63798.	8.96E+09	188.8368	37.6533	0.00
1.2600	-0.8407	2125193.	-53784.	0.01126	63577.	8.98E+09	191.2018	38.2105	0.00
1.2740	-0.8388	2115397.	-53752.	0.01130	63356.	8.99E+09	193.5647	38.7701	0.00
1.2880	-0.8369	2105603.	-53719.	0.01134	63135.	9.01E+09	195.9252	39.3321	0.00
1.3020	-0.8350	2095812.	-53686.	0.01138	62914.	9.03E+09	198.2832	39.8964	0.00
1.3160	-0.8330	2086024.	-53652.	0.01142	62693.	9.04E+09	200.6383	40.4631	0.00
1.3300	-0.8311	2076239.	-53618.	0.01145	62472.	9.06E+09	202.9903	41.0320	0.00
1.3440	-0.8292	2066457.	-53584.	0.01149	62251.	9.07E+09	205.3390	41.6033	0.00
1.3580	-0.8273	2056679.	-53549.	0.01153	62030.	9.08E+09	207.6841	42.1768	0.00
1.3720	-0.8253	2046903.	-53514.	0.01157	61810.	9.10E+09	210.0253	42.7525	0.00
1.3860	-0.8234	2037131.	-53479.	0.01161	61589.	9.11E+09	212.3625	43.3305	0.00
1.4000	-0.8214	2027363.	-53443.	0.01164	61369.	9.12E+09	214.6953	43.9106	0.00
1.4140	-0.8195	2017598.	-53407.	0.01168	61148.	9.14E+09	217.0236	44.4929	0.00
1.4280	-0.8175	2007837.	-53370.	0.01172	60928.	9.15E+09	219.3471	45.0774	0.00
1.4420	-0.8155	1998079.	-53333.	0.01175	60708.	9.16E+09	221.6655	45.6640	0.00
1.4560	-0.8135	1988325.	-53295.	0.01179	60487.	9.17E+09	223.9785	46.2526	0.00
1.4700	-0.8116	1978575.	-53258.	0.01183	60267.	9.18E+09	226.2860	46.8434	0.00
1.4840	-0.8096	1968829.	-53219.	0.01186	60047.	9.19E+09	228.5878	47.4362	0.00
1.4980	-0.8076	1959087.	-53181.	0.01190	59827.	9.20E+09	230.8834	48.0310	0.00
1.5120	-0.8056	1949349.	-53142.	0.01194	59608.	9.21E+09	233.1728	48.6278	0.00
1.5260	-0.8036	1939615.	-53102.	0.01197	59388.	9.22E+09	235.4556	49.2266	0.00
1.5400	-0.8015	1929886.	-53063.	0.01201	59168.	9.23E+09	237.7316	49.8273	0.00
1.5540	-0.7995	1920160.	-53023.	0.01204	58949.	9.24E+09	240.0006	50.4300	0.00
1.5680	-0.7975	1910440.	-52982.	0.01208	58729.	9.25E+09	242.2622	51.0345	0.00
1.5820	-0.7955	1900723.	-52941.	0.01211	58510.	9.26E+09	244.5164	51.6409	0.00
1.5960	-0.7934	1891011.	-52900.	0.01214	58291.	9.27E+09	246.7628	52.2492	0.00
1.6100	-0.7914	1881304.	-52858.	0.01218	58072.	9.28E+09	249.0011	52.8593	0.00
1.6240	-0.7893	1871602.	-52816.	0.01221	57853.	9.29E+09	251.2312	53.4711	0.00
1.6380	-0.7873	1861904.	-52774.	0.01225	57634.	9.30E+09	253.4528	54.0847	0.00
1.6520	-0.7852	1852212.	-52731.	0.01228	57415.	9.31E+09	255.6656	54.7000	0.00
1.6660	-0.7832	1842524.	-52688.	0.01231	57196.	9.32E+09	257.8694	55.3171	0.00
1.6800	-0.7811	1832841.	-52644.	0.01235	56978.	9.33E+09	260.0640	55.9358	0.00
1.6940	-0.7790	1823164.	-52601.	0.01238	56759.	9.33E+09	262.2490	56.5562	0.00
1.7080	-0.7769	1813491.	-52556.	0.01241	56541.	9.34E+09	264.4243	57.1781	0.00
1.7220	-0.7748	1803824.	-52512.	0.01244	56323.	9.35E+09	266.5896	57.8017	0.00
1.7360	-0.7727	1794162.	-52467.	0.01248	56105.	9.36E+09	268.7447	58.4268	0.00
1.7500	-0.7706	1784506.	-52421.	0.01251	55887.	9.36E+09	270.8892	59.0534	0.00

1.7640	-0.7685	1774855.	-52376.	0.01254	55669.	9.37E+09	273.0231	59.6816	0.00
1.7780	-0.7664	1765209.	-52330.	0.01257	55451.	9.38E+09	275.1459	60.3112	0.00
1.7920	-0.7643	1755569.	-52283.	0.01260	55233.	9.39E+09	277.2576	60.9422	0.00
1.8060	-0.7622	1745935.	-52237.	0.01264	55016.	9.39E+09	279.3578	61.5746	0.00
1.8200	-0.7601	1736307.	-52189.	0.01267	54799.	9.39E+09	281.4462	62.2084	0.00
1.8340	-0.7579	1726685.	-52142.	0.01270	54581.	9.40E+09	283.5227	62.8435	0.00
1.8480	-0.7558	1717068.	-52094.	0.01273	54364.	9.40E+09	285.7941	63.5260	0.00
1.8620	-0.7537	1707457.	-52046.	0.01276	54147.	9.41E+09	288.1121	64.2232	0.00
1.8760	-0.7515	1697853.	-51997.	0.01279	53931.	9.41E+09	290.4236	64.9233	0.00
1.8900	-0.7494	1688255.	-51948.	0.01282	53714.	9.42E+09	292.7284	65.6263	0.00
1.9040	-0.7472	1678662.	-51899.	0.01285	53497.	9.42E+09	295.0262	66.3324	0.00
1.9180	-0.7451	1669077.	-51849.	0.01288	53281.	9.43E+09	297.3170	67.0413	0.00
1.9320	-0.7429	1659497.	-51799.	0.01291	53065.	9.43E+09	299.6005	67.7532	0.00
1.9460	-0.7407	1649924.	-51749.	0.01294	52849.	9.43E+09	301.8765	68.4680	0.00
1.9600	-0.7385	1640358.	-51698.	0.01297	52633.	9.43E+09	304.1448	69.1858	0.00
1.9740	-0.7364	1630798.	-51646.	0.01300	52417.	9.44E+09	306.4053	69.9064	0.00
1.9880	-0.7342	1621245.	-51595.	0.01303	52201.	9.44E+09	308.6576	70.6299	0.00
2.0020	-0.7320	1611698.	-51543.	0.01305	51986.	9.44E+09	310.9017	71.3564	0.00
2.0160	-0.7298	1602158.	-51490.	0.01308	51771.	9.44E+09	313.1373	72.0857	0.00
2.0300	-0.7276	1592626.	-51437.	0.01311	51555.	9.44E+09	315.3642	72.8179	0.00
2.0440	-0.7254	1583100.	-51384.	0.01314	51340.	9.44E+09	317.5822	73.5530	0.00
2.0580	-0.7232	1573581.	-51331.	0.01317	51126.	9.44E+09	319.7912	74.2909	0.00
2.0720	-0.7210	1564070.	-51277.	0.01320	50911.	9.44E+09	321.9909	75.0317	0.00
2.0860	-0.7187	1554566.	-51223.	0.01322	50696.	9.44E+09	324.1811	75.7753	0.00
2.1000	-0.7165	1545068.	-51168.	0.01325	50482.	9.44E+09	326.3617	76.5218	0.00
2.1140	-0.7143	1535579.	-51113.	0.01328	50268.	9.44E+09	328.5324	77.2711	0.00
2.1280	-0.7121	1526097.	-51058.	0.01331	50054.	9.44E+09	330.6930	78.0232	0.00
2.1420	-0.7098	1516622.	-51002.	0.01333	49840.	9.44E+09	332.8434	78.7781	0.00
2.1560	-0.7076	1507155.	-50946.	0.01336	49626.	9.44E+09	334.9834	79.5358	0.00
2.1700	-0.7053	1497695.	-50889.	0.01339	49413.	9.44E+09	337.1126	80.2964	0.00
2.1840	-0.7031	1488243.	-50832.	0.01341	49199.	9.44E+09	339.2311	81.0597	0.00
2.1980	-0.7008	1478799.	-50775.	0.01344	48986.	9.44E+09	341.3385	81.8257	0.00
2.2120	-0.6986	1469363.	-50718.	0.01347	48773.	9.44E+09	343.4346	82.5946	0.00
2.2260	-0.6963	1459934.	-50660.	0.01349	48560.	9.44E+09	345.5193	83.3662	0.00
2.2400	-0.6940	1450514.	-50602.	0.01352	48348.	9.44E+09	347.5923	84.1405	0.00
2.2540	-0.6918	1441102.	-50543.	0.01354	48135.	9.44E+09	349.6535	84.9176	0.00
2.2680	-0.6895	1431698.	-50484.	0.01357	47923.	9.44E+09	351.7027	85.6974	0.00
2.2820	-0.6872	1422302.	-50425.	0.01359	47711.	9.44E+09	353.7396	86.4799	0.00
2.2960	-0.6849	1412914.	-50365.	0.01362	47499.	9.44E+09	355.7641	87.2652	0.00
2.3100	-0.6826	1403535.	-50305.	0.01364	47287.	9.44E+09	357.7760	88.0531	0.00
2.3240	-0.6803	1394164.	-50245.	0.01367	47076.	9.44E+09	359.7750	88.8437	0.00
2.3380	-0.6780	1384801.	-50185.	0.01369	46864.	9.44E+09	361.7610	89.6370	0.00
2.3520	-0.6757	1375448.	-50124.	0.01372	46653.	9.44E+09	363.7338	90.4329	0.00
2.3660	-0.6734	1366102.	-50062.	0.01374	46442.	9.44E+09	365.6931	91.2315	0.00
2.3800	-0.6711	1356766.	-50001.	0.01377	46231.	9.44E+09	367.6388	92.0328	0.00
2.3940	-0.6688	1347438.	-49939.	0.01379	46021.	9.44E+09	369.5707	92.8366	0.00
2.4080	-0.6665	1338119.	-49877.	0.01382	45811.	9.44E+09	371.4886	93.6431	0.00
2.4220	-0.6641	1328809.	-49814.	0.01384	45600.	9.44E+09	373.3923	94.4522	0.00
2.4360	-0.6618	1319507.	-49751.	0.01386	45390.	9.44E+09	375.2815	95.2639	0.00
2.4500	-0.6595	1310215.	-49688.	0.01389	45181.	9.44E+09	377.1666	96.0808	0.00
2.4640	-0.6572	1300932.	-49624.	0.01391	44971.	9.44E+09	379.2030	96.9428	0.00
2.4780	-0.6548	1291658.	-49560.	0.01393	44762.	9.44E+09	381.2277	97.8085	0.00
2.4920	-0.6525	1282393.	-49496.	0.01396	44553.	9.44E+09	383.2404	98.6779	0.00
2.5060	-0.6501	1273137.	-49432.	0.01398	44344.	9.44E+09	385.2410	99.5510	0.00

2.5200	-0.6478	1263891.	-49367.	0.01400	44135.	9.44E+09	387.2294	100.4279	0.00
2.5340	-0.6454	1254654.	-49302.	0.01402	43926.	9.44E+09	389.2054	101.3085	0.00
2.5480	-0.6431	1245427.	-49236.	0.01405	43718.	9.44E+09	391.1687	102.1929	0.00
2.5620	-0.6407	1236209.	-49170.	0.01407	43510.	9.44E+09	393.1192	103.0810	0.00
2.5760	-0.6383	1227001.	-49104.	0.01409	43302.	9.44E+09	395.0567	103.9729	0.00
2.5900	-0.6360	1217802.	-49037.	0.01411	43095.	9.44E+09	396.9811	104.8685	0.00
2.6040	-0.6336	1208614.	-48971.	0.01413	42887.	9.44E+09	398.8921	105.7679	0.00
2.6180	-0.6312	1199435.	-48903.	0.01415	42680.	9.44E+09	400.7896	106.6711	0.00
2.6320	-0.6288	1190265.	-48836.	0.01418	42473.	9.44E+09	402.6735	107.5781	0.00
2.6460	-0.6265	1181106.	-48768.	0.01420	42266.	9.44E+09	404.5435	108.4888	0.00
2.6600	-0.6241	1171957.	-48700.	0.01422	42060.	9.44E+09	406.3994	109.4034	0.00
2.6740	-0.6217	1162818.	-48632.	0.01424	41854.	9.44E+09	408.2412	110.3217	0.00
2.6880	-0.6193	1153689.	-48563.	0.01426	41647.	9.44E+09	410.0685	111.2439	0.00
2.7020	-0.6169	1144570.	-48494.	0.01428	41442.	9.44E+09	411.8813	112.1699	0.00
2.7160	-0.6145	1135461.	-48424.	0.01430	41236.	9.44E+09	413.6793	113.0997	0.00
2.7300	-0.6121	1126363.	-48355.	0.01432	41031.	9.44E+09	415.4625	114.0333	0.00
2.7440	-0.6097	1117275.	-48285.	0.01434	40825.	9.44E+09	417.2305	114.9708	0.00
2.7580	-0.6073	1108198.	-48215.	0.01436	40621.	9.44E+09	418.9832	115.9121	0.00
2.7720	-0.6048	1099131.	-48144.	0.01438	40416.	9.44E+09	420.7206	116.8573	0.00
2.7860	-0.6024	1090074.	-48073.	0.01440	40212.	9.44E+09	422.4422	117.8063	0.00
2.8000	-0.6000	1081028.	-48002.	0.01442	40007.	9.44E+09	424.1481	118.7592	0.00
2.8140	-0.5976	1071993.	-47931.	0.01444	39803.	9.44E+09	425.8380	119.7160	0.00
2.8280	-0.5952	1062969.	-47859.	0.01446	39600.	9.44E+09	427.5118	120.6767	0.00
2.8420	-0.5927	1053955.	-47787.	0.01448	39396.	9.44E+09	429.1692	121.6412	0.00
2.8560	-0.5903	1044952.	-47715.	0.01449	39193.	9.44E+09	430.8101	122.6097	0.00
2.8700	-0.5879	1035960.	-47642.	0.01451	38990.	9.44E+09	432.4343	123.5820	0.00
2.8840	-0.5854	1026979.	-47570.	0.01453	38787.	9.44E+09	434.0417	124.5583	0.00
2.8980	-0.5830	1018009.	-47496.	0.01455	38585.	9.44E+09	435.6321	125.5385	0.00
2.9120	-0.5805	1009050.	-47423.	0.01457	38383.	9.44E+09	437.2052	126.5226	0.00
2.9260	-0.5781	1000103.	-47350.	0.01458	38181.	9.44E+09	438.7609	127.5107	0.00
2.9400	-0.5756	991166.	-47276.	0.01460	37979.	9.44E+09	440.2991	128.5027	0.00
2.9540	-0.5732	982241.	-47202.	0.01462	37777.	9.44E+09	441.8195	129.4987	0.00
2.9680	-0.5707	973327.	-47127.	0.01464	37576.	9.44E+09	443.3220	130.4986	0.00
2.9820	-0.5683	964424.	-47053.	0.01465	37375.	9.44E+09	444.8064	131.5025	0.00
2.9960	-0.5658	955533.	-46978.	0.01467	37175.	9.44E+09	446.2726	132.5104	0.00
3.0100	-0.5633	946653.	-46903.	0.01469	36974.	9.44E+09	447.7203	133.5223	0.00
3.0240	-0.5609	937784.	-46827.	0.01471	36774.	9.44E+09	449.1494	134.5382	0.00
3.0380	-0.5584	928927.	-46752.	0.01472	36574.	9.44E+09	450.5596	135.5580	0.00
3.0520	-0.5559	920082.	-46676.	0.01474	36374.	9.44E+09	451.4247	136.4229	0.00
3.0660	-0.5534	911249.	-46600.	0.01475	36175.	9.44E+09	451.9102	137.1810	0.00
3.0800	-0.5510	902427.	-46524.	0.01477	35976.	9.44E+09	452.8232	138.0769	0.00
3.0940	-0.5485	893616.	-46448.	0.01479	35777.	9.44E+09	453.7117	138.9742	0.00
3.1080	-0.5460	884818.	-46372.	0.01480	35578.	9.44E+09	454.5756	139.8726	0.00
3.1220	-0.5435	876031.	-46295.	0.01482	35380.	9.44E+09	455.4147	140.7723	0.00
3.1360	-0.5410	867256.	-46219.	0.01483	35182.	9.44E+09	456.2288	141.6733	0.00
3.1500	-0.5385	858493.	-46142.	0.01485	34984.	9.44E+09	457.0178	142.5754	0.00
3.1640	-0.5360	849742.	-46065.	0.01486	34787.	9.44E+09	457.7815	143.4787	0.00
3.1780	-0.5335	841002.	-45988.	0.01488	34589.	9.44E+09	458.5198	144.3831	0.00
3.1920	-0.5310	832275.	-45911.	0.01489	34392.	9.44E+09	459.2325	145.2886	0.00
3.2060	-0.5285	823559.	-45834.	0.01491	34196.	9.44E+09	459.9195	146.1951	0.00
3.2200	-0.5260	814856.	-45757.	0.01492	33999.	9.44E+09	460.5806	147.1028	0.00
3.2340	-0.5235	806164.	-45679.	0.01494	33803.	9.44E+09	461.2156	148.0114	0.00
3.2480	-0.5210	797485.	-45602.	0.01495	33607.	9.44E+09	461.8244	148.9211	0.00
3.2620	-0.5185	788817.	-45524.	0.01497	33411.	9.44E+09	462.4069	149.8316	0.00

3.2760	-0.5160	780162.	-45446.	0.01498	33216.	9.44E+09	462.9628	150.7432	0.00
3.2900	-0.5134	771519.	-45368.	0.01499	33021.	9.44E+09	463.4921	151.6556	0.00
3.3040	-0.5109	762888.	-45291.	0.01501	32826.	9.44E+09	463.9946	152.5689	0.00
3.3180	-0.5084	754269.	-45213.	0.01502	32632.	9.44E+09	464.4701	153.4830	0.00
3.3320	-0.5059	745663.	-45134.	0.01503	32437.	9.44E+09	464.9185	154.3979	0.00
3.3460	-0.5033	737068.	-45056.	0.01505	32243.	9.44E+09	465.3397	155.3136	0.00
3.3600	-0.5008	728486.	-44978.	0.01506	32050.	9.44E+09	465.7334	156.2301	0.00
3.3740	-0.4983	719916.	-44900.	0.01507	31856.	9.44E+09	466.0996	157.1472	0.00
3.3880	-0.4958	711359.	-44821.	0.01509	31663.	9.44E+09	466.4381	158.0650	0.00
3.4020	-0.4932	702813.	-44743.	0.01510	31470.	9.44E+09	466.7488	158.9834	0.00
3.4160	-0.4907	694280.	-44665.	0.01511	31277.	9.44E+09	467.0315	159.9024	0.00
3.4300	-0.4881	685760.	-44586.	0.01512	31085.	9.44E+09	467.2860	160.8220	0.00
3.4440	-0.4856	677251.	-44508.	0.01514	30893.	9.44E+09	467.5122	161.7421	0.00
3.4580	-0.4831	668756.	-44429.	0.01515	30701.	9.44E+09	467.7101	162.6627	0.00
3.4720	-0.4805	660272.	-44351.	0.01516	30510.	9.44E+09	467.8794	163.5837	0.00
3.4860	-0.4780	651801.	-44272.	0.01517	30319.	9.44E+09	468.0199	164.5051	0.00
3.5000	-0.4754	643342.	-44193.	0.01518	30128.	9.44E+09	468.1316	165.4269	0.00
3.5140	-0.4729	634896.	-44115.	0.01519	29937.	9.44E+09	468.2144	166.3490	0.00
3.5280	-0.4703	626462.	-44036.	0.01521	29747.	9.44E+09	468.2680	167.2714	0.00
3.5420	-0.4678	618041.	-43957.	0.01522	29557.	9.44E+09	468.2923	168.1940	0.00
3.5560	-0.4652	609632.	-43879.	0.01523	29367.	9.44E+09	468.2873	169.1168	0.00
3.5700	-0.4626	601236.	-43800.	0.01524	29177.	9.44E+09	468.2527	170.0397	0.00
3.5840	-0.4601	592852.	-43721.	0.01525	28988.	9.44E+09	468.1884	170.9628	0.00
3.5980	-0.4575	584481.	-43643.	0.01526	28799.	9.44E+09	468.0943	171.8859	0.00
3.6120	-0.4549	576122.	-43564.	0.01527	28610.	9.44E+09	467.9703	172.8090	0.00
3.6260	-0.4524	567776.	-43485.	0.01528	28422.	9.44E+09	467.8162	173.7320	0.00
3.6400	-0.4498	559442.	-43407.	0.01529	28234.	9.44E+09	467.6319	174.6550	0.00
3.6540	-0.4472	551120.	-43328.	0.01530	28046.	9.44E+09	467.4172	175.5778	0.00
3.6680	-0.4447	542812.	-43250.	0.01531	27858.	9.44E+09	467.1720	176.5005	0.00
3.6820	-0.4421	534515.	-43171.	0.01532	27671.	9.44E+09	467.4309	177.6260	0.00
3.6960	-0.4395	526232.	-43093.	0.01533	27484.	9.44E+09	468.0366	178.8979	0.00
3.7100	-0.4369	517961.	-43014.	0.01534	27297.	9.44E+09	468.6174	180.1759	0.00
3.7240	-0.4344	509702.	-42935.	0.01535	27111.	9.44E+09	469.1731	181.4601	0.00
3.7380	-0.4318	501456.	-42856.	0.01536	26925.	9.44E+09	469.7036	182.7503	0.00
3.7520	-0.4292	493223.	-42777.	0.01537	26739.	9.44E+09	470.2087	184.0468	0.00
3.7660	-0.4266	485003.	-42698.	0.01537	26553.	9.44E+09	470.6882	185.3495	0.00
3.7800	-0.4240	476795.	-42619.	0.01538	26368.	9.44E+09	471.1418	186.6585	0.00
3.7940	-0.4215	468600.	-42540.	0.01539	26183.	9.44E+09	471.5695	187.9738	0.00
3.8080	-0.4189	460417.	-42461.	0.01540	25999.	9.44E+09	471.9710	189.2955	0.00
3.8220	-0.4163	452248.	-42381.	0.01541	25814.	9.44E+09	472.3461	190.6236	0.00
3.8360	-0.4137	444091.	-42302.	0.01542	25630.	9.44E+09	472.6946	191.9581	0.00
3.8500	-0.4111	435947.	-42223.	0.01542	25446.	9.44E+09	473.0164	193.2991	0.00
3.8640	-0.4085	427816.	-42143.	0.01543	25263.	9.44E+09	473.3112	194.6467	0.00
3.8780	-0.4059	419697.	-42064.	0.01544	25079.	9.44E+09	473.5789	196.0009	0.00
3.8920	-0.4033	411592.	-41984.	0.01545	24896.	9.44E+09	473.8192	197.3617	0.00
3.9060	-0.4007	403499.	-41904.	0.01545	24714.	9.44E+09	474.0320	198.7292	0.00
3.9200	-0.3981	395419.	-41825.	0.01546	24531.	9.44E+09	474.2171	200.1034	0.00
3.9340	-0.3955	387353.	-41745.	0.01547	24349.	9.44E+09	474.3743	201.4845	0.00
3.9480	-0.3929	379299.	-41665.	0.01547	24167.	9.44E+09	474.5035	202.8724	0.00
3.9620	-0.3903	371258.	-41586.	0.01548	23986.	9.44E+09	474.6043	204.2672	0.00
3.9760	-0.3877	363230.	-41506.	0.01549	23805.	9.44E+09	474.6767	205.6689	0.00
3.9900	-0.3851	355215.	-41426.	0.01549	23624.	9.44E+09	474.7204	207.0777	0.00
4.0040	-0.3825	347213.	-41346.	0.01550	23443.	9.44E+09	474.4965	208.3887	0.00
4.0180	-0.3799	339223.	-41267.	0.01551	23263.	9.44E+09	473.6493	209.4426	0.00

4.0320	-0.3773	331247.	-41187.	0.01551	23083.	9.44E+09	472.7684	210.4966	0.00
4.0460	-0.3747	323284.	-41108.	0.01552	22903.	9.44E+09	471.8538	211.5507	0.00
4.0600	-0.3721	315334.	-41029.	0.01552	22724.	9.44E+09	470.9056	212.6050	0.00
4.0740	-0.3695	307396.	-40950.	0.01553	22544.	9.44E+09	469.9237	213.6594	0.00
4.0880	-0.3669	299472.	-40871.	0.01553	22366.	9.44E+09	468.9083	214.7140	0.00
4.1020	-0.3643	291560.	-40792.	0.01554	22187.	9.44E+09	467.8592	215.7687	0.00
4.1160	-0.3617	283662.	-40714.	0.01554	22009.	9.44E+09	466.7767	216.8235	0.00
4.1300	-0.3591	275776.	-40635.	0.01555	21831.	9.44E+09	465.6606	217.8786	0.00
4.1440	-0.3564	267903.	-40557.	0.01555	21653.	9.44E+09	464.5110	218.9338	0.00
4.1580	-0.3538	260042.	-40479.	0.01556	21476.	9.44E+09	463.3280	219.9893	0.00
4.1720	-0.3512	252195.	-40402.	0.01556	21298.	9.44E+09	462.1116	221.0449	0.00
4.1860	-0.3486	244360.	-40324.	0.01557	21122.	9.44E+09	460.8618	222.1008	0.00
4.2000	-0.3460	236538.	-40247.	0.01557	20945.	9.44E+09	459.5787	223.1569	0.00
4.2140	-0.3434	228728.	-40170.	0.01558	20769.	9.44E+09	458.2623	224.2134	0.00
4.2280	-0.3408	220932.	-40093.	0.01558	20593.	9.44E+09	456.9127	225.2701	0.00
4.2420	-0.3381	213148.	-40016.	0.01558	20417.	9.44E+09	455.5299	226.3271	0.00
4.2560	-0.3355	205376.	-39940.	0.01559	20242.	9.44E+09	454.1140	227.3844	0.00
4.2700	-0.3329	197617.	-39863.	0.01559	20066.	9.44E+09	452.6650	228.4421	0.00
4.2840	-0.3303	189871.	-39788.	0.01560	19892.	9.44E+09	451.1829	229.5002	0.00
4.2980	-0.3277	182137.	-39712.	0.01560	19717.	9.44E+09	449.6680	230.5588	0.00
4.3120	-0.3250	174415.	-39636.	0.01560	19543.	9.44E+09	448.1201	231.6178	0.00
4.3260	-0.3224	166706.	-39561.	0.01560	19369.	9.44E+09	446.5394	232.6772	0.00
4.3400	-0.3198	159010.	-39486.	0.01561	19195.	9.44E+09	444.9260	233.7372	0.00
4.3540	-0.3172	151326.	-39412.	0.01561	19022.	9.44E+09	443.2798	234.7978	0.00
4.3680	-0.3145	143654.	-39337.	0.01561	18848.	9.44E+09	441.6011	235.8590	0.00
4.3820	-0.3119	135994.	-39263.	0.01562	18675.	9.44E+09	439.8898	236.9208	0.00
4.3960	-0.3093	128347.	-39190.	0.01562	18503.	9.44E+09	438.1461	237.9833	0.00
4.4100	-0.3067	120712.	-39116.	0.01562	18330.	9.44E+09	436.3699	239.0465	0.00
4.4240	-0.3041	113089.	-39043.	0.01562	18158.	9.44E+09	434.5615	240.1106	0.00
4.4380	-0.3014	105478.	-38970.	0.01562	17987.	9.44E+09	432.7209	241.1755	0.00
4.4520	-0.2988	97879.	-38898.	0.01563	17815.	9.44E+09	430.8482	242.2413	0.00
4.4660	-0.2962	90292.	-38825.	0.01563	17644.	9.44E+09	428.9434	243.3080	0.00
4.4800	-0.2936	82718.	-38754.	0.01563	17473.	9.44E+09	427.0067	244.3758	0.00
4.4940	-0.2909	75155.	-38682.	0.01563	17302.	9.44E+09	425.0381	245.4447	0.00
4.5080	-0.2883	67604.	-38611.	0.01563	17132.	9.44E+09	423.0378	246.5147	0.00
4.5220	-0.2857	60065.	-38540.	0.01563	16962.	9.44E+09	421.0059	247.5860	0.00
4.5360	-0.2830	52538.	-38469.	0.01563	16792.	9.44E+09	418.9425	248.6586	0.00
4.5500	-0.2804	45022.	-38399.	0.01563	16622.	9.44E+09	416.8476	249.7326	0.00
4.5640	-0.2778	37519.	-38329.	0.01564	16453.	9.44E+09	414.7214	250.8081	0.00
4.5780	-0.2752	30026.	-38260.	0.01564	16284.	9.44E+09	412.5639	251.8852	0.00
4.5920	-0.2725	22546.	-38191.	0.01564	16115.	9.44E+09	410.3754	252.9640	0.00
4.6060	-0.2699	15077.	-38122.	0.01564	15946.	9.44E+09	408.1560	254.0446	0.00
4.6200	-0.2673	7620.	-38053.	0.01564	15778.	9.44E+09	405.9056	255.1270	0.00
4.6340	-0.2647	173.7311	-37985.	0.01564	15610.	9.44E+09	403.6246	256.2114	0.00
4.6480	-0.2620	-7261.	-37918.	0.01564	15770.	9.44E+09	401.3129	257.2980	0.00
4.6620	-0.2594	-14684.	-37851.	0.01564	15937.	9.44E+09	398.9708	258.3868	0.00
4.6760	-0.2568	-22096.	-37784.	0.01564	16104.	9.44E+09	396.5983	259.4780	0.00
4.6900	-0.2542	-29497.	-37717.	0.01564	16272.	9.44E+09	394.1955	260.5717	0.00
4.7040	-0.2515	-36886.	-37651.	0.01564	16438.	9.44E+09	391.7627	261.6681	0.00
4.7180	-0.2489	-44265.	-37586.	0.01563	16605.	9.44E+09	389.2994	262.7669	0.00
4.7320	-0.2463	-51632.	-37521.	0.01563	16771.	9.44E+09	386.7977	263.8627	0.00
4.7460	-0.2436	-58989.	-37456.	0.01563	16937.	9.44E+09	384.2550	264.9539	0.00
4.7600	-0.2410	-66334.	-37391.	0.01563	17103.	9.44E+09	381.6715	266.0401	0.00
4.7740	-0.2384	-73669.	-37328.	0.01563	17269.	9.44E+09	379.0471	267.1212	0.00

4.7880	-0.2358	-80993.	-37264.	0.01563	17434.	9.44E+09	376.3819	268.1971	0.00
4.8020	-0.2331	-88306.	-37201.	0.01563	17599.	9.44E+09	373.6759	269.2676	0.00
4.8160	-0.2305	-95608.	-37139.	0.01563	17764.	9.44E+09	370.9292	270.3324	0.00
4.8300	-0.2279	-102900.	-37076.	0.01562	17928.	9.44E+09	368.1418	271.3915	0.00
4.8440	-0.2253	-110182.	-37015.	0.01562	18093.	9.44E+09	365.3137	272.4445	0.00
4.8580	-0.2226	-117453.	-36954.	0.01562	18257.	9.44E+09	362.4452	273.4914	0.00
4.8720	-0.2200	-124713.	-36893.	0.01562	18421.	9.44E+09	359.5361	274.5319	0.00
4.8860	-0.2174	-131964.	-36833.	0.01562	18584.	9.44E+09	356.5867	275.5659	0.00
4.9000	-0.2148	-139204.	-36773.	0.01561	18748.	9.44E+09	353.7448	276.7087	0.00
4.9140	-0.2121	-146434.	-36714.	0.01561	18911.	9.44E+09	351.9706	278.7248	0.00
4.9280	-0.2095	-153653.	-36655.	0.01561	19074.	9.44E+09	350.1628	280.7637	0.00
4.9420	-0.2069	-160863.	-36596.	0.01561	19237.	9.44E+09	348.3211	282.8263	0.00
4.9560	-0.2043	-168063.	-36538.	0.01560	19399.	9.44E+09	346.4455	284.9132	0.00
4.9700	-0.2017	-175253.	-36480.	0.01560	19562.	9.44E+09	344.5357	287.0252	0.00
4.9840	-0.1990	-182432.	-36422.	0.01560	19724.	9.44E+09	342.5917	289.1631	0.00
4.9980	-0.1964	-189602.	-36365.	0.01559	19886.	9.44E+09	340.6132	291.3278	0.00
5.0120	-0.1938	-196762.	-36331.	0.01559	0.00	9.37E+09	57.1454	49.5373	0.00
5.0260	-0.1912	-203921.	-36322.	0.01559	0.00	9.37E+09	57.3192	50.3686	0.00
5.0400	-0.1886	-211077.	-36312.	0.01558	0.00	9.38E+09	57.4936	51.2233	0.00
5.0540	-0.1859	-218232.	-36302.	0.01558	0.00	9.40E+09	57.6685	52.1024	0.00
5.0680	-0.1833	-225384.	-36293.	0.01557	0.00	9.41E+09	57.8440	53.0068	0.00
5.0820	-0.1807	-232535.	-36283.	0.01557	0.00	9.43E+09	58.0200	53.9378	0.00
5.0960	-0.1781	-239684.	-36273.	0.01557	0.00	9.44E+09	58.1965	54.8965	0.00
5.1100	-0.1755	-246830.	-36263.	0.01556	0.00	9.45E+09	58.3738	55.8841	0.00
5.1240	-0.1729	-253975.	-36254.	0.01556	0.00	9.48E+09	58.5516	56.9020	0.00
5.1380	-0.1703	-261118.	-36244.	0.01555	0.00	9.52E+09	58.7301	57.9516	0.00
5.1520	-0.1676	-268259.	-36234.	0.01555	0.00	9.56E+09	58.9094	59.0343	0.00
5.1660	-0.1650	-275398.	-36224.	0.01554	0.00	9.60E+09	59.0894	60.1517	0.00
5.1800	-0.1624	-282535.	-36214.	0.01554	0.00	9.63E+09	59.2701	61.3056	0.00
5.1940	-0.1598	-289670.	-36204.	0.01553	0.00	9.66E+09	59.4517	62.4977	0.00
5.2080	-0.1572	-296803.	-36194.	0.01553	0.00	9.71E+09	59.6341	63.7299	0.00
5.2220	-0.1546	-303934.	-36184.	0.01552	0.00	9.77E+09	59.8174	65.0044	0.00
5.2360	-0.1520	-311063.	-36174.	0.01552	0.00	9.83E+09	60.0016	66.3233	0.00
5.2500	-0.1494	-318190.	-36164.	0.01551	0.00	9.89E+09	60.1868	67.6889	0.00
5.2640	-0.1468	-325315.	-36154.	0.01551	0.00	9.94E+09	60.3731	69.1037	0.00
5.2780	-0.1442	-332437.	-36144.	0.01550	0.00	9.99E+09	60.5604	70.5705	0.00
5.2920	-0.1416	-339558.	-36133.	0.01550	0.00	1.01E+10	60.7489	72.0922	0.00
5.3060	-0.1390	-346676.	-36123.	0.01549	0.00	1.01E+10	60.9386	73.6719	0.00
5.3200	-0.1364	-353793.	-36113.	0.01548	0.00	1.02E+10	61.1296	75.3129	0.00
5.3340	-0.1338	-360907.	-36103.	0.01548	0.00	1.03E+10	61.3219	77.0189	0.00
5.3480	-0.1312	-368019.	-36092.	0.01547	0.00	1.03E+10	61.5157	78.7938	0.00
5.3620	-0.1286	-375129.	-36082.	0.01547	0.00	1.04E+10	61.7110	80.6418	0.00
5.3760	-0.1260	-382237.	-36072.	0.01546	0.00	1.04E+10	61.9079	82.5676	0.00
5.3900	-0.1234	-389343.	-36061.	0.01545	0.00	1.05E+10	62.1064	84.5760	0.00
5.4040	-0.1208	-396446.	-36051.	0.01545	0.00	1.06E+10	62.3068	86.6726	0.00
5.4180	-0.1182	-403548.	-36040.	0.01544	0.00	1.06E+10	62.5091	88.8633	0.00
5.4320	-0.1156	-410647.	-36030.	0.01544	0.00	1.07E+10	62.7135	91.1544	0.00
5.4460	-0.1130	-417744.	-36019.	0.01543	0.00	1.08E+10	62.9201	93.5531	0.00
5.4600	-0.1104	-424838.	-36009.	0.01542	0.00	1.08E+10	63.1290	96.0671	0.00
5.4740	-0.1078	-431931.	-35998.	0.01542	0.00	1.09E+10	63.3404	98.7048	0.00
5.4880	-0.1052	-439021.	-35987.	0.01541	0.00	1.09E+10	63.5545	101.4757	0.00
5.5020	-0.1026	-446109.	-35977.	0.01540	0.00	1.10E+10	63.7715	104.3899	0.00
5.5160	-0.1000	-453195.	-35966.	0.01540	0.00	1.10E+10	63.9917	107.4590	0.00
5.5300	-0.09746	-460278.	-35955.	0.01539	0.00	1.10E+10	64.2152	110.6955	0.00

5.5440	-0.09487	-467359.	-35944.	0.01538	0.00	1.11E+10	64.4424	114.1135	0.00
5.5580	-0.09229	-474438.	-35933.	0.01537	0.00	1.11E+10	64.6735	117.7286	0.00
5.5720	-0.08971	-481515.	-35923.	0.01537	0.00	1.12E+10	64.9090	121.5584	0.00
5.5860	-0.08713	-488589.	-35912.	0.01536	0.00	1.12E+10	65.1492	125.6226	0.00
5.6000	-0.08455	-495661.	-35901.	0.01535	0.00	1.12E+10	65.3945	129.9432	0.00
5.6140	-0.08197	-502731.	-35890.	0.01534	0.00	1.13E+10	65.6454	134.5453	0.00
5.6280	-0.07939	-509798.	-35879.	0.01534	0.00	1.13E+10	65.9026	139.4572	0.00
5.6420	-0.07681	-516863.	-35868.	0.01533	0.00	1.13E+10	66.1665	144.7113	0.00
5.6560	-0.07424	-523925.	-32574.	0.01532	0.00	1.13E+10	39137.	88564.	0.00
5.6700	-0.07167	-529882.	-26022.	0.01531	0.00	1.13E+10	38869.	91116.	0.00
5.6840	-0.06909	-534742.	-19514.	0.01531	0.00	1.13E+10	38605.	93867.	0.00
5.6980	-0.06652	-538512.	-13050.	0.01530	0.00	1.13E+10	38346.	96840.	0.00
5.7120	-0.06395	-541198.	-6629.	0.01529	0.00	1.13E+10	38092.	100063.	0.00
5.7260	-0.06139	-542810.	-250.7445	0.01528	0.00	1.13E+10	37844.	103570.	0.00
5.7400	-0.05882	-543352.	6087.	0.01527	0.00	1.13E+10	37603.	107400.	0.00
5.7540	-0.05625	-542833.	12384.	0.01527	0.00	1.13E+10	37369.	111599.	0.00
5.7680	-0.05369	-541258.	18643.	0.01526	0.00	1.13E+10	37143.	116224.	0.00
5.7820	-0.05113	-538635.	24865.	0.01525	0.00	1.13E+10	36928.	121342.	0.00
5.7960	-0.04857	-534968.	31052.	0.01524	0.00	1.13E+10	36724.	127037.	0.00
5.8100	-0.04601	-530265.	37206.	0.01523	0.00	1.13E+10	36534.	133412.	0.00
5.8240	-0.04345	-524530.	43329.	0.01523	0.00	1.13E+10	36361.	140598.	0.00
5.8380	-0.04089	-517768.	49425.	0.01522	0.00	1.12E+10	36207.	148759.	0.00
5.8520	-0.03833	-509984.	55497.	0.01521	0.00	1.12E+10	36077.	158109.	0.00
5.8660	-0.03578	-501181.	61549.	0.01520	0.00	1.11E+10	35977.	168927.	0.00
5.8800	-0.03323	-491362.	67588.	0.01520	0.00	1.11E+10	35913.	181590.	0.00
5.8940	-0.03067	-480529.	73620.	0.01519	0.00	1.10E+10	35897.	196612.	0.00
5.9080	-0.02812	-468682.	79655.	0.01518	0.00	1.09E+10	35943.	214722.	0.00
5.9220	-0.02557	-455821.	85704.	0.01517	0.00	1.08E+10	36073.	236981.	0.00
5.9360	-0.02302	-441940.	91785.	0.01517	0.00	1.07E+10	36318.	264999.	0.00
5.9500	-0.02048	-427035.	97921.	0.01516	0.00	1.06E+10	36729.	301346.	0.00
5.9640	-0.01793	-411092.	104147.	0.01515	0.00	1.04E+10	37396.	350384.	0.00
5.9780	-0.01539	-394093.	110501.	0.01515	0.00	1.02E+10	38247.	417648.	0.00
5.9920	-0.01284	-376014.	116396.	0.01514	0.00	1.00E+10	31922.	417648.	0.00
6.0060	-0.01030	-357034.	121227.	0.01513	0.00	9.89E+09	25600.	417648.	0.00
6.0200	-0.00776	-337331.	124997.	0.01513	0.00	9.72E+09	19281.	417648.	0.00
6.0340	-0.00521	-317084.	127706.	0.01512	0.00	9.60E+09	12964.	417648.	0.00
6.0480	-0.00267	-296470.	129354.	0.01512	0.00	9.49E+09	6649.	417648.	0.00
6.0620	-1.35E-04	-275668.	129940.	0.01511	0.00	9.43E+09	336.4567	417648.	0.00
6.0760	0.00240	-254856.	129467.	0.01511	0.00	9.38E+09	-5974.	417648.	0.00
6.0900	0.00494	-234213.	127933.	0.01510	0.00	9.37E+09	-12283.	417648.	0.00
6.1040	0.00748	-213916.	125340.	0.01510	0.00	9.37E+09	-18590.	417648.	0.00
6.1180	0.01001	-194143.	121879.	0.01510	0.00	9.36E+09	-22613.	379360.	0.00
6.1320	0.01255	-175008.	117957.	0.01509	0.00	9.36E+09	-24072.	322246.	0.00
6.1460	0.01508	-156553.	113817.	0.01509	0.00	9.36E+09	-25217.	280835.	0.00
6.1600	0.01762	-138809.	109501.	0.01509	0.00	9.36E+09	-26160.	249435.	0.00
6.1740	0.02015	-121803.	105039.	0.01508	0.00	9.36E+09	-26969.	224805.	0.00
6.1880	0.02269	-105559.	100448.	0.01508	0.00	9.36E+09	-27680.	204969.	0.00
6.2020	0.02522	-90095.	95744.	0.01508	0.00	9.36E+09	-28322.	188651.	0.00
6.2160	0.02775	-75431.	90936.	0.01508	0.00	9.36E+09	-28910.	174992.	0.00
6.2300	0.03029	-61582.	86034.	0.01508	0.00	9.36E+09	-29457.	163390.	0.00
6.2440	0.03282	-48565.	81042.	0.01508	0.00	9.36E+09	-29971.	153413.	0.00
6.2580	0.03535	-36393.	75966.	0.01508	0.00	9.36E+09	-30459.	144741.	0.00
6.2720	0.03789	-25082.	70809.	0.01508	0.00	9.36E+09	-30926.	137135.	0.00
6.2860	0.04042	-14643.	65576.	0.01507	0.00	9.36E+09	-31375.	130409.	0.00

6.3000	0.04295	-5090.	60268.	0.01507	0.00	9.36E+09	-31809.	124419.	0.00
6.3140	0.04548	3566.	54889.	0.01507	0.00	9.36E+09	-32231.	119050.	0.00
6.3280	0.04802	11312.	49440.	0.01507	0.00	9.36E+09	-32643.	114210.	0.00
6.3420	0.05055	18137.	43922.	0.01508	0.00	9.36E+09	-33045.	109825.	0.00
6.3560	0.05308	24028.	38337.	0.01508	0.00	9.36E+09	-33439.	105833.	0.00
6.3700	0.05561	28976.	32687.	0.01508	0.00	9.36E+09	-33827.	102184.	0.00
6.3840	0.05815	32970.	26972.	0.01508	0.00	9.36E+09	-34208.	98835.	0.00
6.3980	0.06068	35997.	21193.	0.01508	0.00	9.36E+09	-34585.	95752.	0.00
6.4120	0.06321	38049.	15352.	0.01508	0.00	9.36E+09	-34956.	92902.	0.00
6.4260	0.06575	39114.	9448.	0.01508	0.00	9.36E+09	-35324.	90262.	0.00
6.4400	0.06828	39182.	3483.	0.01508	0.00	9.36E+09	-35688.	87808.	0.00
6.4540	0.07081	38243.	479.6592	0.01508	0.00	9.36E+09	-69.0421	163.7983	0.00
6.4680	0.07335	37301.	468.0385	0.01508	0.00	9.36E+09	-69.2996	158.7303	0.00
6.4820	0.07588	36358.	456.3751	0.01508	0.00	9.36E+09	-69.5506	153.9862	0.00
6.4960	0.07841	35412.	444.6701	0.01508	0.00	9.36E+09	-69.7958	149.5359	0.00
6.5100	0.08095	34465.	432.9243	0.01508	0.00	9.36E+09	-70.0357	145.3530	0.00
6.5240	0.08348	33516.	421.1386	0.01508	0.00	9.36E+09	-70.2707	141.4140	0.00
6.5380	0.08602	32564.	409.3138	0.01508	0.00	9.36E+09	-70.5012	137.6983	0.00
6.5520	0.08855	31611.	397.4505	0.01508	0.00	9.36E+09	-70.7277	134.1873	0.00
6.5660	0.09108	30655.	385.5495	0.01508	0.00	9.36E+09	-70.9504	130.8646	0.00
6.5800	0.09362	29698.	373.6114	0.01509	0.00	9.36E+09	-71.1697	127.7155	0.00
6.5940	0.09615	28738.	361.6368	0.01509	0.00	9.36E+09	-71.3857	124.7267	0.00
6.6080	0.09869	27776.	349.6262	0.01509	0.00	9.36E+09	-71.5988	121.8863	0.00
6.6220	0.1012	26813.	337.5800	0.01509	0.00	9.36E+09	-71.8092	119.1835	0.00
6.6360	0.1038	25847.	325.4985	0.01509	0.00	9.36E+09	-72.0170	116.6085	0.00
6.6500	0.1063	24879.	313.3824	0.01509	0.00	9.36E+09	-72.2225	114.1524	0.00
6.6640	0.1088	23909.	301.2319	0.01509	0.00	9.36E+09	-72.4257	111.8073	0.00
6.6780	0.1114	22937.	289.0474	0.01509	0.00	9.36E+09	-72.6269	109.5658	0.00
6.6920	0.1139	21963.	276.8293	0.01509	0.00	9.36E+09	-72.8262	107.4211	0.00
6.7060	0.1164	20987.	264.5778	0.01509	0.00	9.36E+09	-73.0236	105.3672	0.00
6.7200	0.1190	20009.	252.2935	0.01509	0.00	9.36E+09	-73.2194	103.3983	0.00
6.7340	0.1215	19028.	239.9765	0.01509	0.00	9.36E+09	-73.4135	101.5094	0.00
6.7480	0.1240	18046.	227.6268	0.01509	0.00	9.36E+09	-73.6062	99.6956	0.00
6.7620	0.1266	17062.	215.2448	0.01509	0.00	9.36E+09	-73.7974	97.9525	0.00
6.7760	0.1291	16075.	202.8309	0.01509	0.00	9.36E+09	-73.9873	96.2761	0.00
6.7900	0.1316	15086.	190.3853	0.01509	0.00	9.36E+09	-74.1760	94.6627	0.00
6.8040	0.1342	14095.	177.9079	0.01509	0.00	9.36E+09	-74.3635	93.1087	0.00
6.8180	0.1367	13103.	165.3992	0.01509	0.00	9.36E+09	-74.5498	91.6109	0.00
6.8320	0.1392	12107.	152.8593	0.01509	0.00	9.36E+09	-74.7351	90.1664	0.00
6.8460	0.1418	11110.	140.2883	0.01509	0.00	9.36E+09	-74.9194	88.7724	0.00
6.8600	0.1443	10111.	127.6863	0.01509	0.00	9.36E+09	-75.1028	87.4261	0.00
6.8740	0.1469	9110.	115.0537	0.01509	0.00	9.36E+09	-75.2852	86.1254	0.00
6.8880	0.1494	8106.	102.3904	0.01509	0.00	9.36E+09	-75.4668	84.8678	0.00
6.9020	0.1519	7100.	89.6968	0.01509	0.00	9.36E+09	-75.6475	83.6512	0.00
6.9160	0.1545	6092.	76.9729	0.01509	0.00	9.36E+09	-75.8275	82.4738	0.00
6.9300	0.1570	5082.	64.2188	0.01509	0.00	9.36E+09	-76.0068	81.3335	0.00
6.9440	0.1595	4070.	51.4346	0.01509	0.00	9.36E+09	-76.1853	80.2288	0.00
6.9580	0.1621	3056.	38.6204	0.01509	0.00	9.36E+09	-76.3632	79.1579	0.00
6.9720	0.1646	2039.	25.7766	0.01509	0.00	9.36E+09	-76.5404	78.1194	0.00
6.9860	0.1671	1021.	12.9031	0.01509	0.00	9.36E+09	-76.7170	77.1117	0.00
7.0000	0.1697	0.00	0.00	0.01509	0.00	9.36E+09	-76.8930	38.0668	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses

are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

Pile-head deflection = -0.97500000 inches
Computed slope at pile head = 0.000000 radians
Maximum bending moment = 3006528. inch-lbs
Maximum shear force = 129940. lbs
Depth of maximum bending moment = 0.000000 feet below pile head
Depth of maximum shear force = 6.06200000 feet below pile head
Number of iterations = 160
Number of zero deflection points = 1

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 2

Pile-head conditions are Displacement and Moment (Loading Type 4)
Displacement of pile head = -0.975000 inches
Moment at pile head = 1885473.0 in-lbs
Axial load at pile head = 403000.0 lbs

Depth X	Deflect. y	Bending Moment	Shear Force	Slope S	Total Stress	Bending Stiffness	Soil Res. p	Soil Spr. Es*h	Distrib. Lat. Load
feet	inches	in-lbs	lbs	radians	psi*	lb-in^2	lb/inch	lb/inch	lb/inch
0.00	-0.9750	1885473.	-41020.	0.00493	58166.	8.04E+07	0.00	0.00	0.00
0.01400	-0.9738	1878115.	-41020.	0.00886	58000.	8.04E+07	1.5747	0.2716	0.00
0.02800	-0.9720	1870491.	-41020.	0.01084	57828.	9.12E+09	3.1692	0.5477	0.00
0.04200	-0.9702	1862864.	-41019.	0.01087	57655.	9.13E+09	4.7833	0.8283	0.00
0.05600	-0.9684	1855236.	-41018.	0.01091	57483.	9.14E+09	6.4168	1.1132	0.00
0.07000	-0.9665	1847605.	-41017.	0.01094	57311.	9.16E+09	8.0695	1.4026	0.00
0.08400	-0.9647	1839973.	-41015.	0.01097	57139.	9.17E+09	9.7410	1.6964	0.00
0.09800	-0.9628	1832338.	-41014.	0.01101	56966.	9.18E+09	11.4312	1.9946	0.00
0.1120	-0.9610	1824702.	-41011.	0.01104	56794.	9.19E+09	13.1399	2.2971	0.00
0.1260	-0.9591	1817063.	-41009.	0.01108	56622.	9.21E+09	14.8667	2.6040	0.00
0.1400	-0.9573	1809423.	-41006.	0.01111	56449.	9.22E+09	16.6114	2.9153	0.00
0.1540	-0.9554	1801781.	-41004.	0.01114	56277.	9.23E+09	18.3739	3.2309	0.00
0.1680	-0.9535	1794137.	-41000.	0.01117	56104.	9.24E+09	20.1538	3.5508	0.00
0.1820	-0.9517	1786492.	-40997.	0.01121	55931.	9.25E+09	21.9509	3.8751	0.00
0.1960	-0.9498	1778845.	-40993.	0.01124	55759.	9.26E+09	23.7650	4.2037	0.00
0.2100	-0.9479	1771196.	-40989.	0.01127	55586.	9.27E+09	25.5958	4.5366	0.00
0.2240	-0.9460	1763546.	-40984.	0.01130	55413.	9.29E+09	27.4432	4.8737	0.00
0.2380	-0.9441	1755895.	-40980.	0.01133	55241.	9.30E+09	29.3068	5.2152	0.00
0.2520	-0.9422	1748242.	-40974.	0.01137	55068.	9.31E+09	31.1864	5.5609	0.00
0.2660	-0.9403	1740589.	-40969.	0.01140	54895.	9.32E+09	33.0818	5.9109	0.00
0.2800	-0.9383	1732934.	-40963.	0.01143	54722.	9.32E+09	34.9927	6.2651	0.00

0.2940	-0.9364	1725277.	-40957.	0.01146	54550.	9.33E+09	36.9189	6.6235	0.00
0.3080	-0.9345	1717620.	-40951.	0.01149	54377.	9.34E+09	38.8602	6.9862	0.00
0.3220	-0.9326	1709962.	-40944.	0.01152	54204.	9.35E+09	40.8163	7.3531	0.00
0.3360	-0.9306	1702303.	-40937.	0.01155	54031.	9.36E+09	42.7869	7.7241	0.00
0.3500	-0.9287	1694643.	-40930.	0.01158	53858.	9.37E+09	44.7719	8.0994	0.00
0.3640	-0.9267	1686982.	-40922.	0.01161	53685.	9.37E+09	46.7710	8.4788	0.00
0.3780	-0.9248	1679320.	-40914.	0.01164	53512.	9.38E+09	48.7839	8.8624	0.00
0.3920	-0.9228	1671658.	-40906.	0.01167	53339.	9.39E+09	50.8105	9.2501	0.00
0.4060	-0.9208	1663995.	-40897.	0.01170	53166.	9.39E+09	52.8504	9.6420	0.00
0.4200	-0.9189	1656332.	-40888.	0.01173	52993.	9.40E+09	54.9035	10.0381	0.00
0.4340	-0.9169	1648668.	-40879.	0.01176	52820.	9.40E+09	56.9694	10.4382	0.00
0.4480	-0.9149	1641004.	-40869.	0.01179	52647.	9.41E+09	59.0480	10.8424	0.00
0.4620	-0.9129	1633339.	-40859.	0.01182	52474.	9.41E+09	61.1390	11.2508	0.00
0.4760	-0.9110	1625675.	-40848.	0.01185	52301.	9.42E+09	63.2421	11.6632	0.00
0.4900	-0.9090	1618010.	-40838.	0.01188	52128.	9.42E+09	65.3572	12.0797	0.00
0.5040	-0.9070	1610345.	-40826.	0.01191	51955.	9.43E+09	67.4840	12.5003	0.00
0.5180	-0.9050	1602680.	-40815.	0.01194	51782.	9.43E+09	69.6222	12.9249	0.00
0.5320	-0.9030	1595014.	-40803.	0.01197	51609.	9.43E+09	71.7716	13.3535	0.00
0.5460	-0.9009	1587350.	-40791.	0.01199	51436.	9.43E+09	73.9320	13.7862	0.00
0.5600	-0.8989	1579685.	-40778.	0.01202	51263.	9.43E+09	76.1031	14.2229	0.00
0.5740	-0.8969	1572020.	-40765.	0.01205	51090.	9.44E+09	78.2847	14.6636	0.00
0.5880	-0.8949	1564356.	-40752.	0.01208	50917.	9.44E+09	80.4765	15.1083	0.00
0.6020	-0.8928	1556692.	-40738.	0.01211	50744.	9.44E+09	82.6783	15.5570	0.00
0.6160	-0.8908	1549029.	-40724.	0.01213	50571.	9.44E+09	84.8857	16.0088	0.00
0.6300	-0.8888	1541366.	-40710.	0.01216	50398.	9.44E+09	87.0905	16.4624	0.00
0.6440	-0.8867	1533704.	-40695.	0.01219	50225.	9.44E+09	89.3037	16.9196	0.00
0.6580	-0.8847	1526042.	-40680.	0.01222	50052.	9.44E+09	91.5249	17.3807	0.00
0.6720	-0.8826	1518381.	-40664.	0.01224	49879.	9.44E+09	93.7540	17.8454	0.00
0.6860	-0.8806	1510721.	-40648.	0.01227	49707.	9.44E+09	95.9907	18.3139	0.00
0.7000	-0.8785	1503062.	-40632.	0.01230	49534.	9.44E+09	98.2346	18.7860	0.00
0.7140	-0.8764	1495404.	-40615.	0.01232	49361.	9.44E+09	100.4856	19.2618	0.00
0.7280	-0.8744	1487747.	-40598.	0.01235	49188.	9.44E+09	102.7434	19.7413	0.00
0.7420	-0.8723	1480091.	-40581.	0.01238	49015.	9.44E+09	105.0078	20.2244	0.00
0.7560	-0.8702	1472436.	-40563.	0.01240	48842.	9.44E+09	107.2785	20.7112	0.00
0.7700	-0.8681	1464783.	-40545.	0.01243	48670.	9.44E+09	109.5551	21.2015	0.00
0.7840	-0.8660	1457130.	-40526.	0.01245	48497.	9.44E+09	111.8376	21.6955	0.00
0.7980	-0.8639	1449479.	-40507.	0.01248	48324.	9.44E+09	114.1256	22.1930	0.00
0.8120	-0.8618	1441830.	-40488.	0.01251	48152.	9.44E+09	116.4189	22.6941	0.00
0.8260	-0.8597	1434182.	-40468.	0.01253	47979.	9.44E+09	118.7171	23.1987	0.00
0.8400	-0.8576	1426536.	-40448.	0.01256	47806.	9.44E+09	121.0201	23.7068	0.00
0.8540	-0.8555	1418891.	-40427.	0.01258	47634.	9.44E+09	123.3277	24.2185	0.00
0.8680	-0.8534	1411249.	-40406.	0.01261	47461.	9.44E+09	125.6394	24.7336	0.00
0.8820	-0.8513	1403608.	-40385.	0.01263	47289.	9.44E+09	127.9552	25.2523	0.00
0.8960	-0.8491	1395969.	-40363.	0.01266	47116.	9.44E+09	130.2746	25.7743	0.00
0.9100	-0.8470	1388332.	-40341.	0.01268	46944.	9.44E+09	132.5976	26.2998	0.00
0.9240	-0.8449	1380697.	-40319.	0.01271	46772.	9.44E+09	134.9237	26.8288	0.00
0.9380	-0.8427	1373064.	-40296.	0.01273	46599.	9.44E+09	137.2528	27.3611	0.00
0.9520	-0.8406	1365434.	-40273.	0.01276	46427.	9.44E+09	139.5846	27.8968	0.00
0.9660	-0.8385	1357805.	-40249.	0.01278	46255.	9.44E+09	141.9189	28.4359	0.00
0.9800	-0.8363	1350180.	-40225.	0.01280	46083.	9.44E+09	144.2553	28.9783	0.00
0.9940	-0.8342	1342556.	-40200.	0.01283	45911.	9.44E+09	146.5937	29.5240	0.00
1.0080	-0.8320	1334935.	-40176.	0.01285	45739.	9.44E+09	148.9338	30.0731	0.00
1.0220	-0.8298	1327317.	-40150.	0.01288	45567.	9.44E+09	151.2752	30.6254	0.00
1.0360	-0.8277	1319701.	-40125.	0.01290	45395.	9.44E+09	153.6178	31.1811	0.00

1.0500	-0.8255	1312088.	-40099.	0.01292	45223.	9.44E+09	155.9614	31.7399	0.00
1.0640	-0.8233	1304478.	-40072.	0.01295	45051.	9.44E+09	158.3055	32.3020	0.00
1.0780	-0.8212	1296871.	-40046.	0.01297	44879.	9.44E+09	160.6501	32.8673	0.00
1.0920	-0.8190	1289267.	-40018.	0.01299	44708.	9.44E+09	162.9948	33.4358	0.00
1.1060	-0.8168	1281666.	-39991.	0.01301	44536.	9.44E+09	165.3393	34.0075	0.00
1.1200	-0.8146	1274068.	-39963.	0.01304	44365.	9.44E+09	167.6835	34.5823	0.00
1.1340	-0.8124	1266473.	-39935.	0.01306	44193.	9.44E+09	170.0270	35.1602	0.00
1.1480	-0.8102	1258881.	-39906.	0.01308	44022.	9.44E+09	172.3697	35.7413	0.00
1.1620	-0.8080	1251293.	-39877.	0.01310	43851.	9.44E+09	174.7111	36.3254	0.00
1.1760	-0.8058	1243708.	-39847.	0.01313	43679.	9.44E+09	177.0512	36.9126	0.00
1.1900	-0.8036	1236127.	-39817.	0.01315	43508.	9.44E+09	179.3895	37.5028	0.00
1.2040	-0.8014	1228549.	-39787.	0.01317	43337.	9.44E+09	181.7260	38.0961	0.00
1.2180	-0.7992	1220975.	-39756.	0.01319	43166.	9.44E+09	184.0602	38.6924	0.00
1.2320	-0.7970	1213405.	-39725.	0.01321	42995.	9.44E+09	186.4135	39.2961	0.00
1.2460	-0.7947	1205838.	-39693.	0.01324	42825.	9.44E+09	188.7841	39.9071	0.00
1.2600	-0.7925	1198275.	-39661.	0.01326	42654.	9.44E+09	191.1531	40.5214	0.00
1.2740	-0.7903	1190717.	-39629.	0.01328	42483.	9.44E+09	193.5202	41.1389	0.00
1.2880	-0.7881	1183162.	-39596.	0.01330	42313.	9.44E+09	195.8853	41.7596	0.00
1.3020	-0.7858	1175611.	-39563.	0.01332	42142.	9.44E+09	198.2480	42.3836	0.00
1.3160	-0.7836	1168065.	-39530.	0.01334	41972.	9.44E+09	200.6081	43.0107	0.00
1.3300	-0.7813	1160523.	-39496.	0.01336	41802.	9.44E+09	202.9654	43.6411	0.00
1.3440	-0.7791	1152985.	-39462.	0.01338	41632.	9.44E+09	205.3196	44.2746	0.00
1.3580	-0.7768	1145451.	-39427.	0.01340	41462.	9.44E+09	207.6705	44.9112	0.00
1.3720	-0.7746	1137922.	-39392.	0.01342	41292.	9.44E+09	210.0178	45.5510	0.00
1.3860	-0.7723	1130398.	-39356.	0.01344	41122.	9.44E+09	212.3613	46.1939	0.00
1.4000	-0.7701	1122878.	-39321.	0.01346	40952.	9.44E+09	214.7008	46.8398	0.00
1.4140	-0.7678	1115363.	-39284.	0.01348	40782.	9.44E+09	217.0359	47.4889	0.00
1.4280	-0.7655	1107853.	-39248.	0.01350	40613.	9.44E+09	219.3666	48.1410	0.00
1.4420	-0.7633	1100347.	-39211.	0.01352	40443.	9.44E+09	221.6924	48.7961	0.00
1.4560	-0.7610	1092847.	-39173.	0.01354	40274.	9.44E+09	224.0132	49.4542	0.00
1.4700	-0.7587	1085351.	-39135.	0.01356	40105.	9.44E+09	226.3287	50.1154	0.00
1.4840	-0.7564	1077861.	-39097.	0.01358	39936.	9.44E+09	228.6387	50.7795	0.00
1.4980	-0.7542	1070376.	-39058.	0.01360	39767.	9.44E+09	230.9430	51.4465	0.00
1.5120	-0.7519	1062896.	-39019.	0.01362	39598.	9.44E+09	233.2412	52.1165	0.00
1.5260	-0.7496	1055421.	-38980.	0.01364	39429.	9.44E+09	235.5332	52.7894	0.00
1.5400	-0.7473	1047952.	-38940.	0.01366	39261.	9.44E+09	237.8186	53.4652	0.00
1.5540	-0.7450	1040488.	-38900.	0.01368	39092.	9.44E+09	240.0973	54.1438	0.00
1.5680	-0.7427	1033029.	-38860.	0.01369	38924.	9.44E+09	242.3691	54.8253	0.00
1.5820	-0.7404	1025576.	-38819.	0.01371	38756.	9.44E+09	244.6336	55.5096	0.00
1.5960	-0.7381	1018129.	-38777.	0.01373	38588.	9.44E+09	246.8906	56.1967	0.00
1.6100	-0.7358	1010688.	-38736.	0.01375	38420.	9.44E+09	249.1398	56.8866	0.00
1.6240	-0.7335	1003252.	-38694.	0.01377	38252.	9.44E+09	251.3811	57.5792	0.00
1.6380	-0.7311	995823.	-38651.	0.01378	38084.	9.44E+09	253.6142	58.2746	0.00
1.6520	-0.7288	988399.	-38609.	0.01380	37916.	9.44E+09	255.8388	58.9727	0.00
1.6660	-0.7265	980981.	-38565.	0.01382	37749.	9.44E+09	258.0547	59.6734	0.00
1.6800	-0.7242	973570.	-38522.	0.01384	37582.	9.44E+09	260.2616	60.3768	0.00
1.6940	-0.7219	966164.	-38478.	0.01385	37415.	9.44E+09	262.4593	61.0829	0.00
1.7080	-0.7195	958765.	-38434.	0.01387	37248.	9.44E+09	264.6476	61.7915	0.00
1.7220	-0.7172	951372.	-38389.	0.01389	37081.	9.44E+09	266.8262	62.5027	0.00
1.7360	-0.7149	943986.	-38344.	0.01391	36914.	9.44E+09	268.9948	63.2165	0.00
1.7500	-0.7125	936606.	-38299.	0.01392	36747.	9.44E+09	271.1532	63.9328	0.00
1.7640	-0.7102	929232.	-38253.	0.01394	36581.	9.44E+09	273.3012	64.6516	0.00
1.7780	-0.7078	921865.	-38207.	0.01396	36415.	9.44E+09	275.4385	65.3729	0.00
1.7920	-0.7055	914505.	-38160.	0.01397	36248.	9.44E+09	277.5649	66.0967	0.00

1.8060	-0.7031	907152.	-38114.	0.01399	36082.	9.44E+09	279.6801	66.8228	0.00
1.8200	-0.7008	899805.	-38066.	0.01400	35917.	9.44E+09	281.7839	67.5513	0.00
1.8340	-0.6984	892465.	-38019.	0.01402	35751.	9.44E+09	283.8760	68.2822	0.00
1.8480	-0.6961	885132.	-37971.	0.01404	35585.	9.44E+09	286.1635	69.0655	0.00
1.8620	-0.6937	877806.	-37923.	0.01405	35420.	9.44E+09	288.4981	69.8658	0.00
1.8760	-0.6914	870488.	-37874.	0.01407	35255.	9.44E+09	290.8265	70.6702	0.00
1.8900	-0.6890	863176.	-37825.	0.01408	35090.	9.44E+09	293.1485	71.4789	0.00
1.9040	-0.6866	855871.	-37776.	0.01410	34925.	9.44E+09	295.4639	72.2919	0.00
1.9180	-0.6843	848574.	-37726.	0.01411	34760.	9.44E+09	297.7725	73.1091	0.00
1.9320	-0.6819	841285.	-37675.	0.01413	34596.	9.44E+09	300.0742	73.9305	0.00
1.9460	-0.6795	834002.	-37625.	0.01414	34431.	9.44E+09	302.3687	74.7561	0.00
1.9600	-0.6771	826728.	-37574.	0.01416	34267.	9.44E+09	304.6559	75.5860	0.00
1.9740	-0.6748	819461.	-37523.	0.01417	34103.	9.44E+09	306.9355	76.4202	0.00
1.9880	-0.6724	812201.	-37471.	0.01419	33939.	9.44E+09	309.2073	77.2585	0.00
2.0020	-0.6700	804949.	-37419.	0.01420	33776.	9.44E+09	311.4712	78.1012	0.00
2.0160	-0.6676	797705.	-37366.	0.01422	33612.	9.44E+09	313.7269	78.9481	0.00
2.0300	-0.6652	790469.	-37313.	0.01423	33449.	9.44E+09	315.9743	79.7992	0.00
2.0440	-0.6628	783241.	-37260.	0.01424	33285.	9.44E+09	318.2132	80.6546	0.00
2.0580	-0.6604	776021.	-37206.	0.01426	33123.	9.44E+09	320.4433	81.5143	0.00
2.0720	-0.6580	768810.	-37152.	0.01427	32960.	9.44E+09	322.6645	82.3783	0.00
2.0860	-0.6556	761606.	-37098.	0.01428	32797.	9.44E+09	324.8765	83.2465	0.00
2.1000	-0.6532	754410.	-37043.	0.01430	32635.	9.44E+09	327.0793	84.1189	0.00
2.1140	-0.6508	747223.	-36988.	0.01431	32472.	9.44E+09	329.2725	84.9957	0.00
2.1280	-0.6484	740045.	-36932.	0.01432	32310.	9.44E+09	331.4559	85.8767	0.00
2.1420	-0.6460	732874.	-36877.	0.01434	32149.	9.44E+09	333.6295	86.7620	0.00
2.1560	-0.6436	725712.	-36820.	0.01435	31987.	9.44E+09	335.7929	87.6516	0.00
2.1700	-0.6412	718559.	-36764.	0.01436	31825.	9.44E+09	337.9460	88.5455	0.00
2.1840	-0.6388	711415.	-36707.	0.01438	31664.	9.44E+09	340.0886	89.4436	0.00
2.1980	-0.6364	704279.	-36650.	0.01439	31503.	9.44E+09	342.2205	90.3460	0.00
2.2120	-0.6339	697152.	-36592.	0.01440	31342.	9.44E+09	344.3414	91.2528	0.00
2.2260	-0.6315	690034.	-36534.	0.01441	31182.	9.44E+09	346.4513	92.1638	0.00
2.2400	-0.6291	682925.	-36475.	0.01443	31021.	9.44E+09	348.5499	93.0791	0.00
2.2540	-0.6267	675825.	-36417.	0.01444	30861.	9.44E+09	350.6369	93.9987	0.00
2.2680	-0.6243	668734.	-36358.	0.01445	30701.	9.44E+09	352.7122	94.9226	0.00
2.2820	-0.6218	661652.	-36298.	0.01446	30541.	9.44E+09	354.7757	95.8509	0.00
2.2960	-0.6194	654580.	-36238.	0.01447	30381.	9.44E+09	356.8270	96.7834	0.00
2.3100	-0.6170	647516.	-36178.	0.01449	30222.	9.44E+09	358.8661	97.7202	0.00
2.3240	-0.6145	640462.	-36118.	0.01450	30063.	9.44E+09	360.8926	98.6614	0.00
2.3380	-0.6121	633418.	-36057.	0.01451	29904.	9.44E+09	362.9065	99.6069	0.00
2.3520	-0.6097	626383.	-35996.	0.01452	29745.	9.44E+09	364.9074	100.5566	0.00
2.3660	-0.6072	619357.	-35934.	0.01453	29586.	9.44E+09	366.8953	101.5107	0.00
2.3800	-0.6048	612341.	-35873.	0.01454	29428.	9.44E+09	368.8699	102.4692	0.00
2.3940	-0.6023	605335.	-35811.	0.01455	29270.	9.44E+09	370.8310	103.4319	0.00
2.4080	-0.5999	598338.	-35748.	0.01456	29112.	9.44E+09	372.7784	104.3990	0.00
2.4220	-0.5974	591351.	-35685.	0.01457	28954.	9.44E+09	374.7119	105.3704	0.00
2.4360	-0.5950	584375.	-35622.	0.01458	28797.	9.44E+09	376.6313	106.3461	0.00
2.4500	-0.5925	577408.	-35559.	0.01459	28639.	9.44E+09	378.5469	107.3291	0.00
2.4640	-0.5901	570451.	-35495.	0.01460	28482.	9.44E+09	380.6148	108.3640	0.00
2.4780	-0.5876	563504.	-35431.	0.01461	28325.	9.44E+09	382.6713	109.4045	0.00
2.4920	-0.5852	556567.	-35366.	0.01462	28169.	9.44E+09	384.7162	110.4508	0.00
2.5060	-0.5827	549640.	-35302.	0.01463	28013.	9.44E+09	386.7494	111.5029	0.00
2.5200	-0.5803	542724.	-35236.	0.01464	27856.	9.44E+09	388.7707	112.5607	0.00
2.5340	-0.5778	535818.	-35171.	0.01465	27701.	9.44E+09	390.7799	113.6244	0.00
2.5480	-0.5753	528922.	-35105.	0.01466	27545.	9.44E+09	392.7768	114.6938	0.00

2.5620	-0.5729	522037.	-35039.	0.01467	27389.	9.44E+09	394.7613	115.7692	0.00
2.5760	-0.5704	515162.	-34972.	0.01468	27234.	9.44E+09	396.7332	116.8504	0.00
2.5900	-0.5679	508298.	-34906.	0.01469	27079.	9.44E+09	398.6922	117.9376	0.00
2.6040	-0.5655	501445.	-34839.	0.01470	26925.	9.44E+09	400.6383	119.0307	0.00
2.6180	-0.5630	494602.	-34771.	0.01471	26770.	9.44E+09	402.5712	120.1298	0.00
2.6320	-0.5605	487770.	-34703.	0.01472	26616.	9.44E+09	404.4908	121.2349	0.00
2.6460	-0.5580	480949.	-34635.	0.01473	26462.	9.44E+09	406.0297	122.2355	0.00
2.6600	-0.5556	474139.	-34567.	0.01473	26308.	9.44E+09	406.9415	123.0557	0.00
2.6740	-0.5531	467339.	-34498.	0.01474	26155.	9.44E+09	407.8285	123.8760	0.00
2.6880	-0.5506	460551.	-34430.	0.01475	26002.	9.44E+09	408.6906	124.6964	0.00
2.7020	-0.5481	453773.	-34361.	0.01476	25849.	9.44E+09	409.5277	125.5169	0.00
2.7160	-0.5457	447007.	-34292.	0.01477	25696.	9.44E+09	410.3397	126.3374	0.00
2.7300	-0.5432	440252.	-34223.	0.01478	25543.	9.44E+09	411.1264	127.1580	0.00
2.7440	-0.5407	433507.	-34154.	0.01478	25391.	9.44E+09	411.8879	127.9785	0.00
2.7580	-0.5382	426774.	-34085.	0.01479	25239.	9.44E+09	412.6239	128.7989	0.00
2.7720	-0.5357	420052.	-34015.	0.01480	25087.	9.44E+09	413.3343	129.6193	0.00
2.7860	-0.5332	413341.	-33946.	0.01481	24936.	9.44E+09	414.0191	130.4395	0.00
2.8000	-0.5307	406641.	-33876.	0.01481	24785.	9.44E+09	414.6782	131.2596	0.00
2.8140	-0.5283	399953.	-33807.	0.01482	24634.	9.44E+09	415.3114	132.0795	0.00
2.8280	-0.5258	393276.	-33737.	0.01483	24483.	9.44E+09	415.9187	132.8991	0.00
2.8420	-0.5233	386610.	-33667.	0.01483	24332.	9.44E+09	416.4999	133.7185	0.00
2.8560	-0.5208	379955.	-33597.	0.01484	24182.	9.44E+09	417.0550	134.5376	0.00
2.8700	-0.5183	373311.	-33527.	0.01485	24032.	9.44E+09	417.5839	135.3564	0.00
2.8840	-0.5158	366679.	-33457.	0.01485	23883.	9.44E+09	418.0864	136.1748	0.00
2.8980	-0.5133	360059.	-33386.	0.01486	23733.	9.44E+09	418.5626	136.9929	0.00
2.9120	-0.5108	353449.	-33316.	0.01487	23584.	9.44E+09	419.0122	137.8105	0.00
2.9260	-0.5083	346851.	-33246.	0.01487	23435.	9.44E+09	419.4353	138.6276	0.00
2.9400	-0.5058	340265.	-33175.	0.01488	23286.	9.44E+09	419.8316	139.4442	0.00
2.9540	-0.5033	333690.	-33104.	0.01489	23138.	9.44E+09	420.2012	140.2603	0.00
2.9680	-0.5008	327126.	-33034.	0.01489	22990.	9.44E+09	420.5440	141.0758	0.00
2.9820	-0.4983	320574.	-32963.	0.01490	22842.	9.44E+09	420.8598	141.8907	0.00
2.9960	-0.4958	314033.	-32892.	0.01490	22694.	9.44E+09	421.1487	142.7050	0.00
3.0100	-0.4933	307504.	-32822.	0.01491	22547.	9.44E+09	421.4104	143.5185	0.00
3.0240	-0.4908	300986.	-32751.	0.01491	22400.	9.44E+09	421.6450	144.3314	0.00
3.0380	-0.4883	294480.	-32680.	0.01492	22253.	9.44E+09	421.8523	145.1434	0.00
3.0520	-0.4858	287986.	-32609.	0.01492	22106.	9.44E+09	422.0324	145.9547	0.00
3.0660	-0.4833	281503.	-32538.	0.01493	21960.	9.44E+09	422.3781	146.8322	0.00
3.0800	-0.4808	275031.	-32467.	0.01493	21814.	9.44E+09	423.1007	147.8509	0.00
3.0940	-0.4783	268572.	-32396.	0.01494	21668.	9.44E+09	423.7993	148.8721	0.00
3.1080	-0.4757	262124.	-32325.	0.01494	21523.	9.44E+09	424.4738	149.8958	0.00
3.1220	-0.4732	255687.	-32253.	0.01495	21377.	9.44E+09	425.1240	150.9219	0.00
3.1360	-0.4707	249262.	-32182.	0.01495	21232.	9.44E+09	425.7498	151.9506	0.00
3.1500	-0.4682	242849.	-32110.	0.01496	21087.	9.44E+09	426.3509	152.9817	0.00
3.1640	-0.4657	236448.	-32039.	0.01496	20943.	9.44E+09	426.9273	154.0152	0.00
3.1780	-0.4632	230058.	-31967.	0.01497	20799.	9.44E+09	427.4789	155.0512	0.00
3.1920	-0.4607	223681.	-31895.	0.01497	20655.	9.44E+09	428.0054	156.0896	0.00
3.2060	-0.4581	217315.	-31823.	0.01497	20511.	9.44E+09	428.5068	157.1303	0.00
3.2200	-0.4556	210960.	-31751.	0.01498	20368.	9.44E+09	428.9829	158.1735	0.00
3.2340	-0.4531	204618.	-31679.	0.01498	20224.	9.44E+09	429.4335	159.2191	0.00
3.2480	-0.4506	198288.	-31607.	0.01498	20082.	9.44E+09	429.8585	160.2670	0.00
3.2620	-0.4481	191969.	-31535.	0.01499	19939.	9.44E+09	430.2578	161.3172	0.00
3.2760	-0.4456	185663.	-31462.	0.01499	19797.	9.44E+09	430.6312	162.3697	0.00
3.2900	-0.4430	179368.	-31390.	0.01499	19655.	9.44E+09	430.9786	163.4246	0.00
3.3040	-0.4405	173085.	-31317.	0.01500	19513.	9.44E+09	431.2999	164.4818	0.00

3.3180	-0.4380	166814.	-31245.	0.01500	19371.	9.44E+09	431.5949	165.5412	0.00
3.3320	-0.4355	160556.	-31172.	0.01500	19230.	9.44E+09	431.8634	166.6029	0.00
3.3460	-0.4330	154309.	-31100.	0.01501	19089.	9.44E+09	432.1054	167.6668	0.00
3.3600	-0.4304	148074.	-31027.	0.01501	18948.	9.44E+09	432.3207	168.7330	0.00
3.3740	-0.4279	141851.	-30955.	0.01501	18808.	9.44E+09	432.5092	169.8013	0.00
3.3880	-0.4254	135641.	-30882.	0.01501	18667.	9.44E+09	432.6707	170.8719	0.00
3.4020	-0.4229	129442.	-30809.	0.01502	18528.	9.44E+09	432.8050	171.9446	0.00
3.4160	-0.4204	123255.	-30736.	0.01502	18388.	9.44E+09	432.9122	173.0194	0.00
3.4300	-0.4178	117081.	-30664.	0.01502	18249.	9.44E+09	432.9919	174.0964	0.00
3.4440	-0.4153	110918.	-30591.	0.01502	18109.	9.44E+09	433.0442	175.1755	0.00
3.4580	-0.4128	104768.	-30518.	0.01503	17971.	9.44E+09	433.0688	176.2567	0.00
3.4720	-0.4103	98630.	-30445.	0.01503	17832.	9.44E+09	433.0656	177.3399	0.00
3.4860	-0.4077	92504.	-30373.	0.01503	17694.	9.44E+09	433.0345	178.4252	0.00
3.5000	-0.4052	86389.	-30300.	0.01503	17556.	9.44E+09	432.9754	179.5125	0.00
3.5140	-0.4027	80288.	-30227.	0.01503	17418.	9.44E+09	432.8882	180.6018	0.00
3.5280	-0.4002	74198.	-30155.	0.01503	17281.	9.44E+09	432.7726	181.6931	0.00
3.5420	-0.3976	68120.	-30082.	0.01503	17143.	9.44E+09	432.6286	182.7863	0.00
3.5560	-0.3951	62054.	-30009.	0.01504	17006.	9.44E+09	432.4561	183.8815	0.00
3.5700	-0.3926	56001.	-29937.	0.01504	16870.	9.44E+09	432.2548	184.9786	0.00
3.5840	-0.3901	49960.	-29864.	0.01504	16733.	9.44E+09	432.0248	186.0775	0.00
3.5980	-0.3875	43931.	-29791.	0.01504	16597.	9.44E+09	431.7658	187.1783	0.00
3.6120	-0.3850	37914.	-29719.	0.01504	16462.	9.44E+09	431.4778	188.2810	0.00
3.6260	-0.3825	31909.	-29646.	0.01504	16326.	9.44E+09	431.1605	189.3854	0.00
3.6400	-0.3799	25916.	-29574.	0.01504	16191.	9.44E+09	430.8140	190.4916	0.00
3.6540	-0.3774	19935.	-29502.	0.01504	16056.	9.44E+09	430.4380	191.5996	0.00
3.6680	-0.3749	13967.	-29429.	0.01504	15921.	9.44E+09	430.0325	192.7093	0.00
3.6820	-0.3724	8010.	-29357.	0.01504	15787.	9.44E+09	430.0888	194.0424	0.00
3.6960	-0.3698	2066.	-29285.	0.01504	15652.	9.44E+09	430.4620	195.5378	0.00
3.7100	-0.3673	-3866.	-29212.	0.01504	15693.	9.44E+09	430.8106	197.0424	0.00
3.7240	-0.3648	-9786.	-29140.	0.01504	15827.	9.44E+09	431.1344	198.5564	0.00
3.7380	-0.3623	-15694.	-29068.	0.01504	15960.	9.44E+09	431.4331	200.0800	0.00
3.7520	-0.3597	-21589.	-28995.	0.01504	16093.	9.44E+09	431.7066	201.6131	0.00
3.7660	-0.3572	-27473.	-28923.	0.01504	16226.	9.44E+09	431.9547	203.1560	0.00
3.7800	-0.3547	-33344.	-28850.	0.01504	16358.	9.44E+09	432.1773	204.7087	0.00
3.7940	-0.3522	-39203.	-28777.	0.01504	16491.	9.44E+09	432.3742	206.2713	0.00
3.8080	-0.3496	-45050.	-28705.	0.01504	16623.	9.44E+09	432.5451	207.8440	0.00
3.8220	-0.3471	-50884.	-28632.	0.01504	16754.	9.44E+09	432.6899	209.4269	0.00
3.8360	-0.3446	-56706.	-28559.	0.01504	16886.	9.44E+09	432.8085	211.0201	0.00
3.8500	-0.3420	-62516.	-28487.	0.01504	17017.	9.44E+09	432.9006	212.6237	0.00
3.8640	-0.3395	-68314.	-28414.	0.01503	17148.	9.44E+09	432.9661	214.2379	0.00
3.8780	-0.3370	-74099.	-28341.	0.01503	17278.	9.44E+09	433.0048	215.8628	0.00
3.8920	-0.3345	-79872.	-28268.	0.01503	17409.	9.44E+09	433.0165	217.4986	0.00
3.9060	-0.3319	-85632.	-28196.	0.01503	17539.	9.44E+09	433.0011	219.1453	0.00
3.9200	-0.3294	-91381.	-28123.	0.01503	17668.	9.44E+09	432.9583	220.8032	0.00
3.9340	-0.3269	-97117.	-28050.	0.01503	17798.	9.44E+09	432.8880	222.4723	0.00
3.9480	-0.3244	-102840.	-27977.	0.01502	17927.	9.44E+09	432.7901	224.1529	0.00
3.9620	-0.3218	-108551.	-27905.	0.01502	18056.	9.44E+09	432.6642	225.8451	0.00
3.9760	-0.3193	-114250.	-27832.	0.01502	18185.	9.44E+09	432.5104	227.5491	0.00
3.9900	-0.3168	-119937.	-27759.	0.01502	18313.	9.44E+09	432.3283	229.2650	0.00
4.0040	-0.3143	-125611.	-27687.	0.01502	18441.	9.44E+09	431.9006	230.8770	0.00
4.0180	-0.3118	-131273.	-27614.	0.01501	18569.	9.44E+09	430.9038	232.2080	0.00
4.0320	-0.3092	-136923.	-27542.	0.01501	18696.	9.44E+09	429.8750	233.5431	0.00
4.0460	-0.3067	-142560.	-27470.	0.01501	18824.	9.44E+09	428.8143	234.8823	0.00
4.0600	-0.3042	-148185.	-27398.	0.01501	18951.	9.44E+09	427.7216	236.2258	0.00

4.0740	-0.3017	-153798.	-27326.	0.01500	19077.	9.44E+09	426.5970	237.5736	0.00
4.0880	-0.2991	-159398.	-27255.	0.01500	19204.	9.44E+09	425.4406	238.9258	0.00
4.1020	-0.2966	-164987.	-27183.	0.01500	19330.	9.44E+09	424.2523	240.2826	0.00
4.1160	-0.2941	-170563.	-27112.	0.01500	19456.	9.44E+09	423.0322	241.6442	0.00
4.1300	-0.2916	-176127.	-27041.	0.01499	19581.	9.44E+09	421.7805	243.0105	0.00
4.1440	-0.2891	-181679.	-26970.	0.01499	19707.	9.44E+09	420.4970	244.3818	0.00
4.1580	-0.2866	-187219.	-26900.	0.01499	19832.	9.44E+09	419.1818	245.7581	0.00
4.1720	-0.2840	-192747.	-26830.	0.01498	19957.	9.44E+09	417.8351	247.1397	0.00
4.1860	-0.2815	-198262.	-26759.	0.01498	20081.	9.44E+09	416.4568	248.5267	0.00
4.2000	-0.2790	-203766.	-26690.	0.01498	20205.	9.44E+09	415.0470	249.9192	0.00
4.2140	-0.2765	-209258.	-26620.	0.01497	20329.	9.44E+09	413.6058	251.3174	0.00
4.2280	-0.2740	-214738.	-26551.	0.01497	20453.	9.44E+09	412.1332	252.7214	0.00
4.2420	-0.2715	-220206.	-26482.	0.01496	20576.	9.44E+09	410.6293	254.1315	0.00
4.2560	-0.2689	-225662.	-26413.	0.01496	20699.	9.44E+09	409.0942	255.5478	0.00
4.2700	-0.2664	-231106.	-26344.	0.01496	20822.	9.44E+09	407.5278	256.9705	0.00
4.2840	-0.2639	-236539.	-26276.	0.01495	20945.	9.44E+09	405.9304	258.3998	0.00
4.2980	-0.2614	-241959.	-26208.	0.01495	21067.	9.44E+09	404.3018	259.8359	0.00
4.3120	-0.2589	-247368.	-26140.	0.01494	21189.	9.44E+09	402.6423	261.2791	0.00
4.3260	-0.2564	-252766.	-26072.	0.01494	21311.	9.44E+09	400.9519	262.7295	0.00
4.3400	-0.2539	-258152.	-26005.	0.01493	21433.	9.44E+09	399.2307	264.1874	0.00
4.3540	-0.2514	-263526.	-25938.	0.01493	21554.	9.44E+09	397.4767	265.6517	0.00
4.3680	-0.2489	-268889.	-25872.	0.01493	21675.	9.44E+09	395.6825	267.1175	0.00
4.3820	-0.2464	-274240.	-25805.	0.01492	21796.	9.44E+09	393.8472	268.5843	0.00
4.3960	-0.2438	-279579.	-25739.	0.01492	21917.	9.44E+09	391.9708	270.0520	0.00
4.4100	-0.2413	-284908.	-25674.	0.01491	22037.	9.44E+09	390.0531	271.5205	0.00
4.4240	-0.2388	-290225.	-25608.	0.01491	22157.	9.44E+09	388.0943	272.9899	0.00
4.4380	-0.2363	-295530.	-25543.	0.01490	22277.	9.44E+09	386.0940	274.4600	0.00
4.4520	-0.2338	-300825.	-25479.	0.01489	22396.	9.44E+09	384.0524	275.9308	0.00
4.4660	-0.2313	-306108.	-25414.	0.01489	22515.	9.44E+09	381.9693	277.4023	0.00
4.4800	-0.2288	-311380.	-25350.	0.01488	22634.	9.44E+09	379.8447	278.8743	0.00
4.4940	-0.2263	-316641.	-25287.	0.01488	22753.	9.44E+09	377.6786	280.3469	0.00
4.5080	-0.2238	-321891.	-25223.	0.01487	22872.	9.44E+09	375.4708	281.8199	0.00
4.5220	-0.2213	-327130.	-25160.	0.01487	22990.	9.44E+09	373.2214	283.2934	0.00
4.5360	-0.2188	-332358.	-25098.	0.01486	23108.	9.44E+09	370.9303	284.7672	0.00
4.5500	-0.2163	-337575.	-25036.	0.01486	23226.	9.44E+09	368.5975	286.2414	0.00
4.5640	-0.2138	-342782.	-24974.	0.01485	23343.	9.44E+09	366.2230	287.7158	0.00
4.5780	-0.2113	-347977.	-24913.	0.01484	23460.	9.44E+09	363.8067	289.1904	0.00
4.5920	-0.2089	-353162.	-24852.	0.01484	23578.	9.44E+09	361.3486	290.6652	0.00
4.6060	-0.2064	-358336.	-24791.	0.01483	23694.	9.44E+09	358.8487	292.1401	0.00
4.6200	-0.2039	-363500.	-24731.	0.01482	23811.	9.44E+09	356.3070	293.6150	0.00
4.6340	-0.2014	-368653.	-24672.	0.01482	23927.	9.44E+09	353.7235	295.0900	0.00
4.6480	-0.1989	-373796.	-24612.	0.01481	24043.	9.44E+09	351.0982	296.5650	0.00
4.6620	-0.1964	-378929.	-24554.	0.01480	24159.	9.44E+09	348.4311	298.0399	0.00
4.6760	-0.1939	-384051.	-24495.	0.01480	24275.	9.44E+09	345.7222	299.5146	0.00
4.6900	-0.1914	-389163.	-24437.	0.01479	24390.	9.44E+09	342.9715	300.9893	0.00
4.7040	-0.1889	-394265.	-24380.	0.01478	24505.	9.44E+09	340.1792	302.4637	0.00
4.7180	-0.1865	-399356.	-24323.	0.01478	24620.	9.44E+09	337.3451	303.9380	0.00
4.7320	-0.1840	-404438.	-24267.	0.01477	24735.	9.44E+09	334.4694	305.4120	0.00
4.7460	-0.1815	-409510.	-24211.	0.01476	24849.	9.44E+09	331.5520	306.8858	0.00
4.7600	-0.1790	-414572.	-24155.	0.01475	24964.	9.44E+09	328.5931	308.3593	0.00
4.7740	-0.1765	-419624.	-24100.	0.01475	25078.	9.44E+09	325.5927	309.8325	0.00
4.7880	-0.1741	-424666.	-24046.	0.01474	25192.	9.44E+09	322.5509	311.3055	0.00
4.8020	-0.1716	-429699.	-23992.	0.01473	25305.	9.44E+09	319.4677	312.7782	0.00
4.8160	-0.1691	-434722.	-23939.	0.01472	25419.	9.44E+09	316.3432	314.2505	0.00

4.8300	-0.1666	-439736.	-23886.	0.01472	25532.	9.44E+09	313.1775	315.7227	0.00
4.8440	-0.1642	-444741.	-23833.	0.01471	25645.	9.44E+09	309.9708	317.1946	0.00
4.8580	-0.1617	-449736.	-23782.	0.01470	25757.	9.44E+09	306.7230	318.6662	0.00
4.8720	-0.1592	-454722.	-23730.	0.01469	25870.	9.44E+09	303.4344	320.1377	0.00
4.8860	-0.1568	-459699.	-23680.	0.01468	25982.	9.44E+09	300.1051	321.6091	0.00
4.9000	-0.1543	-464667.	-23629.	0.01468	26094.	9.44E+09	296.8837	323.2423	0.00
4.9140	-0.1518	-469626.	-23580.	0.01467	26206.	9.44E+09	294.7325	326.1097	0.00
4.9280	-0.1494	-474576.	-23530.	0.01466	26318.	9.44E+09	292.5436	329.0262	0.00
4.9420	-0.1469	-479517.	-23481.	0.01465	26430.	9.44E+09	290.3165	331.9936	0.00
4.9560	-0.1444	-484449.	-23433.	0.01464	26541.	9.44E+09	288.0509	335.0141	0.00
4.9700	-0.1420	-489373.	-23385.	0.01463	26652.	9.44E+09	285.7465	338.0899	0.00
4.9840	-0.1395	-494288.	-23337.	0.01463	26763.	9.44E+09	283.4029	341.2234	0.00
4.9980	-0.1371	-499195.	-23289.	0.01462	26874.	9.44E+09	281.0198	344.4170	0.00
5.0120	-0.1346	-504093.	-23261.	0.01461	0.00	1.12E+10	58.4719	72.9697	0.00
5.0260	-0.1322	-508988.	-23251.	0.01460	0.00	1.12E+10	58.6619	74.5659	0.00
5.0400	-0.1297	-513882.	-23241.	0.01459	0.00	1.11E+10	58.8529	76.2229	0.00
5.0540	-0.1273	-518773.	-23231.	0.01458	0.00	1.11E+10	59.0448	77.9441	0.00
5.0680	-0.1248	-523663.	-23221.	0.01458	0.00	1.10E+10	59.2376	79.7333	0.00
5.0820	-0.1224	-528550.	-23211.	0.01457	0.00	1.10E+10	59.4314	81.5947	0.00
5.0960	-0.1199	-533434.	-23201.	0.01456	0.00	1.09E+10	59.6263	83.5327	0.00
5.1100	-0.1175	-538317.	-23191.	0.01455	0.00	1.09E+10	59.8223	85.5520	0.00
5.1240	-0.1150	-543197.	-23181.	0.01454	0.00	1.08E+10	60.0196	87.6578	0.00
5.1380	-0.1126	-548075.	-23171.	0.01454	0.00	1.08E+10	60.2180	89.8558	0.00
5.1520	-0.1101	-552951.	-23161.	0.01453	0.00	1.07E+10	60.4178	92.1521	0.00
5.1660	-0.1077	-557825.	-23151.	0.01452	0.00	1.06E+10	60.6191	94.5535	0.00
5.1800	-0.1053	-562696.	-23141.	0.01451	0.00	1.05E+10	60.8218	97.0672	0.00
5.1940	-0.1028	-567565.	-23131.	0.01450	0.00	1.04E+10	61.0262	99.7013	0.00
5.2080	-0.1004	-572431.	-23120.	0.01449	0.00	1.04E+10	61.2323	102.4646	0.00
5.2220	-0.09796	-577295.	-23110.	0.01448	0.00	1.03E+10	61.4402	105.3668	0.00
5.2360	-0.09553	-582157.	-23100.	0.01447	0.00	1.02E+10	61.6501	108.4185	0.00
5.2500	-0.09310	-587016.	-23089.	0.01446	0.00	1.01E+10	61.8621	111.6316	0.00
5.2640	-0.09067	-591873.	-23079.	0.01445	0.00	9.94E+09	62.0765	115.0192	0.00
5.2780	-0.08824	-596728.	-23068.	0.01444	0.00	9.84E+09	62.2933	118.5957	0.00
5.2920	-0.08582	-601580.	-23058.	0.01443	0.00	9.73E+09	62.5128	122.3774	0.00
5.3060	-0.08339	-606430.	-23047.	0.01442	0.00	9.64E+09	62.7353	126.3823	0.00
5.3200	-0.08097	-611277.	-23037.	0.01441	0.00	9.58E+09	62.9610	130.6307	0.00
5.3340	-0.07855	-616121.	-23026.	0.01440	0.00	9.56E+09	63.1901	135.1455	0.00
5.3480	-0.07613	-620963.	-19690.	0.01439	0.00	9.58E+09	39655.	87505.	0.00
5.3620	-0.07372	-624686.	-13050.	0.01438	0.00	9.63E+09	39389.	89766.	0.00
5.3760	-0.07130	-627295.	-6455.	0.01437	0.00	9.71E+09	39125.	92184.	0.00
5.3900	-0.06889	-628800.	95.9236	0.01436	0.00	9.82E+09	38863.	94775.	0.00
5.4040	-0.06648	-629207.	6603.	0.01435	0.00	9.95E+09	38604.	97558.	0.00
5.4180	-0.06407	-628524.	13067.	0.01434	0.00	1.01E+10	38348.	100556.	0.00
5.4320	-0.06166	-626758.	19489.	0.01433	0.00	1.03E+10	38096.	103794.	0.00
5.4460	-0.05926	-623915.	25868.	0.01432	0.00	1.05E+10	37847.	107304.	0.00
5.4600	-0.05685	-620004.	32206.	0.01431	0.00	1.07E+10	37603.	111119.	0.00
5.4740	-0.05445	-615031.	38503.	0.01430	0.00	1.09E+10	37364.	115283.	0.00
5.4880	-0.05205	-609003.	44760.	0.01429	0.00	1.10E+10	37130.	119846.	0.00
5.5020	-0.04965	-601927.	50979.	0.01428	0.00	1.12E+10	36902.	124867.	0.00
5.5160	-0.04725	-593808.	57160.	0.01427	0.00	1.12E+10	36682.	130420.	0.00
5.5300	-0.04485	-584653.	63305.	0.01426	0.00	1.13E+10	36470.	136595.	0.00
5.5440	-0.04246	-574468.	69415.	0.01425	0.00	1.14E+10	36268.	143502.	0.00
5.5580	-0.04007	-563259.	75492.	0.01424	0.00	1.14E+10	36079.	151279.	0.00
5.5720	-0.03767	-551032.	81538.	0.01423	0.00	1.14E+10	35903.	160102.	0.00

5.5860	-0.03528	-537790.	87557.	0.01423	0.00	1.14E+10	35746.	170199.	0.00
5.6000	-0.03289	-523539.	93551.	0.01422	0.00	1.14E+10	35609.	181866.	0.00
5.6140	-0.03051	-508282.	99524.	0.01421	0.00	1.14E+10	35500.	195499.	0.00
5.6280	-0.02812	-492023.	105481.	0.01420	0.00	1.14E+10	35425.	211644.	0.00
5.6420	-0.02573	-474764.	111430.	0.01420	0.00	1.14E+10	35394.	231063.	0.00
5.6560	-0.02335	-456505.	117379.	0.01419	0.00	1.13E+10	35423.	254867.	0.00
5.6700	-0.02097	-437246.	123339.	0.01418	0.00	1.13E+10	35534.	284728.	0.00
5.6840	-0.01858	-416983.	129328.	0.01418	0.00	1.13E+10	35763.	323296.	0.00
5.6980	-0.01620	-395711.	135370.	0.01417	0.00	1.11E+10	36170.	375033.	0.00
5.7120	-0.01382	-373418.	141295.	0.01416	0.00	1.09E+10	34364.	417648.	0.00
5.7260	-0.01144	-350154.	146571.	0.01416	0.00	1.07E+10	28449.	417648.	0.00
5.7400	-0.00907	-326087.	150854.	0.01415	0.00	1.04E+10	22537.	417648.	0.00
5.7540	-0.00669	-301384.	154144.	0.01415	0.00	1.00E+10	16627.	417648.	0.00
5.7680	-0.00431	-276211.	156441.	0.01414	0.00	9.78E+09	10719.	417648.	0.00
5.7820	-0.00194	-250735.	157746.	0.01414	0.00	9.57E+09	4813.	417648.	0.00
5.7960	4.39E-04	-225123.	158058.	0.01413	0.00	9.43E+09	-1091.	417648.	0.00
5.8100	0.00281	-199541.	157379.	0.01413	0.00	9.37E+09	-6994.	417648.	0.00
5.8240	0.00519	-174157.	155708.	0.01413	0.00	9.36E+09	-12895.	417648.	0.00
5.8380	0.00756	-149136.	153046.	0.01412	0.00	9.36E+09	-18795.	417648.	0.00
5.8520	0.00993	-124646.	149393.	0.01412	0.00	9.36E+09	-24693.	417648.	0.00
5.8660	0.01231	-100852.	145110.	0.01412	0.00	9.36E+09	-26304.	359115.	0.00
5.8800	0.01468	-77801.	140612.	0.01412	0.00	9.36E+09	-27240.	311795.	0.00
5.8940	0.01705	-55518.	136174.	0.01412	0.00	9.36E+09	-25595.	252215.	0.00
5.9080	0.01942	-33958.	131977.	0.01412	0.00	9.36E+09	-24364.	210765.	0.00
5.9220	0.02179	-13085.	127919.	0.01654	0.00	-454399.	-23950.	184635.	0.00
5.9360	0.02498	6784.	123789.	0.01711	0.00	-308191.	-25220.	169638.	0.00
5.9500	0.02754	26192.	119417.	0.00597	0.00	-236808.	-26818.	163599.	0.00
5.9640	0.02698	46100.	114917.	-0.00332	0.00	9.36E+09	-26764.	166650.	0.00
5.9780	0.02642	65254.	110425.	-0.00332	0.00	9.36E+09	-26711.	169832.	0.00
5.9920	0.02586	83653.	105942.	-0.00332	0.00	9.36E+09	-26658.	173155.	0.00
6.0060	0.02531	101300.	101468.	-0.00332	0.00	9.36E+09	-26606.	176627.	0.00
6.0200	0.02475	118196.	97002.	-0.00332	0.00	9.37E+09	-26554.	180259.	0.00
6.0340	0.02419	134342.	92545.	-0.00332	0.00	9.37E+09	-26504.	184061.	0.00
6.0480	0.02363	149740.	88097.	-0.00331	0.00	9.41E+09	-26454.	188045.	0.00
6.0620	0.02308	164392.	83657.	-0.00331	0.00	9.45E+09	-26405.	192224.	0.00
6.0760	0.02252	178297.	79225.	-0.00331	0.00	9.51E+09	-26357.	196614.	0.00
6.0900	0.02197	191459.	74801.	-0.00330	0.00	9.60E+09	-26310.	201228.	0.00
6.1040	0.02141	203878.	70384.	-0.00330	0.00	9.67E+09	-26265.	206086.	0.00
6.1180	0.02086	215555.	65976.	-0.00330	0.00	9.78E+09	-26221.	211207.	0.00
6.1320	0.02030	226492.	61574.	-0.00329	0.00	9.89E+09	-26178.	216611.	0.00
6.1460	0.01975	236690.	57180.	-0.00329	0.00	9.98E+09	-26136.	222324.	0.00
6.1600	0.01920	246150.	52792.	-0.00329	0.00	1.01E+10	-26096.	228371.	0.00
6.1740	0.01865	254873.	48411.	-0.00328	0.00	1.02E+10	-26058.	234783.	0.00
6.1880	0.01809	262861.	44037.	-0.00328	0.00	1.02E+10	-26021.	241593.	0.00
6.2020	0.01754	270114.	39668.	-0.00327	0.00	1.03E+10	-25987.	248840.	0.00
6.2160	0.01699	276633.	35305.	-0.00327	0.00	1.04E+10	-25954.	256567.	0.00
6.2300	0.01645	282419.	30947.	-0.00326	0.00	1.04E+10	-25924.	264823.	0.00
6.2440	0.01590	287473.	26594.	-0.00326	0.00	1.04E+10	-25897.	273663.	0.00
6.2580	0.01535	291796.	22246.	-0.00326	0.00	1.05E+10	-25872.	283152.	0.00
6.2720	0.01480	295388.	17901.	-0.00325	0.00	1.05E+10	-25851.	293364.	0.00
6.2860	0.01426	298251.	13560.	-0.00325	0.00	1.05E+10	-25834.	304384.	0.00
6.3000	0.01371	300384.	9221.	-0.00324	0.00	1.05E+10	-25820.	316313.	0.00
6.3140	0.01317	301788.	4883.	-0.00324	0.00	1.05E+10	-25812.	329267.	0.00
6.3280	0.01263	302463.	547.4519	-0.00323	0.00	1.04E+10	-25808.	343386.	0.00

6.3420	0.01208	302409.	-3788.	-0.00323	0.00	1.04E+10	-25810.	358833.	0.00
6.3560	0.01154	301627.	-8125.	-0.00322	0.00	1.04E+10	-25820.	375805.	0.00
6.3700	0.01100	300115.	-12465.	-0.00322	0.00	1.03E+10	-25837.	394540.	0.00
6.3840	0.01046	297874.	-16807.	-0.00321	0.00	1.03E+10	-25863.	415329.	0.00
6.3980	0.00992	294903.	-21052.	-0.00321	0.00	1.02E+10	-24667.	417648.	0.00
6.4120	0.00938	291235.	-25084.	-0.00320	0.00	1.02E+10	-23329.	417648.	0.00
6.4260	0.00885	286908.	-28891.	-0.00320	0.00	1.01E+10	-21993.	417648.	0.00
6.4400	0.00831	281961.	-32473.	-0.00319	0.00	1.00E+10	-20658.	417648.	0.00
6.4540	0.00777	276430.	-35832.	-0.00319	0.00	9.99E+09	-19326.	417648.	0.00
6.4680	0.00724	270353.	-38967.	-0.00318	0.00	9.94E+09	-17996.	417648.	0.00
6.4820	0.00670	263768.	-41879.	-0.00318	0.00	9.88E+09	-16667.	417648.	0.00
6.4960	0.00617	256712.	-44567.	-0.00317	0.00	9.83E+09	-15341.	417648.	0.00
6.5100	0.00564	249223.	-47033.	-0.00317	0.00	9.77E+09	-14016.	417648.	0.00
6.5240	0.00511	241338.	-49277.	-0.00317	0.00	9.70E+09	-12693.	417648.	0.00
6.5380	0.00457	233095.	-51298.	-0.00316	0.00	9.66E+09	-11372.	417648.	0.00
6.5520	0.00404	224530.	-53098.	-0.00316	0.00	9.62E+09	-10052.	417648.	0.00
6.5660	0.00351	215681.	-54676.	-0.00315	0.00	9.59E+09	-8734.	417648.	0.00
6.5800	0.00298	206586.	-56033.	-0.00315	0.00	9.54E+09	-7418.	417648.	0.00
6.5940	0.00246	197281.	-57169.	-0.00315	0.00	9.50E+09	-6103.	417648.	0.00
6.6080	0.00193	187803.	-58084.	-0.00314	0.00	9.45E+09	-4790.	417648.	0.00
6.6220	0.00140	178190.	-58778.	-0.00314	0.00	9.43E+09	-3478.	417648.	0.00
6.6360	8.72E-04	168479.	-59252.	-0.00314	0.00	9.41E+09	-2167.	417648.	0.00
6.6500	3.45E-04	158706.	-59507.	-0.00313	0.00	9.39E+09	-857.9920	417648.	0.00
6.6640	-1.81E-04	148909.	-59541.	-0.00313	0.00	9.37E+09	450.1831	417648.	0.00
6.6780	-7.07E-04	139124.	-59355.	-0.00313	0.00	9.37E+09	1757.	417648.	0.00
6.6920	-0.00123	129389.	-58950.	-0.00313	0.00	9.37E+09	3063.	417648.	0.00
6.7060	-0.00176	119740.	-58326.	-0.00312	0.00	9.36E+09	4368.	417648.	0.00
6.7200	-0.00228	110214.	-57483.	-0.00312	0.00	9.36E+09	5672.	417648.	0.00
6.7340	-0.00281	100849.	-56420.	-0.00312	0.00	9.36E+09	6976.	417648.	0.00
6.7480	-0.00333	91680.	-55139.	-0.00312	0.00	9.36E+09	8278.	417648.	0.00
6.7620	-0.00385	82744.	-53639.	-0.00312	0.00	9.36E+09	9580.	417648.	0.00
6.7760	-0.00438	74079.	-51920.	-0.00312	0.00	9.36E+09	10882.	417648.	0.00
6.7900	-0.00490	65721.	-49983.	-0.00311	0.00	9.36E+09	12182.	417648.	0.00
6.8040	-0.00542	57706.	-47827.	-0.00311	0.00	9.36E+09	13482.	417648.	0.00
6.8180	-0.00595	50072.	-45453.	-0.00311	0.00	9.36E+09	14782.	417648.	0.00
6.8320	-0.00647	42856.	-42860.	-0.00311	0.00	9.36E+09	16082.	417648.	0.00
6.8460	-0.00699	36093.	-40049.	-0.00311	0.00	9.36E+09	17381.	417648.	0.00
6.8600	-0.00751	29820.	-37020.	-0.00311	0.00	9.36E+09	18680.	417648.	0.00
6.8740	-0.00804	24075.	-33773.	-0.00311	0.00	9.36E+09	19978.	417648.	0.00
6.8880	-0.00856	18894.	-30308.	-0.00311	0.00	9.36E+09	21277.	417648.	0.00
6.9020	-0.00908	14313.	-26657.	-0.00311	0.00	9.36E+09	22178.	410314.	0.00
6.9160	-0.00960	10358.	-22918.	-0.00311	0.00	9.36E+09	22332.	390686.	0.00
6.9300	-0.01013	7033.	-19155.	-0.00311	0.00	9.36E+09	22477.	372942.	0.00
6.9440	-0.01065	4343.	-15367.	-0.00311	0.00	9.36E+09	22614.	356824.	0.00
6.9580	-0.01117	2290.	-11557.	-0.00311	0.00	9.36E+09	22745.	342117.	0.00
6.9720	-0.01169	880.3073	-7725.	-0.00311	0.00	9.36E+09	22871.	328645.	0.00
6.9860	-0.01221	115.6924	-3872.	-0.00311	0.00	9.36E+09	22992.	316257.	0.00
7.0000	-0.01274	0.00	0.00	-0.00311	0.00	9.36E+09	23108.	152414.	0.00

Lateral toe displacement of the internal H-pile core within the peastone-filled shaft

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the

magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 2:

Pile-head deflection = -0.97500000 inches
Computed slope at pile head = 0.00492834 radians
Maximum bending moment = 1885473. inch-lbs
Maximum shear force = 158058. lbs
Depth of maximum bending moment = 0.000000 feet below pile head
Depth of maximum shear force = 5.79600000 feet below pile head
Number of iterations = 14
Number of zero deflection points = 2

Summary of Pile-head Responses for Conventional Analyses

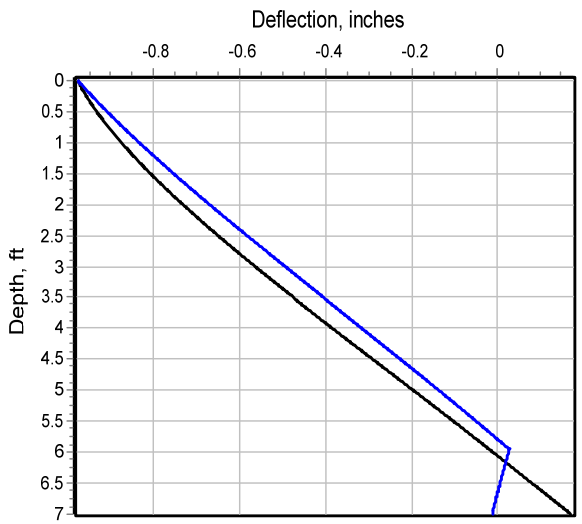
Definitions of Pile-head Loading Conditions:

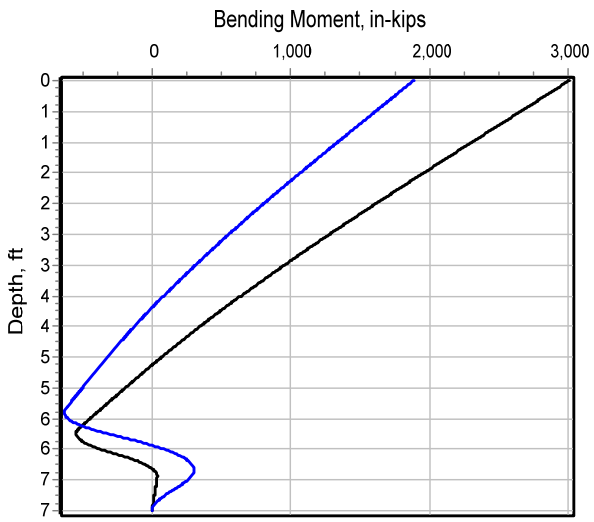
Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

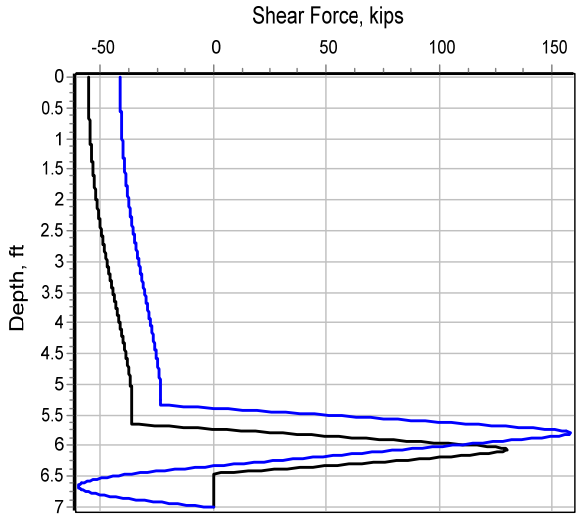
Load Case No.	Load Type	Load 1 Pile-head	Load Type	Load 2 Pile-head	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	y, in	-0.9750	S, rad	0.00	403000.	-0.9750	0.00	129940.	3006528.
2	y, in	-0.9750	M, in-lb	1885473.	403000.	-0.9750	0.00493	158058.	1885473.

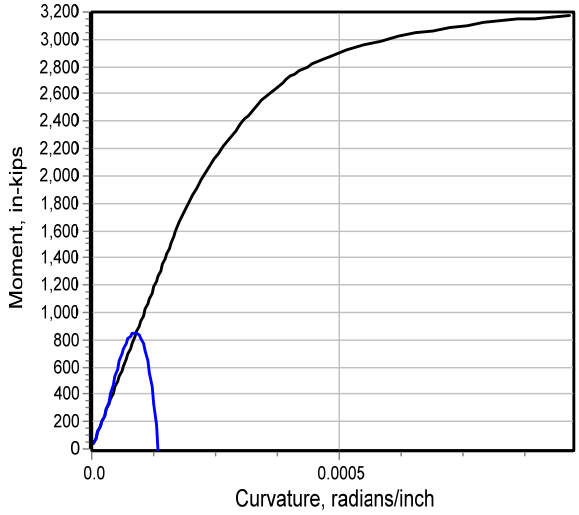
Maximum pile-head deflection = -0.9750000000 inches
Maximum pile-head rotation = 0.0049283353 radians = 0.282373 deg.

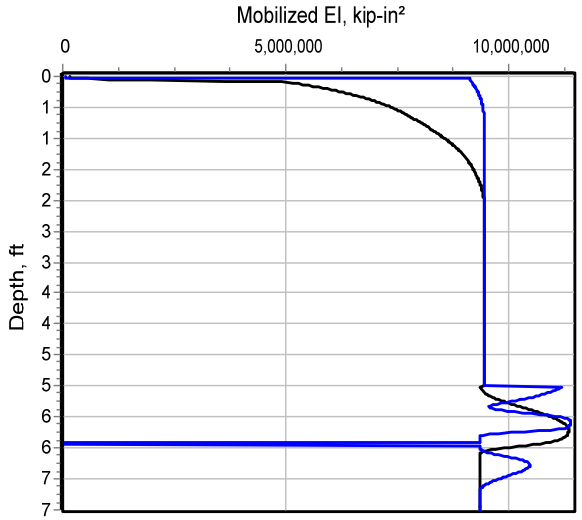
The analysis ended normally.

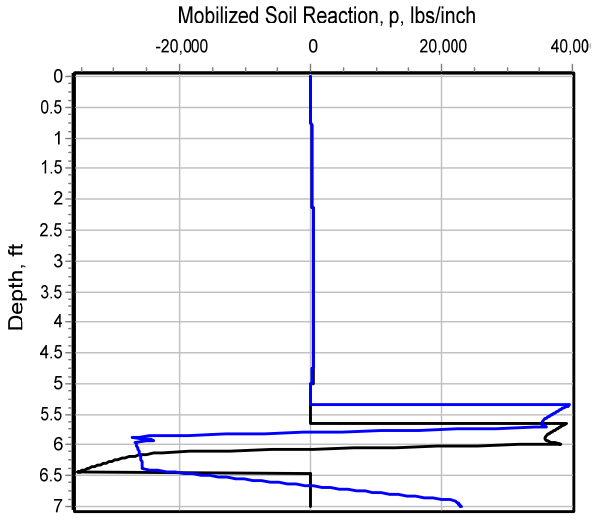












Legend:
----- First Iteration Load Case (with axial load and lateral deflection applied to pile head)
----- Second Iteration Load Case (with axial load, lateral deflection, and plastic hinge moment applied to pile head)

APPENDIX G

Special Provision 501 - Foundation Piles (Pre-Excavation for Piles)

SPECIAL PROVISION
SECTION 501
FOUNDATION PILES
(Pre-Excavation for Piles)

501.01 Description. The following is added to Subsection 501.01 of the Standard Specifications:

This work shall consist of drilling a hole cased to at least top of bedrock to remove all subsurface material, placing a pile into the hole, and backfilling the space between the casing and pile.

501.02 Materials. The following is added to Subsection 501.02 of the Standard Specifications:

Materials shall meet the following requirements:

a) Pea stone fill: A hard, washed, rounded or subrounded stone with maximum size of 3/8-inch, with a maximum of 10 percent (by weight) passing the No. 4 sieve size.
b) Concrete: Meeting the requirements Section 502 Structural Concrete.

501.021 Definitions.

a) Earth. All soil, cobbles, and boulders will be considered excavation of earth
b) Rock. All excavation of bedrock for the rock socket will be considered excavation of rock.

501.03 Quality Control Plan. The following is added to Subsection 501.03 of the Standard Specifications:

At least 15 working days prior to beginning Pre-Excavation for Piles, the Contractor shall submit an Installation and Quality Control Plan for review by the Resident. Standard Specification 105.7 shall govern the review process.

The Installation and Quality Control Plan shall, at a minimum, include the following:

A. List of proposed equipment to be used including but not limited to the following: drilling equipment, drills, drill bits, augers, buckets, drill casing, final cleaning and bottom inspection equipment, water recovery and treatment equipment, rock coring equipment, tremies or grout pumps.
B. Details of the overall pile foundation construction sequence.
C. Details of excavation methods in soils and bedrock, including methods of removing any obstructions such as boulders or cobbles.

D. Details of equipment and methods that will be used to clean bedrock-sockets after they have been advanced to the minimum required depth below top of bedrock as shown on the Plans.
E. Details of installing piles and supporting piles vertically and laterally in their final positions until dynamic pile testing and production pile driving is complete.
F. Details of pea-stone material and placement method.
G. Sample daily construction records.
H. Details of how verticality of casing and excavation will be determined.

501.049 Construction Requirements. The following Subsection is added to Subsection 501.049 of the Standard Specifications:

The pre-excavation of abutment piles shall consist of augering, pre-boring, or some other means of excavation to produce an excavation to the depth and diameter specified in the Contract Documents. The excavation shall be cased so it is maintained open to allow for backfilling around the pile in and above the rock socket with pea stone fill in accordance with the Contract Documents. Temporary casing is considered an acceptable option.

The pile shall be placed into the excavation before backfilling with pea stone fill. The contractor shall measure the pile tip elevation at least once before and after casing extraction and take care not to lift the pile more than 1 (one) foot above the bottom of the rock socket. If the pile lifts more than one foot during the casing extraction, the pile must be removed and the casing and pile installation and backfill must be repeated.

Except where the rock socket is inadvertently drilled deeper than 2 feet below top of bedrock, the entire pre-excavation shall be filled with pea stone fill and the temporary casing shall be removed prior to driving in accordance with Section 501 of the Standard Specifications.

In cases where the rock socket is drilled deeper than 2 feet below top of bedrock, this deeper excavation shall be backfilled with tremie concrete, and the pile shall not be installed until a minimum compressive strength of 4000 psi is obtained in the concrete.

501.05 Method of Measurement. The following is added to Subsection 501.05 of the Standard Specifications:

The quantities of Pre-Excavation for Piles to be measured for payment will be the total number of linear feet of excavation to the depth specified in the Contract Documents or as ordered by the Resident, measured to the nearest linear foot.

a) Earth. Where Structure Excavation and Pre-excavation for Piles, Earth occur jointly or separately at the same location, measurement for Pre-excavation for Abutment Piles, Earth will be made only below the lower limits of Structure Excavation.

b) Rock. The quantity of Pre-excavation for Piles, Rock to be measured for payment will be below the top surface of bedrock as determined by the Resident.

Drilling Equipment Mobilization for Pre-Excavation for Piles shall be measured as outlined in Subsection 501.05(a), Equipment Mobilization, of the Standard Specifications.

501.06 Basis of Payment. The following is added to subsection 501.05 of the Standard Specifications:

The accepted quantities of Pre-Excavation for Piles, Earth and Pre-Excavation for Piles, Rock will be paid for at the Contract Unit Price per linear foot. Payment will be full compensation for furnishing, transporting, storing, and installing the materials specified including the pea stone fill and for tremie concrete required where there is over-excavation of the rock socket, for performing required excavation, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item		Pay Unit
501.811	Pre-Excavation for Piles, Earth	Linear Foot
501.812	Pre-Excavation for Piles, Rock	Linear Foot
501.804	Drilling Equipment Mobilization, Pre-Excavation for Pile	Lump Sum

golder.com