GEI Consultants

Geotechnical Design Report

Smelt Brook Bridge (#2774) over Smelt Brook WIN 026630.07

Perry, Maine

Submitted to:
Thornton Tomasetti
14 York Street
Portland, ME 04101

Submitted by:
GEI Consultants, Inc.
5 Milk Street
Portland, ME 04101
207.797.8901

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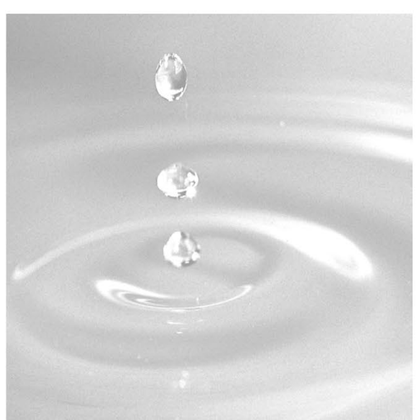

Michael R. Johnescu, P.E.
Project Manager

Nicolas Betancur, P.E.
Senior Geotechnical Engineer

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Executive Summary

This report presents the results of our subsurface explorations and geotechnical recommendations for the proposed replacement of the existing Smelt Brook Bridge (#2774), which carries South River Road (Route 1) over Smelt Brook, in Perry, Washington County, Maine.

Our recommendations in this report are based on our review of the results of preliminary (Phase 1) and final design phase (Phase 2) subsurface exploration programs conducted by New England Boring Contractors (NEBC) of Hermon, Maine. The Phase 1 subsurface exploration program took place from April 12 and April 18, 2024, during which three borings (BB-PSB-101 through BB-PSB-103) were advanced. The Phase 2 subsurface exploration program occurred between May 14 and May 15, 2025 and included three additional borings (BB-PSB-201, BB-PSB-202, and BB-PSB-202A). Soil sampling was performed at 5-foot intervals using Standard Penetration Testing (SPT). Approximately 13 to 22.5 feet of bedrock was cored in the borings. A GEI Consultants, Inc. engineer observed and documented the borings.

The borings encountered approximately 17.5 to 28.9 feet of fill and up to 5.6 feet of glacial till overlying shale bedrock. Bedrock was encountered in the borings from approximately El. 9.0 to El. -0.3 (21 to 29 feet below ground surface). The borings were terminated between El. 1.5 and El. -17.0 (28.5 to 46.5 feet below ground surface).

Based on our pile design analyses, we recommend that HP14x117 piles approximately 19.5 to 21 feet in length be installed in rock sockets with minimum length of 10.3 feet and 4.3 feet, for Abutments 1 and 2, respectively, and a minimum socket diameter of 30-inches. At Abutment 1, the bottom 5.3 feet of the rock sockets should be tremie filled with 4,000 pounds per square inch (psi) grout, and the remainder backfilled with Granular Borrow, MaineDOT Bridge Design Guide (MaineDOT BDG) Type 4 soil. At Abutment 2, the bottom 3.3 feet of the rock sockets should be tremie filled with 4,000 psi grout, and the remainder backfilled with Granular Borrow, MaineDOT BDG Type 4 soil, 703.19. All piles should be fitted with a steel shoe bearing plate that is welded to the toe of the pile and a minimum of 3-inch grout cover should be provided below the base of the steel shoe bearing plate. We recommend the remainder of drilled hole be backfilled with Granular Borrow, MaineDOT BDG Type 4 soil, 703.19. Piles can be spaced at 6 feet on-center in a single row and oriented with weak axis bending (pile webs perpendicular to centerline of girders).

Our professional services for this project have been performed in accordance with generally accepted engineering practices; no warranty, express or implied, is made.

1. Introduction

1.1. Purpose

This report presents the results of the subsurface explorations, our evaluation of the existing subsurface conditions, and our geotechnical recommendations for design and construction of the proposed replacement of Smelt Brook Bridge (#2774), which carries South River Road (Route 1) over Smelt Brook, in Perry, Washington County, Maine as shown in Sheet 1.

1.2. Scope

Our scope of work included:

- Reviewing available published geologic data for the project vicinity and the design drawings of the existing bridge.
- Preparing a Health and Safety Plan prior to conducting field activities.
- Preparing a Traffic Control Plan in accordance with Work Zone Traffic Control Guidebook, MaineDOT, March 2015, and the MUTCD (FHWA).
- Engaging a drilling subcontractor to complete preliminary (Phase 1) and final design (Phase 2) subsurface exploration programs.
- Providing full-time observation during the subsurface exploration programs and classification of the soil samples in general accordance with Maine Department of Transportation (MaineDOT) guidelines.
- Engaging a third-party laboratory to perform Atterberg limits, grain size analyses, and water contents of representative soil samples, and elastic moduli of rock in uniaxial compression on representative rock samples.
- Reviewed the results of the subsurface explorations, prepared a subsurface profile, and developed soil properties for geotechnical analyses.
- Developed geotechnical recommendations for the design and construction of a new integral abutment bridge supported on rock socketed H-piles.
- Preparing this geotechnical design report presenting the results of the subsurface explorations and our geotechnical analyses and recommendations.

1.3. Authorization

We performed this work in accordance with our proposal revised January 2, 2025, and the email notice to proceed from Thorton Tomasetti on April 15, 2025.

1.4. Project Personnel

The following personnel at GEI were involved with the field exploration, evaluations, recommendations, and preparation of this report:

Michael Johnescu, P.E.	Project Manager
Laureen M. Beintum, P.E. (MA)	In-house Consultant
Nicolas Betancur, P.E.	Senior Geotechnical Engineer
Sebastian Carvajal	Staff Engineer
Yonathan Sojo	Drafter

1.5. Elevation Datum

Elevations in this report are in feet and are referenced to the 1988 North American Vertical Datum (NAVD 1988).

2. Site and Project Description

2.1. Site and Project Description

We understand that MaineDOT is considering replacing the Smelt Brook Bridge (#2774), which carries South River Road (Route 1) over Smelt Brook in Perry, Maine. Sheet 1 shows the site location map. The Maine State Highway Commission drawing set dated 1936 refers to the bridge as an Ashlar Masonry Culvert at STA 130+43. The drawings show the top of road at approximately El. 29, and the footings at El. 3 and El. 0 on the upstream and downstream ends, respectively. The drawing notes indicate the downstream elevation is based on bedrock at El. 0. The vertical datum is not specified in the 1936 drawings.

The 1936 drawings show the bridge opening as approximately 9 feet wide by 13.5 feet tall. The abutments consist of ashlar masonry, and there is a 1.5-foot-thick reinforced concrete slab spanning the top of the bridge. Up to 28 feet of fill was placed to raise the existing grade to top of road elevation, and the fill thickness over the concrete slab is roughly 14 feet thick.

From the April 15, 2021 Highway Bridge Inspection Report, the stone masonry abutments were likely founded on bedrock. The granite block joints were reported to be well mortared with approximately 5% or less mortar missing. On the southwest wingwall, a block four courses from the top had displaced laterally into the channel approximately 6 inches. A concrete repair was made by placing concrete behind the wingwall at this block, doubling the wall thickness. Weep holes at the bottom of the abutments were reported to be functional with groundwater observed flowing out of the weep holes. There was minor cracking and heavy efflorescent staining on the underside of the deck at the downstream end. The underside of the concrete deck had three areas with 4- to 8-inch-deep spalls and cracking with efflorescence.

The proposed replacement bridge will be a 110-foot-span, 35-foot-wide single span integral abutment bridge, with each abutment supported on six (6) HP 14x117 piles spaced 6’-0” on-center and socketed into bedrock. Grade raises are expected to be less than two feet, with finished grade elevations of approximately El. 30 and El. 31.5 at proposed Abutments 1 and 2, respectively. Channel protection consisting of heavy riprap will be placed at an approximate slope of 1.75H:1V in front of each of the proposed abutments.

2.2. Project Design Basis

Our recommendations are based on the Maine Department of Transportation (MaineDOT) Bridge Design Guide (BDG), dated August 2003 and revised June 2018. Our recommendations conform to the AASHTO 2020 LRFD Bridge Design Specifications, 9th Edition.

3. Subsurface Conditions

3.1. Site Geology

The Reconnaissance Surficial Geology of the Eastport Quadrangle, Maine, prepared by the Harlod W. Borns Jr in 1975, indicates the surficial material in the area of the bridge is Presumpscot Formation, which consists of glaciomarine silt, clay, and sand. In this location, the unit is described as mostly low permeability silt and clay. However, these materials were not encountered in our recent boring explorations, instead artificial fill consisting of mixtures of fine to coarse sand and gravel with boulders and cobbles were encountered. Areas of glacial till are mapped nearby, and consist of a heterogeneous mixture of sand, silt, clay, and stones. The glacial till can either be basil till or ablation till. Basil till is described as fine grained and very compact, with low permeability and poor drainage. Ablation till is described as loose, sandy, and stony with moderate permeability and fair to good drainage. The surficial geology map is shown in Fig. A-1 in Appendix A.

The Bedrock Geology of the Eastport Quadrangle, Maine, prepared by Olcott Gates in 1975, indicates bedrock at the site consists of the Eastport Formation, described as grey, green, locally maroon, siltstone and shale, with a few conglomerate lenses, ostracodes, pelecypods, gastropods, and lingulas. The bedrock geology map is shown in Fig. A-2, Appendix A.

3.2. 2024 Subsurface Exploration Program

New England Boring Contractors (NEBC) of Hermon, Maine drilled three borings (BB-PSB-101 through BB-PSB-103) between April 12 and April 18, 2024. The boring locations are shown in Sheet 2. The boring locations were chosen in the field based on access and clearance from existing utilities. A GEI field engineer coordinated the drilling and logged the borings. Boring logs are provided in Appendix B.1. The as-drilled boring locations were surveyed by MaineDOT. The boring locations and elevations are included on the boring logs and summarized in Table 1.

A Mobile B-53 track-mounted drill rig was used to advance the borings. The borings were drilled using solid stem augers (SSA) for the first several feet of fill material, and then 4-inch (HW) and 3-inch-inside-diameter (NW) (ID) steel casing was advanced with drive and wash or spin and wash techniques in all borings. A tri-cone roller bit with water was used to clean the soil cutting from inside the casing. NEBC advanced ahead of the casing with the rotary bit at various depths due to the dense nature of the overburden and the presence of boulders and cobbles. Soil samples were recovered using an oversized 3-inch split spoon sampler when the recovery with the standard split spoon sampler was insufficient. Bedrock was cored using a 2-inch, NQ-sized core barrel in all borings. The borings were advanced to depths ranging from 40.1 and 44.4 feet below existing grade.

Standard Penetration Tests (SPT) were obtained at approximate 5-foot depth intervals in all borings. The split spoons were advanced with an automatic hammer consisting of a hydraulically actuated 140-lb weight falling 30 inches in accordance with ASTM D 1586. At least 13 feet of bedrock was cored in all the borings. NEBC provided the Standard Penetration Test Energy Measurement Calibration Report prepared by GZA GeoEnvironmental, Inc. for the Mobile B-53 drill rig used at the site. The calibration results for the automatic hammer (NEBC D-28) indicate an average energy transfer ratio of 76.5%. Therefore, we used a hammer energy ratio correction factor of C_E =1.28 to correct SPT N Values for hammer energy.

Recovered split-spoon soil samples were placed in jars, and rock core samples were placed in wooden boxes. The soil and rock samples were sent to our Portland, Maine office for verification of field classification. Individual sample descriptions are provided in the boring logs in Appendix B.1. Rock core photographs are provided in Appendix B.2.

Borings BB-PSB-101 through BB-PSB-103 were backfilled with bentonite chips, soil cuttings, and gravel, and patched with asphalt upon completion.

3.3. 2025 Subsurface Exploration Program

GEI engaged NEBC of Hermon, Maine to drill three additional borings (BB-PSB-201, BB-PSB-202, and BB-PSB-202A) between May 14 to May, 15, 2025. Boring BB-PSB-202 required an offset boring to be drilled, BB-PSB-202A, due to out of plumb casing. Boring BB-PSB-201 was drilled at the proposed Abutment 1 and borings BB-PSB-202 and BB-PSB-202A were drilled at the proposed Abutment 2 as shown on Sheet 2. A GEI field engineer coordinated the drilling and logged the borings. The as-drilled boring locations were estimated in the field using tape ties taken by the GEI field engineer at the completion of the drilling program. The as-drilled boring elevations were estimated using MaineDOT topographic survey data in conjunction with the tape ties. The boring locations and elevations are only accurate to the degree implied and are included on the boring logs and summarized in Table 1. Boring logs are provided in Appendix B.1.

A Mobile B-53 track-mounted drill rig was used to advance the borings. The borings were drilled using a combination of solid stem augers (SSA) for the first 5 to 9 feet of fill material, and then 4-inch-inside-diameter (HW) (ID) and 3-inch-ID (NW) steel casing was advanced with drive and wash or spin and wash drilling techniques in all borings. A tri-cone roller bit with water was used to clean the soil cuttings from inside the casing. NEBC advanced ahead of the casing with the rotary bit at various depths due to the dense nature of the overburden and the presence of boulders and cobbles. Bedrock was cored using a 2-inch, NQ-sized core barrel in borings BB-PSB-201 and BB-PSB-202A. The borings were advanced to depths ranging from 28.5 and 46 feet below existing grade.

SPT were obtained at approximate 5-foot depth intervals in all borings except boring BB-PSB-202A. Boring BB-PSB-202A was drilled continuously without sampling until 29 feet below ground surface. The split spoons were advanced with an automatic hammer consisting of a hydraulically actuated 140-lb weight falling 30 inches in accordance with ASTM D 1586. At least 16 feet of bedrock was cored in borings BB-PSB-201 and BB-PSB-202A. NEBC provided the Standard Penetration Test Energy Measurement Calibration Report prepared by GZA GeoEnvironmental, Inc. for the Mobile B-53 drill rig used at the site. The calibration results for the automatic hammer (NEBC D-23) indicate an average energy transfer ratio of 83.4%. Therefore, we used a hammer energy ratio correction factor of C_E =1.39 to correct SPT N Values for hammer energy.

Recovered split-spoon soil samples were placed in jars, and rock core samples were placed in wooden boxes. The soil and rock samples were sent to our Portland, Maine office for verification of field classification. Individual sample descriptions are provided in the boring logs in Appendix B.1. Rock core photographs are provided in Appendix B.2.

Borings BB-PSB-201 through BB-PSB-202A were backfilled with soil cuttings and gravel, and patched with asphalt upon completion.

3.4. Sample Review

The soil samples from the borings were examined at the office by Michael Johnescu. The field engineer examined the rock core samples and calculated the Rock Quality Designations (RQDs) of the rock core samples in the field. Based on our review, it is our opinion that the descriptions in the boring logs in Appendix B are a reasonable characterization of the conditions encountered.

3.5. Laboratory Testing

We engaged Soil Metrics LLC. of Cape Elizabeth, Maine to perform grain size analyses (ASTM D 6913) on eight soil samples, combined sieve and hydrometer analysis (ASTM D 422) on two soil samples, an Atterberg limits test (ASTM D 4318) on two soil samples, and moisture content tests (ASTM D 2216) on ten soil samples obtained in the borings to confirm the sample descriptions and to provide data for engineering analyses. GEI also engaged GeoTesting Express, Inc. (GTX) of Acton, Massachusetts to perform Elastic Moduli in Uniaxial Compression in accordance with ASTM D7012D on five rock core samples. The samples were taken from borings BB-PSB-101, -102, -201, and -202A which are all abutment borings except for BB-PSB-102. There were only a few samples that met the criteria for testing due to the highly fractured nature of the recovered bedrock cores, and no samples from abutment boring BB-PSB-103 were suitable for testing. The gradation results and Atterberg limits results are provided in Tables 2 and 3, respectively, and the compiled soil and rock lab results are provided in Appendix C.

3.6. Subsurface Conditions

The materials encountered in the borings are described below in order of increasing depth. Conditions are only known at the boring locations, and conditions between borings may differ from those indicated below and shown in the interpretative subsurface profile in Sheet 3.

The soil descriptions below refer to N_{60}, which is the measured N-value corrected to an equivalent hammer energy of 60 percent efficiency (i.e., the standard energy assumed in many SPT correlations). Field-measured N-values as well as corrected, N_{60} values are reported on the boring logs in Appendix B.1.

- Existing Fill – Granular fill was encountered in all the borings. Where fully penetrated, the thickness of the fill ranged from 16.4 feet to 27.7 feet. Boring BB-PSB-202 terminated in the fill layer at 28.5 feet below ground surface. A 12- to 17-inch-thick layer of asphalt was encountered above the fill in all borings.

  The granular fill observed in the borings was variable from grey and dark brown, medium dense to very dense gravel, with trace sand to sandy, and trace to little silt, to; brown and grey, medium dense to very dense, fine to coarse-grained sand, with some gravel and trace silt to silty. Split-spoon samples within the upper 5 feet of the fill layer at boring BB-PSB-101 and

BB-PSB-102 consisted of a very stiff silt with some gravel and very stiff silty clay with little gravel and sand. Two of the split-spoon samples near the bottom of the fill layer in boring BB-PSB-201 consisted of hard silty clay with little gravel and sand and medium stiff silt with little gravel. This layer contains probable boulders and cobbles based on the drill rig behavior, SPT results, and split-spoon sample recoveries. Grain size analyses performed on seven of the samples indicate the percent fines ranged from 0.1 to 74.0 percent, and an Atterberg limit test performed on two of the samples indicated moderately plastic fines. USCS classifications were CL, ML, GW, GW-GM, and GP, and the AASHTO classifications were A-1-a, A-4(0), A-6, and A-7-6.

Corrected N-values (N_{60}) in the fill ranged from 7 to over 100 blows per foot (bpf), with an average of 29 bpf, indicating a mostly medium dense soil.

- Glacial Till – Glacial till was encountered below the fill in borings BB-PSB-101, -102, -201, and -202A. The thickness of the glacial till ranged from 0.8 feet at boring BB-PSB-202A to 5.6 feet at boring BB-PSB-102. The material varied from grey and brown, dense, sandy gravel, with little silt, to; light brown and grey, dense, gravelly sand, with some clay. One of the split-spoon sample in boring BB-PSB-201 consisted of silty fine to coarse sand with little gravel, and trace clay. Grain size analyses performed on three of the samples indicate the percent fines ranged from 15.6 to 31.8 percent. USCS classifications were GM and SM, and the AASHTO classification were A-1-b and A-2(0).

  The N_{60} value ranged from 38 to 41 bpf, with an average of 40 bpf, indicating a mostly dense soil.

- Bedrock – Bedrock was encountered in borings BB-PSB-101, -102, -201, and -202A between 21 and 29.3 feet below ground surface (bgs) (approximately El. 9.0 to El. -0.3). Bedrock elevation was highest near Abutment 1 (BB-PSB-101 and PBS-201) and shallowest near Abutment 2.

  The bedrock was generally classified as purplish grey to grey, hard to moderately hard, fine-grained shale, and ranged from fresh to very slightly weathered. The bedrock had horizontal to vertical joints, as shown in the rock core photos in Appendix B.2. The RQD in the shale ranged from 0 to 58 percent, with an average of 18 percent, indicating a very poor to poor rock quality.

  Elastic Moduli in Uniaxial Compression in accordance with ASTM D7012D were performed on bedrock samples from borings BB-PSB-101, -102, -201, and -202A. The average unconfined compressive strength of the five tested samples was 6,411 psi, and the individual results are provided in Table 4.

3.7. Groundwater and Surface Water Levels

Groundwater levels were measured in borings BB PSB 101 and 103 at the beginning of a new shift before any drilling activity. Groundwater level was measured in boring BB PSB 202A at the end of drilling activity. Groundwater levels ranged from 18.7 to 24.3 feet bgs (approximately El. 9.4 to El. 4.6), respectively. Groundwater was not encountered in boring BB PSB 102. Groundwater levels were not measured in BB PSB 201 and BB PSB 202. These measurements may not accurately reflect the true groundwater level. The bridge is constructed on a manmade causeway along the coast, and groundwater levels are likely influenced by tides and precipitation. Significantly different groundwater levels may occur at other times and locations.

According to the tidal hydraulic guidance criteria for the project, Smelt Brook is subject to a Highest Astronomical Tide (HAT) Line at El. 14.5.

4. Design Recommendations

4.1. General

We understand that the preferred configuration of the replacement structure is a simple span concrete superstructure on integral abutments. The new abutments will be approximately 55 feet from the existing bridge centerline (i.e., approximately a 110-foot span), and the new bridge is expected to match the roadway width. The preferred substructure for the replacement bridge is integral abutments supported on rock socketed H-piles.

The borings encountered bedrock at approximately 8 to 10 feet below the proposed bottom of pile cap at Abutment 1, and approximately 16 to 17 feet below proposed bottom of pile cap at Abutment 2. At Abutment 1, bedrock was directly overlain by a dense glacial till layer. Glacial till was not encountered in the borings performed at Abutment 2, and bedrock was directly overlain by medium dense to very dense fill.

Significant re-grading of the roadway surrounding the bridge is not anticipated. The design preference will be to keep final grades as close as possible to existing grades.

Recommendations for designing foundations for the replacement abutments are presented below. Calculations supporting these recommendations are presented in Appendix D.

4.2. Soil Properties and Lateral Earth Pressures

Recommended soil properties and earth pressure coefficients for design are presented in Table 5. We selected these values based on published correlations to SPT N-values, our review of the soil descriptions, and our engineering judgment.

Recommended earth pressure coefficients are provided in Table 4. For the integral abutments, the lateral earth pressures developed against the abutment by the backfill are a function of the movement of the abutment and can range from at-rest pressure to full passive pressure. The abutment reinforcement should be designed for the passive earth pressure (Pp) that results on the back face of the abutment when the bridge expands. This earth pressure should be calculated using the formula provided in Section 5.4.2.11 of the MaineDOT BDG. The Passive Lateral Earth Pressure Coefficient (Kp) needed for this equation is provided in Table 5 of this report and was evaluated using FHWA NHI-06-089 Figure 10-4. This Kp value was obtained assuming a magnitude of wall rotation equal to 0.02, expressed in terms of the ratio of wall movement to wall height (Y/H). However, the designer should calculate Kp using both FHWA NHI-06-089 and MassDOT Bridge Design Manual Figure 3.10.8-1 and use the more stringent value. It should also be noted that the design passive pressure coefficient should be no less than Kp calculated using Rankine, regardless of estimated wall rotation.

4.3. Integral Abutment Pile Design

We understand that the proposed replacement bridge substructure will consist of integral bridge abutments supported on steel H-piles. Based on the results of our subsurface explorations, the depth of overburden below the bottom of the proposed pile caps is limited and it is considered insufficient to provide adequate lateral stability for driven H-piles installed to top of rock. Within the footprint of the proposed abutments, the depth to rock from the bottom of the piles caps varies approximately between 8 and 10 feet at Abutment 1 and between 16 and 17 feet at Abutment 2. Because of the limited embedment depths available at the site, we recommend that the abutments be supported on rock-socketed steel H-piles. Our recommendations are based on design analyses performed using the computer program LPile Version 2022-12.010 by Ensoft Inc., a program for the analysis of individual piles subjected to lateral loading using the p-y method.

We performed LPile analyses for HP 14x89 and HP 14x117 steel piles using loading provided by Thornton Tomasetti. The loading included Strength I Limit State factored axial load of 338 kips and the larger thermal movement between thermal contraction and thermal expansion as estimated by Thornton Tomasetti. The thermal movement was input as unfactored and factored thermal contraction of 0.436 and 0.523 inches, respectively. A load factor g_{TU} of 1.2 was applied to the thermal movement in accordance with AASHTO LRFD Table 3.4.1-1. It is our understanding that the structural pile design was based on the larger of the bending moment obtained using the factored thermal movement loading and that obtained applying the load factor g_{TU} of 1.2 to the resulting bending moment using unfactored thermal movement loading.

The analyses used the intact H-pile section without corrosion loss consideration to maximize the bending moment demand. We assumed a pile spacing of 6 feet and a p-multiplier of 1.0, consistent with a 5B pile spacing (with B equal to a pile depth of 14.2 inches) in accordance with AASHTO LRFD Section 10.7.2.4. A p-multiplier of 1.0 is also conservative as it results in a stiffer soil response and a higher flexural demand on the piles.

Thornton Tomasetti estimated scour depths of approximately 7 and 9 feet for Abutment 1 and 2, respectively. We did not consider scour in our pile design analyses as the scour estimates appear unrealistic. The flood events considered in the scour analyses are tidal in nature and peak velocities occur for discrete amounts of time during the tidal cycle. The peak velocities may not last long enough for scour to reach the estimated depths. Based on our subsurface explorations, we expect the stream bed to be composed of exposed bedrock which we do not expect to be scour-susceptible according to the rock quality encountered. We also considered scour of the estimated magnitude to be unlikely given the proposed heavy riprap protection in front and around the abutments and the significant distance between the proposed abutment piles (approximately 48 to 50 feet) and the toe of the riprap at the Wilson Stream channel.

Based on the results of our laterally loaded pile analyses and coordination with Thornton Tomasetti, we recommend that the pile foundations consist of HP 14x117 steel piles. The recommended pile layout consists of a single row of six (6) HP 14x117 piles oriented with the weak axis bending (pile webs perpendicular to centerline of girders). The piles can be spaced at 6 feet on-center along the bridge transverse direction. The piles should be installed in a minimum 30-inch-diameter rock socket extending a minimum of 10.3 and 4.3 feet into bedrock at abutments 1 and 2, respectively. The rock socket should be tremie filled with grout with a minimum compressive strength of 4,000 psi. The grout column should extend upward a minimum of 5 and 3 feet from the toe of the piles at abutments 1 and 2, respectively. A steel shoe bearing plate should be welded to the toe of the pile and a minimum of 3-inch grout cover should be provided below the base of the steel shoe bearing plate. The rest of the pile length above the grout column should be backfilled with MaineDOT BDG Type 4 Soil, 703.19, (Granular Borrow) to the bottom of the pile cap. The Granular Borrow backfill is recommended to provide a softer soil response and reduce the flexural demand on the piles.

The estimated pile lengths, as measured from the bottom of the proposed pile cap, are approximately 19.5 and 21 feet including a minimum 10.3- and 4.3-foot rock socket length for abutments 1 and 2, respectively. The estimated geotechnical resistance of the piles conservatively ignores the contribution from the Granular Borrow backfill along the piles and relies entirely on the axial resistance of the rock socket. We estimated side and end bearing resistance of the rock socket at each abutment following ASSHTO procedures for drilled shaft design. We adopted side and end bearing resistance factors of 0.55 and 0.5 in accordance with AASHTO LRFD Bridge Design Specifications Table 10.5.5.2.4-1 assuming no load testing is performed. We estimated factored geotechnical resistance in side and end bearing respectively of 260 kips and 538 kips for abutment 1 and 162 kips and 547 kips for abutment 2. We understand that MaineDOT's preference is for rock socketed H-Piles to rely on end bearing. Assuming intimate contact between the rock surface at the bottom of the excavated rock socket and the grout, a factored axial resistance of 538 and 547 kips can be used for design for abutment 1 and 2, respectively.

Supporting calculations for these recommendations are provided in Appendix D.

4.4. Seismic Design Parameters

Based on the borings and our seismic design calculations (Appendix D), we conclude that the site should be classified as Site Class D.

Based on the 2020 AASHTO LRFD seismic hazard maps for the 1,000-year return period, we recommend the following parameters for seismic design:

- Horizontal Peak Ground Coefficient (PGA) = 0.080
- Horizontal Response Spectral Coefficient (period = 0.2 sec) (S_s) = 0.160
- Horizontal Response Spectral Coefficient (period = 1.0 sec) (S_1) = 0.040

The applicable site coefficients for peak ground acceleration ([F_{PGA}], short-period range [F_A], and long-period range [F_v]) at this site are 1.6, 1.6, and 2.4, respectively. Application of these site coefficients results in the following recommended coefficients for development of design response spectra:

- Response Spectral Acceleration, A_s = 0.128
- Design Spectral Acceleration Coefficient at 0.2 second period, S_{DS} = 0.256
- Design Spectral Acceleration Coefficient at 1.0 second period, S_{D1} = 0.096

This site falls into Seismic Zone 1, based on the 1-second-period design spectral acceleration. For multiple span bridges in Seismic Zone 1, there is no detailed seismic analysis required other than connection design and seat bearing length.

4.5. Settlement and Stability

The proposed bridge design calls for minimal grade raises at the approaches, and the existing fill and glacial till encountered in the borings was generally medium dense to very dense sand and gravel, with lesser amounts of silt and clay. The site also has relatively shallow bedrock at the location of the approaches. Based on the material encountered in the borings, MaineDOT slopes of 2H:1V or 1.75H:1V if riprap protected, are expected to be stable. Furthermore, we do not anticipate settlement related issues based on the subsurface conditions encountered.

4.6. Frost Protection

Glacial till and existing or imported granular backfill, are anticipated to be present at the abutments and are frost susceptible. Based on MaineDOT BDG Section 5.2.1, the Freezing Index for the site is approximately 1200. Moisture content ranged from 0.5 to 21.5 percent for tests performed on the fill soil samples. For a coarse-grained soil with a water content 10 percent and a Freeze Index of 1200 the estimated depth of frost penetration is 6.1 feet.

5. Construction Recommendations

5.1. Rock Socketed Pile Installation

The piles will need to be installed by means of temporary casing seated into rock to facilitate excavation of the rock sockets and provide a seal to allow for placement of tremie grout or concrete within the rock socket. A minimum of 3 inches of 4,000 psi grout cover should be provided between the bottom of the rock socket and the tip of the H-Piles. H-Piles should be equipped with a steel bearing shoe plate welded to the toe of the pile. The Contractor should provide means of temporarily supporting the pile between the bottom of the steel plate and the bottom of the rock socket excavation to ensure the minimum grout or concrete cover below the pile toe. This temporary support will also facilitate supporting the pile plumb while the grout attains sufficient strength prior to backfilling around and along the remaining pile length above the grout column.

The Contractor needs to be aware of the strength of the rock encountered at the site when selecting tooling for excavation of the rock sockets. Average measured uniaxial compressive strength of intact specimens is in the order of 6,400 psi. The shale encountered on site may be susceptible to softening when exposed to air and water. Rock sockets need to be tremie filled with grout immediately after excavation to minimize the risk of softening due to prolonged exposure to air and water. The Contractor must carefully plan the sequence of pile installation to minimize the amount of time that rock sockets are left open prior to grout placement. Excavated rock sockets should not be allowed to remain open and exposed to air and water overnight. We recommend a maximum waiting period of 4 hours between the end of rock socket excavation and grout placement.

Temporary casing may need to be equipped with carbide teeth to clear obstructions and to be seated into rock. The piles should be backfilled with Granular Borrow prior to removing the temporary casing. The backfill material needs to extend from the top of the rock socket to the bottom of the pile cap.

5.2. Obstructions

The borings indicate the presence of boulders and cobbles in the fill and glacial till. The Contractor needs to consider these obstructions in selecting adequate tooling to advance the temporary casing and excavate the overburden materials.

5.3. Backfilling

MaineDOT granular borrow for underwater backfill should be used behind the abutments in accordance with MaineDOT BDG, Section 5.4.2.13. Drainage behind the integral abutment should be designed in accordance with MaineDOT BDG, Section 5.4.1.9, to minimize hydrostatic pressure and control erosion of the underside of the abutment embankment riprap. It is our understanding that MaineDOT prefers the use of French drains on the uphill side of integral abutments to prevent buildup of hydrostatic pressure. The French drains should be sloped to drain by gravity and should outlet through a series of 4-inch diameter weep holes, spaced at a maximum distance of 10 feet on center.

Fill for the roadway and behind the abutments, backfill of excavations for utilities, and crushed stone for scour protection, if any, should be placed and compacted in accordance with MaineDOT Standard Specifications Section 206 (2020 version). However, we recommend that compaction in areas too small for a smooth wheel vibratory compactor, within 5 feet of walls less than 15 feet high, or within 10 feet of walls greater than 15 feet high, should be performed using a vibratory walk-behind roller or plate compactor (weighing at least 200 pounds imparting an impact load of at least 2.5 tons), with soil placed in maximum 6-inch-loose lifts.

5.4. Re-Use of Existing Materials

Based on the soil descriptions on the boring logs, some of the existing on-site granular soils may meet the requirements for common borrow. Suitability for reuse can be confirmed by testing samples to evaluate if the soil in question meets the MaineDOT requirements for common borrow. The on-site soils may have oversized cobbles and boulders that would need to be removed prior to re-use as common borrow. The Contractor should be aware that materials that are not free draining may be difficult to compact in wet weather.

5.5. Freezing Conditions

If construction is performed during freezing weather, special precautions will be required to prevent the soil subgrades from freezing. Freezing of the soil beneath foundations and pavements during construction may result in heave and subsequent settlement of the structure.

All soil subgrades should be free of frost before foundation construction. Frost-susceptible soils that have frozen should be removed and replaced with compacted gravel borrow. The foundation and the soil adjacent to the foundation should be insulated until they are backfilled.

Soil placed as fill should be free of frost, as should the ground on which it is placed.

6. Limitations

Our recommendations are based on the project information provided to us at the time of this report and may require modification if there are any changes in the nature, design, or location of the proposed construction. We recommend that GEI be engaged to perform a final design geotechnical exploration and prepare final design geotechnical foundation and construction recommendations. We recommend that GEI be engaged to review the final plans and specifications to evaluate whether changes in the project affect the validity of our recommendations and whether our recommendations have been properly implemented in the design.

The recommendations in this report are based in part on the data obtained from the borings. The nature and extent of variations between borings may not become evident until construction. If variations from the anticipated conditions are encountered, it may be necessary to revise the recommendations in this report. Therefore, we recommend that GEI be engaged to make site visits during construction to: a) check that the subsurface conditions exposed during construction are in general conformance with our design assumptions, and b) ascertain that, in general, the geotechnical aspects of the work are being performed in compliance with the contract documents.

Our professional services for this project have been performed in accordance with generally accepted engineering practices; no warranty, express or implied, is made.

Tables

Table 1. Subsurface Explorations
Geotechnical Design Report
Smelt Brook Bridge #2774
WIN 026630.07
Perry, Maine

Exploration Number	STA	Offset	Northing (ft)	Easting (ft)	Surface Elevation[1,2] (ft)	Depth of Exploration (ft)	Depth to Groundwater (ft)	Depth to Fill (Asphalt Thickness) (ft)	Depth to Glacial Till (ft)	Depth to Top of Bedrock (ft)
BB-PSB-101	19+06	10.0 RT	409615.8	2496331.3	28.1	40.1	18.7	1.1	17.5	21.2
BB-PSB-102	19+42	10.5 RT	409632.5	2496363.0	27.8	42.3	NE	1.4	22.5	28.1
BB-PSB-103	20+03	9.0 RT	409659.8	2496416.9	28.9	44.4	24.3	1.2	NE	28.9
BB-PSB-201	18+90	7.7 LT	409622.9	2496308.3	29.5	46.5	NM	1.0	17.5	20.5
BB-PSB-202	20+01	7.1 LT	409673.9	2496408.6	30.0	28.5	NM	1.1	NE	NE
BB-PSB-202A	20+03	6.8 LT	409674.5	2496410.0	30.0	46.0	24.3	1.1	28.5	29.3

1. The boring coordinates and elevations for BB-PSB-101 through -103 were surveyed by MaineDOT. Elevations are referenced to NAVD88.
2. The boring coordinates and elevations for BB-PSB-201 through -202A were estimated using tape ties and a topographic survey provided by MaineDOT, and should be considered accurate to the degree implied.
3. Boring BB-PSB-202 was terminated without coring due to out of plumb casing. Offset boring BB-PSB-202A was drilled approximately 1.5 feet north of -202 to collect rock core samples.
4. NE = Not Encountered
5. NM = Not Measured

Table 2. Grain Size Analysis Results
Geotechnical Design Report
Smelt Brook Bridge #2774
WIN 026630.07
Perry, Maine

Exploration Number	Surface Elevation (ft)	Sample Number	Sample Depth (ft)			Sample Elevation (ft)			Material	Description	MC (%)	% Fines	AASHTO	USCS
BB-PSB-101	28.1	1D	1.5	-	3.5	26.6	-	24.6	Fill	Brown and grey SILT, some sand, some gravel	12.6	49.9	A-4(0)	ML
BB-PSB-101	28.1	4D	14.0	-	16.0	14.1	-	12.1	Fill	Brown and grey GRAVEL, some sand, trace silt	13.0	6.5	A-1-a	GW
BB-PSB-101	28.1	5D	19.0	-	21.0	9.1	-	7.1	Glacial Till	Yellowish brown and grey Gravelly SAND, little silt	12.6	15.6	A-1-b	GM
BB-PSB-102	27.8	2D	4.0		6.0	23.8		21.8	Fill	Yellowish brown and grey Silty CLAY, little gravel, little sand	21.5	74.0	A-7-6	CL
BB-PSB-102	27.8	6D	24.0	-	26.0	3.8	-	1.8	Glacial Till	Yellowish brown and grey Gravelly SAND, little silt	12.0	20.8	A-1-b	GM
BB-PSB-103	28.9	3D	9.0	-	11.0	19.9	-	17.9	Fill	Grey and reddish brown GRAVEL	0.5	0.1	A-1-a	GP
BB-PSB-201	29.5	2D	4.0	-	6.0	25.5	-	23.5	Fill	Light brown Sandy GRAVEL, trace silt	2.3	10.0	A-1-a	GW-GM
BB-PSB-201	29.5	3D	9.0	-	11.0	20.5	-	18.5	Fill	Light brown to orange Silty CLAY, little gravel, little sand	20.1	68.7	A-6	CL
BB-PSB-201	29.5	5D	19.0	-	20.3	10.5	-	9.2	Glacial Till	fine to coarse SAND, some silt, little gravel	12.4	31.8	A-2(0)	SM
BB-PSB-202	30	4D	14.0	-	16.0	16.0	-	14.0	Fill	Dark brown to black GRAVEL, trace sand, trace silt	4.9	0.8	A-1-a	GW

Table 3. Atterberg Limits Test Results
Geotechnical Design Report
Smelt Brook Bridge #2774
WIN 026630.07
Perry, Maine

Exploration Number	Surface Elevation (ft)	Sample Number	Sample Depth (ft)			Sample Elevation (ft)			Material	Description	LL	PL	PI	MC (%)	AASHTO	USCS
BB-PSB-102	27.8	2D	4.0	-	6.0	23.8	-	21.8	Fill	Yellowish brown and grey Silty CLAY, little gravel, little sand	40.1	22.9	17.2	21.5	A-7-6	CL
BB-PSB-201	29.5	3D	9.0	-	11.0	20.5	-	18.5	Fill	Light brown to orange Silty CLAY, little gravel, little sand	38.2	23.5	14.7	20.1	A-6	CL

Table 4. Rock Core Laboratory Test Results
Geotechnical Design Report
Smelt Brook Bridge #2774
WIN 026630.07
Perry, Maine

Exploration Number	Ground Surface El. (ft)	Depth to Bedrock (ft)	Run Number	Run Depth (ft)	Run Depth into Bedrock (ft)	Penetration (in)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Sample Depth (ft)	Sample Depth into Bedrock (ft)	Sample El. (ft)	Unit Weight (lb/ft^3)	Unconfined Compressive Strength (psi)	Young's Modulus (ksi)	Poisson's Ratio	Rock Classification
BB-PSB-101	28.1	21.2	R1	22.0 - 24.7	0.8 - 3.5	32	32	100%	0	0%	-	-						Shale
BB-PSB-101	28.1	21.2	R2	24.7 - 27.7	3.5 - 6.5	36	36	100%	4	11%	-	-						Shale
BB-PSB-101	28.1	21.2	R3	27.7 - 31.5	6.5 - 10.3	46	46	100%	0	0%	-	-						Shale
BB-PSB-101	28.1	21.2	R4	31.5 - 35.9	10.3 - 14.7	53	52	98%	17	33%	-	-						Shale
BB-PSB-101	28.1	21.2	R5	35.9 - 40.1	14.7 - 18.9	50	50	100%	24	48%	36.0 - 36.3	14.8 - 15.1	-7.9	170	6,499	14,500	--	Shale
BB-PSB-101	28.1	21.2	R5	35.9 - 40.1	14.7 - 18.9	50	50	100%	24	48%	39.3 39.7	18.1 - 18.5	-11.2	171	9,628	5,260	0.30	Shale
BB-PSB-102	27.8	28.1	R1	29.0 - 32.4	0.9 - 4.3	41	40	98%	14	34%	30.2 - 30.6	2.1 - 2.5	-2.4	173	4,414	4,500	0.35	Shale
BB-PSB-102	27.8	28.1	R2	32.4 - 37.0	4.3 - 8.9	55	55	100%	4	7%	-	-						Shale
BB-PSB-102	27.8	28.1	R3	37.0 - 39.0	8.9 - 10.9	24	22	92%	4	17%	-	-						Shale
BB-PSB-102	27.8	28.1	R4	39.0 - 42.3	10.9 - 14.2	40	38	95%	20	50%	-	-						Shale
BB-PSB-103	28.9	28.9	R1	29.9 - 30.5	1.0 - 1.6	7	6	86%	0	0%	-	-						Shale
BB-PSB-103	28.9	28.9	R2	30.5 - 30.7	1.6 - 1.8	2	0	0%	0	0%	-	-						Shale
BB-PSB-103	28.9	28.9	R3	30.7 - 31.0	1.8 - 2.1	4	4	100%	0	0%	-	-						Shale
BB-PSB-103	28.9	28.9	R4	31.0 - 31.4	2.1 - 2.5	5	5	100%	0	0%	-	-						Shale
BB-PSB-103	28.9	28.9	R5	31.4 - 32.3	2.5 - 3.4	11	8	73%	0	0%	-	-						Shale
BB-PSB-103	28.9	28.9	R6	32.3 - 33.0	3.4 - 4.1	8	8	100%	0	0%	-	-						Shale
BB-PSB-103	28.9	28.9	R7	33.0 - 35.1	4.1 - 6.2	25	25	100%	0	0%	-	-						Shale
BB-PSB-103	28.9	28.9	R8	35.1 - 35.5	6.2 - 6.6	5	4	80%	0	0%	-	-						Shale
BB-PSB-103	28.9	28.9	R9	35.5 - 38.4	6.6 - 9.5	35	35	100%	8	23%	-	-						Shale
BB-PSB-103	28.9	28.9	R10	38.4 - 40.3	9.5 - 11.4	23	23	100%	0	0%	-	-						Shale
BB-PSB-103	28.9	28.9	R11	40.3 - 44.2	11.4 - 15.3	47	46	98%	6	13%	-	-						Shale
BB-PSB-103	28.9	28.9	R12	44.2 - 44.4	15.3 - 15.5	2	0	0%	0	0%	-	-						--
BB-PSB-201	29.5	20.5	R1	24.0 - 25.3	3.5 - 4.8	16	14	88%	0	0%	-	-						Shale
BB-PSB-201	29.5	20.5	R2	25.3 - 26.1	4.8 - 5.6	10	10	100%	0	0%	-	-						Shale/Conglomerate
BB-PSB-201	29.5	20.5	R3	26.1 - 29.0	5.6 - 8.5	35	32	91%	16	47%	26.3 - 26.7	5.8 - 6.2	3.2	170	4,849	2,700	0.08	Shale/Conglomerate
BB-PSB-201	29.5	20.5	R4	29.0 - 31.4	8.5 - 10.9	29	27	93%	9	31%	-	-						Shale
BB-PSB-201	29.5	20.5	R5	31.4 - 32.0	10.9 - 11.5	7	7	100%	0	0%	-	-						Shale
BB-PSB-201	29.5	20.5	R6	32.0 - 33.0	11.5 - 12.5	12	11	92%	5	38%	-	-						Shale
BB-PSB-201	29.5	20.5	R7	33.0 - 35.0	12.5 - 14.5	24	7	29%	0	0%	-	-						Shale
BB-PSB-201	29.5	20.5	R8	35.0 - 37.5	14.5 - 17.0	30	30	100%	8	28%	-	-						Shale
BB-PSB-201	29.5	20.5	R9	37.5 - 41.5	17.0 - 21.0	48	44	92%	10	21%	-	-						Shale
BB-PSB-201	29.5	20.5	R10	41.5 - 46.5	21.0 - 26.0	60	58	97%	32	53%	-	-						Shale
BB-PSB-202A	30	29.3	R1	29.3 - 34.0	0.0 - 4.7	56	49	88%	22	40%	-	-						Shale
BB-PSB-202A	30	29.3	R2	34.0 - 34.5	4.7 - 5.2	6	6	100%	0	0%	-	-						Shale
BB-PSB-202A	30	29.3	R3	34.5 - 38.0	5.2 - 8.7	42	42	100%	22	52%	34.6 - 35	5.3 - 5.7	-4.6	171	6,665	4,350	0.38	Shale
BB-PSB-202A	30	29.3	R4	38.0 - 41.0	8.7 - 11.7	36	36	100%	11	31%	-	-						Shale
BB-PSB-202A	30	29.3	R5	41.0 - 43.0	11.7 - 13.7	24	19	79%	4	17%	-	-						Shale
BB-PSB-202A	30	29.3	R6	43.0 - 46.0	13.7 - 16.7	36	36	100%	21	58%	-	-						Shale

Min	0%
Max	58%
Avg	18%
Weighted Average	27%

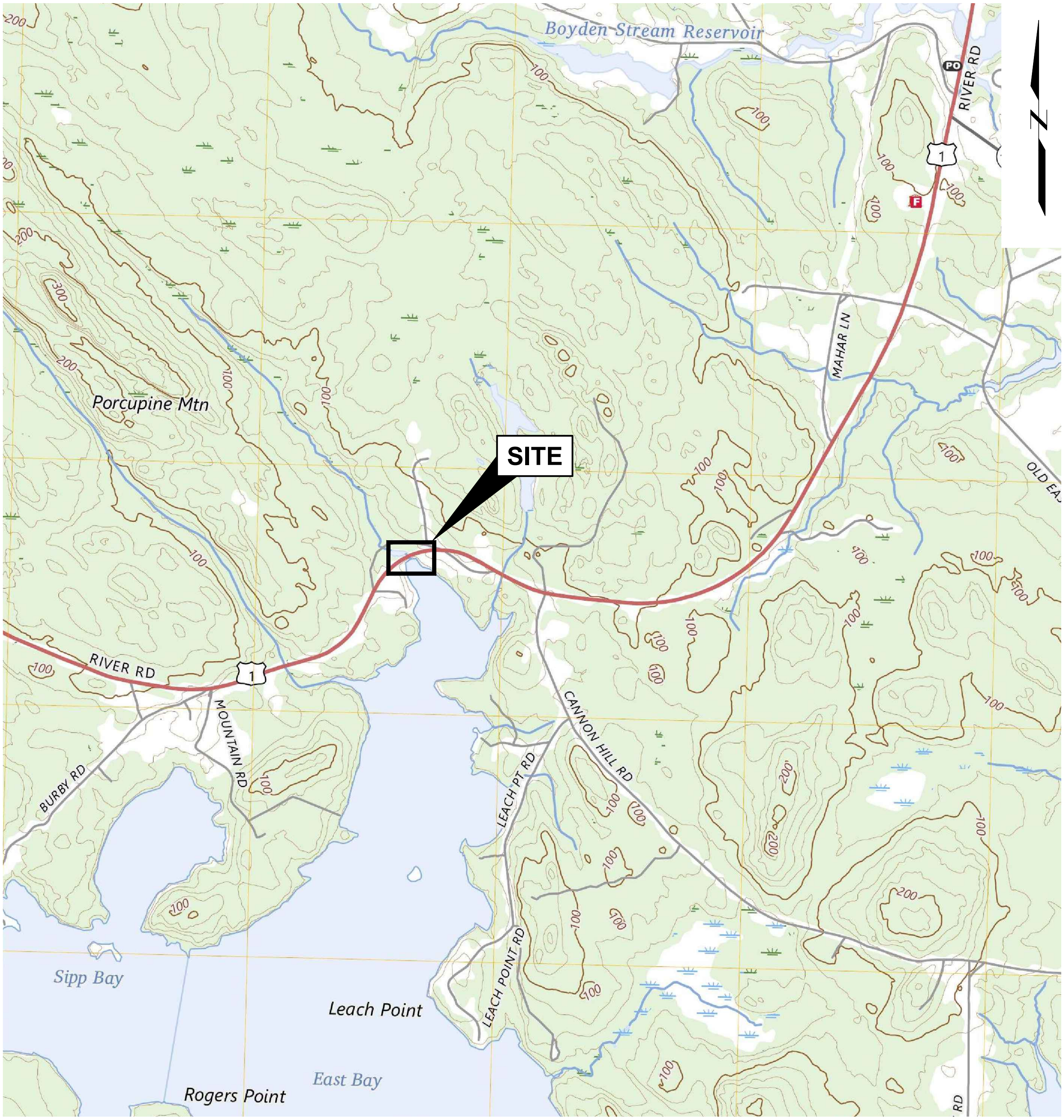
Table 5. Recommended Soil Properties
Geotechnical Design Report
Smelt Brook Bridge #2774
WIN 026630.07
Perry, Maine

Layer/Soil Type	Unit Weight, γ (pcf)	Friction Angle, ϕ (deg)	Earth Pressure Coefficients[1,2]			
			Active, $K_{a\_Rankine}$[3]	Active, $K_{a\_Coulomb}$[3]	At Rest, K_0	Passive, K_p
Existing Fill	125	34	0.28	0.25	0.44	5.8
Glacial Till	135	38	0.24	0.22	0.38	5.8
Granular Borrow	125	32	0.31	0.27	0.47	5.8
Gravel Borrow	135	36	0.26	0.24	0.41	5.8

Notes:

1. Recommended earth pressure coefficients are associated with vertical wall face and horizontal ground both in front and behind the wall, and are in accordance with the recommendations of Section 3.6 of the MaineDOT BDG, AASHTO LRFD 3.11.5.2, 3.11.5.3, and FHWA NHI-06-089. Supporting calculations are included in Appendix D. For sloping wall face, calculate using log spiral method and actual wall slope angle, with the interface angle assumed to be half the angle of internal friction of the soil.
2. Seismic earth pressure coefficients are not included because the bridge is classified under Seismic Zone 1. Seismic coefficients should be evaluated if necessary during final design based on the final bridge type.
3. Active earth pressure using Coulomb's Theory should be used for gravity and short-heel cantilever walls. Use Rankine's Theory for long-heel cantilever walls.
4. Passive earth pressure for walls should be neglected for cases outlined in MaineDOT BDG 3.6.9. MaineDOT BDG 5.4.2.11 recommends abutment and wingwall reinforcement be sized assuming passive earth pressure on the backface of the wall. Design passive pressure coefficient should be calculated using MassDOT BDM Figure 3.10.8-1 and NHI-06-089 Figure 10-4, and the more stringent value should apply. However, passive earth pressure should be no less than Rankine passive earth pressure, regardless of wall rotation. (FHWA NHI-06-089 Figure 10-4 Assuming a wall rotation of 0.02 for dense granular soil. The bridge designer should use MassDOT BDM Figure 3.10.8-1)

Sheets



0 2000 4000

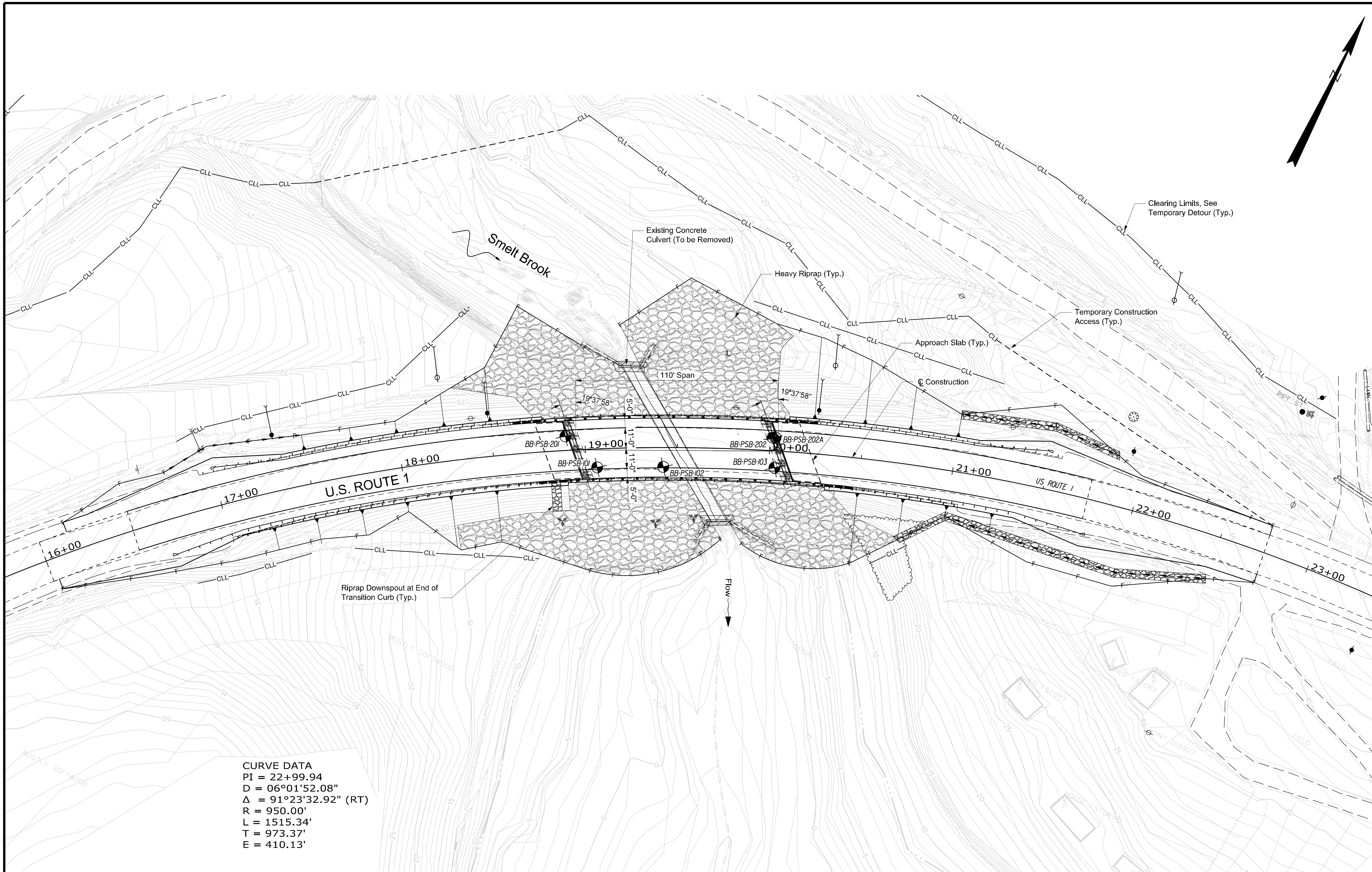
SCALE, FEET

QUADRANGLE LOCATION

SOURCE:

USGS TOPOGRAPHIC QUADRANGLE, 7.5 MINUTE SERIES: EASTPORT QUADRANGLE, MAINE-WASHINGTON COUNTY, 2024.
NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88)
20-FOOT CONTOUR INTERVAL

Smelt Brook Bridge (#2774) over Smelt Brook WIN 026630.07 Perry, Maine	GEI Consultants	SITE LOCATION MAP
Thornton Tomasetti Portland, Maine	Project 2502334	Aug. 2025 Sheet 1



LEGEND

CASED WASHED BORINGS

SOURCE

Base plan is developed from electronic files (Contours.dgn, Text.dgn, Topo.dgn) provided to GEI by Thornton Tomasetti on April 26, 2024, electronic files (Alignment_Route 1.dgn, and Plan_Route 1.dgn) provided to GEI by Thornton Tomasetti on May 22, 2025 and electronic files (Corridor_Route 1_Linework.dgn and Corridor_Route 1.dgn) provided to GEI by Thornton Tomasetti on June 31, 2025.

NOTES

1. Borings BB-PSB-101 through BB-PSB-103 were drilled by New England Boring Contractors of Hermon, Maine between April 12 and April 18, 2024 and were observed by GEI personnel.
2. Borings BB-PSB-201 through BB-PSB-202A were drilled by New England Boring Contractors of Hermon, Maine between May 14 and May 15, 2025 and were observed by GEI personnel.
3. As-drilled boring locations for borings BB-PSB-101 through BB-PSB-103 were surveyed by MaineDOT and provided to GEI.
4. As-drilled boring locations for borings BB-PSB-201 through BB-PSB-202A were located using tape ties and should be considered accurate to the degree implied.

PLAN

25 0 25 50

Scale of Feet

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

APPROVED	DATE
COMMISSIONER:	
CHIEF ENGINEER:	

SIGNATURE

P.E. NUMBER

DATE

		BY	DATE
PROJ. MANAGER	M. JOHNESCU		
DESIGN-DETAILED	M. JOHNESCU	Y. SOJO	7\17\2025
CHECKED-REVIEWED	M. JOHNESCU	N. BETANCUR	8\5\2025
DESIGN2-DETAILED2			
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

BRIDGE NO. 2774
CROSSING SMELT BROOK
PERRY

BORING LOCATION PLAN

SHEET NUMBER

2

OF 3

NOTES

1) Profile developed from electronic files (Profile.dgn) provided to GEI by Thornton Tomasetti on May 22, 2025 and electronic files (Profile_Route 1.dgn) provided to GEI by Thornton Tomasetti on June 31, 2025.

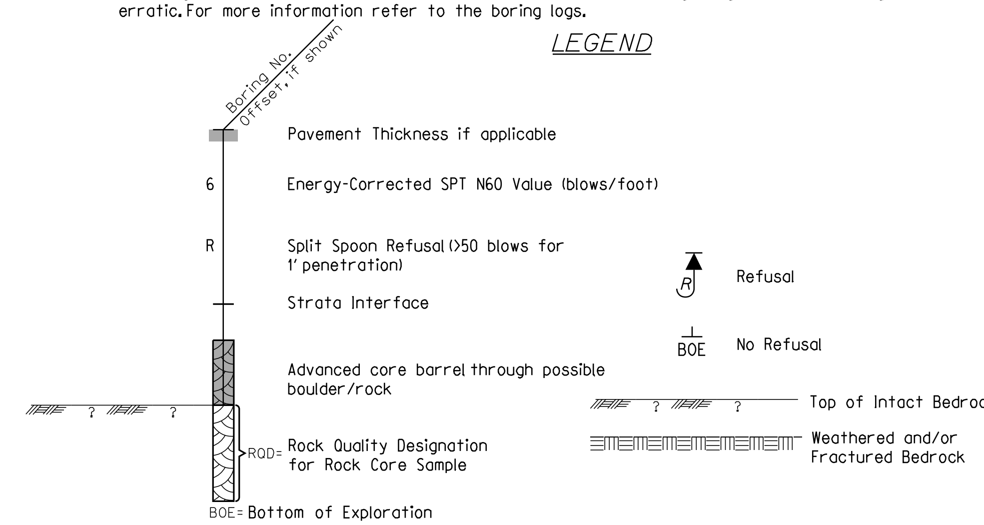
2) As-drilled boring locations for borings BB-PSB-101 through BB-PSB-103 were surveyed by MaineDOT and provided to GEI.

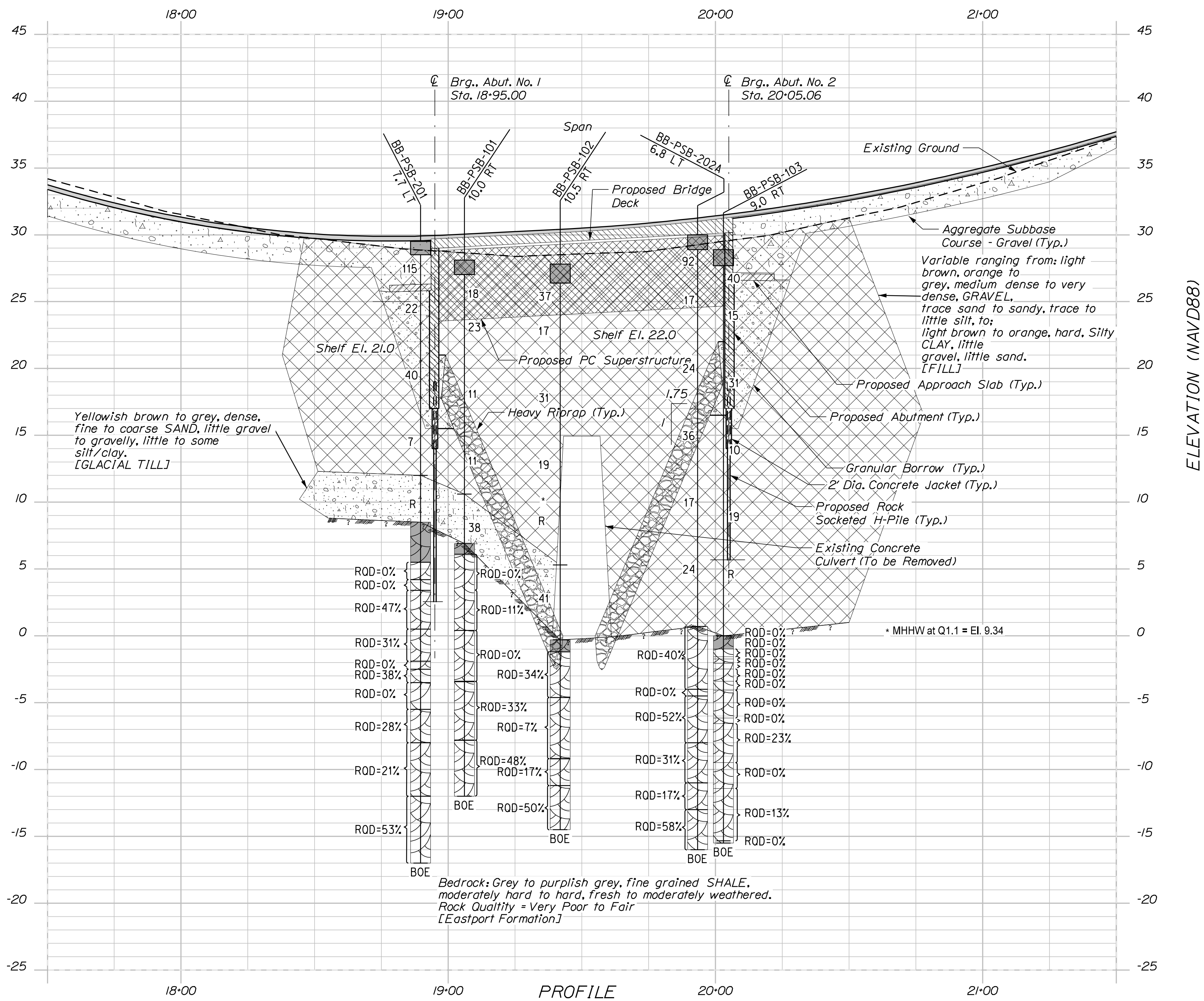
3) As-drilled boring locations for borings BB-PSB-201 through BB-PSB-202A were located using tape ties and should be considered accurate to the degree implied.

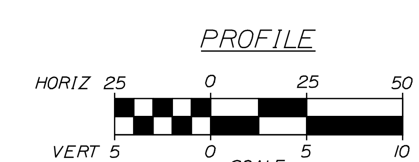
4) Boring BB-PSB-202 is not shown since offset boring BB-PSB-202A was drilled approximately 2 feet away. Boring BB-PSB-202A shown in the profile contains the blow counts from boring BB-PSB-202 since boring BB-PSB-202A was drilled straight down to bedrock without performing SPTs.

5) This generalized interpretive soil profile is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and have been developed by interpretations of widely spaced explorations and samples. Actual soil transitions may vary and are probably more erratic. For more information refer to the boring logs.

LEGEND







STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

APPROVED	DATE
COMMISSIONER:	
CHIEF ENGINEER:	

	BY	DATE
PROJ. MANAGER	M. JOHNESCU	
DESIGN-DETAILED	M. JOHNESCU	
CHECKED-REVIEWED	Y. SOJO	7/17/2025
DESIGN2-DETAILED2	N. BETANOUR	8/5/2025
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

BRIDGE NO. 2774
CROSSING SMELT BROOK
PERRY

INTERPRETIVE SUBSURFACE PROFILE

SHEET NUMBER
3
OF 3

Username: SOJO YONATHAN Date:8/5/2025
Division:
Filename: ...\SHT\003_GeoProfile-Perry.dgn

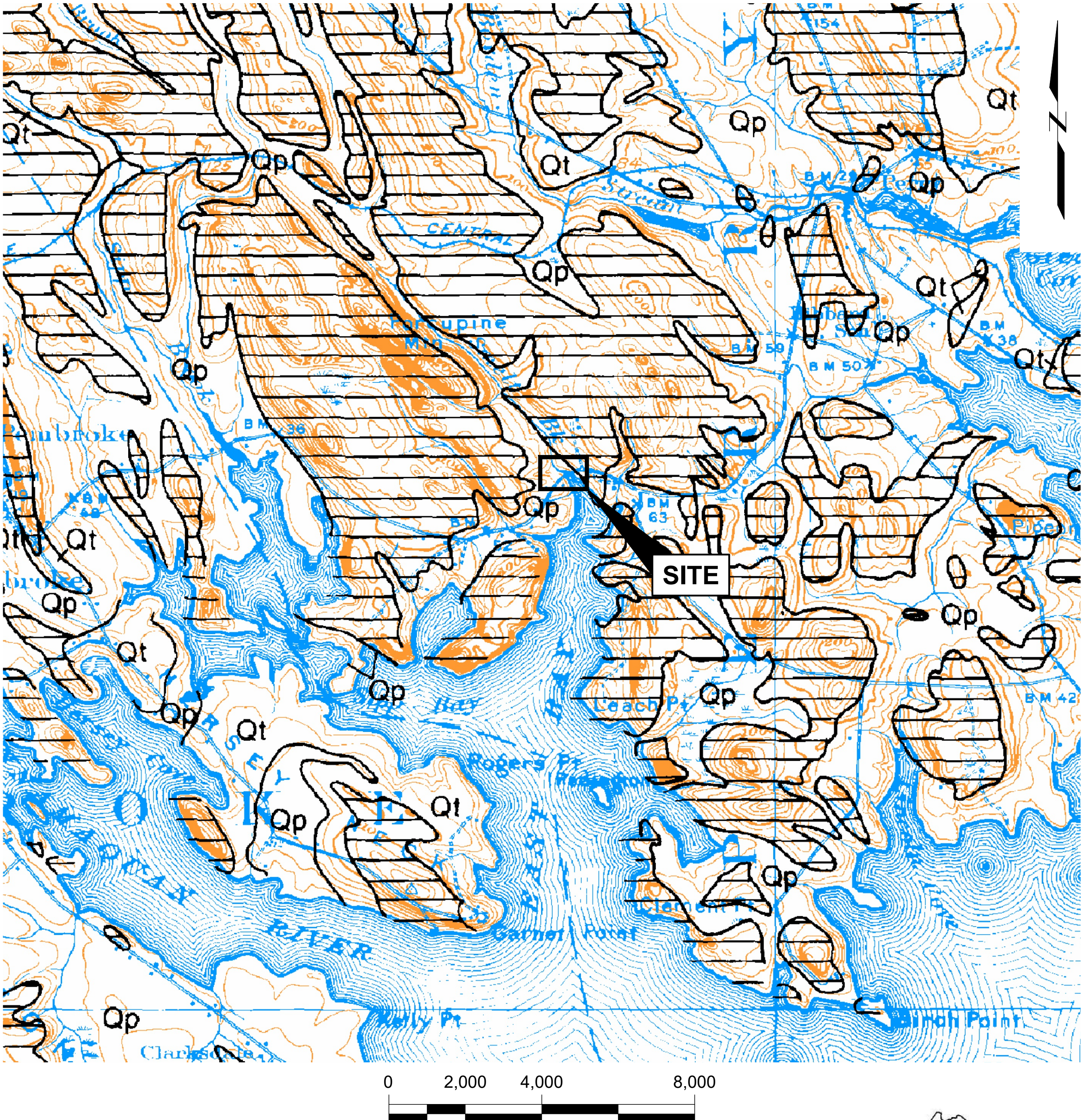
Filename: B:\Working\THORNTON TOMASETTI\2502334 MaineDOT Downeast Bridges Phase II\00__CAD\DGN\02__Perry\SHT\003__GeoProfile-Perry.dgn

Appendix A Geology

A.1. Surficial Geology Map

A.2. Bedrock Geology

A.1. Surficial Geology Map



LEGEND:

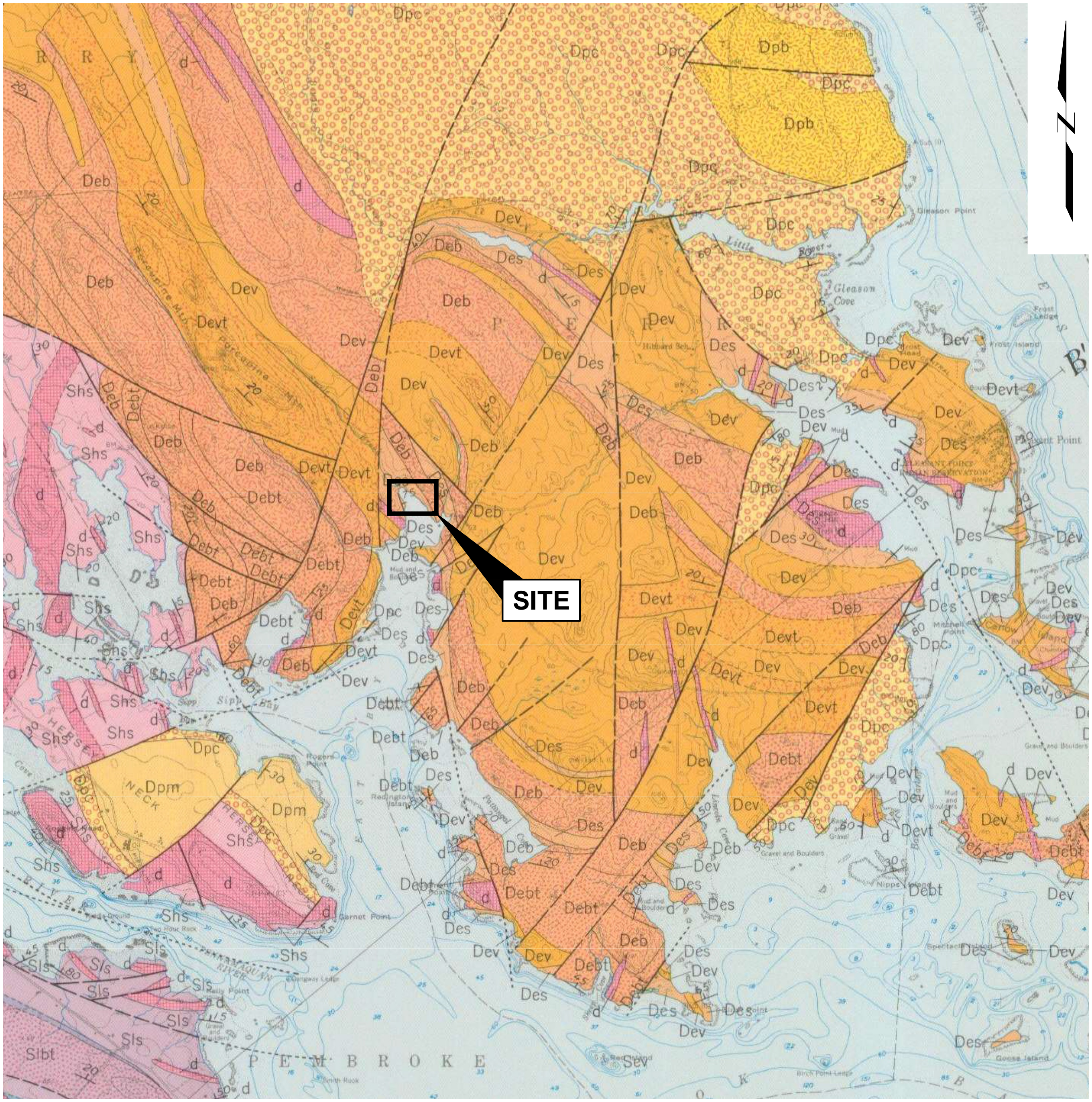
Qp - Glacial-marine deposits (Presumpscot Formation): Silt, clay and sand. Commonly a clayey silt, but sand is very abundant at the surface in some places. Low permeability silt and clay.
Qt - Till: Heterogeneous mixture of sand, silt, clay, and stones.
Ruled pattern Indicates areas of many outcrops and/or surficial deposits (generally less than 10 ft. thick).

SOURCE:

Map created with Maine Surficial Geology 1:62,500 Maps from Maine Geological Survey. The project site is located on the Eastport Quadrangle, Maine, prepared by Harold W. Borns, Jr in 1975.

Smelt Brook Bridge (#2774) over Smelt Brook WIN 026630.07 Perry, Maine	GEI Consultants	SURFICIAL GEOLOGY MAP
Thornton Tomasetti Portland, Maine	Project 2502334	Aug. 2025 Fig. A-1

A.2. Bedrock Geology Map



LEGEND:

Des - Eastport Formation: Grey, green, locally maroon siltstone and shale. A few conglomerate lenses. Ostracodes, pelecypods, gastropods, lingulas.

SOURCE:

Map created with Maine Bedrock Geology 1:48,000 Maps from Maine Geological Survey. The project site is located on Eastport Quadrangle, Maine, prepared by Olcott Gates in 1975.

Smelt Brook Bridge (#2774) over Smelt Brook WIN 026630.07 Perry, Maine	GEI Consultants	BEDROCK GEOLOGY MAP
Thornton Tomasetti Portland, Maine	Project 2502334	Aug. 2025 Fig. A-2

Appendix B   Boring Logs and Core Photographs

B.1. Boring Logs

B.2. Rock Core Photographs

B.3. Automatic Hammer Calibration Report Summary Tables

B.1. Boring Logs

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS (more than half of material is larger than No. 200 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

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

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_{60}-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_{60}-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):

$$RQD\ (\%) = \frac{\text{sum of the lengths of intact pieces of core* > 4 inches}}{\text{length of core advance}}$$

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

Rock Quality Based on RQD

Rock 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 quality (very poor, poor, etc.)
ref: ASTM D6032 and FHWA NHI-16-072 GEC 5 - Geotechnical Site Characterization, Table 4-12
Recovery (inch/inch and percentage)
Rock Core Rate (X.X ft - Y.Y ft (min:sec))

Sample Container Labeling Requirements:

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

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	**Project:** Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook **Location:** Perry, Maine	**Boring No.:** BB-PSB-101 **WIN:** 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	28.1	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	G. McDougal	**Datum:**	NAVD88	**Sampler:**	Standard 2" and 3" Split Spoon
Logged By:	M. Schoeff	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	4/17/2024 - 4/18/2024	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N 409615.8, E 2496331.3	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	18.7 ft bgs
Hammer Efficiency Factor:	0.765	**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
$S_{u/r}$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane 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	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA			13" ASPHALT	
	1D	24/11	1.5 - 3.5	9/9/5/7	14	18		27.0		1.1 Brown and grey, damp, very stiff, SILT, some sand, some gravel, (Fill).	A-4(0), ML WC=12.6%
	2D	24/5	4.0 - 6.0	6/10/8/16	18	23	12¹			Brown and grey, damp, medium dense, fine to coarse SAND, some gravel, little silt, (Fill). ¹12 blows for 0.4 ft.	
5							88				
							84				
							57				
							57				
	3D	24/2	9.0 - 11.0	6/4/5/3	9	11	19			Brown and grey, moist, medium dense, GRAVEL, little sand, trace silt, (Fill). Poor recovery with 2-inch spoon. Ran a 3-inch spoon at the same interval and recovered a 2.5-inch rock in tip of 3-inch spoon.	
10							24				
							42				
							97				
							103				
	4D	24/1	14.0 - 16.0	12/5/4/4	9	11	19			Brown and grey, moist, medium dense, GRAVEL, some sand, trace silt, (Fill). Poor recovery with 2-inch spoon. Ran a 3-inch spoon at the same interval and recovered a 11-inch of material.	A-1-a, GW WC=13.0%
15							34				
							31				
							101	10.6		17.5	
							117				
	5D	24/11	19.0 - 21.0	20/12/18/26	30	38	60			Yellowish brown and grey, wet, dense, Gravelly SAND, little silt, (Glacial Till).	A-1-b, GM WC=12.6%
20							108				
							RC	6.9		21.2 Approximate Top of Bedrock at Elev. 6.9 ft. Roller Cone ahead to 22 ft bgs.	
	R1	32/32	22.0 - 24.7	RQD = 0%			NQ			R1: Bedrock: Grey, fine grained SHALE, mod. hard to hard, fresh to slightly weathered, low angle to vertical, very close to close, tight to open joints with silt infilling. [Eastport Formation] Rock Quality: Very Poor	
25	R2	36/36	24.7 - 27.7	RQD = 11%							

Remarks:

1. Automatic hammer NEBC D-28. Energy Transfer Ratio = 0.765.
2. Water level measured at beginning of shift on 4/18 at 7:42.
3. Borehole backfilled with bentonite chips, soil, and gravel. Patched with cold patch asphalt.

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:	Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook	**Boring No.:**	BB-PSB-101		
Location:	Perry, Maine	**WIN:**	026630.07		
Driller:	New England Boring Contractors	**Elevation (ft.)**	28.1	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	G. McDougal	**Datum:**	NAVD88	**Sampler:**	Standard 2" and 3" Split Spoon
Logged By:	M. Schoeff	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	4/17/2024 - 4/18/2024	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N 409615.8, E 2496331.3	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	18.7 ft bgs
Hammer Efficiency Factor:	0.765	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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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
$S_{u/r}$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane 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										100% Recovery R1: Core Times (min:sec) 22.0-23.0 ft (3:43) 23.0-24.0 ft (4:16) 24.0-24.7 ft (4:59)	
	R3	46/46	27.7 - 31.5	RQD = 0%						R2: Bedrock: Grey, fine grained SHALE, mod. hard to hard, slightly weathered, low angle to steep, very close to close, tight to open joints with silt infilling. [Eastport Formation] Rock Quality: Very Poor 100% Recovery R2: Core Times (min:sec) 24.7-25.7 ft (6:06) 25.7-26.7 ft (5:45) 26.7-27.7 ft (9:08)	
30	R4	53/52	31.5 - 35.9	RQD = 33%						R3: Bedrock: Grey, fine grained SHALE, mod. hard to hard, fresh to slightly weathered, low angle to steep, very close to close, tight to open joints with silt infilling. Granite intrusion at 38". [Eastport Formation] Rock Quality: Very Poor 100% Recovery R3: Core Times (min:sec) 27.7-28.7 ft (3:34) 28.7-29.7 ft (1:50) 29.7-30.7 ft (2:16) 30.7-31.5 ft (3:09)	q_p = 936 ksf
35	R5	50/50	35.9 - 40.1	RQD = 48%						R4: Bedrock: Grey, fine grained SHALE, mod. hard to hard, fresh to slightly weathered, low angle to vertical, very close to close, tight to open joints with silt infilling. [Eastport Formation] Rock Quality: Poor 98% Recovery R4: Core Times (min:sec) 31.5-32.5 ft (4:08) 32.5-33.5 ft (3:02) 33.5-34.5 ft (2:43) 34.5-35.5 ft (2:44) 35.5-35.9 ft (2:12)	q_p = 1386 ksf
40								-12.0		R5: Bedrock: Grey, fine grained SHALE, mod. hard to hard, fresh to slightly weathered, low angle to vertical, very close to close, tight to open joints with silt infilling. [Eastport Formation] Rock Quality: Poor 100% Recovery R5: Core Times (min:sec) 35.9-36.9 ft (2:01) 36.9-37.9 ft (2:20) 37.9-38.9 ft (2:02) 38.9-39.9 ft (1:47) 39.9-40.1 ft (1:30) 40.1	
45										**Bottom of Exploration at 40.1 feet below ground surface.**	
50											

Remarks:

1. Automatic hammer NEBC D-28. Energy Transfer Ratio = 0.765.
2. Water level measured at beginning of shift on 4/18 at 7:42.
3. Borehole backfilled with bentonite chips, soil, and gravel. Patched with cold patch asphalt.

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: Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook
Location: Perry, Maine

Boring No.: BB-PSB-102
WIN: 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	27.8	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	G. McDougal	**Datum:**	NAVD88	**Sampler:**	Standard 2" and 3" Split Spoon
Logged By:	M. Schoeff	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	4/16/2024 - 4/17/2024	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N 409632.5, E 2496363.1	**Casing ID/OD:**	4.00"/4.50" (HW-4")	**Water Level*:**	Not Encountered
Hammer Efficiency Factor:	0.765	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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WOR/C = Weight of Rods or Casing
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$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
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N-uncorrected = Raw Field SPT N-value
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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	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA			17" ASPHALT	
	1D	24/8	1.4 - 3.4	11/16/13/12	29	37		26.4		1.4 Brown and grey, damp, dense, fine to coarse SAND, some gravel, trace silt, (Fill).	
	2D	24/10	4.0 - 6.0	7/6/7/8	13	17	25			Yellowish brown and grey, moist, very stiff, Silty CLAY, little gravel, little sand, (FILL).	A-7-6, CL WC=21.5% LL=40.1 PL=22.9 PI=17.2
5							31				
							98				
							126				
							82				
	3D	24/5	9.0 - 11.0	15/9/15/13	24	31	46			Grey, wet, dense, GRAVEL, little coarse sand, trace silt, (Fill).	
10							54				
							69				
							49				
							41				
	4D	24/4	14.0 - 16.0	7/7/8/7	15	19	23			Grey and brown, wet, medium dense, GRAVEL, little sand, little silt, (Fill). Poor recovery with 2-inch spoon. Ran a 3-inch spoon at the same interval and recovered a 2-inch gravel in tip of 3-inch spoon.	
15							35				
							57				
							122				
							162				
	5D	5/4	19.0 - 19.4	50(5")	--	--	162			Grey, wet, GRAVEL, little sand, (Fill). Poor recovery with 2-inch spoon. Ran a 3-inch spoon at the same interval and recovered a 2-inch gravel in tip of 3-inch spoon.	
20							83				
							55				
							74	5.3		22.5	
							97				
25	6D	24/4	24.0 - 26.0	18/17/15/36	32	41	43			Yellowish brown and grey, wet, dense, Gravelly SAND, little silt, (Glacial Till).	A-1-b, GM WC=12.0%

Remarks:

1. Automatic hammer NEBC D-28. Energy Transfer Ratio = 0.765.
2. Borehole backfilled with gravel and patched with cold patch asphalt.

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: Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook
Location: Perry, Maine

Boring No.: BB-PSB-102

WIN: 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	27.8	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	G. McDougal	**Datum:**	NAVD88	**Sampler:**	Standard 2" and 3" Split Spoon
Logged By:	M. Schoeff	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	4/16/2024 - 4/17/2024	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N 409632.5, E 2496363.1	**Casing ID/OD:**	4.00"/4.50" (HW-4")	**Water Level*:**	Not Encountered
Hammer Efficiency Factor:	0.765	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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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.)	Laboratory Testing Results/ AASHTO and Unified Class.
25							99		
							76		
							179		
							30[1]	-0.3	
	R1	41/40	29.0 - 32.4	RQD = 34%			NQ		
30									q_p = 636 ksf
	R2	55/55	32.4 - 37.0	RQD = 7%					
35									
	R3	24/22	37.0 - 39.0	RQD = 17%					
	R4	40/38	39.0 - 42.3	RQD = 50%					
40									
								-14.5	
45									
50									

Visual Description and Remarks

Poor recovery with 2-inch spoon. Ran a 3-inch spoon at the same interval and recovered a 12-inch of material.

[1]30 blows for 0.1 ft.
Roll ahead to 29 ft bgs.

28.1

Approximate Top of Bedrock at Elev. -0.3 ft.
R1: Bedrock: Purplish grey, fine grained SHALE, hard, fresh to slightly weathered, low angle to steep, very close to close, tight to open joints with silt infilling.
[Eastport Formation]
Rock Quality: Poor
98% Recovery
R1: Core Times (min:sec)
29.0-30.0 ft (3:17)
30.0-31.0 ft (4:10)
31.0-32.0 ft (3:44)
32.0-32.4 ft (2:32)
R2: Bedrock: Purplish grey, fine grained SHALE, hard, fresh to very slightly weathered, low angle to steep, very close to close, tight joints with silt infilling.
[Eastport Formation]
Rock Quality: Very Poor
100% Recovery
R2: Core Times (min:sec)
32.4-33.4 ft (5:01)
33.4-34.4 ft (3:28)
34.4-35.4 ft (3:09)
35.4-36.4 ft (2:57)
36.4-37.0 ft (2:21)
R3: Bedrock: Purplish grey to grey, fine grained SHALE, hard, fresh to very slightly weathered, low angle to steep, very close to close, tight joints with silt infilling.
[Eastport Formation]
Rock Quality: Very Poor
92% Recovery
R3: Core Times (min:sec)
37.0-38.0 ft (3:18)
38.0-39.0 ft (2:35)
R4: Bedrock: Purplish grey to grey, fine grained SHALE, hard, fresh to very slightly weathered, low angle to steep, very close to close, tight to open joints with silt infilling.
[Eastport Formation]
Rock Quality: Poor
95% Recovery
R4: Core Times (min:sec)
39.0-39.3 ft (2:07)
39.3-40.3 ft (5:12)
40.3-41.3 ft (5:06)
41.3-42.3 ft (4:59)

Remarks:

1. Automatic hammer NEBC D-28. Energy Transfer Ratio = 0.765.
2. Borehole backfilled with gravel and patched with cold patch asphalt.

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:** Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook **Location:** Perry, Maine	**Boring No.:** BB-PSB-102 **WIN:** 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	27.8	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	G. McDougal	**Datum:**	NAVD88	**Sampler:**	Standard 2" and 3" Split Spoon
Logged By:	M. Schoeff	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	4/16/2024 - 4/17/2024	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N 409632.5, E 2496363.1	**Casing ID/OD:**	4.00"/4.50" (HW-4")	**Water Level*:**	Not Encountered
Hammer Efficiency Factor: 0.765		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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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
$S_{u/r}$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane 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.
50										42.3 **Bottom of Exploration at 42.3 feet below ground surface.**	
55											
60											
65											
70											
75											

Remarks:

1. Automatic hammer NEBC D-28. Energy Transfer Ratio = 0.765.
2. Borehole backfilled with gravel and patched with cold patch asphalt.

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Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	Project: Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook Location: Perry, Maine	Boring No.: BB-PSB-103 WIN: 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	28.9	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	G. McDougal	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	M. Schoeff	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	4/12/2024 - 4/16/2024	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N 409659.8, E 2496416.9	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	24.3 ft bgs
Hammer Efficiency Factor:	0.765	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
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R = Rock Core Sample
SSA = Solid Stem Auger
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RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
$S_{u/r}$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane 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)
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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	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA			14" ASPHALT	
	1D	24/9	1.2 - 3.2	17/20/11/20	31	40		27.7		1.2 Brown and grey, damp, dense, fine to coarse SAND, some gravel, little silt, (Fill).	
							54				
	2D	24/4	4.0 - 6.0	7/7/5/5	12	15	33			Brown, wet, medium dense, Gravelly fine to coarse SAND, some silt, (Fill)	
5							31				
							23				
							35				
							34				
	3D	24/1	9.0 - 11.0	9/9/15/13	24	31	15			Grey and reddish brown, wet, dense, GRAVEL, (Fill).	A-1-a, GP WC=0.5%
10							41				
							29				
							34				
							41				
	4D	24/1	14.0 - 16.0	6/4/4/4	8	10	17			Gravel in tip.	
15							30				
							61				
							44				
							52				
	5D	24/1	19.0 - 21.0	11/7/8/8	15	19	15			Grey, wet, medium dense, GRAVEL, trace silt, (Fill).	
20							60				
							52				
							48				
							103				
25	6D	7/0	24.0 - 24.6	46/50(2")	--	--	39			No recovery. Roll ahead of casing 24 to 29.9 ft bgs. No returns from 24 to 29.0 ft bgs	

Remarks:

1. Automatic hammer NEBC D-28. Energy Transfer Ratio = 0.765.
2. Water level in boring measured before drilling activities on 4/ 16/24 at 8:00.
3. Borehole backfilled with gravel and patched with cold patch asphalt.

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* 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: Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook
Location: Perry, Maine

Boring No.: BB-PSB-103
WIN: 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	28.9	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	G. McDougal	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	M. Schoeff	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	4/12/2024 - 4/16/2024	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N 409659.8, E 2496416.9	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	24.3 ft bgs
Hammer Efficiency Factor: 0.765		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
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V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
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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
$S_{u/r}$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane 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	Laboratory Testing Results/ AASHTO and Unified Class.
25							63			
							72			
							89			
							126			
	MD	0/0	29.9 - 29.9	50(0")			57[1]	0.0		
30	R1	7/6	29.9 - 30.5	RQD = 0%						
	R2	2/0	30.5 - 30.7	RQD = 0%			NQ			
	R3	4/4	30.7 - 31.0	RQD = 0%						
	R4	5/5	31.0 - 31.4	RQD = 0%						
	R5	11/8	31.4 - 32.3	RQD = 0%						
	R6	8/8	32.3 - 33.0	RQD = 0%						
	R7	25/25	33.0 - 35.1	RQD = 0%						
35	R8	5/4	35.1 - 35.5	RQD = 0%						
	R9	35/35	35.5 - 38.4	RQD = 23%						
	R10	23/23	38.4 - 40.3	RQD = 0%						
40	R11	47/46	40.3 - 44.2	RQD = 13%						
	R12	2/0	44.2 - 44.4	RQD = 0%				-15.5		
45										
50										

Visual Description and Remarks

when rolling ahead.
Probable boulder/cobble 24.7 to 25.1 ft bgs.

Probable boulder/cobble 27.0 to 27.7 ft bgs.

Wood chips in returns at 28.3 ft bgs when washing out casing.

28.9

Approximate Top of Bedrock at Elev. 0.0 ft.
Roll ahead to 29.9 ft bgs.
[1]57 blows for 0.9 ft.
R1: Bedrock: Purplish grey to grey, fine grained SHALE, mod. hard, slightly weathered, mod. dipping to steep, close, tight joints with silt infilling.
[Eastport Formation]
Rock Quality: Very Poor
86% Recovery
R1: Core Times (min:sec)
29.9-30.5 ft (10:31)
R2: No recovery
R2: Core Times (min:sec)
30.5-30.7 ft (3:06)
R3: Bedrock: Purplish grey to grey, fine grained SHALE, mod. hard, slightly weathered, mod. dipping to steep, very close, open joints with silt infilling.
[Eastport Formation]
Rock Quality: Very Poor
100% Recovery
R3: Core Times (min:sec)
30.7-31.0 ft (4:25)
R4: Bedrock: Purplish grey to grey, fine grained SHALE, mod. hard, moderate weathered, low angle to vertical, very close, tight to open joints with clay infilling.
[Eastport Formation]
Rock Quality: Very Poor
100% Recovery
R4: Core Times (min:sec)
31.0-31.4 ft (3:03)
R5: Bedrock: Purplish grey to grey, fine grained SHALE, hard, slightly weathered, horizontal to steep, very close to close, tight to open joints with silt infilling.
[Eastport Formation]
Rock Quality: Very Poor
75% Recovery
R5: Core Times (min:sec)
31.4-32.3 ft (11:55)
R6: Bedrock: Purplish grey to grey, fine grained SHALE, hard, slightly weathered, horizontal to steep, very close to close, tight to open joints with silt infilling.
[Eastport Formation]
Rock Quality: Very Poor
100% Recovery
R6: Core Times (min:sec)

Remarks:

1. Automatic hammer NEBC D-28. Energy Transfer Ratio = 0.765.
2. Water level in boring measured before drilling activities on 4/ 16/24 at 8:00.
3. Borehole backfilled with gravel and patched with cold patch asphalt.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook
Location: Perry, Maine

Boring No.: BB-PSB-103
WIN: 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	28.9	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	G. McDougal	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	M. Schoeff	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	4/12/2024 - 4/16/2024	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N 409659.8, E 2496416.9	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	24.3 ft bgs
Hammer Efficiency Factor: 0.765		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
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MV = Unsuccessful Field Vane Shear Test Attempt
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SSA = Solid Stem Auger
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WOH = weight of 140lb. hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
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$S_{u(lab)}$ = Lab Vane 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.
50										32.3-33.0 ft (7:28) R7: Bedrock: Purplish grey to grey, fine grained SHALE, mod. hard to hard, slightly weathered, horizontal to steep, very close, tight to open joints with silt infilling. [Eastport Formation] Rock Quality: Very Poor 100% Recovery R7: Core Times (min:sec) 33.0-34.0 ft (8:27) 34.0-35.0 ft (11:22) 35.0-35.1 ft (3:20)	
55										R8: Bedrock: Purplish grey to grey, fine grained SHALE, mod. hard to hard, slightly weathered, horizontal to steep, very close, tight to open joints with silt infilling. [Eastport Formation] Rock Quality: Very Poor 80% Recovery R8: Core Times (min:sec) 35.1-35.5 ft (3:52) R9: Bedrock: Purplish grey to grey, fine grained SHALE, mod. hard to hard, slightly weathered, low angle to steep, very close to close, tight to open joints with silt infilling.	
60										[Eastport Formation] Rock Quality: Very Poor 100% Recovery R9: Core Times (min:sec) 35.5.4-36.5 ft (8:04) 36.5.4-37.5 ft (9:55) 37.5.4-38.4 ft (6:57) R10: Bedrock: Purplish grey to grey, fine grained SHALE, mod. hard to hard, slightly weathered, low angle to steep, very close to close, tight joints with silt infilling.	
65										[Eastport Formation] Rock Quality: Very Poor 100% Recovery R10: Core Times (min:sec) 38.4-38.5 ft (0:37) 38.5-39.5 ft (8:00) 39.5-40.3 ft (9:43) R11: Bedrock: Purplish grey to grey, fine grained SHALE, hard, slightly weathered, low angle to mod. dipping, very close to close, tight to open joints with silt infilling. [Eastport Formation]	
70										Rock Quality: Very Poor 100% Recovery R11: Core Times (min:sec) 40.3-41.3 ft (7:52) 41.3-42.3 ft (2:43) 42.3-43.3 ft (2:18) 43.3-44.2 ft (2:48) R12: No Recovery. R12: Core Times (min:sec) 44.2-44.4 ft (1:49)	
75										44.4	

Remarks:

1. Automatic hammer NEBC D-28. Energy Transfer Ratio = 0.765.
2. Water level in boring measured before drilling activities on 4/ 16/24 at 8:00.
3. Borehole backfilled with gravel and patched with cold patch asphalt.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook
Location: Perry, Maine

Boring No.: BB-PSB-103
WIN: 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	28.9	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	G. McDougal	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	M. Schoeff	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	4/12/2024 - 4/16/2024	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N 409659.8, E 2496416.9	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	24.3 ft bgs
Hammer Efficiency Factor: 0.765		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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WOH = weight of 140lb. hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
$S_{u/r}$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
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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.
75										**Bottom of Exploration at 44.4 feet below ground surface.**	
80											
85											
90											
95											
100											

Remarks:

1. Automatic hammer NEBC D-28. Energy Transfer Ratio = 0.765.
2. Water level in boring measured before drilling activities on 4/ 16/24 at 8:00.
3. Borehole backfilled with gravel and patched with cold patch asphalt.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook
Location: Perry, Maine

Boring No.: BB-PSB-201
WIN: 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	29.5	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	B. Enos	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	S. Carvajal	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	5/14/25 - 5/14/25	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N:409622.9, E:2496308.3	**Casing ID/OD:**	HW-4" & NW-3'	**Water Level*:**	NM
Hammer Efficiency Factor:	0.834	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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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
$S_{u/r}$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane 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	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA	28.5		12" ASPHALT 1.0	
	1D	24/24	1.0 - 3.0	59/48/35/27	83	115				Dark to light brown to grey, dry, very dense, fine to coarse SAND, some gravel, trace silt, hydrocarbon odor, (Fill).	
	2D	24/6	4.0 - 6.0	7/7/9/22	16	22	SPIN			Light brown, grey, medium dense, Sandy GRAVEL, trace silt, hydrocarbon odor, (Fill).	A-1-a, GW-GM WC=2.3%
5							SPIN				
							65				
							83				
							60*			*60 blows for 0.9 ft.	
	3D	24/8	9.0 - 11.0	7/18/11/7	29	40	37			Light brown to orange, wet, hard, Silty CLAY, little gravel, little sand, (Fill). Roll ahead of casing to 14 ft.	A-6, CL WC=20.1% LL=38.2 PL=23.5 PI=14.7
10							36				
							38				
							20				
							34				
	4D	24/3	14.0 - 16.0	2/2/3/4	5	7	34			Grey, wet, medium stiff, SILT, little gravel, (Fill).	
15							48				
							61				
							71	12.0		17.5	
							57				
	5D	15/9	19.0 - 20.3	6/31/50(3")	--	--	91			Grey, wet, fine to coarse SAND, some silt, little gravel, trace clay (Glacial Till). *146 blows for 0.5 ft.	A-2(0), SM WC=12.4%
20							146* RC	9.0		20.5 Approximate Top of Bedrock at Elev. 9.0 ft. Roller Cone to 24 ft. Rattling from 20.6 to 24 feet.	
	R1	16/14	24.0 - 25.3	RQD = 0%			CORE			R1: Bedrock: Purplish grey to grey, fine grained, SHALE, mod. hard, fresh to slightly weathered. Joints are mod. dipping, very close to close,	
25											

Remarks:

1. Automatic hammer NEBC D-23. Energy Transfer Ratio = 0.834.
2. Borehole backfilled with soil cuttings and gravel. Patched with cold patch asphalt.
3. The boring coordinates and elevation were estimated using tape ties and a topographic survey provided by MaineDOT, and should be considered accurate to the degree implied.

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Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	**Project:** Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook **Location:** Perry, Maine	**Boring No.:** BB-PSB-201 **WIN:** 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	29.5	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	B. Enos	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	S. Carvajal	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	5/14/25 - 5/14/25	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N:409622.9, E:2496308.3	**Casing ID/OD:**	HW-4" & NW-3'	**Water Level*:**	NM
Hammer Efficiency Factor: 0.834		**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
$S_{u/r}$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane 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.)	Laboratory Testing Results/ AASHTO and Unified Class.
25	R2	10/10	25.3 - 26.1	RQD = 0%					
	R3	35/32	26.1 - 29.0	RQD = 47%					q_p=698
	R4	29/27	29.0 - 31.4	RQD = 31%					
30									
	R5	7/7	31.4 - 32.0	RQD = 0%					
	R6	12/11	32.0 - 33.0	RQD = 38%					
	R7	24/7	33.0 - 35.0	RQD = 0%					
35	R8	30/30	35.0 - 37.5	RQD = 28%					
	R9	48/44	37.5 - 41.5	RQD = 21%					
40									
	R10	60/58	41.5 - 46.5	RQD = 53%					
45									
								-17.0	
50									

Visual Description and Remarks

tight to open with brown silt infilling.
[Eastport Formation]
Rock Quality: Very Poor
88% Recovery
R1: Core Times (min:sec)
24.0 - 25.0 ft (3:02)
25.0 - 25.3 ft (4:08)
R2: Bedrock: Purplish grey to grey, fine grained, SHALE, mod. hard, fresh to slightly weathered. Joint is mod. dipping, very close to close, open. Conglomerate 25.9-26.1 ft.
[Eastport Formation]
Rock Quality: Very Poor
100% Recovery
R2: Core Times (min:sec)
25.3 - 26.1 ft (3:34)
R3: Bedrock: Purplish grey to grey, fine grained, SHALE, mod. hard to hard, fresh. Joints are low angle to steep, very close to close, tight to open. Conglomerate 26.1-26.4 ft.
[Eastport Formation]
Rock Quality: Poor
91% Recovery
R3: Core Times (min:sec)
26.1 - 27.1 ft (2:49)
27.1 - 27.1 ft (3:01)
28.1 - 29.0 ft (2:11)
R4: Bedrock: Purplish grey to greenish grey, fine grained, SHALE, mod. hard to hard, fresh. Joints are low angle to steep, very close to close, tight to open with sand and silt infilling.
[Eastport Formation]
Rock Quality: Poor
93% Recovery
R4: Core Times (min:sec)
29.0 - 30.0 ft (2:59)
30.0 - 31.0 ft (2:19)
31.0 - 31.4 ft (1:43)
R5: Bedrock: Greenish grey to grey, fine grained, SHALE, hard, fresh to slightly weathered. Crushed, calcite vein in bottom piece.
[Eastport Formation]
Rock Quality: Very Poor
100% Recovery
R5: Core Times (min:sec)
31.4 -32.0 ft (4:44)
R6: Bedrock: Greenish grey to grey, fine grained, SHALE, hard, fresh. Joints are low angle to mod dipping, very close to close, tight to open, slickensided.
[Eastport Formation]
Rock Quality: Poor
92% Recovery
R6: Core Times (min:sec)
32.0 - 33.0 ft (4:44)
R7: Bedrock: Grey, fine grained, SHALE, mod. hard to hard, fresh to slightly weathered. Rock is crushed, calcite intrusions.
[Eastport Formation]
Rock Quality: Very Poor

Remarks:

1. Automatic hammer NEBC D-23. Energy Transfer Ratio = 0.834.
2. Borehole backfilled with soil cuttings and gravel. Patched with cold patch asphalt.
3. The boring coordinates and elevation were estimated using tape ties and a topographic survey provided by MaineDOT, and should be considered accurate to the degree implied.

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: Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook
Location: Perry, Maine

Boring No.: BB-PSB-201

WIN: 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	29.5	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	B. Enos	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	S. Carvajal	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	5/14/25 - 5/14/25	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N:409622.9, E:2496308.3	**Casing ID/OD:**	HW-4" & NW-3'	**Water Level*:**	NM
Hammer Efficiency Factor:	0.834	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
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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
$S_{u/r}$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane 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.
50										29% Recovery R7: Core Times (min:sec) 33.0 - 34.0 ft (7:00) 34.0 - 35.0 ft (5:59) R8: Bedrock: Light grey to dark grey, fine grained, SHALE, mod. hard to hard, fresh to mod. weathered. Joints are low angle to steep, very close to close, tight to open, grey sand infilling in bottom 1 foot, slickensided. [Eastport Formation] Rock Quality: Poor 100% Recovery R8: Core Times (min:sec) 35.0 - 36.0 ft (3:52) 36.0 - 37.0 ft (1:09) 37.0 - 37.5 ft (1:29) R9: Bedrock: Grey, fine grained, SHALE, mod. hard to hard, fresh to slightly weathered. Joints are low angle to steep, very close to close, tight to open, grey sand infilling in bottom 1 foot, slickensided. Calcite intrusions/ veins present. [Eastport Formation] Rock Quality: Very Poor 92% Recovery R9: Core Times (min:sec) 37.5 - 38.5 ft (1:29) 38.5 - 39.5 ft (2:18) 39.5 - 40.5 ft (1:51) 40.5 - 41.5 ft (1:59) R10: Bedrock: Grey, fine grained, SHALE, mod. hard to hard, fresh. Joints are horizontal to mod. dipping, very close to close, tight to open. [Eastport Formation] Rock Quality: Fair 97% Recovery R10: Core Times (min:sec) 41.5 - 42.5 ft (2:44) 42.5 - 43.5 ft (2:03) 43.5 - 44.5 ft (2:44) 44.5 - 45.5 ft (2:22) 45.5 - 46.5 ft (2:21) 46.5 **Bottom of Exploration at 46.5 feet below ground surface.**	
55											
60											
65											
70											
75											

Remarks:

1. Automatic hammer NEBC D-23. Energy Transfer Ratio = 0.834.
2. Borehole backfilled with soil cuttings and gravel. Patched with cold patch asphalt.
3. The boring coordinates and elevation were estimated using tape ties and a topographic survey provided by MaineDOT, and should be considered accurate to the degree implied.

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:** Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook **Location:** Perry, Maine	**Boring No.:** BB-PSB-202 **WIN:** 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	30.0	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	B. Enos	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	S. Carvajal	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	5/15/25 - 5/15/25	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NA
Boring Location:	N:409673.9, E:2496408.6	**Casing ID/OD:**	HW-4" & NW-3'	**Water Level*:**	NM
Hammer Efficiency Factor:	0.834	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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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
$S_{u/r}$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane 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			13" ASPHALT	
	1D	24/15	1.1 - 3.1	56/44/22/21	66	92		28.9		1.1 Dark grey to light grey, dry, very dense, Sandy GRAVEL, trace silt, (Fill).	
	2D	24/9	4.0 - 6.0	11/8/4/7	12	17				Brown, damp, medium dense, fine to coarse SAND, some gravel, little silt, (Fill).	
5											
	3D	24/2	9.0 - 11.0	4/14/3/4	17	24	34			Dark brown to black, wet, medium dense, GRAVEL, some sand, little silt, (Fill).	
10							63				
							78				
							84				
							61				
	4D	24/5	14.0 - 16.0	8/17/9/9	26	36	25			Dark brown to black, wet, dense, GRAVEL, trace sand, trace silt, (Fill).	A-1-a, GW WC=4.9%
15							53				
							45				
							19				
							30				
	5D	24/0	19.0 - 21.0	9/7/5/6	12	17	11			No recovery.	
20							21				
							26				
							30				
							26				
25	6D	24/5	24.0 - 26.0	7/10/7/6	17	24	24			Brown to black, wet, medium dense, GRAVEL, little sand, little silt, (Fill).	

Remarks:

1. Automatic hammer NEBC D-23. Energy Transfer Ratio = 0.834.
2. Augered with SSA to 9 feet. Switch to Drive & Wash. Drive 4-in casing to 14 feet. Telescope 3-in casing and drive to 28.5 feet.
3. Borehole was too out of plumb for core barrel. An offset boring was drilled for rock coring 1.5 feet north.
4. Borehole backfilled with soil cuttings and gravel. Patched with cold patch asphalt.
5. The boring coordinates and elevation were estimated using tape ties and a topographic survey provided by MaineDOT, and should be considered accurate to the degree implied.

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

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook
Location: Perry, Maine

Boring No.: BB-PSB-202
WIN: 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	30.0	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	B. Enos	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	S. Carvajal	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	5/15/25 - 5/15/25	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NA
Boring Location:	N:409673.9, E:2496408.6	**Casing ID/OD:**	HW-4" & NW-3'	**Water Level*:**	NM
Hammer Efficiency Factor: 0.834		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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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
$S_{u/r}$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane 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							60				
							45				
							173				
							60*	1.5		*60 blows for 0.5 ft. No water return about 28.5 ft bgs.	
										28.5 **Bottom of Exploration at 28.5 feet below ground surface.**	
30											
35											
40											
45											
50											

Remarks:

1. Automatic hammer NEBC D-23. Energy Transfer Ratio = 0.834.
2. Augered with SSA to 9 feet. Switch to Drive & Wash. Drive 4-in casing to 14 feet. Telescope 3-in casing and drive to 28.5 feet.
3. Borehole was too out of plumb for core barrel. An offset boring was drilled for rock coring 1.5 feet north.
4. Borehole backfilled with soil cuttings and gravel. Patched with cold patch asphalt.
5. The boring coordinates and elevation were estimated using tape ties and a topographic survey provided by MaineDOT, and should be considered accurate to the degree implied.

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: Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook Location: Perry, Maine	Boring No.: BB-PSB-202A WIN: 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	30.0	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	B. Enos	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	S. Carvajal	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	5/15/25 - 5/15/25	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N:409674.5, E:2496410.0	**Casing ID/OD:**		**Water Level*:**	24.3 ft bgs
Hammer Efficiency Factor:	0.834	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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U = Thin Wall Tube Sample
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RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
$S_{u/r}$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane 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	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA			13" ASPHALT	
								28.9		1.1	
5							27				
							29				
							18				
							32				
							82				
10							88				
							153				
							175				
							108				
							84				
15							78				
							78				
							71				
							67				
							68				
20							46			Rattling 20 feet.	
							47				
							66				
							148				
							124			Rattling 24 feet. No return.	
25											

Remarks:
1. Automatic hammer NEBC D-23. Energy Transfer Ratio = 0.834.
2. Boring drilled 1.5 ft north from BB-PSB-202
3. Augered with SSA to 5 feet. Switch to Drive & Wash. Drive 4-in casing to 27 feet. Telescope 3-in casing to core. No water in return during rock coring.
4. Borehole backfilled with soil cuttings and gravel. Patched with cold patch asphalt.
5. The boring coordinates and elevation were estimated using tape ties and a topographic survey provided by MaineDOT, and should be considered accurate to the degree implied.

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: Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook
Location: Perry, Maine

Boring No.: BB-PSB-202A
WIN: 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	30.0	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	B. Enos	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	S. Carvajal	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	5/15/25 - 5/15/25	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N:409674.5, E:2496410.0	**Casing ID/OD:**		**Water Level*:**	24.3 ft bgs
Hammer Efficiency Factor:	0.834	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
$S_{u/r}$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane 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.)	Laboratory Testing Results/ AASHTO and Unified Class.
25							110		
							61		
							SPIN		
							SPIN	1.5	
	1D	5/3	29.0 - 29.4	50(5")	--	--		0.7	
30	R1	56/49	29.3 - 34.0	RQD = 40%					
	R2	6/6	34.0 - 34.5	RQD = 0%					
35	R3	42/42	34.5 - 38.0	RQD = 52%					q_p=960
	R4	36/36	38.0 - 41.0	RQD = 31%					
40									
	R5	24/19	41.0 - 43.0	RQD = 17%					
	R6	36/36	43.0 - 46.0	RQD = 58%					
45								-16.0	
50									

Visual Description and Remarks

28.5
Grey, wet, Gravelly SAND, little silt, (Glacial Till)
29.3
Approximate Top of Bedrock at Elev. 0.7 ft.
R1: Bedrock: Greenish grey to purplish grey, fine grained, SHALE, mod. hard to hard, fresh to slightly weathered. Joints are low angle to steep, very close to close, tight to open, grey and purple sand and silt infilling, slickensided joint.
[Eastport Formation]
Rock Quality: Poor
88% Recovery
R1: Core Times (min:sec)
29.3 - 30.3 ft (3:23)
30.3 - 31.3 ft (2:42)
31.3 - 32.3 ft (1:49)
32.3 - 33.3 ft (2:51)
33.3 - 34.0 ft (1:43)
R2: Bedrock: Purplish grey, fine grained, SHALE, mod. hard, slightly weathered. Joints are mod. dipping to steep, very close, tight to open, rusting in joints, slickensided.
[Eastport Formation]
Rock Quality: Very Poor
100% Recovery
R2: Core Times (min:sec)
34.0 - 34.5 (1:50)
R3: Bedrock: Purplish grey to greenish grey, fine grained, SHALE, mod. hard to hard, fresh to slightly weathered. Joints are horizontal to steep, very close to close, tight to open, grey silt and sand infilling, rusting in joints, slickensided. Calcite instrusion/veins.
[Eastport Formation]
Rock Quality: Fair
100% Recovery
R3: Core Times (min:sec)
34.5 - 35.5 (2:30)
35.5 - 36.5 (2:04)
36.5 - 37.5 (1:48)
37.5 - 38.0 (1:28)
R4: Bedrock: Purplish grey to greenish grey, fine grained, SHALE, mod. hard to hard, fresh to slightly weathered. Joints are low angle to steep, very close to close, tight to open, grey silt and sand infilling, rusting in joints, slickensided. Calcite instrusion/veins in bottom 8".
[Eastport Formation]
Rock Quality: Poor
100% Recovery
R4: Core Times (min:sec)
38.0 - 39.0 (2:25)

Remarks:

1. Automatic hammer NEBC D-23. Energy Transfer Ratio = 0.834.
2. Boring drilled 1.5 ft north from BB-PSB-202
3. Augered with SSA to 5 feet. Switch to Drive & Wash. Drive 4-in casing to 27 feet. Telescope 3-in casing to core. No water in return during rock coring.
4. Borehole backfilled with soil cuttings and gravel. Patched with cold patch asphalt.
5. The boring coordinates and elevation were estimated using tape ties and a topographic survey provided by MaineDOT, and should be considered accurate to the degree implied.

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: Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook
Location: Perry, Maine

Boring No.: BB-PSB-202A
WIN: 026630.07

Driller:	New England Boring Contractors	**Elevation (ft.)**	30.0	**Auger ID/OD:**	5" Solid Stem Auger
Operator:	B. Enos	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	S. Carvajal	**Rig Type:**	Mobile B-53	**Hammer Wt./Fall:**	140 lbs/30"
Date Start/Finish:	5/15/25 - 5/15/25	**Drilling Method:**	Drive & Wash	**Core Barrel:**	NQ-2"
Boring Location:	N:409674.5, E:2496410.0	**Casing ID/OD:**		**Water Level*:**	24.3 ft bgs
Hammer Efficiency Factor: 0.834		**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
$S_{u/r}$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane 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.
50										39.0 - 40.0 (2:40) 40.0 - 41.0 (1:48) R5: Bedrock: Greenish grey to purplish grey, fine grained, SHALE, mod. hard to hard, fresh to slightly weathered. Joints are low angle to steep, very close to close, tight to open, grey silt and sand infilling, slickensided. [Eastport Formation] Rock Quality: Very Poor 79% Recovery R5: Core Times (min:sec) 41.0 - 42.0 (2:18) 42.0 - 43.0 (3:33)	
55										R6: Bedrock: Purplish grey, fine grained, SHALE, mod. hard to hard, fresh to slightly weathered. Joints are low angle to steep, very close to close, tight to open, grey silt and sand infilling. [Eastport Formation] Rock Quality: Fair 100% Recovery R6: Core Times (min:sec) 43.0 - 44.0 (2:20) 44.0 - 45.0 (2:26) 45.0 - 46.0 (3:07)	
60										46.0 **Bottom of Exploration at 46.0 feet below ground surface.**	
65											
70											
75											

Remarks:

1. Automatic hammer NEBC D-23. Energy Transfer Ratio = 0.834.
2. Boring drilled 1.5 ft north from BB-PSB-202
3. Augered with SSA to 5 feet. Switch to Drive & Wash. Drive 4-in casing to 27 feet. Telescope 3-in casing to core. No water in return during rock coring.
4. Borehole backfilled with soil cuttings and gravel. Patched with cold patch asphalt.
5. The boring coordinates and elevation were estimated using tape ties and a topographic survey provided by MaineDOT, and should be considered accurate to the degree implied.

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.

B.2. Rock Core Photographs

MaineDOT

Smelt Brook Bridge #2774 carrying Route 1 over Smelt Brook

Perry, ME

Rock Core Photographs

Boring No.	Run	Depth (ft)	Penetration (in)	Recovery (in)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-PSB-101	R1	22.0-24.7	32	32	0	0	Shale	1
BB-PSB-101	R2	24.7-27.7	36	36	4	11	Shale	1-2
BB-PSB-101	R3	27.7-31.5	46	46	0	0	Shale	2-3
BB-PSB-101	R4	31.5-35.9	53	52	17.5	33	Shale	3-4
BB-PSB-101	R5(0-40'')	35.9-40.1	50	50	24	48	Shale	4

Notes:

1. "Box Row" indicates the section of the box where core run is contained: 1 = top, 4 = bottom.
2. Top of core at left. Increasing depth left to right.

MaineDOT

Smelt Brook Bridge #2774 carrying Route 1 over Smelt Brook

Perry, ME

Rock Core Photographs

Boring No.	Run	Depth (ft)	Penetration (in)	Recovery (in)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-PSB-102	R1	29.0-32.4	41	40	14	34	Shale	1
BB-PSB-102	R2	32.4-37.0	55	55	4	7	Shale	1-2
BB-PSB-102	R3	37.0-39.0	24	22	4	17	Shale	2-3
BB-PSB-102	R4	39.0-42.3	40	38	20	50	Shale	3
BB-PSB-101	R5(40''-50'')	35.9-40.1	50	50	24	48	Shale	4

Notes:

1. "Box Row" indicates the section of the box where core run is contained: 1 = top, 4 = bottom.
2. Top of core at left. Increasing depth left to right.

MaineDOT

Smelt Brook Bridge #2774 carrying Route 1 over Smelt Brook

Perry, ME

Rock Core Photographs

Boring No.	Run	Depth (ft)	Penetration (in)	Recovery (in)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-PSB-103	R1	29.9-30.5	7	6	0	0	Shale	1
BB-PSB-103	R2	30.5-30.7	2	0	0	0	Shale	1
BB-PSB-103	R3	30.7-31.0	4	4	0	0	Shale	-
BB-PSB-103	R4	31.0-31.4	5	5	0	0	Shale	1
BB-PSB-103	R5	31.4-32.3	11	8	0	0	Shale	1
BB-PSB-103	R6	32.3-33.0	8	8	0	0	Shale	1
BB-PSB-103	R7	33.0-35.1	25	25	0	0	Shale	1-2
BB-PSB-103	R8	35.1-35.5	5	4	0	0	Shale	-
BB-PSB-103	R9	35.5-38.4	35	35	8	23	Shale	2
BB-PSB-103	R10	38.4-40.3	23	23	0	0	Shale	2-3
BB-PSB-103	R11	40.3-44.2	47	46	6	13	Shale	3-4
BB-PSB-103	R12	44.2-44.4	2	0	0	0	Shale	-

Notes:

1. “Box Row” indicates the section of the box where core run is contained: 1 = top, 4 = bottom.
2. Top of core at left. Increasing depth left to right.

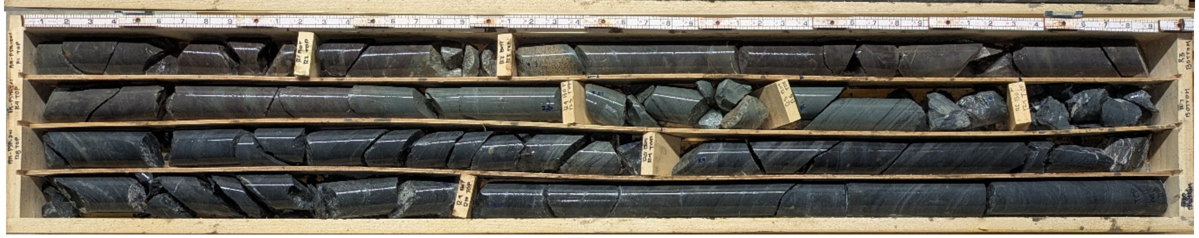
MaineDOT

Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook

Perry, ME

Rock Core Photographs

Boring No.	Run	Depth (ft)	Penetration (in)	Recovery (in)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-PSB-201	R1	24.0-25.3	16	14	0	0	Shale	1
BB-PSB-201	R2	25.3-26.1	10	10	0	0	Shale/Conglomerate	1
BB-PSB-201	R3	26.1-29.0	35	32	16.5	47	Shale/Conglomerate	1
BB-PSB-201	R4	29.0-31.4	29	27	9	31	Shale	2
BB-PSB-201	R5	31.4-32.0	7	7	0	0	Shale	2
BB-PSB-201	R6	32.0-33.0	12	11	4.5	38	Shale	2
BB-PSB-201	R7	33.0-35.0	24	7	0	0	Shale	2
BB-PSB-201	R8	35.0-37.5	30	30	8.5	28	Shale	3
BB-PSB-201	R9	37.5-41.5	48	44	10	21	Shale	3,4
BB-PSB-201	R10	41.5-46.5 (Top 37")	60	58	31.5	53	Shale	4



Notes:

1. "Box Row" indicates the section of the box where core run is contained: 1 = top, 4 = bottom.
2. Top of core at left. Increasing depth left to right.
3. Top photo is dry, bottom photo is wet

MaineDOT

Smelt Brook Bridge (#2774) carrying Route 1 over Smelt Brook
Perry, ME
Rock Core Photographs

Boring No.	Run	Depth (ft)	Penetration (in)	Recovery (in)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-PSB-201	R10	41.5-46.5 (Bot. 23")	60	58	31.5	53	Shale	1
BB-PSB-202A	R1	29.3-34.0	56	49	22.5	40	Shale	1,2
BB-PSB-202A	R2	34.0-34.5	6	6	0	0	Shale	2
BB-PSB-202A	R3	34.5-38.0	42	42	22	52	Shale	2,3
BB-PSB-202A	R4	38.0-41.0	36	36	11	31	Shale	3
BB-PSB-202A	R5	41.0-43.0	24	19	4	17	Shale	4
BB-PSB-202A	R6	43.0-46.0	36	36	21	58	Shale	4

Notes:

4. "Box Row" indicates the section of the box where core run is contained: 1 = top, 4 = bottom.
5. Top of core at left. Increasing depth left to right.
6. Top photo is dry, bottom photo is wet

B.3. Automatic Hammer Calibration Report Summary Tables

TABLE 3 - SUMMARY OF SPT TEST RESULTS
MOBIL B53 - NEBC DRILL RIG #28 (SERIAL NUMBER D28-2/21)

SPT Analyzer Results

PDA-S Ver. 2022.35.2 - Printed: 4/23/2023

Summary of SPT Test Results

Project: Mobil B53 D-28, Test Date: 4/21/2023

BPM: Blows/Minute
FMX: Maximum Force
AMX: Maximum Acceleration
VMX: Maximum Velocity

DMX: Maximum Displacement
DFN: Final Displacement
EMX: Maximum Energy
ETR: Energy Transfer Ratio - Rated

Instr. Length ft	Blows Applied /6"	**N Value**	**N60 Value**	Average BPM bpm	Average FMX kips	Average AMX g's	Average VMX ft/s	Average DMX in	Average DFN in	Average EMX ft-lb	Average ETR %
19.00	**12-19-20-25**	**39**	**49**	50.0	39	3725	14.2	0.42	0.31	252	72.0
24.00	**8-39-26-26**	**65**	**82**	52.7	37	4030	15.1	0.33	0.18	268	76.6
29.00	**5-8-11-13**	**19**	**24**	54.3	40	4426	15.5	0.67	0.63	277	79.2
34.00	**8-7-8-6**	**15**	**19**	54.3	39	3041	14.4	0.83	0.80	270	77.1
39.00	**3-4-6-5**	**10**	**12**	54.2	39	2906	14.4	1.22	1.20	279	79.7
44.00	**11-14-23-15**	**37**	**47**	54.2	40	2694	12.9	0.41	0.32	275	78.7
			Overall Average Values:	52.8	39	3598	14.4	0.49	0.39	268	76.5
			Standard Deviation:	1.6	1	700	1.1	0.26	0.28	11	3.1
			Overall Maximum Value:	55.1	40	5470	17.0	1.50	1.50	288	82.3
			Overall Minimum Value:	49.7	36	2058	12.2	0.25	0.15	240	68.7

Summary of SPT Test Results

Project: Mobil B-53 Drill 23, Test Date: 5/17/2024

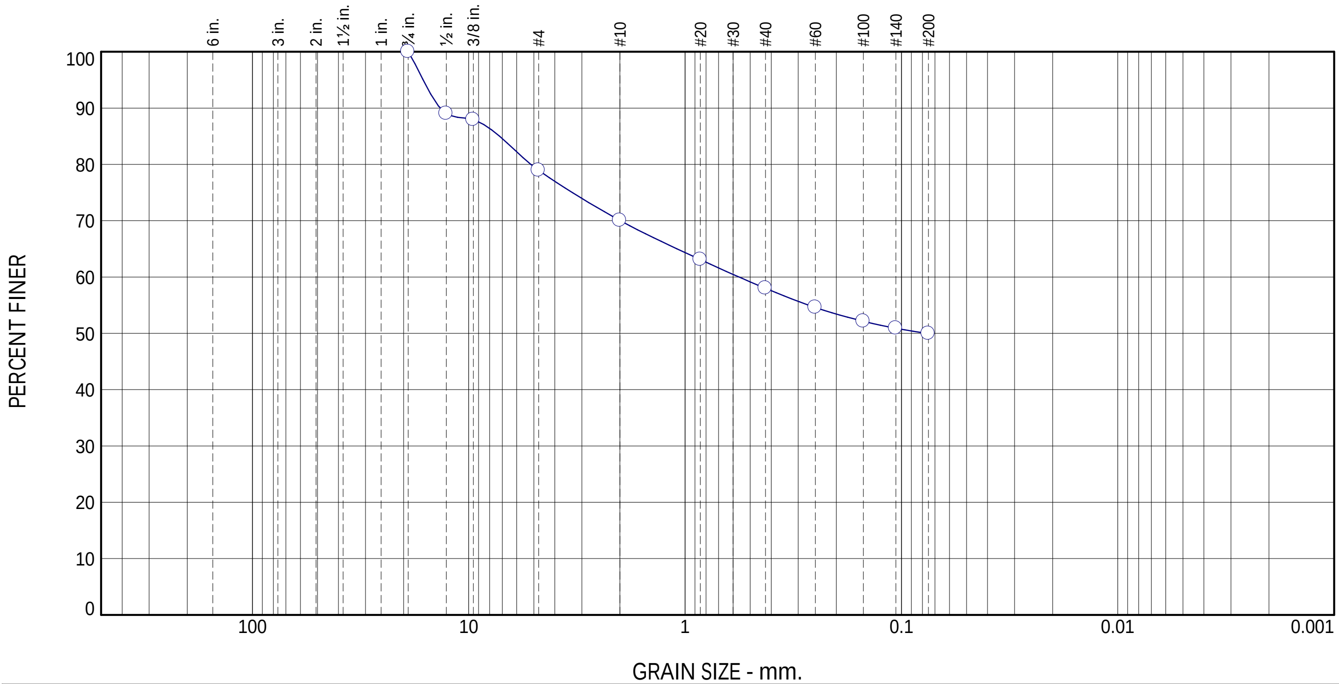
BPM: Blows/Minute
FMX: Maximum Force
AMX: Maximum Acceleration
VMX: Maximum Velocity

DMX: Maximum Displacement
DFN: Final Displacement
EMX: Maximum Energy
ETR: Energy Transfer Ratio - Rated

Instr. Length ft	Blows Applied /6"	**N Value**	**N60 Value**	Average BPM bpm	Average FMX kips	Average AMX g's	Average VMX ft/s	Average DMX in	Average DFN in	Average EMX ft-lb	Average ETR %
19.00	**5-6-5-3**	**11**	**15**	55.6	43	2146	21.3	1.26	1.09	280	80.1
23.00	**7-8-6-7**	**14**	**19**	55.7	42	2272	16.4	0.92	0.86	297	84.8
29.00	**2-6-4-3**	**10**	**13**	55.7	41	2174	17.2	1.37	1.20	288	82.3
31.00	**6-6-5-2**	**11**	**15**	55.7	42	2288	15.0	1.24	1.09	296	84.6
31.00	**3-10-11-9**	**21**	**29**	55.6	42	2130	14.5	0.63	0.57	294	84.1
			Overall Average Values:	55.7	42	2195	16.5	1.01	0.90	292	83.4
			Standard Deviation:	0.1	1	155	2.4	0.34	0.27	8	2.4
			Overall Maximum Value:	56.0	46	2719	21.7	1.77	1.50	313	89.3
			Overall Minimum Value:	55.4	40	1937	14.1	0.60	0.54	275	78.5

Appendix C Laboratory Testing

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	21.1	8.9	12.0	8.1	49.9	

Test Results (ASTM D6913)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)
.75	100.0		
.5	89.0		
.375	87.9		
#4	78.9		
#10	70.0		
#20	63.1		
#40	58.0		
#60	54.6		
#100	52.2		
#140	50.9		
#200	49.9		

* (no specification provided)

Material Description

Gravelly, Sandy SILT

Sieve Test (ASTM D6913)

Test Date: 5/1/2024 Technician: sjr

Test Notes

Entire sample tested. Moisture Content = 12.6 %

Hydrometer Test

Test Date: ______ Technician: ______

Test Notes

Atterberg (ASTM D4318)

PL= LL= PI=

Coefficients

D_{90}= 13.5605 D_{85}= 7.2013

D_{60}= 0.5633 D_{50}= 0.0767

D_{30}= D_{15}=

D_{10}=

C_u= C_c=

USCS (ASTM D2487)

ML

Date Sampled: 4/11-18/2024

Date Received: 4/26/2024

Checked By: sjr

Title: ______

Source of Sample: BB-PSB-101 Depth: 1.5 - 3.5

Sample Number: 1D

Soil Metrics LLC

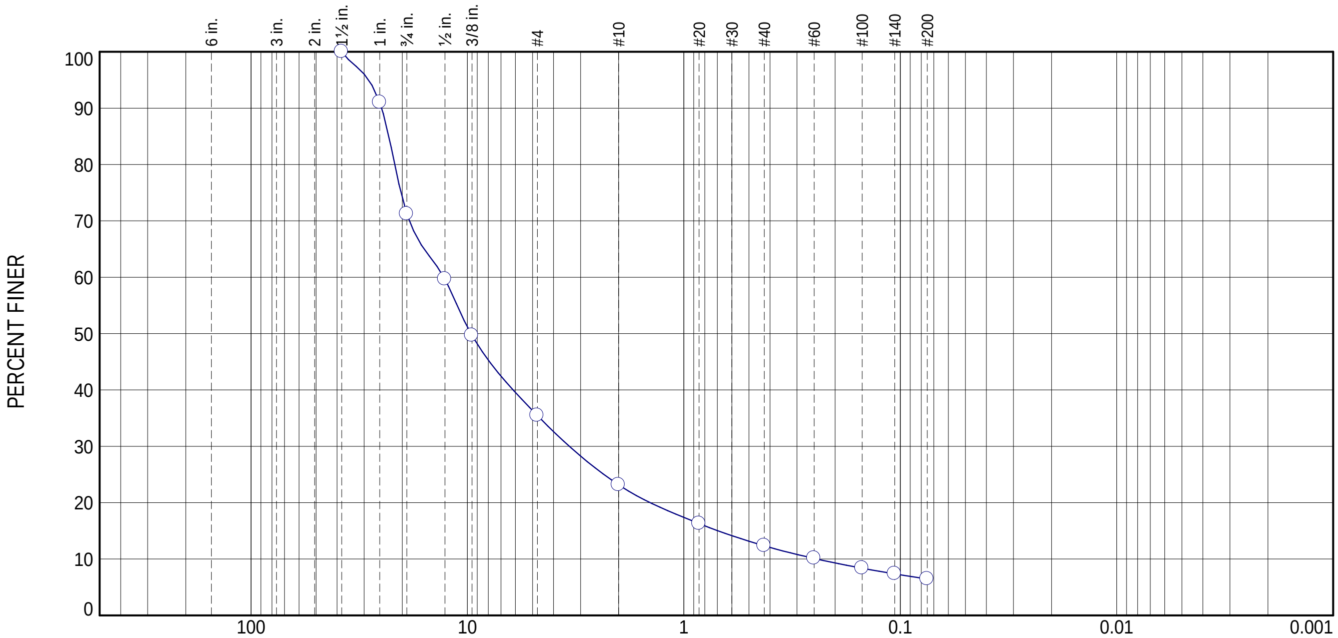
Cape Elizabeth, Maine

Client: GEI Consultants

Project: WIN 026630.07 Smelt Brook Bridge (#2774)

Project No: GEI PN 2400963, Task 2.1 Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	28.8	35.7	12.3	10.9	5.8	6.5	

Test Results (ASTM D6913)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)
1.5	100.0		
1	91.0		
.75	71.2		
.5	59.7		
.375	49.7		
#4	35.5		
#10	23.2		
#20	16.3		
#40	12.3		
#60	10.1		
#100	8.4		
#140	7.4		
#200	6.5		

* (no specification provided)

Material Description

Sandy fine to coarse GRAVEL, trace silt

Atterberg (ASTM D4318)

PL= LL= PI=

Coefficients

D_{90}= 24.8961 D_{85}= 23.0858
D_{60}= 12.8444 D_{50}= 9.6430
D_{30}= 3.3803 D_{15}= 0.6958
D_{10}= 0.2432
C_u= 52.81 C_c= 3.66

Sieve Test (ASTM D6913)

Test Date: 5/1/2024 Technician: sjr

Test Notes

Entire sample tested. Moisture Content = 13.0 %

USCS (ASTM D2487)

GW

Hydrometer Test

Test Date: ____ Technician: ____

Test Notes

Date Sampled: 4/11-18/2024
Date Received: 4/26/2024
Checked By: sjr
Title: ____

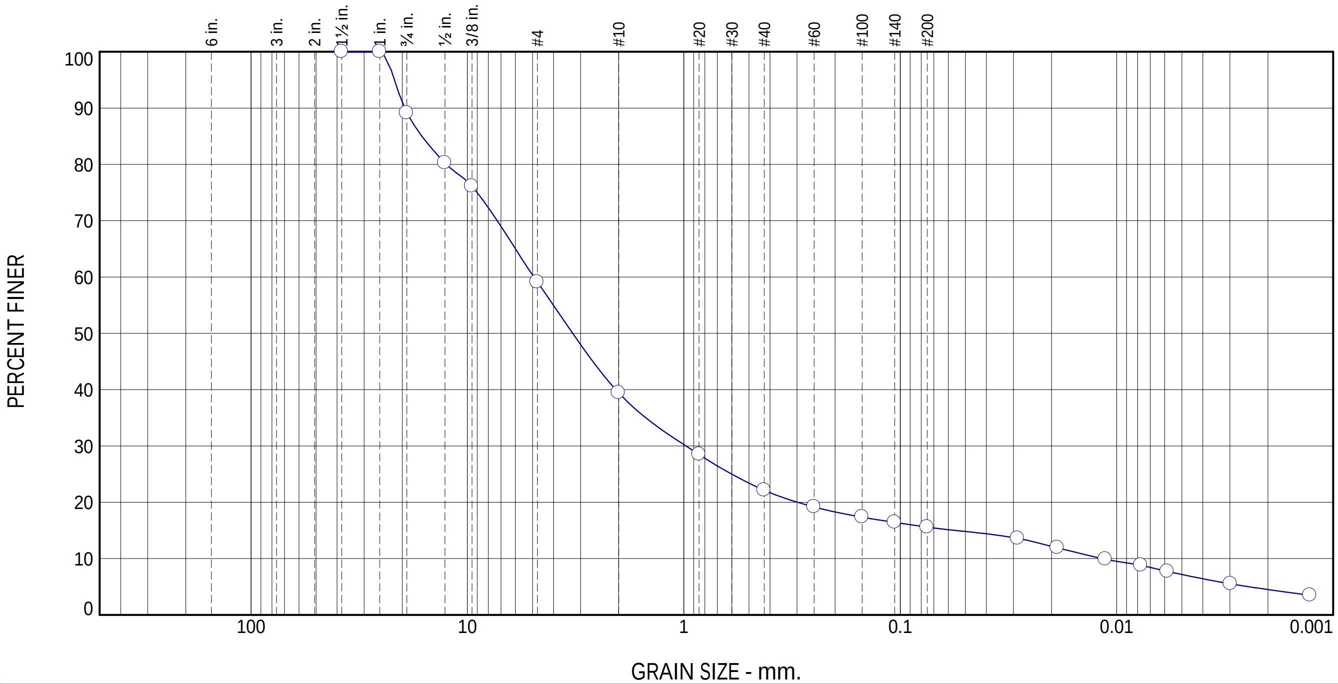
Source of Sample: BB-PSB-101 Depth: 14.0 - 16.0
Sample Number: 4D

Soil Metrics LLC

Cape Elizabeth, Maine

Client: GEI Consultants
Project: WIN 026630.07 Smelt Brook Bridge (#2774)
Project No: GEI PN 2400963, Task 2.1 Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	10.9	30.0	19.7	17.3	6.5	11.1	4.5

Test Results (ASTM D6913 and D422)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)
1.5	100.0		
1	100.0		
.75	89.1		
.5	80.2		
.375	76.1		
#4	59.1		
#10	39.4		
#20	28.5		
#40	22.1		
#60	19.2		
#100	17.4		
#140	16.4		
#200	15.6		
0.0286 mm.	13.6		
0.0188 mm.	11.9		
0.0113 mm.	9.9		
0.0077 mm.	8.8		
0.0058 mm.	7.7		
0.0030 mm.	5.5		
0.0013 mm.	3.5		

* (no specification provided)

Material Description

Atterberg (ASTM D4318)

PL= LL= PI=

Coefficients

D_{90}= 19.5357 D_{85}= 16.2186
D_{60}= 4.9298 D_{50}= 3.2619
D_{30}= 0.9779 D_{15}= 0.0557
D_{10}= 0.0117
C_u= 421.48 C_c= 16.58

Sieve Test (ASTM D6913)

Test Date: 5/1/2024 Technician: sjr

Test Notes

Entire sample tested. Moisture Content = 12.6%

Hydrometer Test (ASTM D422)

Test Date: 5/6/2024 Technician: sjr

Test Notes

USCS (ASTM D2487)

Date Sampled: 4/11-18/2024
Date Received: 4/25/2024
Checked By: sjr
Title:

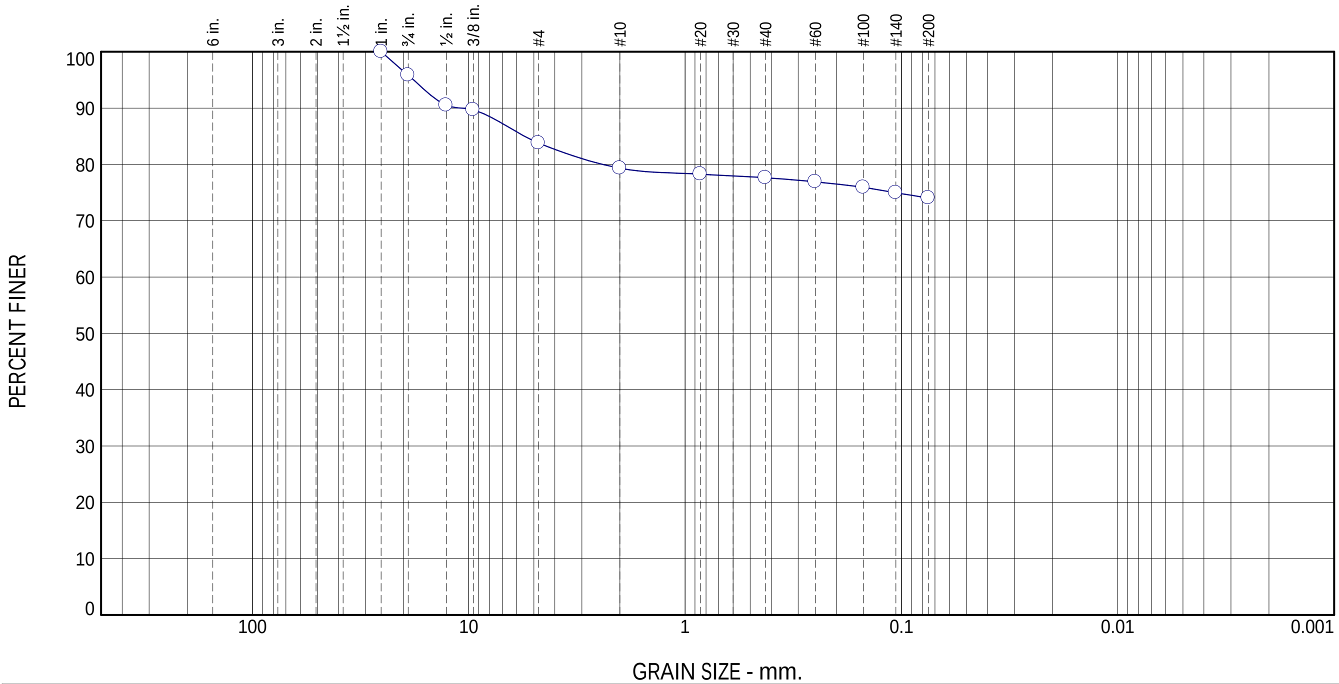
Source of Sample: BB-PSB-101 Depth: 19.0 - 21.0
Sample Number: 5D

Soil Metrics LLC

Cape Elizabeth, Maine

Client: GEI Consultants
Project: WIN 026630.07 Smelt Brook Bridge (#2774)
Project No: GEI PN 2400963, Task 2.1 Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.2	12.0	4.5	1.7	3.6	74.0	

Test Results (ASTM D6913)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)
1	100.0		
.75	95.8		
.5	90.5		
.375	89.7		
#4	83.8		
#10	79.3		
#20	78.3		
#40	77.6		
#60	76.9		
#100	75.9		
#140	75.0		
#200	74.0		

* (no specification provided)

Material Description

Brown CLAY with little fine gravel and trace sand.

Atterberg (ASTM D4318)

PL= 22.9 LL= 40.1 PI= 17.2

Coefficients

D_{90}= 10.8221 D_{85}= 5.5190
D_{60}= D_{50}=
D_{30}= D_{15}=
D_{10}=
C_u= C_c=

Sieve Test (ASTM D6913)

Test Date: 5/1/2024 Technician: sjr

Test Notes

Entire sample tested. Moisture Content = 21.5%

Hydrometer Test

Test Date: ______ Technician: ______

Test Notes

USCS (ASTM D2487)

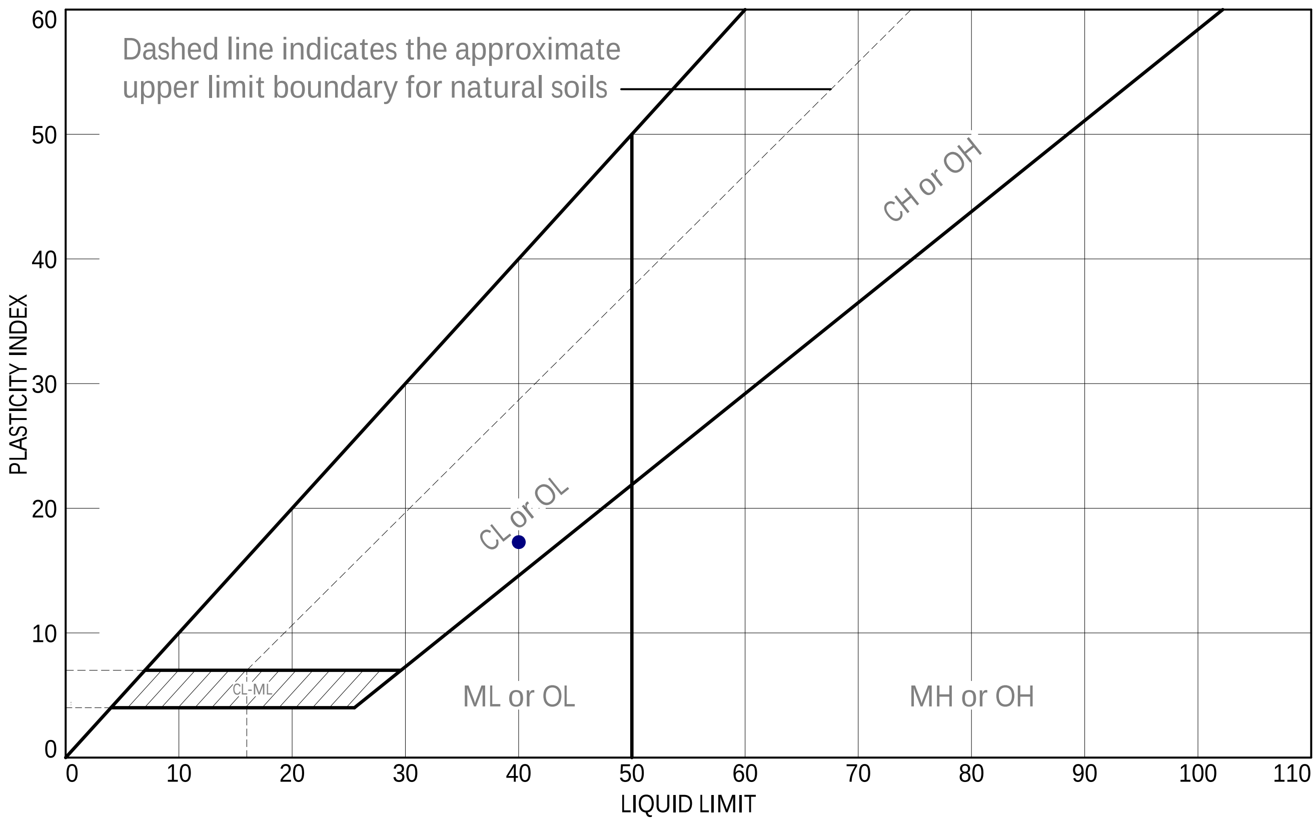
CL

Date Sampled: 4/11-18/2024
Date Received: 4/26/2024
Checked By: sjr
Title: ______

Source of Sample: BB-PSB-102 Depth: 4.0 - 6.0
Sample Number: 2D

Soil Metrics LLC Cape Elizabeth, Maine	Client: GEI Consultants Project: WIN 026630.07 Smelt Brook Bridge (#2774) Project No: GEI PN 2400963, Task 2.1 Figure

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA									
	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LIQUIDITY INDEX	USCS
●	BB-PSB-102	2D	4.0 - 6.0	21.5	22.9	40.1	17.2	-0.1	CL

Soil Metrics LLC

Cape Elizabeth, Maine

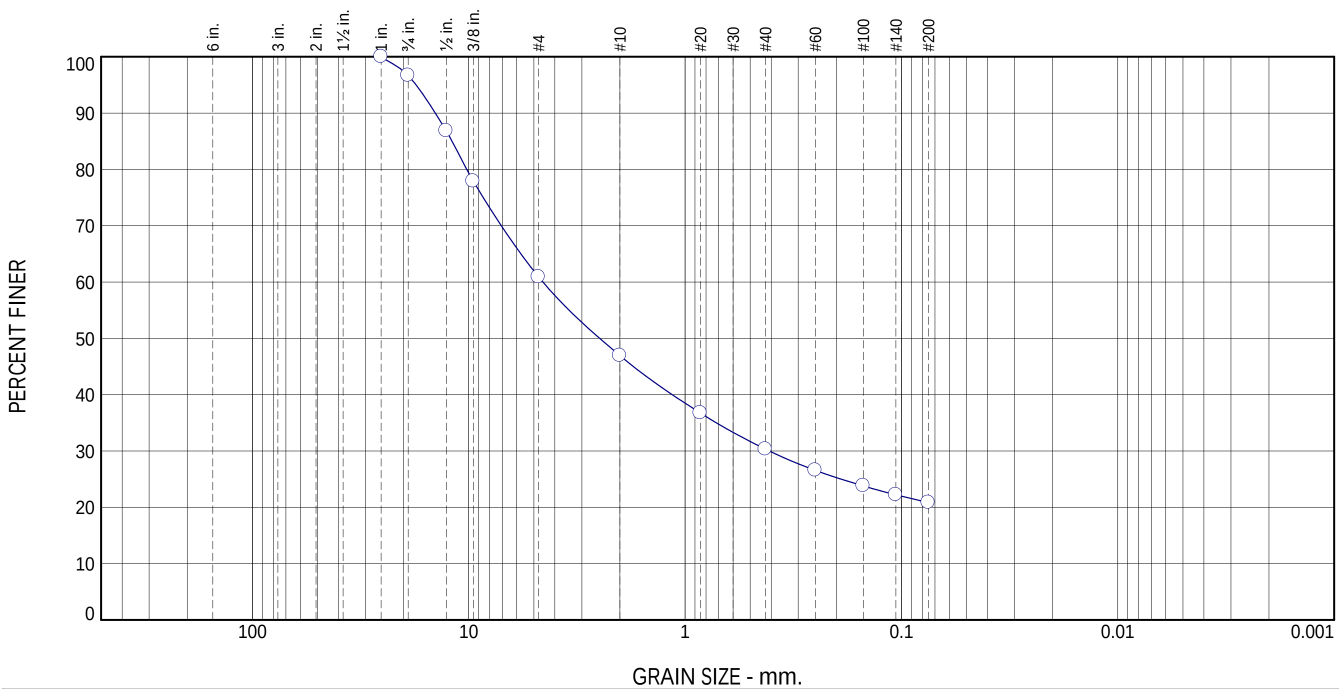
Client: GEI Consultants

Project: WIN 026630.07 Smelt Brook Bridge (#2774)

Project No.: GEI PN 2400963, Task 2.1

Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.3	35.8	14.0	16.6	9.5	20.8	

Test Results (ASTM D6913)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)
1	100.0		
.75	96.7		
.5	86.8		
.375	77.9		
#4	60.9		
#10	46.9		
#20	36.7		
#40	30.3		
#60	26.6		
#100	23.8		
#140	22.2		
#200	20.8		

* (no specification provided)

Material Description

Silty, sandy GRAVEL

Atterberg (ASTM D4318)

PL= LL= PI=

Coefficients

D_{90}= 14.2652 D_{85}= 11.9373
D_{60}= 4.5396 D_{50}= 2.4835
D_{30}= 0.4089 D_{15}=
D_{10}=
C_u= C_c=

Sieve Test (ASTM D6913)

Test Date: 5/1/2024 Technician: sjr

Test Notes

Entire sample tested. Moisture Content = 12.0 %

Hydrometer Test

Test Date: ____________ Technician: ____________

Test Notes

USCS (ASTM D2487)

GM

Date Sampled: 4/11 to 4/18/
Date Received: 4/26/2024
Checked By: sjr
Title: ____________

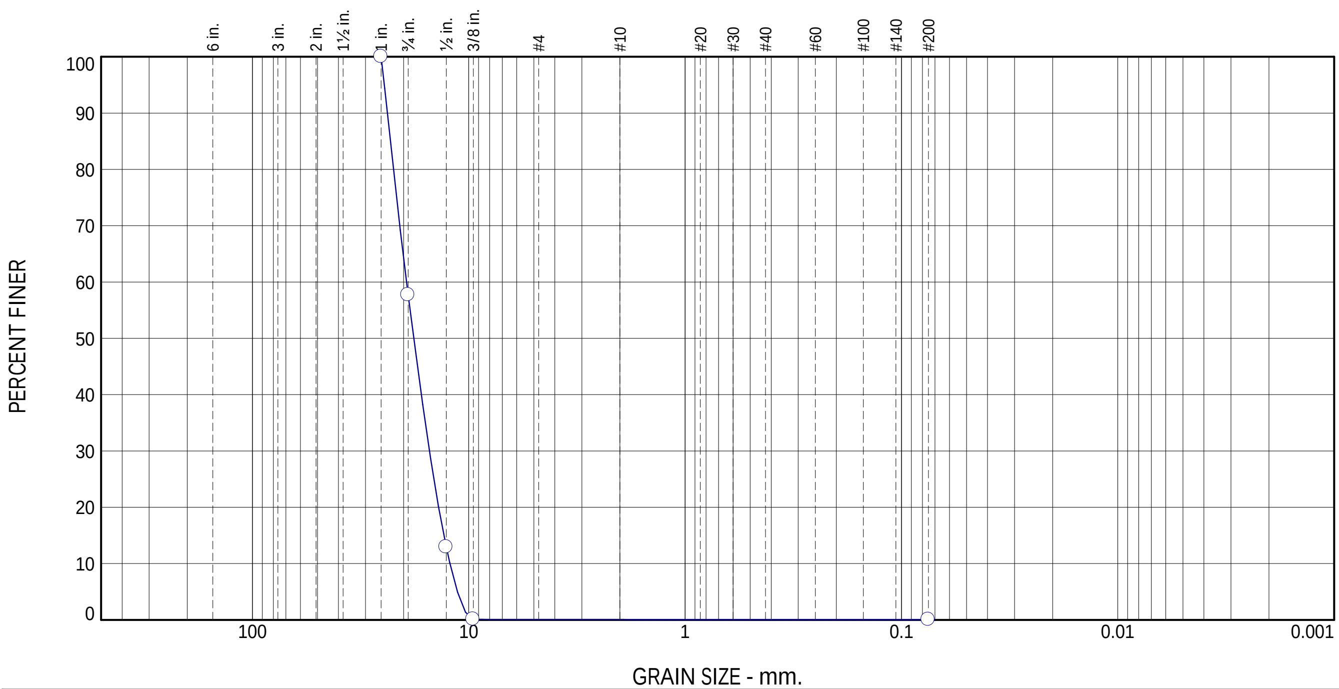
Source of Sample: BB-PSB-102 Depth: 24.0 - 26.0
Sample Number: 6D

Soil Metrics LLC

Cape Elizabeth, Maine

Client: GEI Consultants
Project: WIN 026630.07 Smelt Brook Bridge (#2774)
Project No: GEI PN 2400963, Task 2.1 Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	42.3	57.6		0.1			

Test Results (ASTM D6913)			
Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)
1	100.0		
.75	57.7		
.5	12.9		
.375	0.1		
#200	0.0		

* (no specification provided)

Material Description

fine to coarse GRAVEL

Atterberg (ASTM D4318)

PL= LL= PI=

Coefficients

D_{90}= 23.7652 D_{85}= 23.0011
D_{60}= 19.3884 D_{50}= 17.9370
D_{30}= 15.1819 D_{15}= 13.0292
D_{10}= 12.2082
C_u= 1.59 C_c= 0.97

Sieve Test (ASTM D6913)

Test Date: 5/1/2024 Technician: sjr

Test Notes

Entire sample tested. Sample size was very small, (a few pieces of gravel). Moisture Content = 0.5 %

Hydrometer Test

Test Date: ____________ Technician: ____________

Test Notes

USCS (ASTM D2487)

GP

Date Sampled: 4/11 to 4/18/
Date Received: 4/26/2024
Checked By: sjr
Title: ____________

Source of Sample: BB-PSB-103 Depth: 9.0-11.0
Sample Number: 3D

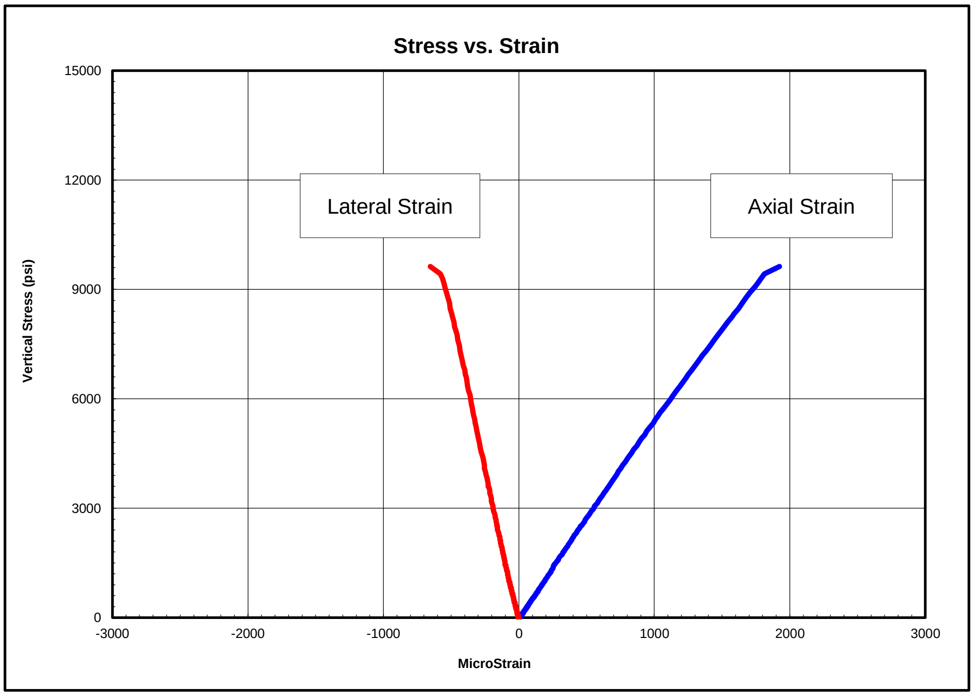
Soil Metrics LLC

Cape Elizabeth, Maine

Client: GEI Consultants
Project: WIN 026630.07 Smelt Brook Bridge (#2774)
Project No: GEI PN 2400963, Task 2.1 Figure

Client:	GEI Consultants, Inc.
Project Name:	Smelt Brook Bridge Replacement
Project Location:	Perry, ME
GTX #:	319169
Test Date:	6/10/2024
Tested By:	gp
Checked By:	jsc
Boring ID:	BB-PSB-101
Sample ID:	R5
Depth, ft:	39.31-39.70
Sample Type:	rock core
Sample Description:	See photographs Intact material failure Best Effort end preparation performed

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 9,628 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
1000-3500	5,500,000	0.32
3500-6100	5,260,000	0.30
6100-8700	4,950,000	0.30

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

GeoTesting EXPRESS

Client:	GEI Consultants, Inc.	Test Date:	6/7/2024
Project Name:	Smelt Brook Bridge Replacement	Tested By:	gp
Project Location:	Perry, ME	Checked By:	smd
GTX #:	319169		
Boring ID:	BB-PSB-101		
Sample ID:	R5		
Depth (ft):	39.31-39.70		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average
Specimen Length, in:	4.37	4.37	4.37
Specimen Diameter, in:	1.98	1.98	1.98
Specimen Mass, g:	605.83		
Bulk Density, lb/ft^3	171		
Length to Diameter Ratio:	2.2		

Minimum Diameter Tolerence Met? YES

Length to Diameter Ratio Tolerance Met? YES

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? YES

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00120	-0.00090	-0.00080	-0.00060	-0.00050	-0.00040	-0.00030	0.00000	0.00000	0.00000	0.00000	0.00010	0.00010	0.00020	0.00020
Diameter 2, in (rotated 90°)	-0.00140	-0.00120	-0.00100	-0.00080	-0.00060	-0.00050	-0.00030	0.00000	0.00010	0.00020	0.00030	0.00030	0.00030	0.00040	0.00050

Difference between max and min readings, in:

0° = 0.00140 90° = 0.00190

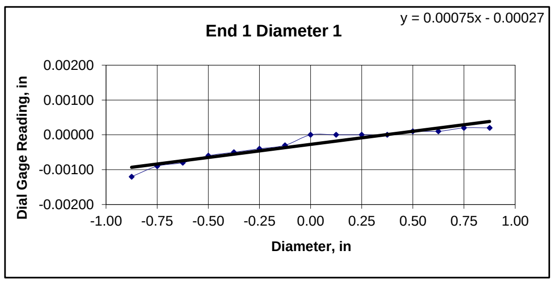
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00090	-0.00080	-0.00060	-0.00040	-0.00020	-0.00010	0.00000	0.00000	0.00010	0.00010	0.00030	0.00040	0.00040	0.00050	0.00070
Diameter 2, in (rotated 90°)	0.00070	0.00060	0.00050	0.00040	0.00030	0.00020	0.00000	0.00000	-0.00010	-0.00030	-0.00040	-0.00050	-0.00080	-0.00090	-0.00110

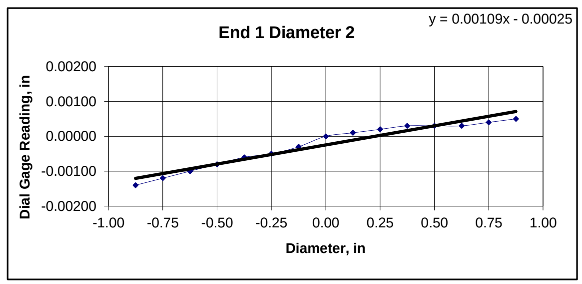
Difference between max and min readings, in:

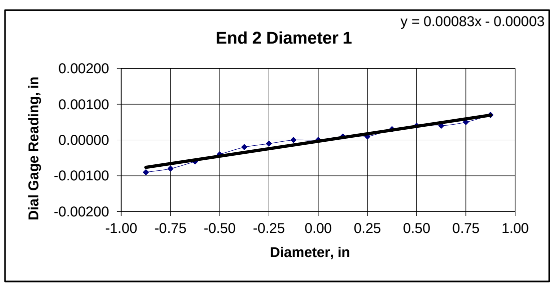
0° = 0.0016 90° = 0.0018

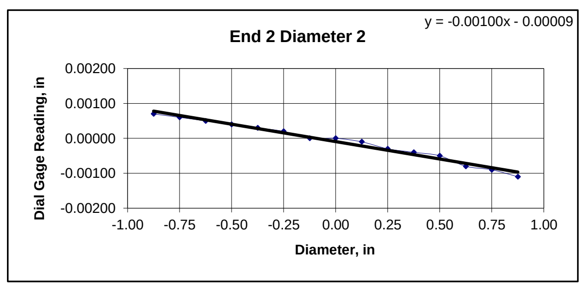
Maximum difference must be < 0.0020 in. Difference = ± 0.00095

Flatness Tolerance Met? YES









DIAMETER 1

End 1:

Slope of Best Fit Line	0.00075
Angle of Best Fit Line:	0.04305

End 2:

Slope of Best Fit Line	0.00083
Angle of Best Fit Line:	0.04780

Maximum Angular Difference: 0.00475

Parallelism Tolerance Met? NO

Spherically Seated

DIAMETER 2

End 1:

Slope of Best Fit Line	0.00109
Angle of Best Fit Line:	0.06270

End 2:

Slope of Best Fit Line	0.00100
Angle of Best Fit Line:	0.05713

Maximum Angular Difference: 0.00557

Parallelism Tolerance Met? NO

Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00140	1.980	0.00071	0.041	YES
Diameter 2, in (rotated 90°)	0.00190	1.980	0.00096	0.055	YES
END 2					
Diameter 1, in	0.00160	1.980	0.00081	0.046	YES
Diameter 2, in (rotated 90°)	0.00180	1.980	0.00091	0.052	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? YES

Client:	GEI Consultants, Inc.	Test Date:	6/7/2024
Project Name:	Smelt Brook Bridge Replacement	Tested By:	gp
Project Location:	Perry, ME	Checked By:	smd
GTX #:	319169		
Boring ID:	BB-PSB-101	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	R5		
Depth (ft):	39.31-39.70		
Visual Description:	See photographs		

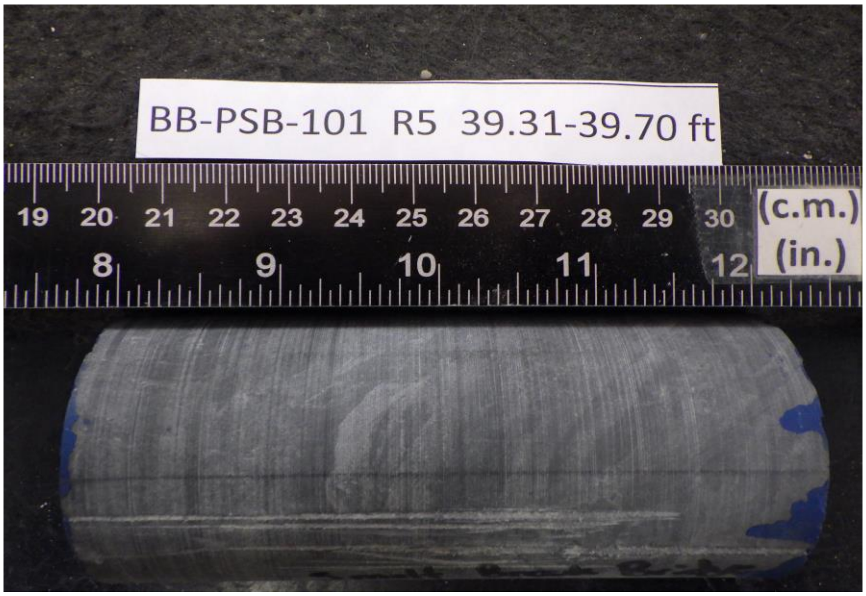
BEST EFFORT END FLATNESS TOLERANCES OF ROCK CORE SPECIMENS TO ASTM D4543

END FLATNESS

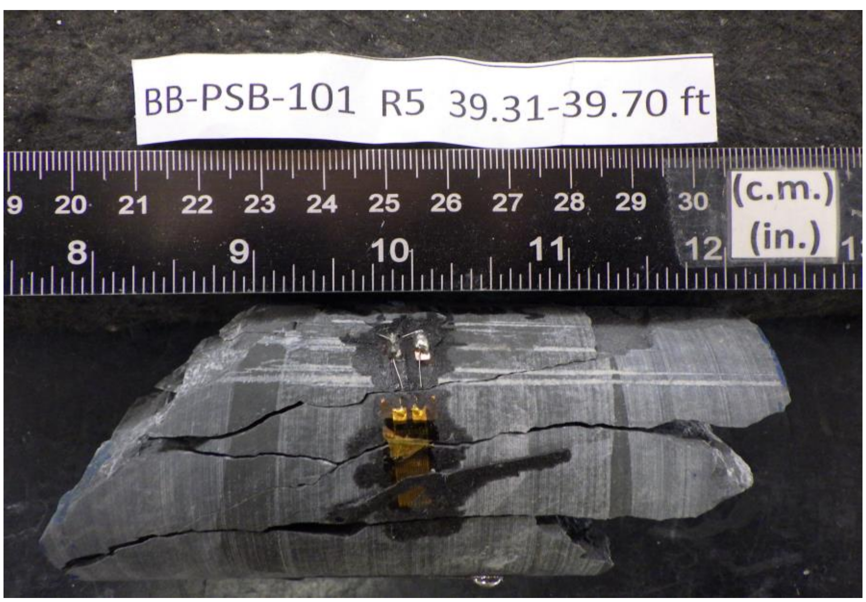
END 1		
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES
END 2		
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES

End Flatness Tolerance Met? YES

Client:	GEI Consultants, Inc.
Project Name:	Smelt Brook Bridge Replacement
Project Location:	Perry, ME
GTX #:	319169
Test Date:	6/10/2024
Tested By:	gp
Checked By:	smd
Boring ID:	BB-PSB-101
Sample ID:	R5
Depth, ft:	39.31-39.70



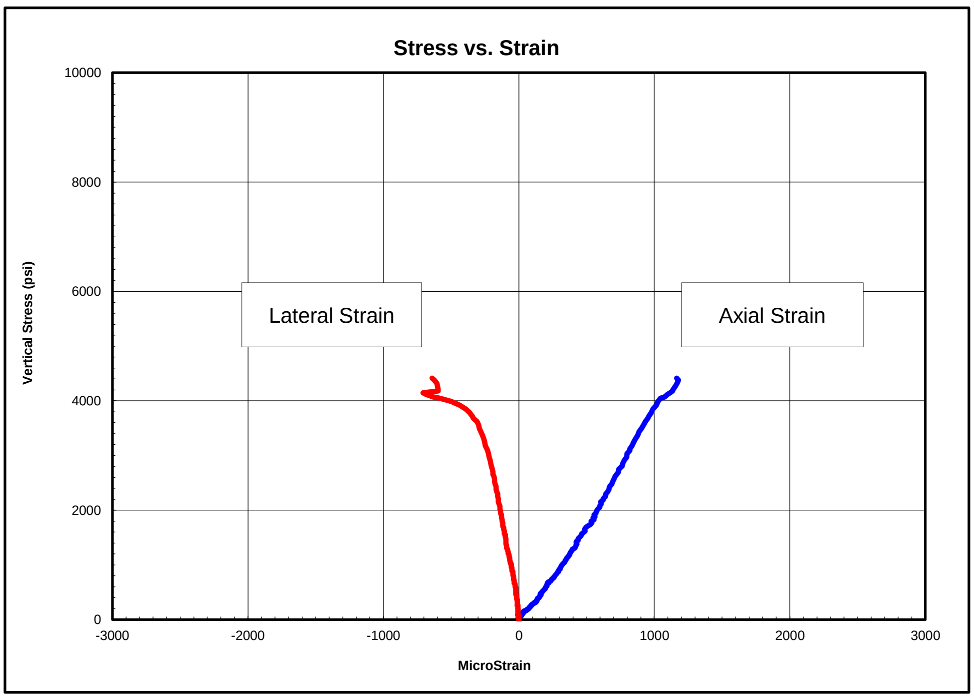
After cutting and grinding



After break

Client:	GEI Consultants, Inc.
Project Name:	Smelt Brook Bridge Replacement
Project Location:	Perry, ME
GTX #:	319169
Test Date:	6/10/2024
Tested By:	gp
Checked By:	jsc
Boring ID:	BB-PSB-102
Sample ID:	R1
Depth, ft:	30.23-30.61
Sample Type:	rock core
Sample Description:	See photographs Intact material failure Best Effort end preparation performed

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 4,414 psi

The strain values recorded within the third stress range for this test produce values of Poisson's Ratio that exceed maximum values found in rocks.

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
400-1600	3,510,000	0.28
1600-2800	4,500,000	0.35
2800-4000	4,380,000	---

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

GeoTesting EXPRESS

Client:	GEI Consultants, Inc.	Test Date:	6/7/2024
Project Name:	Smelt Brook Bridge Replacement	Tested By:	gp
Project Location:	Perry, ME	Checked By:	smd
GTX #:	319169		
Boring ID:	BB-PSB-102		
Sample ID:	R1		
Depth (ft):	30.23-30.61		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average	
Specimen Length, in:	4.37	4.37	4.37	
Specimen Diameter, in:	1.97	1.97	1.97	
Specimen Mass, g:	606.32			
Bulk Density, lb/ft^3	173	**Minimum Diameter Tolerence Met?**		**YES**
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**		**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap $\leq$ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00190	-0.00150	-0.00130	-0.00100	-0.00060	-0.00030	-0.00010	0.00000	0.00010	0.00030	0.00060	0.00090	0.00100	0.00120	0.00090
Diameter 2, in (rotated 90°)	-0.00040	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

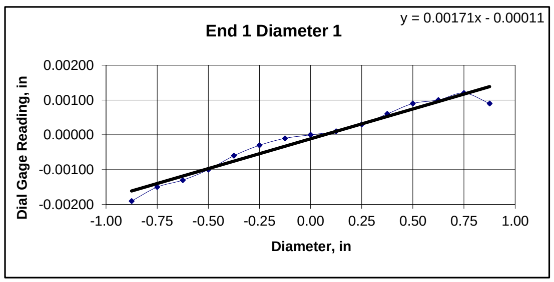
Difference between max and min readings, in:
0° = 0.00310 90° = 0.00040

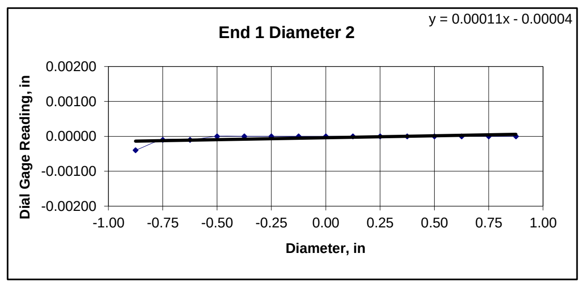
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00150	-0.00130	-0.00100	-0.00080	-0.00050	-0.00040	-0.00010	0.00000	0.00020	0.00040	0.00070	0.00090	0.00110	0.00120	0.00150
Diameter 2, in (rotated 90°)	0.00010	0.00030	0.00020	0.00010	0.00010	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

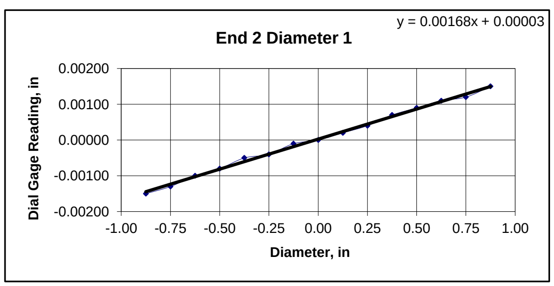
Difference between max and min readings, in:
0° = 0.003 90° = 0.0003

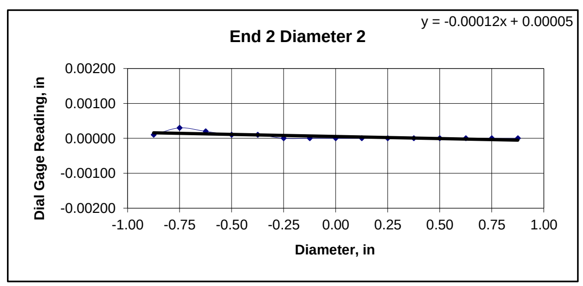
Maximum difference must be < 0.0020 in. Difference = $\pm$ 0.00155

Flatness Tolerance Met? **NO**









DIAMETER 1

End 1:
Slope of Best Fit Line 0.00171
Angle of Best Fit Line: 0.09806

End 2:
Slope of Best Fit Line 0.00168
Angle of Best Fit Line: 0.09626

Maximum Angular Difference: 0.00180

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:
Slope of Best Fit Line 0.00011
Angle of Best Fit Line: 0.00638

End 2:
Slope of Best Fit Line 0.00012
Angle of Best Fit Line: 0.00688

Maximum Angular Difference: 0.00049

Parallelism Tolerance Met? **YES**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00310	1.970	0.00157	0.090	YES
Diameter 2, in (rotated 90°)	0.00040	1.970	0.00020	0.012	YES
END 2					
Diameter 1, in	0.00300	1.970	0.00152	0.087	YES
Diameter 2, in (rotated 90°)	0.00030	1.970	0.00015	0.009	YES

Maximum angle of departure must be $\leq$ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	GEI Consultants, Inc.	Test Date:	6/7/2024
Project Name:	Smelt Brook Bridge Replacement	Tested By:	gp
Project Location:	Perry, ME	Checked By:	smd
GTX #:	319169		
Boring ID:	BB-PSB-102	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	R1		
Depth (ft):	30.23-30.61		
Visual Description:	See photographs		

BEST EFFORT END FLATNESS TOLERANCES OF ROCK CORE SPECIMENS TO ASTM D4543

END FLATNESS

END 1

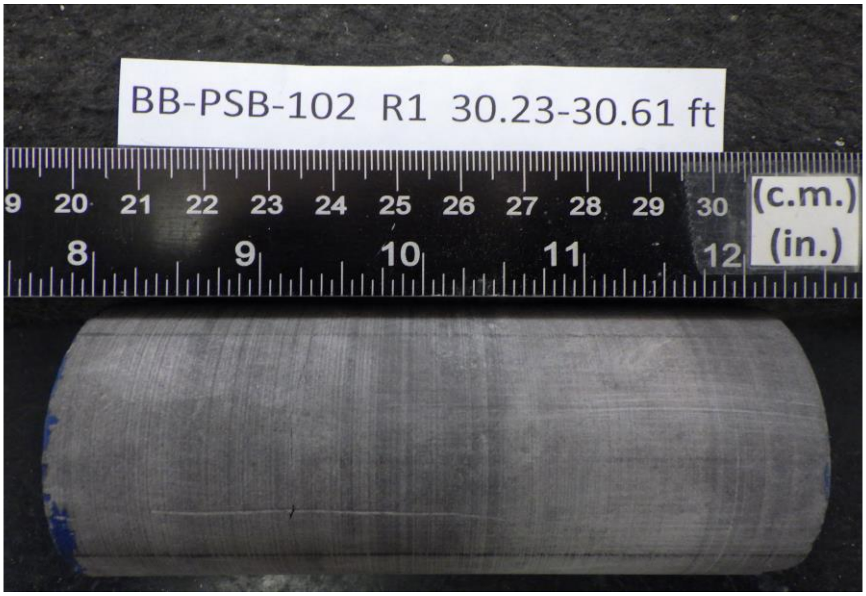
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90^{o})	Is the maximum gap $\leq \pm 0.001$ in.?	YES

END 2

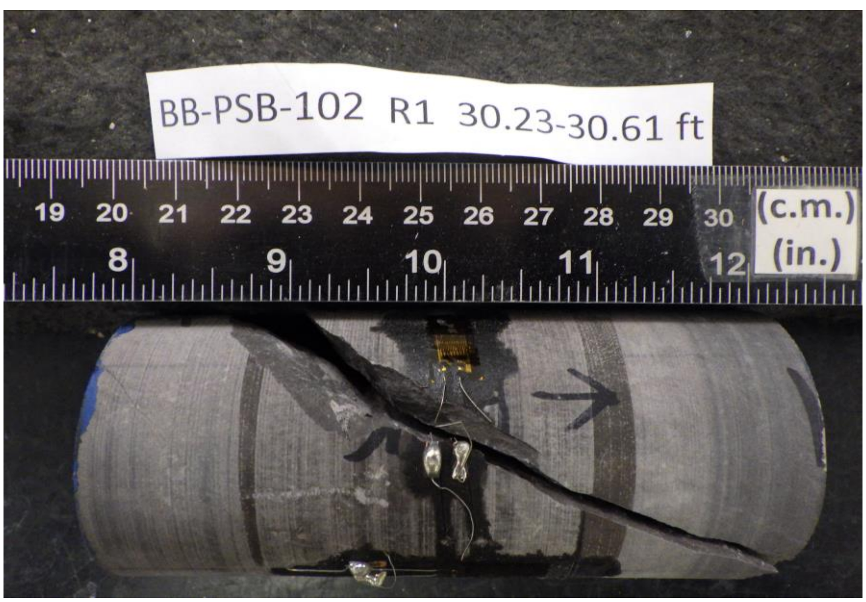
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90^{o})	Is the maximum gap $\leq \pm 0.001$ in.?	YES

End Flatness Tolerance Met? YES

Client:	GEI Consultants, Inc.
Project Name:	Smelt Brook Bridge Replacement
Project Location:	Perry, ME
GTX #:	319169
Test Date:	6/10/2024
Tested By:	gp
Checked By:	smd
Boring ID:	BB-PSB-102
Sample ID:	R1
Depth, ft:	30.23-30.61



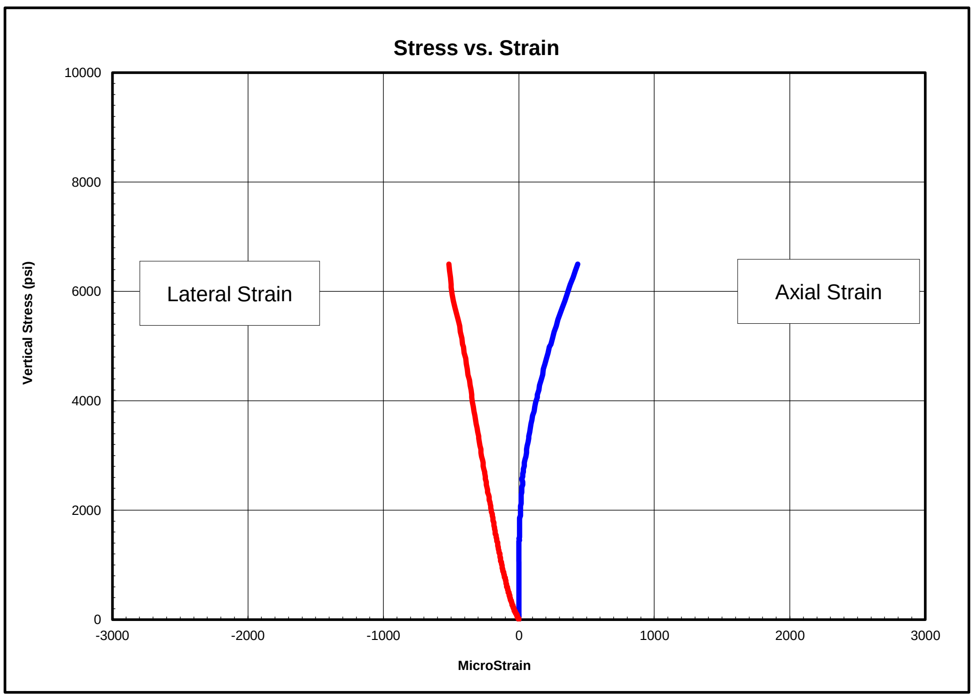
After cutting and grinding



After break

Client:	GEI Consultants, Inc.
Project Name:	Smelt Brook Bridge Replacement
Project Location:	Perry, ME
GTX #:	319169
Test Date:	6/10/2024
Tested By:	gp
Checked By:	jsc
Boring ID:	BB-PSB-101
Sample ID:	R5
Depth, ft:	35.95-36.33
Sample Type:	rock core
Sample Description:	See photographs Intact material failure Best Effort end preparation performed

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 6,499 psi

The strain values recorded for this test produce values of Poisson's Ratio that exceed maximum values found in rocks.

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
700-2400	70,500,000	---
2400-4100	14,500,000	---
4100-5900	8,530,000	---

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	GEI Consultants, Inc.	Test Date:	6/7/2024
Project Name:	Smelt Brook Bridge Replacement	Tested By:	gp
Project Location:	Perry, ME	Checked By:	smd
GTX #:	319169		
Boring ID:	BB-PSB-101		
Sample ID:	R5		
Depth (ft):	35.95-36.33		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average	
Specimen Length, in:	4.32	4.32	4.32	
Specimen Diameter, in:	1.98	1.98	1.98	
Specimen Mass, g:	594.74			
Bulk Density, lb/ft^3	170	**Minimum Diameter Tolerence Met?**		**YES**
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**		**YES**

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00010	-0.00020	-0.00020	-0.00030
Diameter 2, in (rotated 90°)	0.00120	0.00100	0.00080	0.00070	0.00050	0.00030	0.00010	0.00000	-0.00010	-0.00020	-0.00040	-0.00070	-0.00090	-0.00110	-0.00140

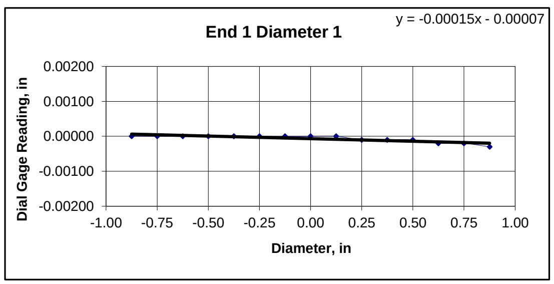
Difference between max and min readings, in:
0° = 0.00030 90° = 0.00260

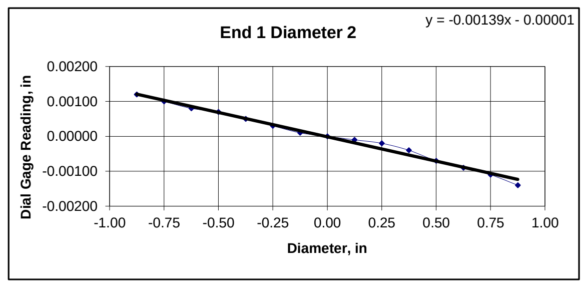
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Diameter 2, in (rotated 90°)	-0.00150	-0.00140	-0.00110	-0.00080	-0.00050	-0.00030	0.00000	0.00000	0.00000	0.00020	0.00050	0.00070	0.00080	0.00090	0.00110

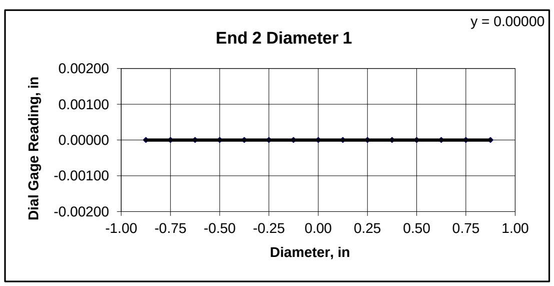
Difference between max and min readings, in:
0° = 0 90° = 0.0026

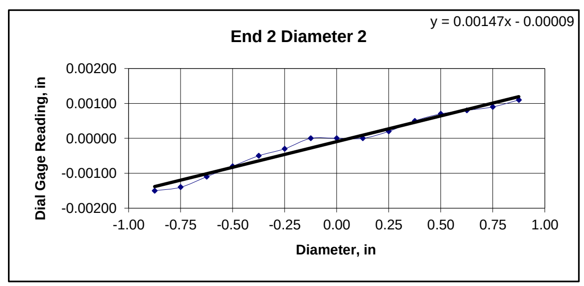
Maximum difference must be < 0.0020 in. Difference = ± 0.00130

Flatness Tolerance Met? **NO**









DIAMETER 1

End 1:		
	Slope of Best Fit Line	0.00015
	Angle of Best Fit Line:	0.00851
End 2:		
	Slope of Best Fit Line	0.00000
	Angle of Best Fit Line:	0.00000
Maximum Angular Difference:		0.00851

Parallelism Tolerance Met? **NO**
Spherically Seated

DIAMETER 2

End 1:		
	Slope of Best Fit Line	0.00139
	Angle of Best Fit Line:	0.07989
End 2:		
	Slope of Best Fit Line	0.00147
	Angle of Best Fit Line:	0.08431
Maximum Angular Difference:		0.00442

Parallelism Tolerance Met? **NO**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00030	1.980	0.00015	0.009	YES
Diameter 2, in (rotated 90°)	0.00260	1.980	0.00131	0.075	YES
END 2					
Diameter 1, in	0.00000	1.980	0.00000	0.000	YES
Diameter 2, in (rotated 90°)	0.00260	1.980	0.00131	0.075	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	GEI Consultants, Inc.	Test Date:	6/7/2024
Project Name:	Smelt Brook Bridge Replacement	Tested By:	gp
Project Location:	Perry, ME	Checked By:	smd
GTX #:	319169		
Boring ID:	BB-PSB-101	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	R5		
Depth (ft):	35.95-36.33		
Visual Description:	See photographs		

BEST EFFORT END FLATNESS TOLERANCES OF ROCK CORE SPECIMENS TO ASTM D4543

END FLATNESS

END 1		
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90^o)	Is the maximum gap $\leq \pm 0.001$ in.?	YES
END 2		
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90^o)	Is the maximum gap $\leq \pm 0.001$ in.?	YES

End Flatness Tolerance Met? YES

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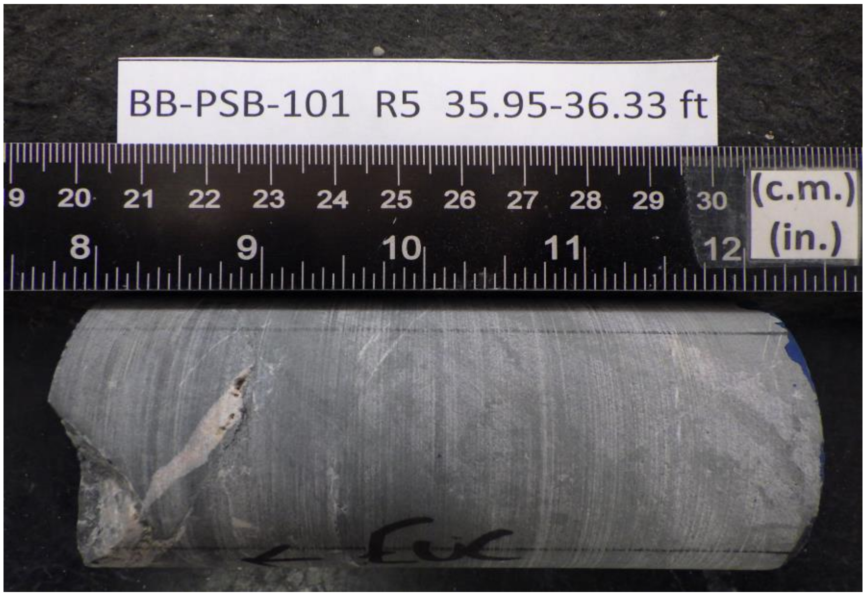
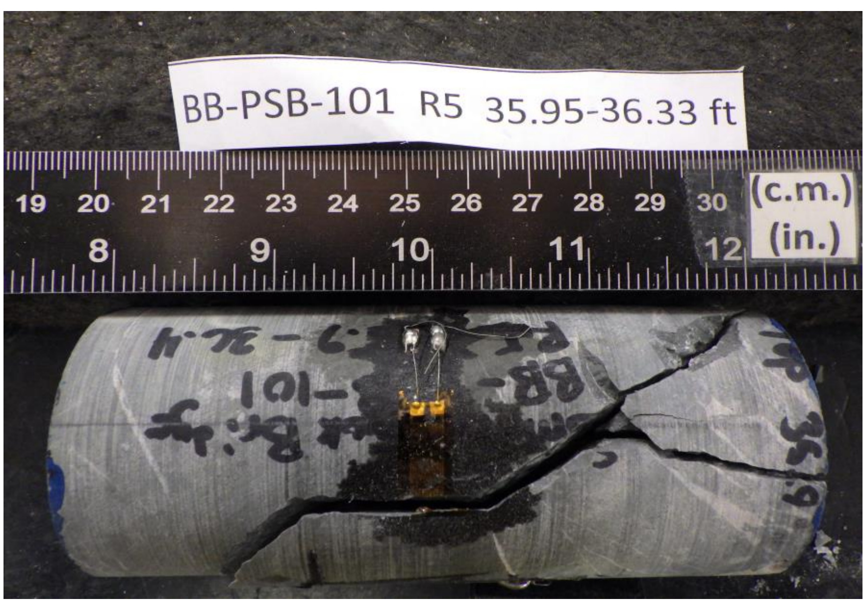
Client:	GEI Consultants, Inc.
Project Name:	Smelt Brook Bridge Replacement
Project Location:	Perry, ME
GTX #:	319169
Test Date:	6/10/2024
Tested By:	gp
Checked By:	jsc
Boring ID:	BB-PSB-101
Sample ID:	R5
Depth, ft:	35.95-36.33

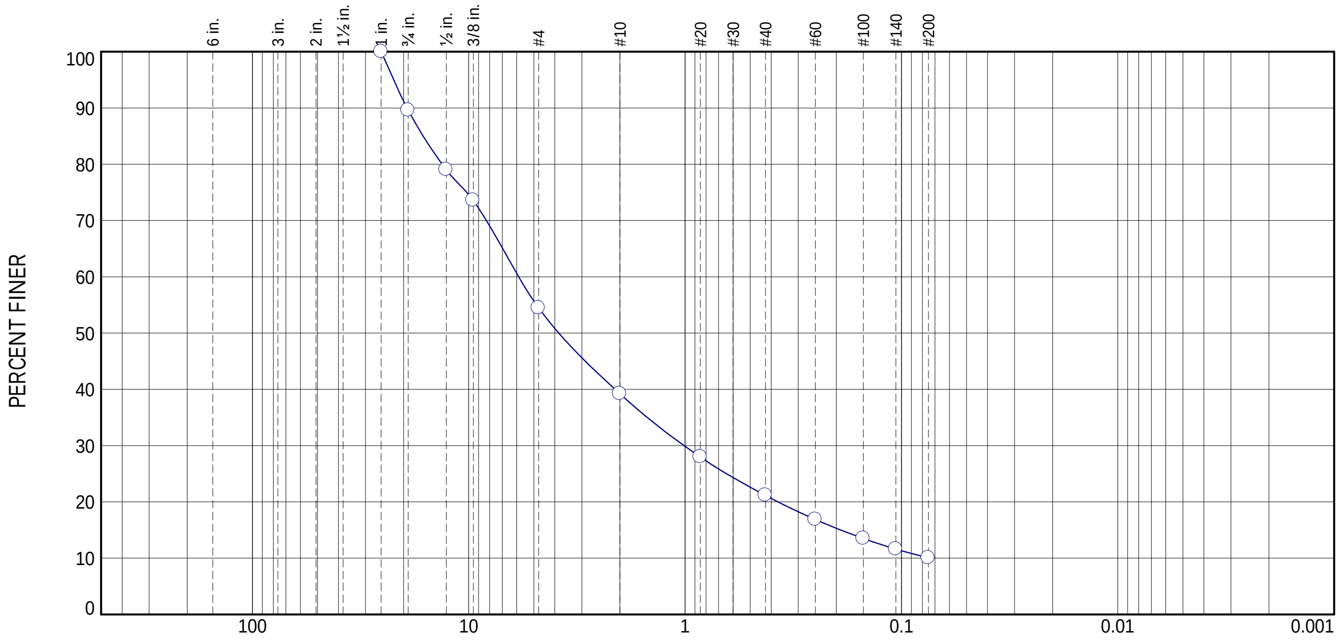


After cutting and grinding



After break

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	10.4	35.1	15.3	18.0	11.2	10.0	

Test Results (ASTM D6913)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)
1	100.0		
.75	89.6		
.5	79.0		
.375	73.6		
#4	54.5		
#10	39.2		
#20	28.0		
#40	21.2		
#60	16.9		
#100	13.5		
#140	11.6		
#200	10.0		

* (no specification provided)

Material Description

Brown gravelly fine to coarse SAND, little silt.

Atterberg (ASTM D4318)

PL= LL= PI=

Coefficients

D_{90}= 19.2878 D_{85}= 16.2360
D_{60}= 5.8772 D_{50}= 3.8350
D_{30}= 1.0109 D_{15}= 0.1909
D_{10}=
C_u= C_c=

Sieve Test (ASTM D6913)

Test Date: 5/23/2025 Technician: sjr

Test Notes

Entire sample tested. As-received moisture content = 2. 3%

USCS (ASTM D2487)

SP-SM

Hydrometer Test

Test Date: ______ Technician: ______

Test Notes

Date Sampled: 5/14-5/15/2025
Date Received: 5/22/2025
Checked By: sjr
Title: ______

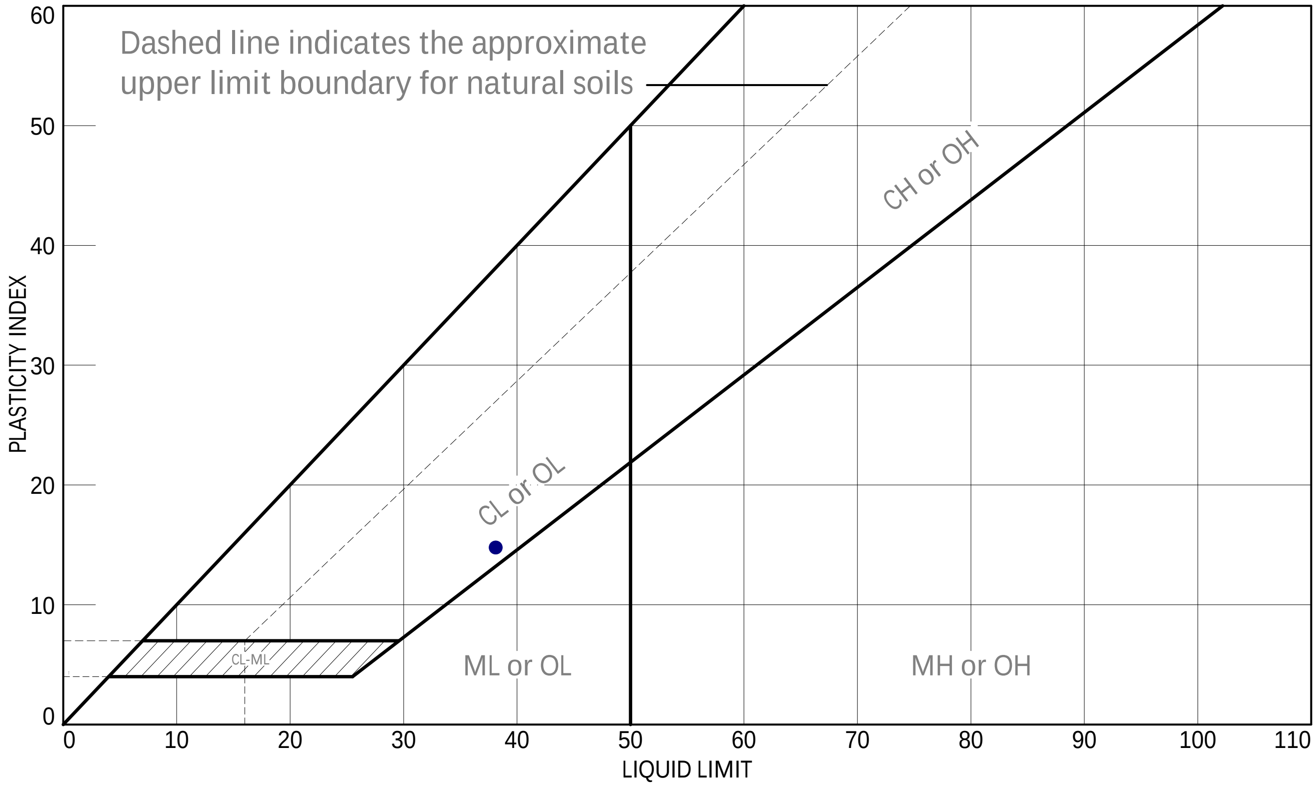
Source of Sample: BB-PSB-201 Depth: 4-6
Sample Number: 2D

Soil Metrics LLC

Cape Elizabeth, Maine

Client: GEI Consultants
Project: WIN 026630.07 Smelt Brook Bridge (#2774)
Perry, ME
Project No: GEI PN 2502334, Task 2.1 Figure

LIQUID AND PLASTIC LIMITS TEST REPORT

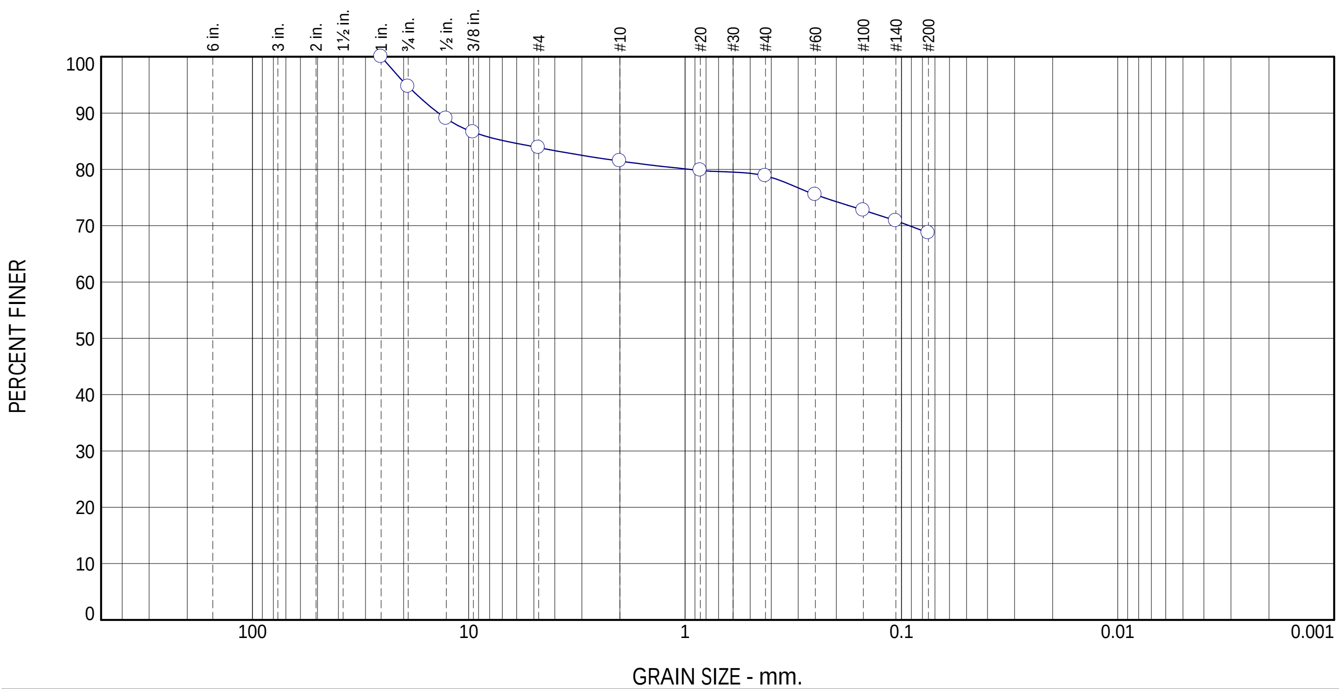


SOIL DATA									
	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LIQUIDITY INDEX	USCS
●	BB-PSB-201	3D	9-11	20.1	23.5	38.2	14.7	-0.2	CL

Soil Metrics LLC Cape Elizabeth, Maine	Client: GEI Consultants Project: WIN 026630.07 Smelt Brook Bridge (#2774) Perry, ME Project No.: GEI PN 2502334, Task 2.1 Figure

Tested By: sjr Checked By: sjr

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	5.3	10.8	2.4	2.7	10.1	68.7	

Test Results (ASTM D6913)			
Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)
1	100.0		
.75	94.7		
.5	89.0		
.375	86.6		
#4	83.9		
#10	81.5		
#20	79.8		
#40	78.8		
#60	75.5		
#100	72.7		
#140	70.9		
#200	68.7		

* (no specification provided)

Material Description

Gray CLAY with sand and gravel.

Sieve Test (ASTM D6913)

Test Date: 5/23/2025 Technician: sjr

Test Notes

Entire sample tested. Air drying necessary for Atterberg Limits. As-received moisture content = 20.1%.

Hydrometer Test

Test Date: ______ Technician: ______

Test Notes

Atterberg (ASTM D4318)

PL= 23.5 LL= 38.2 PI= 14.7

Coefficients

D_{90}= 13.7852 D_{85}= 6.7277
D_{60}= D_{50}=
D_{30}= D_{15}=
D_{10}=
C_u= C_c=

USCS (ASTM D2487)

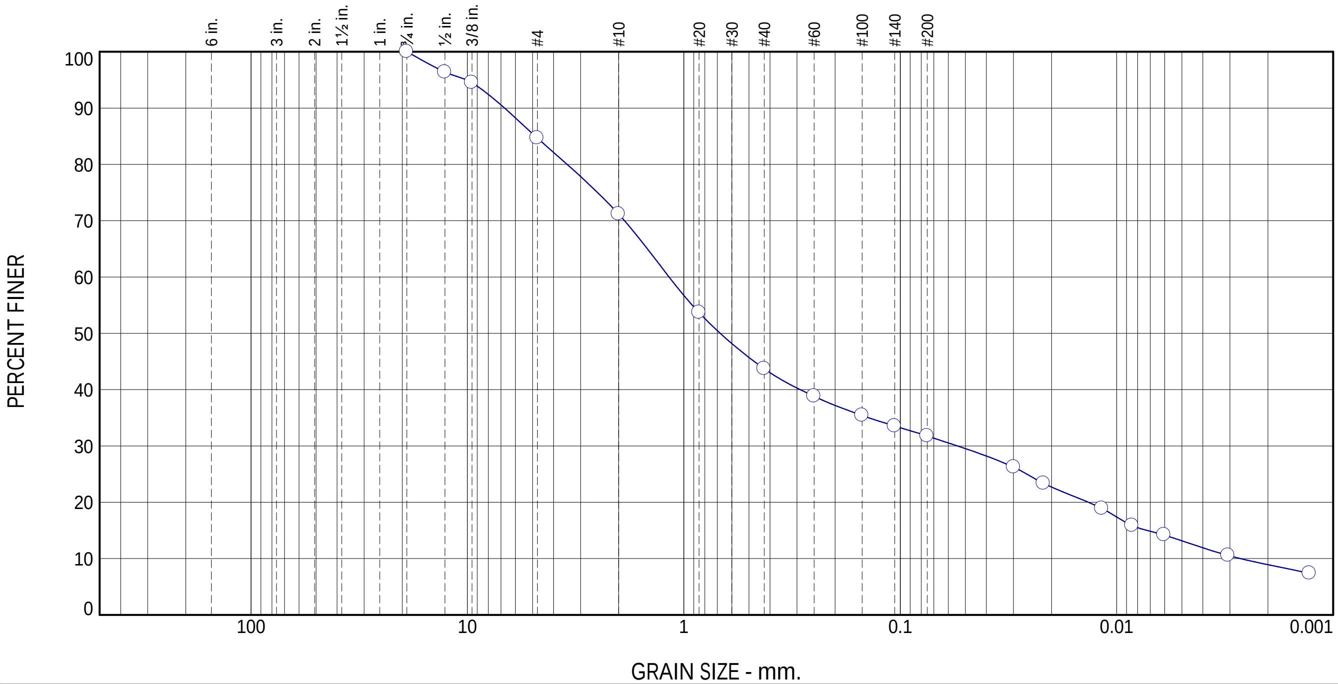
CL

Date Sampled: 5/14-5/15/2025
Date Received: 5/22/2025
Checked By: sjr
Title: ______

Source of Sample: BB-PSB-201 Depth: 9-11
Sample Number: 3D

Soil Metrics LLC Cape Elizabeth, Maine	Client: GEI Consultants Project: WIN 026630.07 Smelt Brook Bridge (#2774) Perry, ME Project No: GEI PN 2502334, Task 2.1 Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	15.3	13.5	27.5	11.9	22.9	8.9

Test Results (ASTM D6913 and D422)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)
.75	100.0		
.5	96.4		
.375	94.5		
#4	84.7		
#10	71.2		
#20	53.7		
#40	43.7		
#60	38.8		
#100	35.4		
#140	33.5		
#200	31.8		
0.0299 mm.	26.2		
0.0218 mm.	23.4		
0.0117 mm.	18.9		
0.0085 mm.	15.9		
0.0060 mm.	14.2		
0.0031 mm.	10.6		
0.0013 mm.	7.4		

* (no specification provided)

Material Description

Brown silty fine to coarse SAND, little fine gravel, trace clay.

Sieve Test (ASTM D6913)

Test Date: 5/23/2025 Technician: sjr

Test Notes

Entire sample tested. As-received moisture content = 12.4%

Hydrometer Test (ASTM D422)

Test Date: 5/29/2025 Technician: sjr

Test Notes

Entire sample tested. As-received moisture content = 12.4%

Atterberg (ASTM D4318)

PL= LL= PI=

Coefficients

D_{90}= 6.7309 D_{85}= 4.8519

D_{60}= 1.1698 D_{50}= 0.6787

D_{30}= 0.0544 D_{15}= 0.0073

D_{10}= 0.0027

C_u= 435.75 C_c= 0.94

USCS (ASTM D2487)

SM

Date Sampled: 5/14-5/15/2025

Date Received: 5/22/2025

Checked By: sjr

Title:

Source of Sample: BB-PSB-201 Depth: 19-21

Sample Number: 5D

Soil Metrics LLC

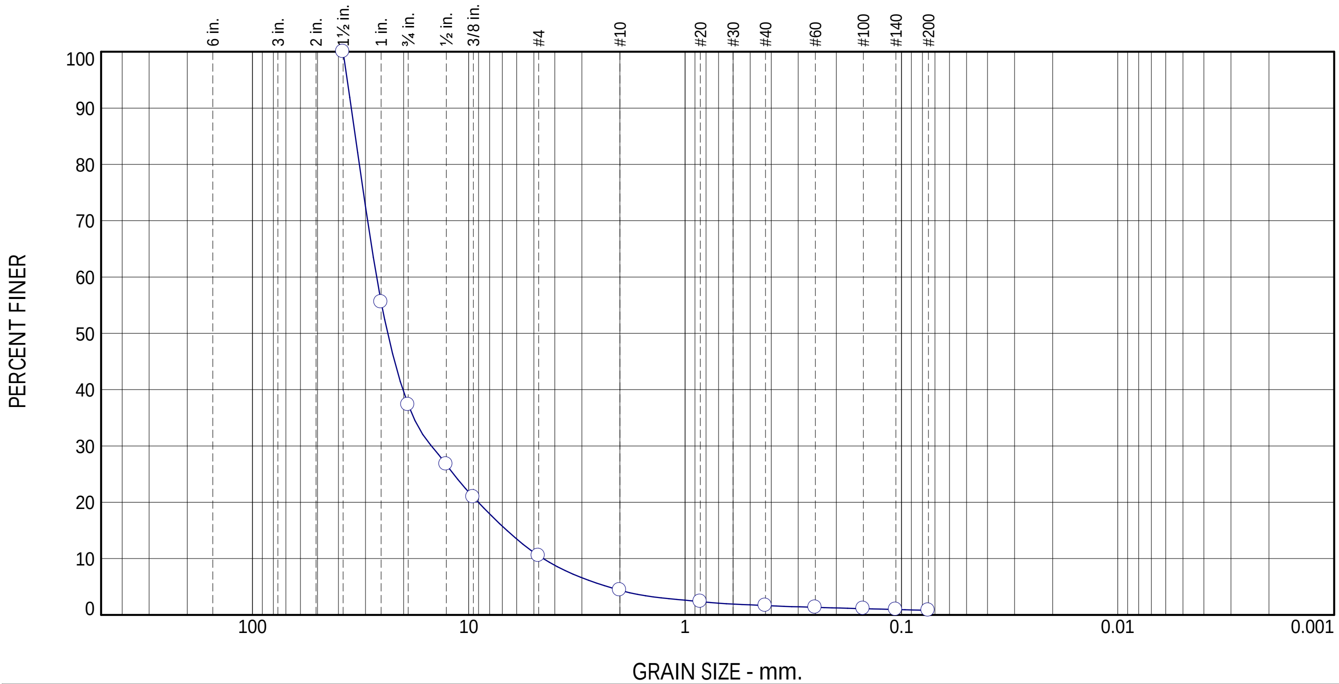
Cape Elizabeth, Maine

Client: GEI Consultants

Project: WIN 026630.07 Smelt Brook Bridge (#2774)
Perry, ME

Project No: GEI PN 2502334, Task 2.1 Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	62.7	26.8	6.1	2.7	0.9	0.8	

Test Results (ASTM D6913)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)
1.5	100.0		
1	55.5		
.75	37.3		
.5	26.7		
.375	20.9		
#4	10.5		
#10	4.4		
#20	2.3		
#40	1.7		
#60	1.3		
#100	1.1		
#140	1.0		
#200	0.8		

* (no specification provided)

Material Description

Gray GRAVEL, trace sand and silt.

Atterberg (ASTM D4318)

PL= LL= PI=

Coefficients

D_{90}= 34.8893 D_{85}= 33.4301
D_{60}= 26.6661 D_{50}= 23.7025
D_{30}= 14.8812 D_{15}= 6.6633
D_{10}= 4.5273
C_u= 5.89 C_c= 1.83

Sieve Test (ASTM D6913)

Test Date: 5/23/2025 Technician: sjr

Test Notes

Entire sample tested. As-received moisture content = 4.9%

Hydrometer Test

Test Date: ____ Technician: ____

Test Notes

USCS (ASTM D2487)

GW

Date Sampled: 5/14-5/15/2025
Date Received: 5/22/2025
Checked By: sjr
Title: ____

Source of Sample: BB-PSB-202 Depth: 14-16
Sample Number: 4D

Soil Metrics LLC

Cape Elizabeth, Maine

Client: GEI Consultants
Project: WIN 026630.07 Smelt Brook Bridge (#2774)
Perry, ME
Project No: GEI PN 2502334, Task 2.1 Figure

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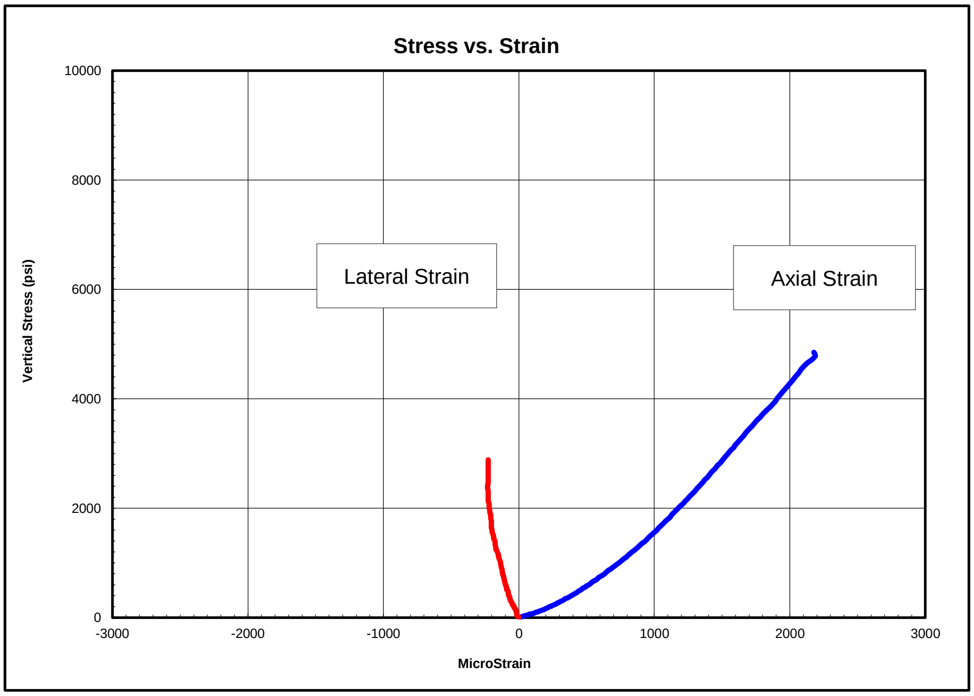
Client:	GEI Consultants, Inc.
Project Name:	WIN 26630.08 Benjamin Lincoln Br. Rep.
Project Location:	Dennysville, ME
GTX #:	321116
Test Date:	6/5/2025
Tested By:	gp
Checked By:	jsc
Boring ID:	BB-PSB-201
Sample ID:	R3
Depth, ft:	26.30-26.65
Sample Type:	rock core
Sample Description:	See photographs Intact material and discontinuity failure Best Effort end preparation performed

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 4,849 psi

Poisson's Ratio within the third stress range could not be determined. The lateral strain gauges failed before the peak value was recorded.

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
500-1800	1,990,000	0.20
1800-3100	2,700,000	0.08
3100-4400	2,770,000	---

Notes:
Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	GEI Consultants, Inc.	Test Date:	6/4/2025
Project Name:	WIN 26630.08 Benjamin Lincoln Br. Rep.	Tested By:	jss
Project Location:	Dennysville, ME	Checked By:	smd
GTX #:	321116		
Boring ID:	BB-PSB-201		
Sample ID:	R3		
Depth (ft):	26.30-26.65		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average		
Specimen Length, in:	4.02	4.02	4.02		
Specimen Diameter, in:	1.99	1.99	1.99		
Specimen Mass, g:	558.58				
Bulk Density, lb/ft^3	170	**Minimum Diameter Tolerence Met?**		**YES**	
Length to Diameter Ratio:	2.0	**Length to Diameter Ratio Tolerance Met?**		**YES**	

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:
Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.
Straightness Tolerance Met? **YES**

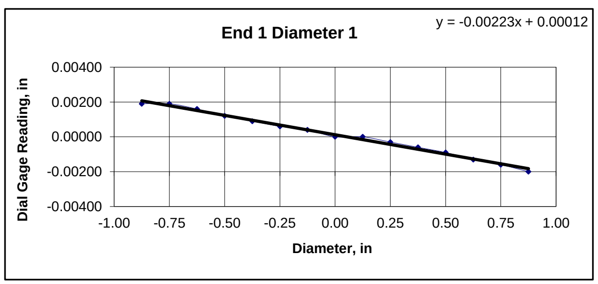
END FLATNESS AND PARALLELISM (Procedure FP1)

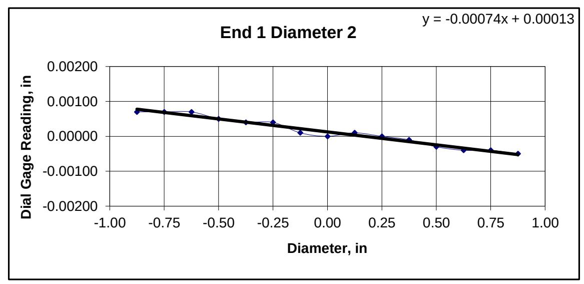
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00190	0.00190	0.00160	0.00120	0.00090	0.00060	0.00040	0.00000	0.00000	-0.00030	-0.00060	-0.00090	-0.00130	-0.00160	-0.00200
Diameter 2, in (rotated 90°)	0.00070	0.00070	0.00070	0.00050	0.00040	0.00040	0.00010	0.00000	0.00010	0.00000	-0.00010	-0.00030	-0.00040	-0.00040	-0.00050

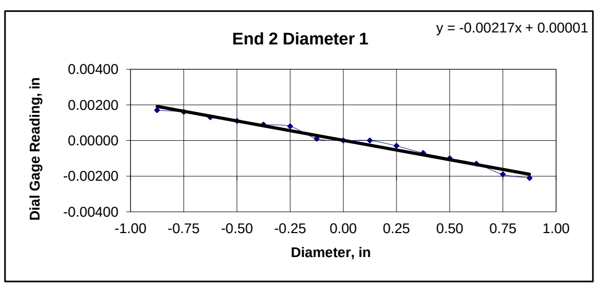
Difference between max and min readings, in:
0° = 0.00390 90° = 0.00120

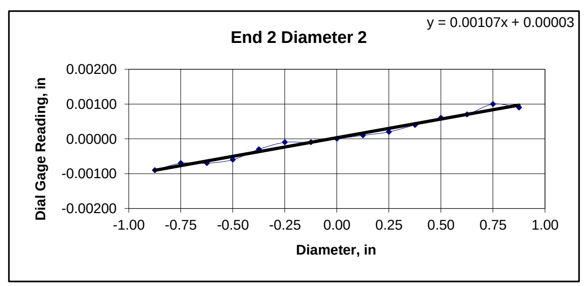
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00170	0.00160	0.00130	0.00110	0.00090	0.00080	0.00010	0.00000	0.00000	-0.00030	-0.00070	-0.00100	-0.00130	-0.00190	-0.00210
Diameter 2, in (rotated 90°)	-0.00090	-0.00070	-0.00070	-0.00060	-0.00030	-0.00010	-0.00010	0.00000	0.00010	0.00020	0.00040	0.00060	0.00070	0.00100	0.00090

Difference between max and min readings, in:
0° = 0.0038 90° = 0.0019
Maximum difference must be < 0.0020 in. Difference = ± 0.00195
Flatness Tolerance Met? **NO**









DIAMETER 1

End 1:

Slope of Best Fit Line	0.00223
Angle of Best Fit Line:	0.12752

End 2:

Slope of Best Fit Line	0.00217
Angle of Best Fit Line:	0.12458

Maximum Angular Difference: 0.00295

Parallelism Tolerance Met? **YES**
Spherically Seated

DIAMETER 2

End 1:

Slope of Best Fit Line	0.00074
Angle of Best Fit Line:	0.04256

End 2:

Slope of Best Fit Line	0.00107
Angle of Best Fit Line:	0.06139

Maximum Angular Difference: 0.01883

Parallelism Tolerance Met? **NO**
Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00390	1.988	0.00196	0.112	YES
Diameter 2, in (rotated 90°)	0.00120	1.988	0.00060	0.035	YES
END 2					
Diameter 1, in	0.00380	1.988	0.00191	0.110	YES
Diameter 2, in (rotated 90°)	0.00190	1.988	0.00096	0.055	YES

Maximum angle of departure must be ≤ 0.25°
Perpendicularity Tolerance Met? **YES**

Client:	GEI Consultants, Inc.	Test Date:	6/4/2025
Project Name:	WIN 26630.08 Benjamin Lincoln Br. Rep.	Tested By:	jss
Project Location:	Dennysville, ME	Checked By:	smd
GTX #:	321116		
Boring ID:	BB-PSB-201	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	R3		
Depth (ft):	26.30-26.65		
Visual Description:	See photographs		

BEST EFFORT END FLATNESS TOLERANCES OF ROCK CORE SPECIMENS TO ASTM D4543

END FLATNESS

END 1		
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES
END 2		
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES

End Flatness Tolerance Met? YES

Client:	GEI Consultants, Inc.
Project Name:	WIN 26630.08 Benjamin Lincoln Br. Rep.
Project Location:	Dennysville, ME
GTX #:	321116
Test Date:	6/5/2025
Tested By:	gp
Checked By:	smd
Boring ID:	BB-PSB-201
Sample ID:	R3
Depth, ft:	26.30-26.65

After cutting and grinding

After break

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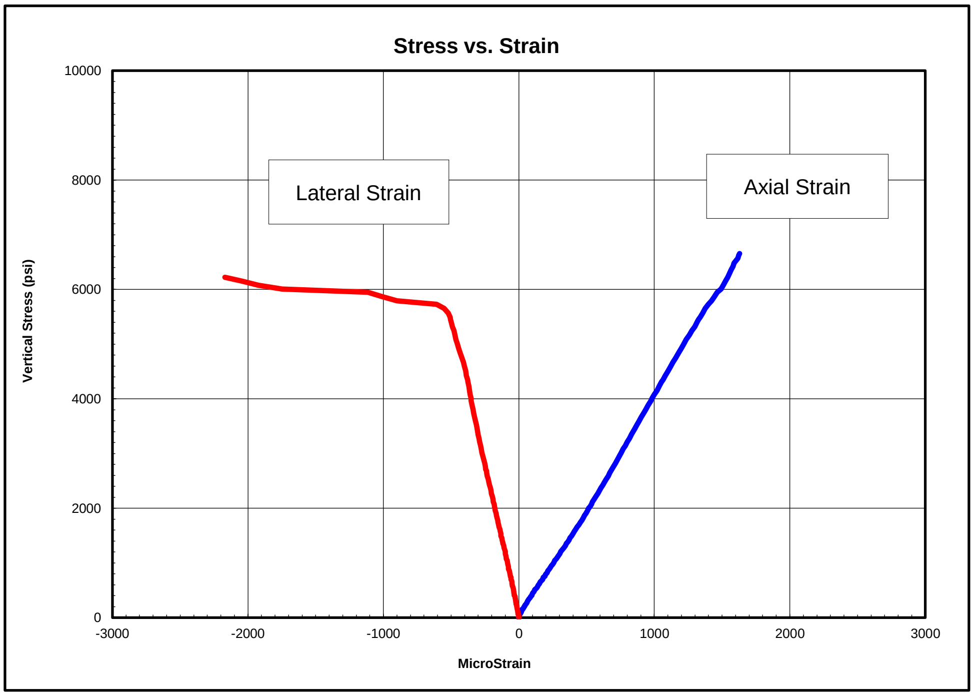
Client:	GEI Consultants, Inc.
Project Name:	WIN 26630.08 Benjamin Lincoln Br. Rep.
Project Location:	Dennysville, ME
GTX #:	321116
Test Date:	6/5/2025
Tested By:	gp
Checked By:	jsc
Boring ID:	BB-PSB-202A
Sample ID:	R3
Depth, ft:	34.61-35.00
Sample Type:	rock core
Sample Description:	See photographs Intact material and discontinuity failure Best Effort end preparation performed

Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 6,665 psi

The strain values recorded within the third stress range for this test produce values of Poisson's Ratio that exceed maximum values found in rocks.

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
700-2400	3,840,000	0.36
2400-4200	4,350,000	0.38
4200-6000	4,050,000	---

Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent to the line in the stress range listed.
Calculations assume samples are isotropic, which is not necessarily the case.

Client:	GEI Consultants, Inc.	Test Date:	6/4/2025
Project Name:	WIN 26630.08 Benjamin Lincoln Br. Rep.	Tested By:	jss
Project Location:	Dennysville, ME	Checked By:	smd
GTX #:	321116		
Boring ID:	BB-PSB-202A		
Sample ID:	R3		
Depth (ft):	34.61-35.00		
Visual Description:	See photographs		

UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY

	1	2	Average	
Specimen Length, in:	4.46	4.46	4.46	
Specimen Diameter, in:	1.99	1.98	1.99	
Specimen Mass, g:	622.36			
Bulk Density, lb/ft^3	171	**Minimum Diameter Tolerence Met?**	**YES**	
Length to Diameter Ratio:	2.2	**Length to Diameter Ratio Tolerance Met?**	**YES**	

DEVIATION FROM STRAIGHTNESS (Procedure S1)

Maximum gap between side of core and reference surface plate:

Is the maximum gap ≤ 0.02 in.? YES

Maximum difference must be < 0.020 in.

Straightness Tolerance Met? **YES**

END FLATNESS AND PARALLELISM (Procedure FP1)

END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00010	0.00010	0.00010	0.00010	0.00010	0.00020	0.00000	0.00000	0.00010	0.00010	0.00010	0.00010	0.00000	-0.00010	-0.00020
Diameter 2, in (rotated 90°)	0.00210	0.00190	0.00170	0.00120	0.00090	0.00090	0.00010	0.00000	-0.00030	-0.00060	-0.00090	-0.00130	-0.00180	-0.00220	-0.00270

Difference between max and min readings, in:

0° = 0.00040 90° = 0.00480

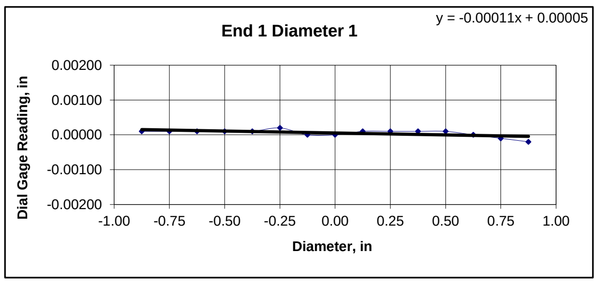
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	-0.00020	-0.00020	-0.00020	-0.00020	-0.00020	-0.00020	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00020	-0.00020	-0.00030	-0.00040
Diameter 2, in (rotated 90°)	-0.00220	-0.00190	-0.00160	-0.00140	-0.00090	-0.00040	-0.00010	0.00000	0.00050	0.00070	0.00090	0.00140	0.00170	0.00250	0.00260

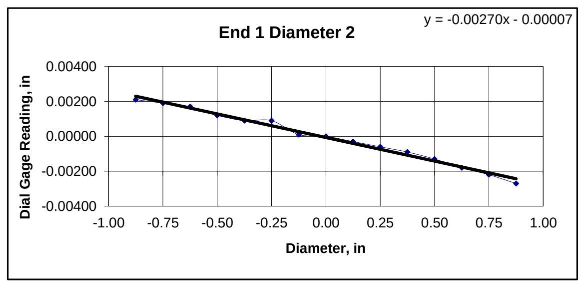
Difference between max and min readings, in:

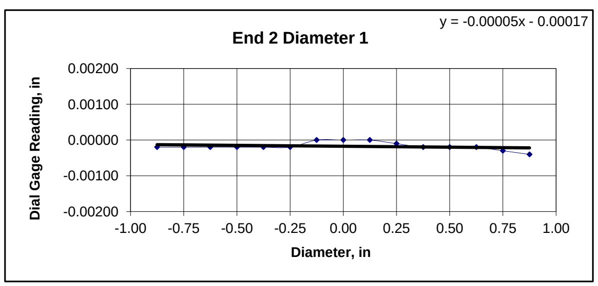
0° = 0.0004 90° = 0.0048

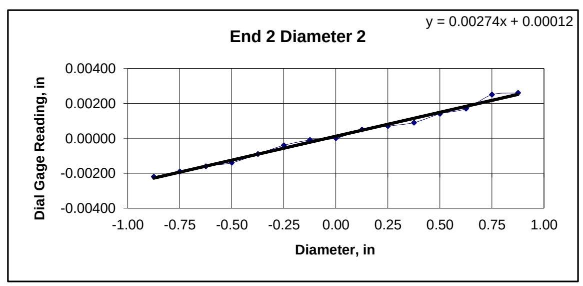
Maximum difference must be < 0.0020 in. Difference = ± 0.00240

Flatness Tolerance Met? **NO**









DIAMETER 1

End 1:		
	Slope of Best Fit Line	0.00011
	Angle of Best Fit Line:	0.00638
End 2:		
	Slope of Best Fit Line	0.00005
	Angle of Best Fit Line:	0.00295
Maximum Angular Difference:		0.00344

Parallelism Tolerance Met? **YES**

Spherically Seated

DIAMETER 2

End 1:		
	Slope of Best Fit Line	0.00270
	Angle of Best Fit Line:	0.15470
End 2:		
	Slope of Best Fit Line	0.00274
	Angle of Best Fit Line:	0.15699
Maximum Angular Difference:		0.00229

Parallelism Tolerance Met? **YES**

Spherically Seated

PERPENDICULARITY (Procedure P1) (Calculated from End Flatness and Parallelism measurements above)

END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?
Diameter 1, in	0.00040	1.986	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00480	1.986	0.00242	0.138	YES
END 2					
Diameter 1, in	0.00040	1.986	0.00020	0.012	YES
Diameter 2, in (rotated 90°)	0.00480	1.986	0.00242	0.138	YES

Maximum angle of departure must be ≤ 0.25°

Perpendicularity Tolerance Met? **YES**

Client:	GEI Consultants, Inc.	Test Date:	6/4/2025
Project Name:	WIN 26630.08 Benjamin Lincoln Br. Rep.	Tested By:	jss
Project Location:	Dennysville, ME	Checked By:	smd
GTX #:	321116		
Boring ID:	BB-PSB-202A	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	R3		
Depth (ft):	34.61-35.00		
Visual Description:	See photographs		

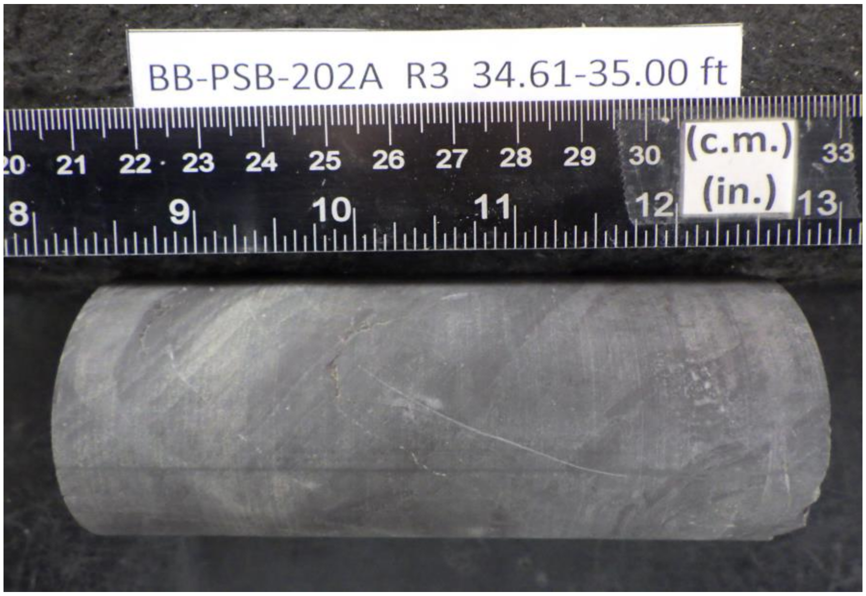
BEST EFFORT END FLATNESS TOLERANCES OF ROCK CORE SPECIMENS TO ASTM D4543

END FLATNESS

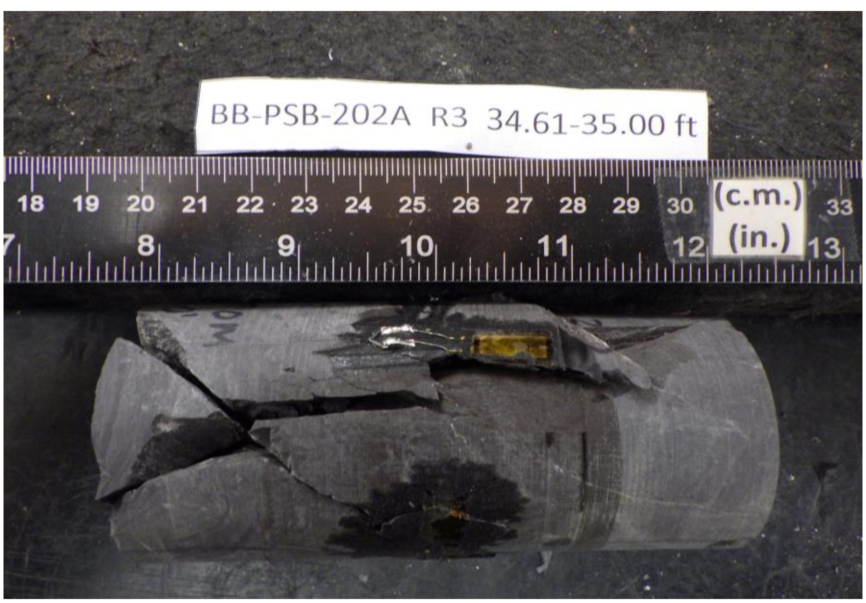
END 1		
Diameter 1	Is the maximum gap ≤ ±0.001 in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap ≤ ±0.001 in.?	YES
END 2		
Diameter 1	Is the maximum gap ≤ ±0.001 in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap ≤ ±0.001 in.?	YES

End Flatness Tolerance Met? YES

Client:	GEI Consultants, Inc.
Project Name:	WIN 26630.08 Benjamin Lincoln Br. Rep.
Project Location:	Dennysville, ME
GTX #:	321116
Test Date:	6/5/2025
Tested By:	gp
Checked By:	smd
Boring ID:	BB-PSB-202A
Sample ID:	R3
Depth, ft:	34.61-35.00



After cutting and grinding



After break

Appendix D Geotechnical Calculations

D.1 Recommended Soil Properties

D.2 Earth Pressure Coefficients

D.3 Site Class Evaluation

D.4 Frost Depth Calculation

D.5 LPile Analyses

D.6 End Bearing Calculation for Rock Socketed Piles

D.1. Recommended Soil Properties

Soil Properties Selection

Purpose:

The purpose of this evaluation is to select representative soil properties for the design of the proposed bridge replacement project. The soil properties will be used in our engineering analyses.

Approach:

We selected values for the engineering properties of soils. Values were selected for the general soil layers observed in the borings.

Unit Weight

We selected a saturated (total) unit weight in pounds per cubic foot (pcf). The buoyant unit weight can then be determined by subtracting the unit weight of fresh water (approximately 62.4 pcf).

Angle of Internal Friction

We selected an angle of internal friction (ϕ) in degrees. We used Mohr-Coulomb drained properties for each soil.

Subsurface Investigation and SPT Correlations for Observed Soil Layers:

We reviewed Standard Penetration Test (SPT) N-Values collected during our subsurface investigation. We estimated angles of internal friction for the soils below based on N-Values corrected for overburden and hammer efficiency ($N1_{60}$). SPTs for borings BB-PSB-101 through BB-PSB-103 were performed with an automatic hammer with a measured efficiency of 76.5 percent. SPTs for borings BB-PSB-201 and BB-PSB-202 were performed with an automatic hammer with a measured efficiency of 83.4 percent.

A summary of corrected N-Values based on general soil type is shown below. We did not include refusals due to cobbles or boulders, and we limited the uncorrected (field) N-value to a maximum of 100 blows per foot.

Results:

We selected the following soil properties for each layer/soil type based on the references provided in the following pages and our engineering judgment:

Soil Type	Average $N1_{60}$ (Blows/ft)	Bulk Unit Weight (γ) (pcf)	Cohesion (c') (lb/ft^2)	Friction Angle (ϕ') (deg)
Fill	41	125	0	34
Glacial Till	36	135	0	38

References:

1. AASHTO LRFD Bridge Design Specifications, 9th Edition, 2020.
2. Terzaghi, K., Peck, R.B., 1968. Soil Mechanics in Engineering Practice, 2nd Edition, John Wiley & Sons, New York.
3. Caltrans Geotechnical Manual, March 2014.
4. NAVFAC Design Manual 7.01 Soil Mechanics, Naval Facilities Engineering Command, September 1986.
5. MaineDOT Bridge Design Guide, August 2003, Updated 2018.

AASHTO LRFD Bridge Design Specifications, 9th Edition, 2020

Table 10.4.6.2.4-1 recommends using the following correlation to select friction angles of granular soils:

Table 10.4.6.2.4-1—Correlation of *SPT* $N1_{60}$ Values to Drained Friction Angle of Granular Soils (modified after Bowles, 1977)

$N1_{60}$	ϕ_f
<4	25–30
4	27–32
10	30–35
30	35–40
50	38–43

Soil Mechanics in Engineering Practice

Karl Terzaghi and Ralph Peck compiled various parameters of soils into the tables below:

Table 6.3
Porosity, Void Ratio, and Unit Weight of Typical Soils in Natural State

Description	Porosity, n (%)	Void ratio, e	Water content, w (%)	Unit weight grams/cm³ γ_d	Unit weight grams/cm³ γ	Unit weight lb/ft³ γ_d	Unit weight lb/ft³ γ
1. Uniform sand, loose	46	0.85	32	1.43	1.89	90	118
2. Uniform sand, dense	34	0.51	19	1.75	2.09	109	130
3. Mixed-grained sand, loose	40	0.67	25	1.59	1.99	99	124
4. Mixed-grained sand, dense	30	0.43	16	1.86	2.16	116	135
5. Glacial till, very mixed-grained	20	0.25	9	2.12	2.32	132	145
6. Soft glacial clay	55	1.2	45	–	1.77	–	110
7. Stiff glacial clay	37	0.6	22	–	2.07	–	129
8. Soft slightly organic clay	66	1.9	70	–	1.58	–	98
9. Soft very organic clay	75	3.0	110	–	1.43	–	89
10. Soft bentonite	84	5.2	194	–	1.27	–	80

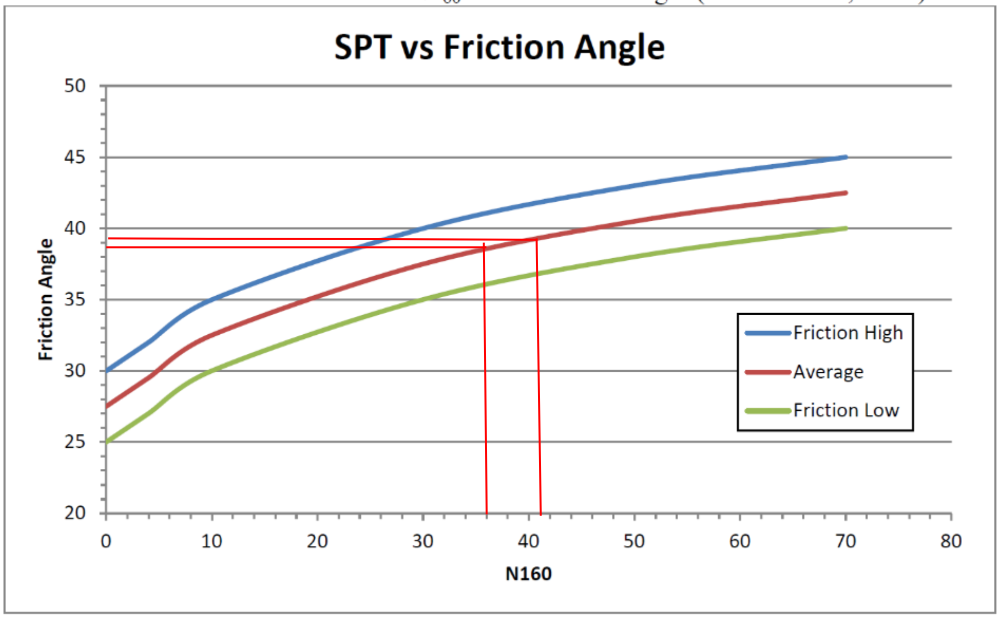
w = water content when saturated, in per cent of dry weight.
γ_d = unit weight in dry state.
γ = unit weight in saturated state.

Table 17.1
Representative Values of ϕ for Sands and Silts

Material	Degrees *Loose*	Degrees *Dense*
Sand, round grains, uniform	27.5	34
Sand, angular grains, well graded	33	45
Sandy gravels	35	50
Silty sand	27–33	30–34
Inorganic silt	27–30	30–35

Caltrans Geotechnical Manual (March 2014)

Chart 1: Correlation of SPT $N1_{60}$ with Friction Angle (after Bowles, 1977)



Choose the friction angle (expressed to the nearest degree) based upon the soil type, particle size(s), and rounding or angularity. Experience should be used to select specific values within the ranges. In general, finer materials or materials with significant (about 30+ %) silt-sized material will fall in the lower portion of the range. Coarser materials with less than 5% fines will fall in the upper portion of the range. The extreme range of phi angles for any $N1_{60}$ is five degrees, so the adjustment factors for particle size and roundness should be only a degree or two. The following bullets provide help in determining which value to select for a given $N1_{60}$ and soil type:

- Use the maximum value for GW
- Use the average for GM and SP
- Use the minimum for SC
- Use the minimum + 0.5 for ML
- Use the average +1 for SW
- Use the average -1 for GC
- Use the Maximum -1 for GP

Values may also be increased with increasing grain size and/or particle angularity, and decreased with decreasing grain size and/or increasing roundness. For example, an SP with $N1_{60}$ = 30 could be assigned phi angles of 37, 38 or 39 degrees for fine, medium and coarse grain sizes respectively.

NAVFAC Design Manual 7.01 Soil Mechanics

TABLE 6
Typical Values of Soil Index Properties

	Particle Size and Gradation				Voids(1)					Unit Weight(2) (lb./cu.ft.)						
	Approximate Size Range (mm)		Approx. D_{10} (mm)	Approx. Range Uniform Coefficient C_u	Void Ratio			Porosity (%)		Dry Weight			Wet Weight		Submerged Weight	
	D_{max}	D_{min}			e_{max} loose	e_{cr}	e_{min} dense	n_{max} loose	n_{min} dense	Min loose	100% Mod. AASHO	Max dense	Min loose	Max dense	Min loose	Max dense
GRANULAR MATERIALS																
Uniform Materials																
a. Equal spheres (theoretical values)	-	-	-	1.0	0.92	-	0.35	47.6	26	-	-	-	-	-	-	-
b. Standard Ottawa SAND	0.84	0.59	0.67	1.1	0.80	0.75	0.50	44	33	92	-	110	93	131	57	69
c. Clean, uniform SAND (fine or medium)	-	-	-	1.2 to 2.0	1.0	0.80	0.40	50	29	83	115	118	84	136	52	73
d. Uniform, inorganic SILT	0.05	0.005	0.012	1.2 to 2.0	1.1	-	0.40	52	29	80	-	118	81	136	51	73
Well-graded Materials																
a. Silty SAND	2.0	0.005	0.02	5 to 10	0.90	-	0.30	47	23	87	122	127	88	142	54	79
b. Clean, fine to coarse SAND	2.0	0.05	0.09	4 to 6	0.95	0.70	0.20	49	17	85	132	138	86	148	53	86
c. Micaceous SAND	-	-	-	-	1.2	-	0.40	55	29	76	-	120	77	139	48	76
d. Silty SAND & GRAVEL	100	0.005	0.02	15 to 300	0.85	-	0.14	46	12	89	-	146(3)	90	155(3)	56	92
MIXED SOILS																
Sandy or Silty CLAY	2.0	0.001	0.003	10 to 30	1.8	-	0.25	64	20	60	130	135	100	147	38	85
Skip-graded Silty CLAY with stones or rk fgmts	250	0.001	-	-	1.0	-	0.20	50	17	84	-	140	115	151	53	89
Well-graded GRAVEL, SAND, SILT & CLAY mixture	250	0.001	0.002	25 to 1000	0.70	-	0.13	41	11	100	140	146(4)	125	156(4)	62	94
CLAY SOILS																
CLAY (30%-50% clay sizes)	0.05	0.5µ	0.001	-	2.4	-	0.50	71	33	50	105	112	94	133	31	71
Colloidal CLAY (-0.002 mm: 50%)	0.01	10Å	-	-	12	-	0.60	92	37	13	90	106	71	128	8	66
ORGANIC SOILS																
Organic SILT	-	-	-	-	3.0	-	0.55	75	35	40	-	110	87	131	25	69
Organic CLAY (30% - 50% clay sizes)	-	-	-	-	4.4	-	0.70	81	41	30		100	81	125	18	62

N Value (blows/ft or 305 mm)	Relative Density	Approximate $\bar{\phi}_{tc}$ (degrees) (a)	(b)
0 to 4	very loose	< 28	< 30
4 to 10	loose	28 to 30	30 to 35
10 to 30	medium	30 to 36	35 to 40
30 to 50	dense	36 to 41	40 to 45
> 50	very dense	> 41	> 45

a - Source: Peck, Hanson, and Thornburn (12), p. 310.
b - Source: Meyerhof (13), p. 17.

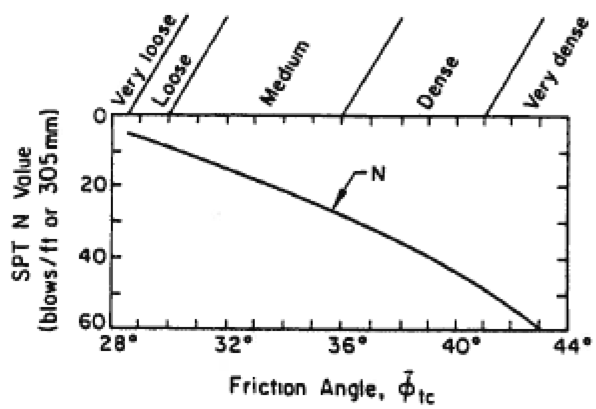


Figure 4-12. N versus $\bar{\phi}_{tc}$

Source: Peck, Hanson, and Thornburn (12), p. 310.

MaineDOT Bridge Design Guide:

Table 3-3 Material Classification

Soil Type	Soil Description	Internal Angle of Friction of Soil, ϕ	Soil Total Unit Weight (pcf)	Coeff. of Friction, tan δ, Concrete to Soil	Interface Friction, Angle, Concrete to Soil δ
1	Very loose to loose silty sand and gravel Very loose to loose sand Very loose to medium density sandy silt Stiff to very stiff clay or clayey silt	29° *	100	0.35	19°
2	Medium density silty sand and gravel Medium density to dense sand Dense to very dense sandy silt	33°	120	0.40	22°
3	Dense to very dense silty sand and gravel Very dense sand	36°	130	0.45	24°
4	Granular underwater backfill Granular borrow	32°	125	0.45	24°
5	Gravel Borrow	36°	135	0.50	27°

* The value given for the internal angle of friction (ϕ) for stiff to very stiff silty clay or clayey silt should be used with caution due to the large possible variation with different moisture contents.

GEI Consultants	**Client:** Thornton Tomasetti **Project:** WIN 026630.07 Smelt Brook Bridge (#2774) **Project No.:** 2502334 **Subject:** Corrected Blow Counts	**Prepared By:** M. Johnescu **Date:** 7/25/2025	**Checked By:** A. Espinosa **Date:** 8/2/2025

Summary of Corrected Blow Counts by Layer

Fill

Boring	No. Values	N_{60} Avg.	N_{60} Max.	N_{60} Min.	$N1_{60}$ Avg.	$N1_{60}$ Max.	$N1_{60}$ Min.
BB-PSB-101	4	16	23	11	22	32	12
BB-PSB-102	4	26	37	17	35	60	20
BB-PSB-103	5	23	40	10	30	66	10
BB-PSB-201	4	46	115	7	70	196	7
BB-PSB-202	6	35	92	17	46	156	15
	Average N_{60}:	**29**	**Average $N1_{60}$:**		**41**		

Glacial Till

Boring	No. Values	N_{60} Avg.	N_{60} Max.	N_{60} Min.	$N1_{60}$ Avg.	$N1_{60}$ Max.	$N1_{60}$ Min.
BB-PSB-101	1	38	38	38	36	36	36
BB-PSB-102	1	41	41	41	36	36	36
	Average N_{60}:	**40**	**Average $N1_{60}$:**		**36**		

GEI Consultants	**Client:** Thornton Tomasetti **Project:** WIN 026630.07 Smelt Brook Bridge (#2774) **Project No.:** 2502334 **Subject:** Corrected Blow Counts	**Prepared By:** M. Johnescu **Date:** 7/25/2025 **Checked By:** A. Espinosa **Date:** 8/2/2025

References: 1) American Association of State Highway and Transportation Officials (AASHTO) "LRFD Bridge Design Specifications, 9th Edition, 2020"

Equations:

Ref. 1 Eqn. No.	Equation	
10.4.6.2.4-2	$N_{60} = (ER / 60\%) * N$	where: N_{60} = SPT blow count corrected for hammer efficiency (blows/ft) ER = hammer efficiency expressed as percent of theoretical free fall energy N = Uncorrected SPT blow count (blows/ft)
10.4.6.2.4-3	$N1_{60} = C_N * N_{60}$	where: $N1_{60}$ = SPT blow count corrected for overburden and hammer efficiency (blows/ft) $C_N = 0.77 * \log_{10}(40/\sigma'_v)$ $[C_N < 2.0]$ σ'_v = vertical effective stress (ksf)

Assumptions:

Ground Surface El.:	28.1	ft
Groundwater El.:	9.4	ft
Depth to Groundwater:	18.7	ft
Average Total Unit Weight of Soil:	125	pcf

Hammer Type	ER (%)	C_E = ER / 60%
Donut	45	0.75
Safety	60	1.00
Automatic	76.5	1.28

Boring:	***BB-PSB-101***			**Corrected Blow Counts**				**Overburden Correction**					**Hammer Efficiency Correction**		
Depth (ft)	**El. (ft)**	**Layer Name**	**N**	**N_{60}**	**$N1_{60}$**	**Avg. N_{60}**	**Avg. $N1_{60}$**	**σ_v (psf)**	**u (psf)**	**σ'_v (psf)**	**σ'_v (ksf)**	**C_N**	**Hammer Type**	**ER (%)**	**C_E**
2.5	25.6	Fill	14	18	29	16	22	313	0	313	0.3	1.62	Automatic	76.5	1.28
5	23.1	Fill	18	23	32			625	0	625	0.6	1.39	Automatic	76.5	1.28
10	18.1	Fill	9	11	13			1,250	0	1,250	1.3	1.16	Automatic	76.5	1.28
15	13.1	Fill	9	11	12			1,875	0	1,875	1.9	1.02	Automatic	76.5	1.28
20	8.1	Glacial Till	30	38	36	38	36	2,500	81	2,419	2.4	0.94	Automatic	76.5	1.28

GEI Consultants	**Client:** Thornton Tomasetti **Project:** WIN 026630.07 Smelt Brook Bridge (#2774) **Project No.:** 2502334 **Subject:** Corrected Blow Counts	**Prepared By:** M. Johnescu **Date:** 7/25/2025 **Checked By:** A. Espinosa **Date:** 8/2/2025

References: 1) American Association of State Highway and Transportation Officials (AASHTO) "LRFD Bridge Design Specifications, 9th Edition, 2020"

Equations:

Ref. 1 Eqn. No.	Equation	
10.4.6.2.4-2	$N_{60} = (ER / 60\%) * N$	where: N_{60} = SPT blow count corrected for hammer efficiency (blows/ft) ER = hammer efficiency expressed as percent of theoretical free fall energy N = Uncorrected SPT blow count (blows/ft)
10.4.6.2.4-3	$N1_{60} = C_N * N_{60}$	where: $N1_{60}$ = SPT blow count corrected for overburden and hammer efficiency (blows/ft) $C_N = 0.77 * \log_{10}(40/\sigma'_v)$ $[C_N < 2.0]$ σ'_v = vertical effective stress (ksf)

Assumptions:

Ground Surface El.:	27.8	ft	
Groundwater El.:	6.3	ft	
Depth to Groundwater:	21.5	ft	(Avg. BB-PSB-101 & -103)
Average Total Unit Weight of Soil:	125	pcf	

Hammer Type	ER (%)	C_E = ER / 60%
Donut	45	0.75
Safety	60	1.00
Automatic	76.5	1.28

Boring:		***BB-PSB-102***		**Corrected Blow Counts**				**Overburden Correction**					**Hammer Efficiency Correction**		
Depth (ft)	**El. (ft)**	**Layer Name**	**N**	**N_{60}**	**$N1_{60}$**	**Avg. N_{60}**	**Avg. $N1_{60}$**	**σ_v (psf)**	**u (psf)**	**σ'_v (psf)**	**σ'_v (ksf)**	**C_N**	**Hammer Type**	**ER (%)**	**C_E**
2.4	25.4	Fill	29	37	60	26	35	300	0	300	0.3	1.64	Automatic	76.5	1.28
5	22.8	Fill	13	17	23			625	0	625	0.6	1.39	Automatic	76.5	1.28
10	17.8	Fill	24	31	35			1,250	0	1,250	1.3	1.16	Automatic	76.5	1.28
15	12.8	Fill	15	19	20			1,875	0	1,875	1.9	1.02	Automatic	76.5	1.28
25	2.8	Glacial Till	32	41	36	41	36	3,125	218	2,907	2.9	0.88	Automatic	76.5	1.28

GEI Consultants	**Client:** Thornton Tomasetti **Project:** WIN 026630.07 Smelt Brook Bridge (#2774) **Project No.:** 2502334 **Subject:** Corrected Blow Counts
Prepared By: M. Johnescu	**Date:** 7/25/2025
Checked By: A. Espinosa	**Date:** 8/2/2025

References: 1) American Association of State Highway and Transportation Officials (AASHTO) "LRFD Bridge Design Specifications, 9th Edition, 2020"

Equations:

Ref. 1 Eqn. No.	Equation		
10.4.6.2.4-2	$N_{60} = (ER / 60\%) * N$	where: N_{60} =	SPT blow count corrected for hammer efficiency (blows/ft)
		ER =	hammer efficiency expressed as percent of theoretical free fall energy
		N =	Uncorrected SPT blow count (blows/ft)
10.4.6.2.4-3	$N1_{60} = C_N * N_{60}$	where: $N1_{60}$ =	SPT blow count corrected for overburden and hammer efficiency (blows/ft)
		C_N =	$0.77 * \log_{10}(40/\sigma'_v)$ $[C_N < 2.0]$
		σ'_v =	vertical effective stress (ksf)

Assumptions:

Ground Surface El.:	28.9	ft
Groundwater El.:	4.6	ft
Depth to Groundwater:	24.3	ft
Average Total Unit Weight of Soil:	125	pcf

Hammer Type	ER (%)	C_E = ER / 60%
Donut	45	0.75
Safety	60	1.00
Automatic	76.5	1.28

Boring:	***BB-PSB-103***			Corrected Blow Counts				Overburden Correction					Hammer Efficiency Correction		
Depth (ft)	El. (ft)	Layer Name	N	N_{60}	$N1_{60}$	Avg. N_{60}	Avg. $N1_{60}$	σ_v (psf)	u (psf)	σ'_v (psf)	σ'_v (ksf)	C_N	Hammer Type	ER (%)	C_E
2.2	26.7	Fill	31	40	66			275	0	275	0.3	1.67	Automatic	76.5	1.28
5	23.9	Fill	12	15	21			625	0	625	0.6	1.39	Automatic	76.5	1.28
10	18.9	Fill	24	31	35	23	30	1,250	0	1,250	1.3	1.16	Automatic	76.5	1.28
15	13.9	Fill	8	10	10			1,875	0	1,875	1.9	1.02	Automatic	76.5	1.28
20	8.9	Fill	15	19	18			2,500	0	2,500	2.5	0.93	Automatic	76.5	1.28

GEI Consultants

Client: Thornton Tomasetti
Project: WIN 026630.07 Smelt Brook Bridge (#2774)
Project No.: 2502334
Subject: Corrected Blow Counts

Prepared By: M. Johnescu
Date: 7/25/2025
Checked By: A. Espinosa
Date: 8/2/2025

References: 1) American Association of State Highway and Transportation Officials (AASHTO) "LRFD Bridge Design Specifications, 9th Edition, 2020"

Equations:

Ref. 1 Eqn. No.	Equation		
10.4.6.2.4-2	$N_{60} = (ER / 60\%) * N$	where: N_{60} =	SPT blow count corrected for hammer efficiency (blows/ft)
		ER =	hammer efficiency expressed as percent of theoretical free fall energy
		N =	Uncorrected SPT blow count (blows/ft)
10.4.6.2.4-3	$N1_{60} = C_N * N_{60}$	where: $N1_{60}$ =	SPT blow count corrected for overburden and hammer efficiency (blows/ft)
		C_N =	$0.77 * \log_{10}(40/\sigma'_v)$ [$C_N < 2.0$]
		σ'_v =	vertical effective stress (ksf)

Assumptions:

Ground Surface El.:	29.5	ft	
Groundwater El.:	5.2	ft	
Depth to Groundwater:	24.3	ft	(BB-PSB-202A)
Average Total Unit Weight of Soil:	125	pcf	

Hammer Type	ER (%)	C_E = ER / 60%
Donut	45	0.75
Safety	60	1.00
Automatic	83.4	1.39

Boring:	***BB-PSB-201***			**Corrected Blow Counts**				**Overburden Correction**					**Hammer Efficiency Correction**		
Depth (ft)	**El. (ft)**	**Layer Name**	**N**	**N_{60}**	**$N1_{60}$**	**Avg. N_{60}**	**Avg. $N1_{60}$**	**σ_v (psf)**	**u (psf)**	**σ'_v (psf)**	**σ'_v (ksf)**	**C_N**	**Hammer Type**	**ER (%)**	**C_E**
2	27.5	Fill	83	115	196	46	70	250	0	250	0.3	1.70	Automatic	83.4	1.39
5	24.5	Fill	16	22	31			625	0	625	0.6	1.39	Automatic	83.4	1.39
10	19.5	Fill	29	40	47			1,250	0	1,250	1.3	1.16	Automatic	83.4	1.39
15	14.5	Fill	5	7	7			1,875	0	1,875	1.9	1.02	Automatic	83.4	1.39

GEI Consultants

Client: Thornton Tomasetti
Project: WIN 026630.07 Smelt Brook Bridge (#2774)
Project No.: 2502334
Subject: Corrected Blow Counts

Prepared By: M. Johnescu
Date: 7/25/2025
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References: 1) American Association of State Highway and Transportation Officials (AASHTO) "LRFD Bridge Design Specifications, 9th Edition, 2020"

Equations:

Ref. 1 Eqn. No.	Equation		
10.4.6.2.4-2	$N_{60} = (ER / 60\%) * N$	where: N_{60} =	SPT blow count corrected for hammer efficiency (blows/ft)
		ER =	hammer efficiency expressed as percent of theoretical free fall energy
		N =	Uncorrected SPT blow count (blows/ft)
10.4.6.2.4-3	$N1_{60} = C_N * N_{60}$	where: $N1_{60}$ =	SPT blow count corrected for overburden and hammer efficiency (blows/ft)
		C_N =	$0.77 * \log_{10}(40/\sigma'_v)$ $[C_N < 2.0]$
		σ'_v =	vertical effective stress (ksf)

Assumptions:

Ground Surface El.:	30.0	ft	
Groundwater El.:	5.7	ft	
Depth to Groundwater:	24.3	ft	(BB-PSB-202A)
Average Total Unit Weight of Soil:	125	pcf	

Hammer Type	ER (%)	C_E = ER / 60%
Donut	45	0.75
Safety	60	1.00
Automatic	83.4	1.39

Boring: ***BB-PSB-202***

Depth (ft)	El. (ft)	Layer Name	N	Corrected Blow Counts: N_{60}	$N1_{60}$	Avg. N_{60}	Avg. $N1_{60}$	Overburden Correction: σ_v (psf)	u (psf)	σ'_v (psf)	σ'_v (ksf)	C_N	Hammer Efficiency Correction: Hammer Type	ER (%)	C_E
2	28.0	Fill	66	92	156	35	46	250	0	250	0.3	1.70	Automatic	83.4	1.39
5	25.0	Fill	12	17	23			625	0	625	0.6	1.39	Automatic	83.4	1.39
10	20.0	Fill	17	24	27			1,250	0	1,250	1.3	1.16	Automatic	83.4	1.39
15	15.0	Fill	26	36	37			1,875	0	1,875	1.9	1.02	Automatic	83.4	1.39
20	10.0	Fill	12	17	15			2,500	0	2,500	2.5	0.93	Automatic	83.4	1.39
25	5.0	Fill	17	24	20			3,125	44	3,081	3.1	0.86	Automatic	83.4	1.39

D.2. Earth Pressure Coefficients

CALCULATE EARTH PRESSURE COEFFICIENTS

Calculations of earth pressure coefficients assigned to soils listed in Soil Properties table of the report are provided in this packet. Active, at-rest, and passive pressures were determined for different soils.

Equations/references utilized for these calculations are provided at the back of this calculation.

	Existing Fill	Glacial Till	Granular Borrow	Gravel Borrow
Friction angle, ϕ (deg)	34	38	32	36
Angle of friction between soil and wall, δ (deg)	23	25	24	27
Slope of backfill behind wall, β (deg)	0	0	0	0
Slope of backfill in front of wall, α (deg) (for passive - enter as neg)	0	0	0	0
Angle of back face of wall to horz, θ (deg)	90	90	90	90
δ/ϕ	0.7	0.7	0.8	0.8
β/ϕ	0.0	0.0	0.0	0.0
Γ	2.93	3.17	2.87	3.12
Active earth pressure coefficient (Rankine method, MaineDOT BDG 3.6.5.2 and AASHTO C3.11.5.3-1), Ka[1]	0.28	0.24	0.31	0.26
Active earth pressure coefficient (Coloumb method, AASHTO LRFD 3.11.5.3-1), Ka[1]	0.25	0.22	0.27	0.24
At-rest earth pressure coefficient (AASHTO LRFD 3.11.5.2-1), Ko	0.44	0.38	0.47	0.41
Passive earth pressure coefficient[2] (FHWA NHI-06-089 Figure 10-4, Assuming a wall rotation of 0.02 for dense granular soil. The bridge designer should use MassDOT BDM Figure 3.10.8-1)	5.8	5.8	5.8	5.8

1. For long-heel cantilever walls, use Rankine active earth pressure in accordance with MaineDOT BDG 3.6.5.2 and AASHTO LRFD Figure C3.11.5.3-1.
2. Passive earth pressure for walls should be neglected for cases outlined in MaineDOT BDG 3.6.9. MaineDOT BDG 5.4.2.11 recommends abutment and wingwall reinforcement be sized assuming passive earth pressure on the backface of the wall. Design passive earth pressure coefficient should be calculated using MassDOT BDM Figure 3.10.8-1 and NHI-06-089 Figure 10-4, and the more stringent value should apply. However, passive earth pressure should be no less than Rankine passive earth pressure, regardless of wall rotation.

From AASHTO LRFD 2021:

3.11.5.2—At-Rest Lateral Earth Pressure Coefficient, k_o

For normally consolidated soils, vertical wall, and level ground, the coefficient of at-rest lateral earth pressure may be taken as:

$$k_o = 1 - \sin\phi'_f \qquad (3.11.5.2\text{-}1)$$

where:

ϕ'_f = effective friction angle of soil
k_o = coefficient of at-rest lateral earth pressure

3.11.5.3—Active Lateral Earth Pressure Coefficient, k_a

Values for the coefficient of active lateral earth pressure may be taken as:

$$k_a = \frac{\sin^2(\theta + \phi'_f)}{\Gamma\,[\sin^2\theta\,\sin(\theta - \delta)]} \qquad (3.11.5.3\text{-}1)$$

in which:

$$\Gamma = \left[1 + \sqrt{\frac{\sin(\phi'_f + \delta)\sin(\phi'_f - \beta)}{\sin(\theta - \delta)\sin(\theta + \beta)}}\right]^2 \qquad (3.11.5.3\text{-}2)$$

where:

δ = friction angle between fill and wall (degrees)
β = angle of fill to the horizontal as shown in Figure 3.11.5.3-1 (degrees)
θ = angle of back face of wall to the horizontal as shown in Figure 3.11.5.3-1 (degrees)
ϕ'_f = effective angle of internal friction (degrees)

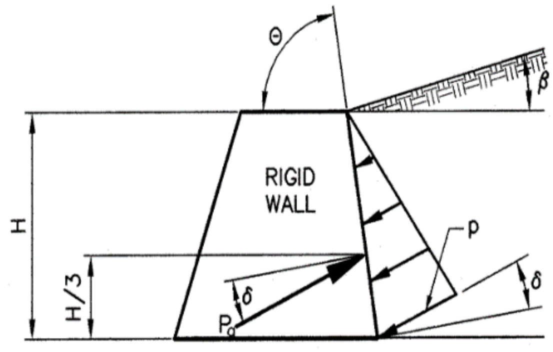


Figure 3.11.5.3-1—Notation for Coulomb Active Earth Pressure

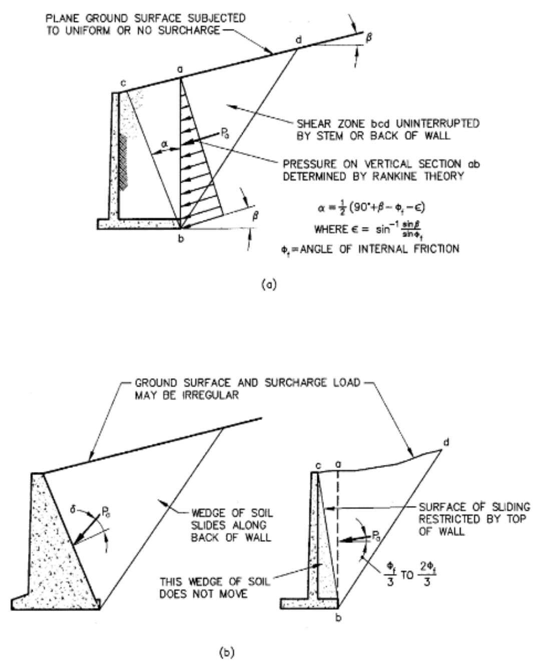
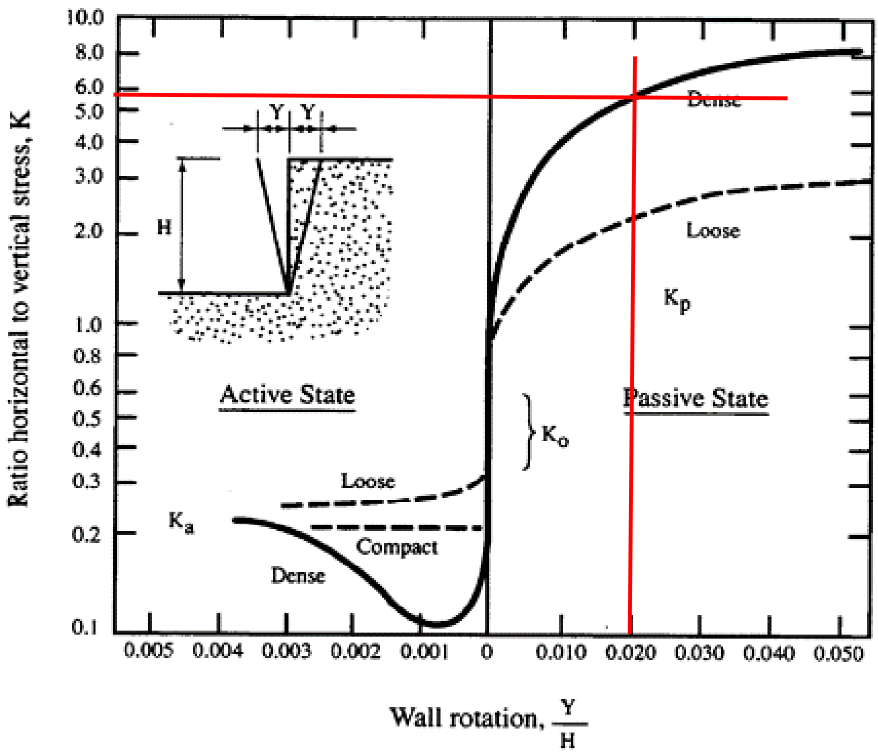


Figure C3.11.5.3-1—Application of (a) Rankine and (b) Coulomb Earth Pressure Theories in Retaining Wall Design

From FHWA NHI-06-089:



Magnitude of Wall Rotation to Reach Failure

Soil type and condition	Rotation, Y/H	
	Active	Passive
Dense cohesionless	0.001	0.02
Loose cohesionless	0.004	0.06
Stiff cohesive	0.010	0.02
Soft cohesive	0.020	0.04

Figure 10-4. Effect of wall movement on wall pressures (after Canadian Geotechnical Society, 1992).

FHWA NHI-06-089
Soils and Foundations – Volume II
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10 – Earth Retaining Structures
December 2006

From MaineDOT BDG 2003:

Table 3-3 Material Classification

Soil Type	Soil Description	Internal Angle of Friction of Soil, ϕ	Soil Total Unit Weight (pcf)	Coeff. of Friction, tan δ, Concrete to Soil	Interface Friction, Angle, Concrete to Soil δ
1	Very loose to loose silty sand and gravel Very loose to loose sand Very loose to medium density sandy silt Stiff to very stiff clay or clayey silt	29° *	100	0.35	19°
2	Medium density silty sand and gravel Medium density to dense sand Dense to very dense sandy silt	33°	120	0.40	22°
3	Dense to very dense silty sand and gravel Very dense sand	36°	130	0.45	24°
4	Granular underwater backfill Granular borrow	32°	125	0.45	24°
5	Gravel Borrow	36°	135	0.50	27°

* The value given for the internal angle of friction (ϕ) for stiff to very stiff silty clay or clayey silt should be used with caution due to the large possible variation with different moisture contents.

For a sloped backfill surface where β > 0°, the coefficient of active earth pressure (Rankine), K_a, may be taken as:

$$K_a = \cos\ \beta \cdot \frac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}}$$

From MassDOT BDM:

$$K = 0.43 + 5.7[1 - e^{-190(\delta_T/H)}]$$

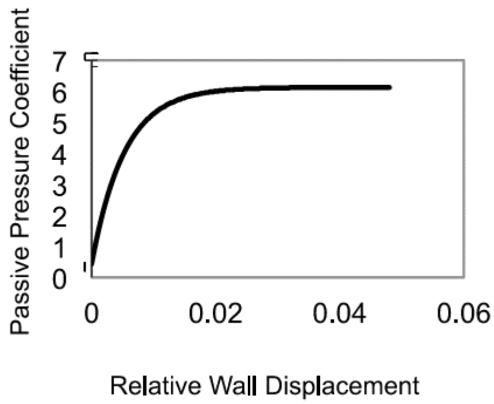


Figure 3.10.8-1: Plot of Passive Pressure Coefficient, K, vs. Relative Wall Displacement, δ_T/H.

D.3. Site Class Evaluation

By: M. Johnescu
Date: 7/25/2025
Checked By: A. Espinosa
Date: 8/3/2025

GEI Consultants

Project: Smelt Brook Bridge (#2774) Replacement Project
WIN 026630.07
GEI Project No.: 2502334

Site Class Evaluation - Smelt Brook Bridge over Smelt Brook

Purpose: Evaluate seismic design criteria in accordance with 2020 AASHTO LRFD Seismic Bridge Design. Evaluate borings based on N_{60} values.

Point	BB-PSB-101		
	N_i	Layer (d_i)	d_i/N_i
1	18	4	0.22
2	23	5	0.22
3	11	5	0.45
4	11	5	0.45
5	38	2	0.06
6	100	79	0.79
	Σ =	100	2.2
		$\bar{N}$	**46**

Point	BB-PSB-102		
	N_i	Layer (d_i)	d_i/N_i
1	37	4	0.11
2	17	5	0.29
3	31	5	0.16
4	19	10	0.53
5	41	4	0.10
6	100	72	0.72
	Σ =	100	1.9
		$\bar{N}$	**52**

Point	BB-PSB-202/202A		
	N_i	Layer (d_i)	d_i/N_i
1	92	4	0.04
2	17	5	0.29
3	24	5	0.21
4	36	5	0.14
5	17	5	0.29
6	24	5	0.22
7	100	71	0.71
	Σ =	100	1.9
		$\bar{N}$	**52**

Point	BB-PSB-103		
	N_i	Layer (d_i)	d_i/N_i
1	40	4	0.10
2	15	5	0.33
3	31	5	0.16
4	10	5	0.50
5	19	10	0.52
6	100	71	0.71
	Σ =	100	2.3
		$\bar{N}$	**43**

Point	BB-PSB-201		
	N_i	Layer (d_i)	d_i/N_i
1	100	4	0.04
2	22	5	0.23
3	40	5	0.13
4	7	7	0.93
5	100	80	0.80
	Σ =	100	2.1
		$\bar{N}$	**47**

$$\bar{N} = \frac{\sum d_i}{\sum d_i/N_i}$$

From AASHTO

N-values are N60 values (i.e., corrected for hammer energy)

Avg. $\bar{N}$ 48

From AASHTO Table 3.10.3.1-1 15 < N < 50
Use Site Class D

Site Seismic Coefficients

Horizontal Peak Ground Acceleration,	PGA =	0.080	USGS Seismic Design Maps (AASHTO Figs. 3.10.2.1-1,-2, and -3)
Horizontal Response Spectral Acceleration (0.2 sec),	S_s =	0.160	
Horizontal Response Spectral Acceleration (1 sec),	S_1 =	0.040	
	F_{PGA} =	1.6	AASHTO Table 3.10.3.2-1
	F_A =	1.6	AASHTO Table 3.10.3.2-2
	F_V =	2.4	AASHTO Table 3.10.3.2-3

Design Response Spectra

Acceleration Coefficient,	$A_s = PGA \times F_{PGA}$	A_S =	0.128	AASHTO Eq. 3.10.4.2-2
Design Spectral Acceleration (0.2 sec),	$S_{DS} = S_S \times F_A$	S_{DS} =	0.256	AASHTO Eq. 3.10.4.2-3
Design Spectral Acceleration (1 sec),	$S_{D1} = S_1 \times F_V$	S_{D1} =	0.096	AASHTO Eq. 3.10.4.2-6

From AASHTO Table 3.10.6-1
Seismic Zone 1

AASHTO Tables:

Table 3.4.2.3-1—Values of F_{pga} and F_a as a Function of Site Class and Mapped Peak Ground Acceleration or Short-Period Spectral Acceleration Coefficient

Site Class	Mapped Peak Ground Acceleration or Spectral Response Acceleration Coefficient at Short Periods				
	$PGA \leq 0.10$ $S_s \leq 0.25$	$PGA = 0.20$ $S_s = 0.50$	$PGA = 0.30$ $S_s = 0.75$	$PGA = 0.40$ $S_s = 1.00$	$PGA \geq 0.50$ $S_s \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	[a]	[a]	[a]	[a]	[a]

Note: Use straight line interpolation for intermediate values of PGA and S_s, where PGA is the peak ground acceleration and S_s is the spectral acceleration coefficient at 0.2 sec obtained from the ground motion maps.

[a] Site-specific response geotechnical investigation and dynamic site response analyses should be considered (Article 3.4.3).

Table 3.4.2.3-2—Values of F_v as a Function of Site Class and Mapped 1-sec Period Spectral Acceleration Coefficient

Site Class	Mapped Spectral Response Acceleration Coefficient at 1-sec Periods				
	$S_1 \leq 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \geq 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	[a]	[a]	[a]	[a]	[a]

Note: Use straight line interpolation for intermediate values of S_1, where S_1 is the spectral acceleration coefficient at 1.0 sec obtained from the ground motion maps.

[a] Site-specific response geotechnical investigation and dynamic site response analyses should be considered (Article 3.4.3).

Table 3.10.6-1—Seismic Zones

Acceleration Coefficient, S_{D1}	Seismic Zone
$S_{D1} \leq 0.15$	1
$0.15 < S_{D1} \leq 0.30$	2
$0.30 < S_{D1} \leq 0.50$	3
$0.50 < S_{D1}$	4

D.4. Frost Depth Calculation

5.2 General

5.2.1 Frost

Any foundation placed on seasonally frozen soils must be embedded below the depth of frost penetration to provide adequate frost protection and to minimize the potential for freeze/thaw movements. Fine-grained soils with low cohesion tend to be most frost susceptible. Soils containing a high percentage of particles smaller than the No. 200 sieve also tend to promote frost penetration.

In order to estimate the depth of frost penetration at a site, Table 5-1 has been developed using the Modified Berggren equation and Figure 5-1 Maine Design Freezing Index Map. The use of Table 5-1 assumes site specific, uniform soil conditions where the Geotechnical Designer has evaluated subsurface conditions. Coarse-grained soils are defined as soils with sand as the major constituent. Fine-grained soils are those having silt and/or clay as the major constituent. If the make-up of the soil is not easily discerned, consult the Geotechnical Designer for assistance. In the event that specific site soil conditions vary, the depth of frost penetration should be calculated by the Geotechnical Designer.

Table 5-1 Depth of Frost Penetration

Design Freezing Index	Frost Penetration (in)					
	Coarse Grained			Fine Grained		
	w=10%	w=20%	w=30%	w=10%	w=20%	w=30%
1000	66.3	55.0	47.5	47.1	40.7	36.9
1100	69.8	57.8	49.8	49.6	42.7	38.7
1200	73.1	60.4	52.0	51.9	44.7	40.5
1300	76.3	63.0	54.3	54.2	46.6	42.2
1400	79.2	65.5	56.4	56.3	48.5	43.9
1500	82.1	67.9	58.4	58.3	50.2	45.4
1600	84.8	70.2	60.3	60.2	51.9	46.9
1700	87.5	72.4	62.2	62.2	53.5	48.4
1800	90.1	74.5	64.0	64.0	55.1	49.8
1900	92.6	76.6	65.7	65.8	56.7	51.1
2000	95.1	78.7	67.5	67.6	58.2	52.5
2100	97.6	80.7	69.2	69.3	59.7	53.8
2200	100.0	82.6	70.8	71.0	61.1	55.1
2300	102.3	84.5	72.4	72.7	62.5	56.4
2400	104.6	86.4	74.0	74.3	63.9	57.6
2500	106.9	88.2	75.6	75.9	65.2	58.8
2600	109.1	89.9	77.1	77.5	66.5	60.0

Design Freezing Index based on Figure 5-1: 1200
Material Based on Laboratory Testing: Predominately Granular
Avg. Moisture Content based on Laboratory Testing: 11.2%

Notes: 1. w = water content
2. Where the Freezing Index and/or water content is between the presented values, linear interpretation may be used to determine the frost penetration.

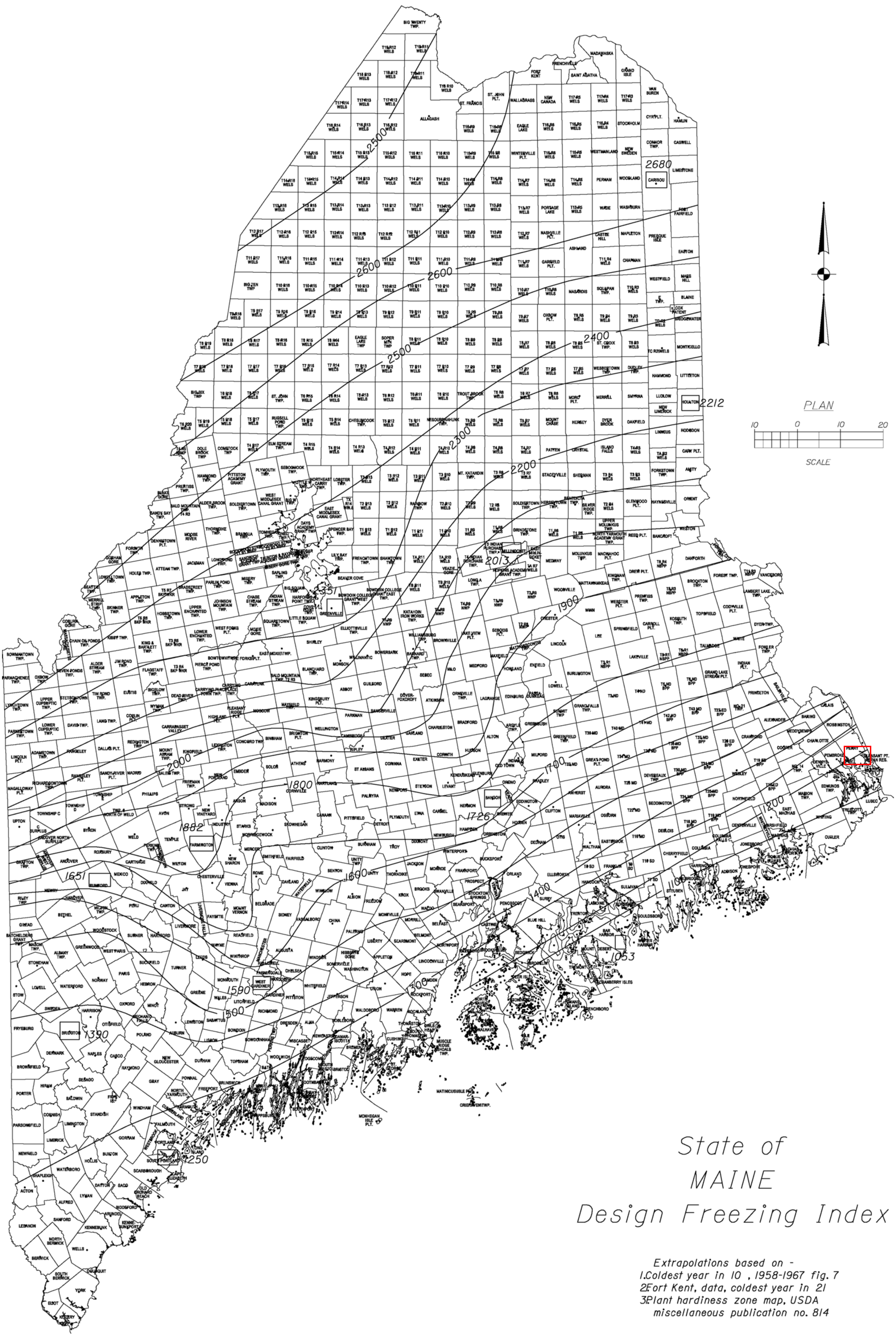


Figure 5-1 Maine Design Freezing Index Map

Example 5-1 illustrates how to use Table 5-1 and Figure 5-1 to determine the depth of frost penetration:

Example 5-1 Depth of Frost Penetration

Given: Site location is Freeport, Maine
Soil conditions: Silty fine to coarse Sand

Step 1. From Figure 5-1 Design Freezing Index = 1300 degree-days
Step 2. From laboratory results: soil water content = 28% and major constituent Sand
Step 3. From Table 5-1: Depth of frost penetration = 56 inches = 4.7 feet

Spread footings founded on bedrock require no minimum embedment depth. Pile supported footings will be embedded for frost protection. The minimum depth of embedment will be calculated using the techniques discussed in Example 5-1. Pile supported integral abutments will be embedded no less than 4.0 feet for frost protection.

Riprap is not to be considered as contributing to the overall thickness of soils required for frost protection.

The final depth of footing embedment may be controlled by the calculated scour depth and be deeper than the depth required for frost protection. Refer to Section 2.3.11 Scour for information regarding scour depth.

5.2.2 Seal Cofferdams

Seal cofferdams are used when a substructure unit must be constructed with its foundation more than 4 feet below the water table, to counteract the buoyant forces produced during pumping of the cofferdam. Once the cofferdam is constructed, the seal is placed under water and water is then pumped out of the cofferdam. This provides a dry platform for construction of the spread footing, or in the case of a pile foundation, the distribution slab. When a seal is needed, the top of footing or distribution slab is located approximately at streambed, and the depth of seal is calculated based upon the buoyancy of the concrete under the expected water surface during construction. The following formula can be used:

$$145 \cdot y = 62.4 \cdot z$$

where:

145 lb/ft^3 =	unit weight of concrete
62.4 lb/ft^3 =	unit weight of water
y =	the depth of seal from top of seal to bottom of seal
z =	the depth of water from water surface to bottom of seal

D.5. LPile Analyses

Lpile Input Parameters
Geotechnical Design Report
Smelt Brook Bridge #2774
WIN 026630.07
Perry, Maine

Abutment 1						
Stratum	**Soil Model**	**Top of Layer Elevation (NAVD88 ft)**	**Effective Unit Weight (pcf)**	**Friction Angle (deg)**	**k (pci)**	**Length Along Pile (ft)**
Existing Fill	Sand (Reese)	17	125	34	122	0
Glacial Till	Sand (Reese)	11.3	135	38	209	5.7
Granular Borrow	Sand (Reese)	8	125	32	83	9
Granular Borrow	Sand (Reese)	7	62.6	32	55	10
Bedrock	Massive Rock	3	108.6	--	--	14

Notes:
1) pcf = lbs per cubic foot, deg = degrees, pci = lbs per cubic inch
2) Top of pile elevation is approx. El. 17.0 for proposed Abutment 1 based on Sheet 3, "Interpretive Subsurface Profile," dated August, 2024.
3) Groundwater at El. 6.6 based on borings BB-PSB-101, -103, and -202A.
4) Top of layer elevation based on Borings BB-PSB-101 and PSB-201.
5) Correlations between the horizontal modulus of subgrade reaction (k) and the soil internal friction angle of a given stratum are based on Figure 3.34 presented in the 2022 LPile Technical Manual.
6) Massive Rock Input Parameters: Unconfined Compressive Strength = 6,411 psi, mi=6, υ=0.29, GSI=35, Weighted RQD =27%, Rock Mass Modulus = 185,500 psi.
7) Model assumes that the top 5 ft of the rock socket is backfilled with Granular Borrow MaineDOT Soil Type 4 (703.19) and grout below that.
8) Model uses a 30-inch rock socket.

Abutment 2						
Stratum	**Soil Model**	**Top of Layer Elevation (NAVD88 ft)**	**Effective Unit Weight (pcf)**	**Friction Angle (deg)**	**k (pci)**	**Length Along Pile (ft)**
Existing Fill Above GWT	Sand (Reese)	17	125.0	34	122	0
Existing Fill Below GWT	Sand (Reese)	6.6	62.6	34	75	10.4
Granular Borrow	Sand (Reese)	0.4	62.6	32	55	16.6
Bedrock	Massive Rock	-0.6	108.6	--	--	17.6

Notes:
1) pcf = lbs per cubic foot, deg = degrees, pci = lbs per cubic inch
2) Top of pile elevation is approx. El. 17.0 for proposed Abutment 2 based on Sheet 3, "Boring Location Plan," dated August, 2024.
3) Groundwater at El. 6.6 based on borings BB-PSB-101, -103, and -202A.
4) Top of layer elevation based on Boring BB-PSB-103, -202, and -202A.
5) Correlations between the horizontal modulus of subgrade reaction (k) and the soil internal friction angle of a given stratum are based on Figure 3.34 presented in the 2022 LPile Technical Manual.
6) Massive Rock Input Parameters: Unconfined Compressive Strength = 6,411 psi, mi=6, υ=0.29, GSI=35, Weighted RQD =27%, Rock Mass Modulus = 185,500 psi.
7) Model assumes that the top 1 ft of the rock socket is backfilled with Granular Borrow MaineDOT Soil Type 4 (703.19) and grout below that.
8) Model uses a 30-inch rock socket.

Lpile Output Summary
Geotechnical Design Report
Smelt Brook Bridge #2774
WIN 026630.07
Perry, Maine

Abutment 1 (10.3' Socket)								
H-Pile Size	**Lpile Case #**	**Lateral Deflection (in)**	**Maximum Factored Axial Load (kips)**	**Max Shear Force (kips)**	**Max Moment (in-kips)**	**Max Total Stress (ksi)**	**Max Bending Stress (ksi)**	**Max Axial Stress (ksi)**
HP 14x117	1	0.4356	338	45.4	2281	48.1	38.3	9.8
HP 14x117	2	0.52272	338	51.9	2657	54.5	44.7	9.8

Notes:
1) Lateral deflection and maximum factored axial load were provided to GEI by Thornton Tomasetti on April 17, 2025.
2) Load Case #1 uses the unfactored thermal contraction movement, Load Case #2 uses the thermal contraction movement with a 1.2 factor.
3) Grouted socket length needs to be at least 5.3' long for 14x117 for the tip movement to stabilize and move towards fixity.

Abutment 2 (4.3' Socket)								
H-Pile Size	**Lpile Case #**	**Lateral Deflection (in)**	**Maximum Factored Axial Load (kips)**	**Max Shear Force (kips)**	**Max Moment (in-kips)**	**Max Total Stress (ksi)**	**Max Bending Stress (ksi)**	**Max Axial Stress (ksi)**
HP 14x117	1	0.4356	338	44.2	2240	47.5	37.6	9.8
HP 14x117	2	0.52272	338	50.5	2606	53.6	43.8	9.8

Notes:
1) Lateral deflection and maximum factored axial load were provided to GEI by Thornton Tomasetti on April 17, 2025.
2) Load Case #1 uses the unfactored thermal contraction movement, Load Case #2 uses the thermal contraction movement with a 1.2 factor.

Thornton Tomasetti

Project:	Perry		
W.O.:	P24769	Sheet:	
Calc By:	ESB	Date:	4/2/2025
Check By:		Date:	

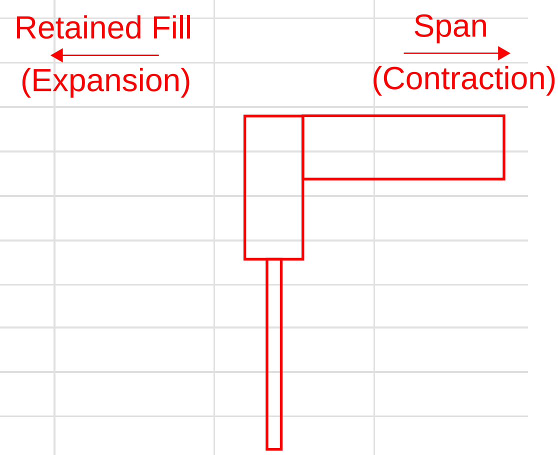
Summary of Unfactored Pile Loads:

DC	186	k/pile
DW	13	k/pile
LL+I, STR I	50	k/pile
LL+I, others	43	k/pile

Note: Loads do not include weight of steel H-pile

Summary of Factored Pile Loads:

STRENGTH I =	338	k/pile
SERVICE I =	241	k/pile



<u>Thermal Contraction - Temperature Fall (toward span)</u>

Δfall =	0.4356	in

<u>Thermal Expansion - Temperature Rise (into backfill)</u>

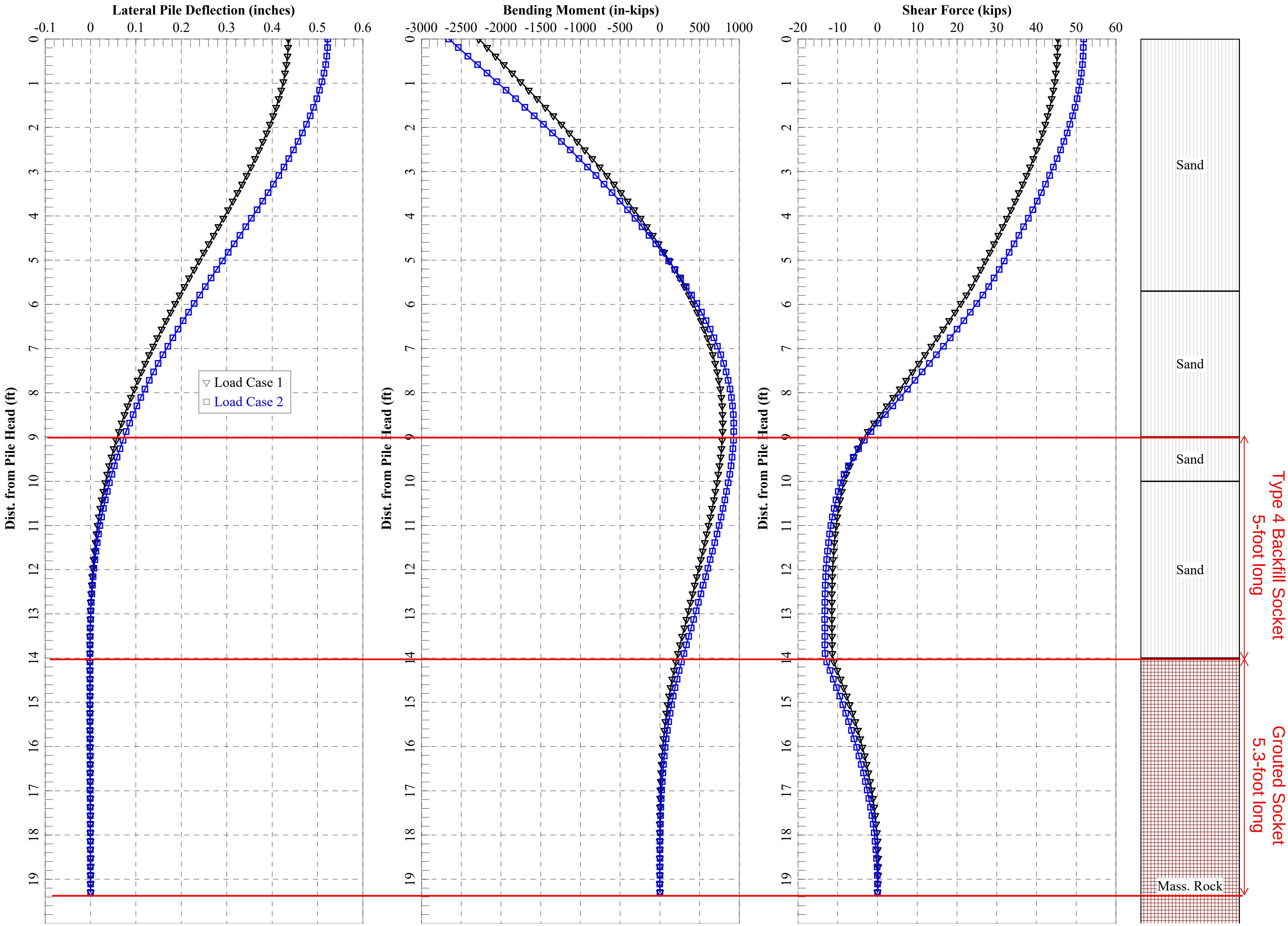
Δrise =	0.363	in

<u>Total Thermal Movement Range at Each Abutment</u>

Δrange =	0.5445	in

Note: Thermal movements do NOT include load factors

Smelt Brook Bridge
Abutment 1 14x117 Piles



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

                    LPile for Windows, Version 2022-12.010

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

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GEI Portland, Maine


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-------------------------------------------------------------------------------
                             Files Used for Analysis
-------------------------------------------------------------------------------

Path to file locations:
\Working\THORNTON TOMASETTI\2502334 MaineDOT Downeast Bridges Phase II\09_Engineering\02_Perry\07_Lpile\Pile Runs\No Scour No
Corrosion\

Name of input data file:
Perry Abutment 1 HP14x117 2025-07-08.lp12d

Name of output report file:
Perry Abutment 1 HP14x117 2025-07-08.lp12o

Name of plot output file:
Perry Abutment 1 HP14x117 2025-07-08.lp12p

Name of runtime message file:
Perry Abutment 1 HP14x117 2025-07-08.lp12r

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

               Date:  July 8, 2025               Time:  19:43:28


-------------------------------------------------------------------------------
                                  Problem Title
-------------------------------------------------------------------------------

Project Name: Smelt Brook Bridge #2774

Job Number: 2502334

Client: Thornton Tomasetti

Engineer: M. Johnescu

Description: Lateral Pile Analysis Abutment 1 HP14x117



-------------------------------------------------------------------------------
                          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
```

- 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                        =           3
Total length of pile                                   =      19.300 ft
Depth of ground surface below top of pile              =      0.0000 ft
```

Pile diameters used for p-y curve computations are defined using 6 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	14.9000
2	14.000	14.9000
3	14.000	30.0000
4	19.000	30.0000
5	19.000	30.0000
6	19.300	30.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

```
   Section 1 is a H weak axis steel pile
   Length of section                                   =    14.000000 ft
   Pile width                                          =    14.200000 in
```

Pile Section No. 2:

```
   Section 2 is a drilled shaft with casing and H section core/insert
   Length of section                                   =     5.000000 ft
   Section Diameter                                    =    30.000000 in
```

Pile Section No. 3:

```
   Section 3 is a round drilled shaft, bored pile, or CIDH pile
   Length of section                                   =     0.300000 ft
   Shaft Diameter                                      =    30.000000 in
```

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        =     5.700000 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                      =    34.000000 deg.
   Friction angle at bottom of layer                   =    34.000000 deg.
   Subgrade k at top of layer                          =   122.000000 pci
   Subgrade k at bottom of layer                       =   122.000000 pci
```

Layer 2 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer           =     5.700000 ft
   Distance from top of pile to bottom of layer        =     9.000000 ft
   Effective unit weight at top of layer               =   135.000000 pcf
   Effective unit weight at bottom of layer            =   135.000000 pcf
   Friction angle at top of layer                      =    38.000000 deg.
   Friction angle at bottom of layer                   =    38.000000 deg.
   Subgrade k at top of layer                          =   209.000000 pci
   Subgrade k at bottom of layer                       =   209.000000 pci
```

Layer 3 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer           =     9.000000 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 = 32.000000 deg.
Friction angle at bottom of layer = 32.000000 deg.
Subgrade k at top of layer = 83.000000 pci
Subgrade k at bottom of layer = 83.000000 pci

Layer 4 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 = 14.000000 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 = 32.000000 deg.
Friction angle at bottom of layer = 32.000000 deg.
Subgrade k at top of layer = 55.000000 pci
Subgrade k at bottom of layer = 55.000000 pci

Layer 5 is massive rock, p-y criteria by Liang et al., 2009

Distance from top of pile to top of layer = 14.000000 ft
Distance from top of pile to bottom of layer = 50.000000 ft
Effective unit weight at top of layer = 108.600000 pcf
Effective unit weight at bottom of layer = 108.600000 pcf
Uniaxial compressive strength at top of layer = 6411. psi
Uniaxial compressive strength at bottom of layer = 6411. psi
Poisson's ratio at top of layer = 0.290000
Poisson's ratio at bottom of layer = 0.290000
Option 1: Intact rock modulus at top of layer = 0.0000 psi
Intact rock modulus at bottom of layer = 0.0000 psi
Option 1: Geologic Strength Index for layer = 35.000000
Option 2: Rock mass modulus at top of layer = 185500. psi
Rock mass modulus at bottom of layer = 185500. psi
Option 2 will use the input value of rock mass modulus to compute the p-y curve in massive rock.
The rock type is (sedimentary) shales, Hoek-Brown Material Constant mi = 6

(Depth of the lowest soil layer extends 30.700 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	Rock Mass Modulus psi	Geologic Strength Index	Int. Rock Modulus psi	Hoek-Brown Material Index, mi	Poisson's Ratio
1	Sand	0.00	125.0000	34.0000	--	122.0000	--	--	0.00	0.00	0.00
	(Reese, et al.)	5.7000	125.0000	34.0000	--	122.0000	--	--	0.00	0.00	0.00
2	Sand	5.7000	135.0000	38.0000	--	209.0000	--	--	0.00	0.00	0.00
	(Reese, et al.)	9.0000	135.0000	38.0000	--	209.0000	--	--	0.00	0.00	0.00
3	Sand	9.0000	125.0000	32.0000	--	83.0000	--	--	0.00	0.00	0.00
	(Reese, et al.)	10.0000	125.0000	32.0000	--	83.0000	--	--	0.00	0.00	0.00
4	Sand	10.0000	62.6000	32.0000	--	55.0000	--	--	0.00	0.00	0.00
	(Reese, et al.)	14.0000	62.6000	32.0000	--	55.0000	--	--	0.00	0.00	0.00
5	Massive	14.0000	108.6000	--	6411.	--	185500.	35.0000	0.00	6.0000	0.2900
	Rock	50.0000	108.6000	--	6411.	--		35.0000	0.00	6.0000	0.2900

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 = 0.435600 in	S = 0.0000 in/in	338000.	N.A.	Yes
2	5	y = 0.522720 in	S = 0.0000 in/in	338000.	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 = 3

Pile Section No. 1:

Dimensions and Properties of Steel H Weak Axis:

Length of Section	=	14.000000 ft
Flange Width	=	14.900000 in
Section Depth	=	14.200000 in
Flange Thickness	=	0.805000 in
Web Thickness	=	0.805000 in
Yield Stress of Pipe	=	50.000000 ksi
Elastic Modulus	=	29000. ksi
Cross-sectional Area	=	34.123950 sq. in.
Moment of Inertia	=	444.363799 in^4
Elastic Bending Stiffness	=	12886550. kip-in^2
Plastic Modulus, Z	=	91.398684in^3
Plastic Moment Capacity = Fy Z	=	4570.in-kip

Axial Structural Capacities:

Nom. Axial Structural Capacity = Fy As	=	1706.197 kips
Nominal Axial Tensile Capacity	=	-1706.197 kips

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

Number	Axial Thrust Force kips
1	338.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 338.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000456	58.7466414	12886018.	82.3695401	10.8801770	
0.00000912	117.4932829	12886018.	44.9097701	11.8552872	
0.00001368	176.2399243	12886018.	32.4231800	12.8303978	
0.00001824	234.9865658	12886018.	26.1798850	13.8055081	
0.00002279	293.7332072	12886018.	22.4339080	14.7806184	
0.00002735	352.4798486	12886018.	19.9365900	15.7557288	
0.00003191	411.2264901	12886018.	18.1527914	16.7308392	
0.00003647	469.9731315	12886018.	16.8149425	17.7059496	
0.00004103	528.7197729	12886018.	15.7743933	18.6810599	
0.00004559	587.4664144	12886018.	14.9419540	19.6561703	
0.00005015	646.2130558	12886018.	14.2608673	20.6312806	
0.00005471	704.9596973	12886018.	13.6932950	21.6063911	
0.00005927	763.7063387	12886018.	13.2130415	22.5815014	
0.00006383	822.4529801	12886018.	12.8013957	23.5566118	
0.00006838	881.1996216	12886018.	12.4446360	24.5317222	
0.00007294	939.9462630	12886018.	12.1324713	25.5068325	
0.00007750	998.6929045	12886018.	11.8570318	26.4819429	
0.00008206	1057.	12886018.	11.6121967	27.4570533	
0.00008662	1116.	12886018.	11.3931337	28.4321636	
0.00009118	1175.	12886018.	11.1959770	29.4072740	
0.00009574	1234.	12886018.	11.0175971	30.3823844	
0.0001003	1292.	12886018.	10.8554336	31.3574947	
0.0001049	1351.	12886018.	10.7073713	32.3326051	
0.0001094	1410.	12886018.	10.5716475	33.3077154	
0.0001140	1469.	12886018.	10.4467816	34.2828258	
0.0001185	1527.	12886018.	10.3315208	35.2579362	
0.0001231	1586.	12886018.	10.2247978	36.2330465	
0.0001277	1645.	12886018.	10.1256979	37.2081569	
0.0001322	1704.	12886018.	10.0334324	38.1832673	
0.0001368	1762.	12886018.	9.9473180	39.1583777	
0.0001413	1821.	12886018.	9.8667594	40.1334880	
0.0001459	1880.	12886018.	9.7912356	41.1085984	
0.0001504	1939.	12886018.	9.7202891	42.0837087	
0.0001550	1997.	12886018.	9.6535159	43.0588191	

0.0001596	2056.	12886018.	9.5905583	44.0339295	
0.0001641	2115.	12886018.	9.5310983	45.0090399	
0.0001687	2174.	12886018.	9.4748524	45.9841502	
0.0001732	2232.	12886018.	9.4215668	46.9592606	
0.0001778	2291.	12886018.	9.3710138	47.9343710	
0.0001869	2409.	12886018.	9.2773059	49.8845917	
0.0001960	2521.	12858940.	9.1960581	50.0000000	Y
0.0002052	2626.	12798181.	9.1271995	50.0000000	Y
0.0002143	2724.	12712785.	9.0686679	50.0000000	Y
0.0002234	2817.	12609239.	9.0188442	50.0000000	Y
0.0002325	2905.	12492687.	8.9763694	50.0000000	Y
0.0002416	2988.	12365452.	8.9404099	50.0000000	Y
0.0002507	3067.	12232788.	8.9096593	50.0000000	Y
0.0002599	3143.	12095201.	8.8836724	50.0000000	Y
0.0002690	3216.	11956154.	8.8614936	50.0000000	Y
0.0002781	3286.	11815055.	8.8429637	50.0000000	Y
0.0002872	3353.	11674191.	8.8273849	50.0000000	Y
0.0002963	3415.	11523717.	8.8123943	50.0000000	Y
0.0003054	3472.	11365458.	8.7978046	50.0000000	Y
0.0003146	3524.	11201760.	8.7835946	50.0000000	Y
0.0003237	3572.	11034440.	8.7697084	50.0000000	Y
0.0003328	3616.	10865046.	8.7560946	50.0000000	Y
0.0003419	3657.	10694896.	8.7427054	50.0000000	Y
0.0003510	3695.	10525105.	8.7294965	50.0000000	Y
0.0003602	3730.	10356041.	8.7166052	50.0000000	Y
0.0003693	3762.	10188400.	8.7040516	50.0000000	Y
0.0003784	3793.	10023433.	8.6916285	50.0000000	Y
0.0003875	3821.	9861248.	8.6794603	50.0000000	Y
0.0003966	3848.	9701670.	8.6677810	50.0000000	Y
0.0004057	3873.	9545581.	8.6560247	50.0000000	Y
0.0004149	3896.	9391591.	8.6446186	50.0000000	Y
0.0004240	3918.	9241864.	8.6333632	50.0000000	Y
0.0004331	3939.	9095233.	8.6225297	50.0000000	Y
0.0004422	3959.	8951699.	8.6115093	50.0000000	Y
0.0004513	3977.	8811781.	8.6011152	50.0000000	Y
0.0004605	3995.	8675311.	8.5904615	50.0000000	Y
0.0004696	4011.	8541626.	8.5804245	50.0000000	Y
0.0004787	4027.	8411829.	8.5703230	50.0000000	Y
0.0004878	4041.	8284768.	8.5604444	50.0000000	Y
0.0004969	4055.	8161113.	8.5508674	50.0000000	Y
0.0005060	4069.	8040641.	8.5411169	50.0000000	Y
0.0005152	4082.	7922849.	8.5319334	50.0000000	Y
0.0005243	4094.	7808122.	8.5227495	50.0000000	Y
0.0005334	4105.	7696454.	8.5135075	50.0000000	Y
0.0005425	4116.	7587489.	8.5048510	50.0000000	Y
0.0005790	4156.	7177238.	8.4706261	50.0000000	Y
0.0006155	4189.	6806076.	8.4387713	50.0000000	Y
0.0006519	4217.	6468428.	8.4084998	50.0000000	Y
0.0006884	4241.	6161017.	8.3801014	50.0000000	Y
0.0007249	4262.	5879897.	8.3536136	50.0000000	Y
0.0007613	4281.	5622502.	8.3283631	50.0000000	Y
0.0007978	4297.	5385837.	8.3046426	50.0000000	Y
0.0008343	4311.	5167859.	8.2822200	50.0000000	Y
0.0008708	4324.	4965920.	8.2607458	50.0000000	Y
0.0009072	4336.	4779028.	8.2401506	50.0000000	Y
0.0009437	4346.	4605422.	8.2212498	50.0000000	Y
0.0009802	4355.	4443484.	8.2025947	50.0000000	Y
0.0010166	4364.	4292679.	8.1849754	50.0000000	Y

Summary of Results for Nominal Moment Capacity for Section 1

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	338.0000000000	4364.

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	=	5.000000 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	=	14.900000 in
Depth of Core/Insert	=	14.200000 in
Flange Thickness of Core/Insert	=	0.805000 in
Web Thickness of Core/Insert	=	0.805000 in

```
Moment of Inertia of Steel Core/Insert              =   444.363799 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                                    =   672.734397 sq. in.
Cross-sectional Area of Steel Casing                =       0.0000 sq. in.
Cross-sectional Area of Steel Core/Insert           =    34.123950 sq. in.
Area of All Steel (Casing, Core/Insert, and Bars)   =    34.123950 sq. in.
Area Ratio of All Steel to Gross Area               =         4.83 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    =     3993.494 kips
Tensile Load for Cracking of Concrete                  =     -393.967 kips
Nominal Axial Tensile Capacity                         =    -1706.197 kips
```

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

Number	Axial Thrust Force kips
1	338.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force =   338.000 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
0.00000456	782.8761714	171723121.	34.6937687	0.0001582	0.00002140	0.6400313	0.00000	0.00000	3.5754402	
0.00000912	1564.	171528982.	24.9230970	0.0002272	-0.00004629	0.9007222	0.00000	0.00000	4.5680465	
0.00001368	2333.	170579709.	21.6877652	0.0002966	-0.000114	1.1517661	0.00000	0.00000	5.5677730	
0.00001824	2333.	127934782.	18.8268166	0.0003433	-0.000204	1.3140789	0.00000	0.00000	5.9107401	C
0.00002279	2534.	111184092.	17.4824496	0.0003985	-0.000285	1.5001533	0.00000	0.00000	6.4997154	C
0.00002735	2802.	102429466.	16.5445521	0.0004526	-0.000368	1.6758684	0.00000	0.00000	7.0556628	C
0.00003191	3056.	95759777.	15.8531125	0.0005059	-0.000451	1.8430432	0.00000	0.00000	7.5916992	C
0.00003647	3301.	90514066.	15.3231746	0.0005589	-0.000535	2.0027381	0.00000	0.00000	8.1157259	C
0.00004103	3541.	86295141.	14.9076175	0.0006117	-0.000619	2.1558956	0.00000	0.00000	-8.855540	C
0.00004559	3776.	82826814.	14.5754161	0.0006645	-0.000703	2.3029682	0.00000	0.00000	-10.278730	C
0.00005015	4007.	79904119.	14.3033012	0.0007173	-0.000787	2.4438914	0.00000	0.00000	-11.702341	C
0.00005471	4234.	77395296.	14.0766627	0.0007701	-0.000871	2.5787242	0.00000	0.00000	-13.125756	C
0.00005927	4458.	75212000.	13.8861653	0.0008230	-0.000955	2.7076302	0.00000	0.00000	-14.546978	C
0.00006383	4677.	73284035.	13.7239633	0.0008759	-0.001039	2.8305674	0.00000	0.00000	-15.966199	C
0.00006838	4894.	71563742.	13.5850599	0.0009290	-0.001123	2.9476104	0.00000	0.00000	-17.382105	C
0.00007294	5107.	70011582.	13.4650653	0.0009822	-0.001206	3.0587155	0.00000	0.00000	-18.794741	C
0.00007750	5317.	68601701.	13.3617839	0.0010356	-0.001289	3.1640141	0.00000	0.00000	-20.201541	C
0.00008206	5523.	67305267.	13.2710209	0.0010890	-0.001373	3.2632244	0.00000	0.00000	-21.605859	C
0.00008662	5726.	66107738.	13.1920462	0.0011427	-0.001456	3.3564995	0.00000	0.00000	-23.004565	C
0.00009118	5926.	64994247.	13.1233241	0.0011966	-0.001539	3.4438037	0.00000	0.00000	-24.397045	C
0.00009574	6123.	63952176.	13.0634353	0.0012507	-0.001621	3.5250663	0.00000	0.00000	-25.783171	C
0.0001003	6316.	62969608.	13.0104604	0.0013049	-0.001704	3.6001124	0.00000	0.00000	-27.165025	C
0.0001049	6505.	62039427.	12.9640571	0.0013594	-0.001786	3.6689603	0.00000	0.00000	-28.540903	C
0.0001094	6691.	61154985.	12.9236788	0.0014140	-0.001868	3.7315681	0.00000	0.00000	-29.909935	C
0.0001140	6874.	60310198.	12.8886486	0.0014690	-0.001950	3.7878552	0.00000	0.00000	-31.271968	C
0.0001185	7053.	59499898.	12.8583956	0.0015241	-0.002032	3.8377379	0.00000	0.00000		

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-32.626843 C
    0.0001231        7228.     58719657.    12.8324354     0.0015796     -0.002113     3.8811295       0.00000       0.00000
-33.974395 C
    0.0001277        7399.     57965660.    12.8103548     0.0016352     -0.002194     3.9179406       0.00000       0.00000
-35.314450 C
    0.0001322        7567.     57234596.    12.7917990     0.0016912     -0.002275     3.9480782       0.00000       0.00000
-36.646829 C
    0.0001368        7731.     56523566.    12.7764635     0.0017474     -0.002356     3.9714459       0.00000       0.00000
-37.971344 C
    0.0001413        7890.     55830032.    12.7637945     0.0018039     -0.002436     3.9879438       0.00000       0.00000
-39.287793 C
    0.0001459        8046.     55151735.    12.7527038     0.0018604     -0.002516     3.9974680       0.00000       0.00000
-40.595975 C
    0.0001504        8197.     54486385.    12.7443241     0.0019173     -0.002596     3.9985262       0.00000       0.00000
-41.895872 C
    0.0001550        8344.     53830547.    12.7425049     0.0019751     -0.002675     3.9991570       0.00000       0.00000
-43.186838 C
    0.0001596        8486.     53182738.    12.7400946     0.0020328     -0.002754     3.9995059       0.00000       0.00000
-44.468190 C
    0.0001641        8623.     52542586.    12.7398494     0.0020909     -0.002833     3.9996772       0.00000       0.00000
-45.739877 C
    0.0001687        8756.     51910172.    12.7415828     0.0021493     -0.002911     3.9997357       0.00000       0.00000
-47.001949 C
    0.0001732        8885.     51285785.    12.7451144     0.0022080     -0.002989     3.9997076       0.00000       0.00000
-48.254530 C
    0.0001778        9009.     50669806.    12.7502672     0.0022670     -0.003067     3.9995797       0.00000       0.00000
-49.497817 C
    0.0001869        9237.     49417413.    12.7611819     0.0023853     -0.003222     3.9987228       0.00000       0.00000
-50.000000 CY
    0.0001960        9436.     48133462.    12.7712281     0.0025036     -0.003377     4.0000000       0.00000       0.00000
-50.000000 CY
    0.0002052        9611.     46846306.    12.7811290     0.0026221     -0.003532     3.9987374       0.00000       0.00000
-50.000000 CY
    0.0002143        9765.     45571260.    12.7905380     0.0027406     -0.003687     3.9997972       0.00000       0.00000
-50.000000 CY
    0.0002234        9900.     44319197.    12.7995220     0.0028593     -0.003842     3.9996057       0.00000       0.00000
-50.000000 CY
    0.0002325       10021.     43100463.    12.8085680     0.0029781     -0.003997     3.9966621       0.00000       0.00000
-50.000000 CY
    0.0002416       10129.     41920518.    12.8175362     0.0030970     -0.004152     3.9962487       0.00000       0.00000
-50.000000 CY
    0.0002507       10225.     40778563.    12.8261503     0.0032161     -0.004306     3.9958022       0.00000       0.00000
-50.000000 CY
    0.0002599       10311.     39679581.    12.8347318     0.0033352     -0.004461     3.9978873       0.00000       0.00000
-50.000000 CY
    0.0002690       10389.     38624638.    12.8434254     0.0034546     -0.004615     3.9999698       0.00000       0.00000
-50.000000 CY
    0.0002781       10460.     37613738.    12.8522550     0.0035742     -0.004769     3.9994398       0.00000       0.00000
-50.000000 CY
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    0.0002872       10523.     36638828.    12.8602261     0.0036936     -0.004923     3.9977229       0.00000       0.00000
-50.000000 CY
    0.0002963       10581.     35708059.    12.8694659     0.0038136     -0.005076     3.9949775       0.00000       0.00000
-50.000000 CY
    0.0003054       10581.     34642147.    12.9110911     0.0039437     -0.005220     3.9999785       0.00000       0.00000
-50.000000 CY
    0.0003146       10581.     33638026.    12.9465200     0.0040726     -0.005364     3.9988902       0.00000       0.00000
-50.000000 CY
    0.0003237       10581.     32690476.    12.9851318     0.0042031     -0.005507     3.9956429       0.00000       0.00000
50.0000000 CY
    0.0003328       10581.     31794847.    13.0291387     0.0043361     -0.005648     3.9988201       0.00000       0.00000
50.0000000 CY
    0.0003419       10581.     30946984.    13.1174774     0.0044851     -0.005772     3.9996825       0.00000       0.00000
50.0000000 CY
    0.0003510       10581.     30143167.    13.1684908     0.0046227     -0.005909     3.9966786       0.00000       0.00000
50.0000000 CY
    0.0003602       10581.     29380048.    13.2230950     0.0047624     -0.006042     3.9959577       0.00000       0.00000
50.0000000 CY
    0.0003693       10581.     28654615.    13.2797721     0.0049039     -0.006174     3.9990624       0.00000       0.00000
50.0000000 CY
    0.0003784       10581.     27964142.    13.3390408     0.0050474     -0.006304     3.9938214       0.00000       0.00000
50.0000000 CY
    0.0003875       10581.     27306163.    13.3983887     0.0051920     -0.006433     3.9999379       0.00000       0.00000
50.0000000 CY
    0.0003966       10581.     26678435.    13.4585141     0.0053380     -0.006561     3.9961684       0.00000       0.00000
50.0000000 CY
    0.0004057       10581.     26078919.    13.5206959     0.0054860     -0.006686     3.9972142       0.00000       0.00000
50.0000000 CY
    0.0004149       10581.     25505756.    13.5840675     0.0056355     -0.006810     3.9975444       0.00000       0.00000
50.0000000 CY
    0.0004240       10581.     24957245.    13.6495948     0.0057872     -0.006932     3.9932669       0.00000       0.00000
50.0000000 CY
    0.0004331       10581.     24431830.    13.6552542     0.0059141     -0.007079     3.9952603       0.00000       0.00000
50.0000000 CY
    0.0004422       10581.     23928081.    13.7187880     0.0060667     -0.007200     3.9995262       0.00000       0.00000
50.0000000 CY
    0.0004513       10581.     23444685.    13.7837918     0.0062211     -0.007319     3.9951594       0.00000       0.00000
50.0000000 CY
    0.0004605       10581.     22980434.    13.8497115     0.0063771     -0.007436     3.9995438       0.00000       0.00000
50.0000000 CY
    0.0004696       10581.     22534212.    13.8551324     0.0065060     -0.007581     3.9888722       0.00000       0.00000
50.0000000 CY
    0.0004787       10581.     22104989.    13.9213813     0.0066640     -0.007697     3.9987696       0.00000       0.00000
50.0000000 CY
    0.0004878       10581.     21691811.    13.9868929     0.0068229     -0.007811     3.9891390       0.00000       0.00000
50.0000000 CY
    0.0004969       10581.     21293797.    13.9916489     0.0069528     -0.007955     3.9934066       0.00000       0.00000
50.0000000 CY
    0.0005060       10581.     20910125.    14.0561973     0.0071130     -0.008068     3.9998729       0.00000       0.00000
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50.0000000 CY
    0.0005152       10581.     20540034.    14.0606157     0.0072435     -0.008211     3.9920462       0.00000       0.00000
50.0000000 CY
    0.0005243       10581.     20182816.    14.1267238     0.0074063     -0.008322     3.9954793       0.00000       0.00000
50.0000000 CY
```

Summary of Results for Nominal Moment Capacity for Section 2

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	338.0000000000	10581.

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. 3:

Dimensions and Properties of Drilled Shaft (Bored Pile):

```
Length of Section                                       =     0.300000 ft
Shaft Diameter                                          =    30.000000 in
Number of Reinforcing Bars                              =            0 bars
Yield Stress of Reinforcing Bars                        =       0.0000 psi
Modulus of Elasticity of Reinforcing Bars               =       0.0000 psi
Gross Area of Shaft                                     =   706.858347 sq. in.
Total Area of Reinforcing Steel                         =       0.0000 sq. in.
Area Ratio of Steel Reinforcement                       =         0.00 percent
Offset of Center of Rebar Cage from Center of Pile      =       0.0000 in
```

Axial Structural Capacities:

```
Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As     =     2403.318 kips
Tensile Load for Cracking of Concrete                   =     -293.989 kips
Nominal Axial Tensile Capacity                          =        0.000 kips
```

Concrete Properties:

```
Compressive Strength of Concrete                        =        4000. psi
Modulus of Elasticity of Concrete                       =     3604997. psi
Modulus of Rupture of Concrete                          =   -474.34165 psi
Compression Strain at Peak Stress                       =     0.001886
Tensile Strain at Fracture of Concrete                  =   -0.0001154
Maximum Coarse Aggregate Size                           =     0.750000 in
```

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

Number	Axial Thrust Force kips
1	338.000

Definitions of Run Messages and Notes:

C = concrete in section has cracked in tension.
Y = stress in reinforcing steel has reached yield stress.
T = ACI 318 criteria for tension-controlled section met, tensile strain in reinforcement exceeds 0.005 while simultaneously compressive strain in concrete more than 0.003. See ACI 318-14, Section 21.2.3.
Z = depth of tensile zone in concrete section is less than 10 percent of section depth.

Bending Stiffness (EI) = Computed Bending Moment / Curvature.
Position of neutral axis is measured from edge of compression side of pile.
Compressive stresses and strains are positive in sign.
Tensile stresses and strains are negative in sign.

Axial Thrust Force =   338.000 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	Run Msg

0.00000125	197.8111059	158248885.	108.0859395	0.0001351	0.00009761	0.5517540	0.00000
0.00000250	395.6055596	158242224.	61.5727688	0.0001539	0.00007893	0.6247525	0.00000
0.00000375	593.3667065	158231122.	46.0816245	0.0001728	0.00006031	0.6971615	0.00000
0.00000500	791.0778875	158215578.	38.3459888	0.0001917	0.00004173	0.7689748	0.00000
0.00000625	988.7224363	158195590.	33.7125590	0.0002107	0.00002320	0.8401860	0.00000
0.00000750	1186.	158171157.	30.6302346	0.0002297	0.00000473	0.9107890	0.00000
0.00000875	1384.	158140033.	28.4342025	0.0002488	-0.00001370	0.9807758	0.00000
0.00001000	1581.	158079169.	26.7914757	0.0002679	-0.00003209	1.0501173	0.00000
0.00001125	1777.	157967660.	25.5167666	0.0002871	-0.00005044	1.1187733	0.00000
0.00001250	1973.	157801725.	24.4990781	0.0003062	-0.00006876	1.1867133	0.00000
0.00001375	2167.	157585248.	23.6612944	0.0003253	-0.00008716	1.2539157	0.00000
0.00001500	2360.	157324408.	22.9735046	0.0003446	-0.000105	1.3203648	0.00000
0.00001625	2360.	145222530.	21.5419794	0.0003501	-0.000137	1.3384648	0.00000 C
0.00001750	2360.	134849492.	20.8696342	0.0003652	-0.000160	1.3900159	0.00000 C
0.00001875	2360.	125859526.	20.2663888	0.0003800	-0.000183	1.4397561	0.00000 C
0.00002000	2360.	117993306.	19.7208085	0.0003944	-0.000206	1.4878253	0.00000 C
0.00002125	2407.	113267581.	19.2245426	0.0004085	-0.000229	1.5343868	0.00000 C
0.00002250	2463.	109476394.	18.7708281	0.0004223	-0.000253	1.5795970	0.00000 C
0.00002375	2515.	105894333.	18.3529355	0.0004359	-0.000277	1.6234251	0.00000 C
0.00002500	2563.	102527892.	17.9667698	0.0004492	-0.000301	1.6660649	0.00000 C
0.00002625	2608.	99361465.	17.6088893	0.0004622	-0.000325	1.7075915	0.00000 C
0.00002750	2650.	96377077.	17.2754655	0.0004751	-0.000350	1.7480495	0.00000 C
0.00002875	2690.	93559692.	16.9638921	0.0004877	-0.000375	1.7874860	0.00000 C
0.00003000	2727.	90896593.	16.6716168	0.0005001	-0.000400	1.8259508	0.00000 C
0.00003125	2762.	88376900.	16.3967030	0.0005124	-0.000425	1.8634965	0.00000 C
0.00003250	2795.	85991209.	16.1375580	0.0005245	-0.000451	1.9001789	0.00000 C
0.00003375	2826.	83731309.	15.8928739	0.0005364	-0.000476	1.9360575	0.00000 C
0.00003500	2856.	81589960.	15.6615818	0.0005482	-0.000502	1.9711954	0.00000 C
0.00003625	2884.	79560714.	15.4428171	0.0005598	-0.000528	2.0056600	0.00000 C
0.00003750	2911.	77618206.	15.2334463	0.0005713	-0.000554	2.0392517	0.00000 C
0.00003875	2936.	75773605.	15.0346999	0.0005826	-0.000580	2.0722291	0.00000 C
0.00004000	2961.	74024109.	14.8462642	0.0005939	-0.000606	2.1046910	0.00000 C
0.00004125	2984.	72339939.	14.6645487	0.0006049	-0.000633	2.1362948	0.00000 C
0.00004250	3007.	70741364.	14.4920268	0.0006159	-0.000659	2.1674611	0.00000 C
0.00004375	3028.	69209155.	14.3263242	0.0006268	-0.000686	2.1979862	0.00000 C
0.00004500	3048.	67743845.	14.1675687	0.0006375	-0.000712	2.2279681	0.00000 C
0.00004625	3068.	66341268.	14.0153674	0.0006482	-0.000739	2.2574364	0.00000 C
0.00004750	3087.	64995113.	13.8688498	0.0006588	-0.000766	2.2863511	0.00000 C
0.00004875	3106.	63704172.	13.7280540	0.0006692	-0.000793	2.3147839	0.00000 C
0.00005125	3140.	61271696.	13.4615535	0.0006899	-0.000848	2.3701729	0.00000 C
0.00005375	3172.	59022225.	13.2136559	0.0007102	-0.000902	2.4237542	0.00000 C
0.00005625	3203.	56937683.	12.9828276	0.0007303	-0.000957	2.4756861	0.00000 C
0.00005875	3231.	54999588.	12.7665782	0.0007500	-0.001012	2.5260387	0.00000 C
0.00006125	3258.	53183821.	12.5623761	0.0007694	-0.001068	2.5745940	0.00000 C
0.00006375	3283.	51492126.	12.3710480	0.0007887	-0.001124	2.6218782	0.00000 C
0.00006625	3306.	49907738.	12.1907212	0.0008076	-0.001180	2.6678074	0.00000 C
0.00006875	3329.	48414972.	12.0189690	0.0008263	-0.001236	2.7122069	0.00000 C
0.00007125	3350.	47019107.	11.8583012	0.0008449	-0.001293	2.7556911	0.00000 C
0.00007375	3370.	45692630.	11.7030698	0.0008631	-0.001349	2.7974925	0.00000 C

0.00007625	3389.	44450815.	11.5582091	0.0008813	-0.001406	2.8386135	0.00000 C
0.00007875	3407.	43265913.	11.4174076	0.0008991	-0.001463	2.8781100	0.00000 C
0.00008125	3425.	42151794.	11.2854000	0.0009169	-0.001521	2.9169468	0.00000 C
0.00008375	3441.	41089312.	11.1576388	0.0009345	-0.001578	2.9544398	0.00000 C
0.00008625	3457.	40082372.	11.0361768	0.0009519	-0.001636	2.9910679	0.00000 C
0.00008875	3473.	39127142.	10.9206147	0.0009692	-0.001693	3.0268688	0.00000 C
0.00009125	3487.	38211157.	10.8078461	0.0009862	-0.001751	3.0613601	0.00000 C
0.00009375	3501.	37343382.	10.7014788	0.0010033	-0.001809	3.0953006	0.00000 C
0.00009625	3514.	36512878.	10.5985191	0.0010201	-0.001867	3.1282138	0.00000 C
0.00009875	3527.	35716708.	10.4986483	0.0010367	-0.001926	3.1601099	0.00000 C
0.0001013	3540.	34959304.	10.4040432	0.0010534	-0.001984	3.1914767	0.00000 C
0.0001038	3552.	34232855.	10.3124514	0.0010699	-0.002043	3.2219429	0.00000 C
0.0001063	3563.	33532905.	10.2227375	0.0010862	-0.002101	3.2513530	0.00000 C
0.0001088	3574.	32864660.	10.1374476	0.0011024	-0.002160	3.2802554	0.00000 C
0.0001113	3585.	32225979.	10.0562838	0.0011188	-0.002219	3.3086467	0.00000 C
0.0001138	3595.	31605419.	9.9750282	0.0011347	-0.002278	3.3357431	0.00000 C
0.0001163	3605.	31010340.	9.8971846	0.0011505	-0.002337	3.3622850	0.00000 C
0.0001188	3615.	30439916.	9.8228822	0.0011665	-0.002396	3.3883382	0.00000 C
0.0001213	3624.	29892615.	9.7519026	0.0011824	-0.002455	3.4138995	0.00000 C
0.0001238	3633.	29358648.	9.6801471	0.0011979	-0.002515	3.4382006	0.00000 C
0.0001263	3642.	28845251.	9.6114139	0.0012134	-0.002574	3.4620132	0.00000 C
0.0001288	3650.	28351450.	9.5455511	0.0012290	-0.002634	3.4853565	0.00000 C
0.0001313	3659.	27876122.	9.4824275	0.0012446	-0.002693	3.5082275	0.00000 C
0.0001338	3667.	27414834.	9.4201637	0.0012599	-0.002753	3.5302829	0.00000 C
0.0001363	3674.	26966410.	9.3584420	0.0012751	-0.002812	3.5514980	0.00000 C
0.0001388	3682.	26533854.	9.2991536	0.0012903	-0.002872	3.5722637	0.00000 C
0.0001413	3689.	26116322.	9.2421704	0.0013055	-0.002932	3.5925771	0.00000 C
0.0001438	3696.	25713025.	9.1873718	0.0013207	-0.002992	3.6124355	0.00000 C
0.0001463	3703.	25321482.	9.1336621	0.0013358	-0.003052	3.6316449	0.00000 C
0.0001488	3710.	24938729.	9.0795433	0.0013506	-0.003112	3.6499564	0.00000 C
0.0001588	3735.	23525903.	8.8818884	0.0014100	-0.003353	3.7188558	0.00000 C
0.0001688	3757.	22261938.	8.7004619	0.0014682	-0.003594	3.7789956	0.00000 C
0.0001788	3777.	21132181.	8.5390611	0.0015264	-0.003836	3.8318646	0.00000 C
0.0001888	3795.	20105890.	8.3869195	0.0015830	-0.004079	3.8764215	0.00000 C
0.0001988	3812.	19180199.	8.2523575	0.0016402	-0.004322	3.9144063	0.00000 C
0.0002088	3826.	18329765.	8.1229913	0.0016957	-0.004567	3.9446424	0.00000 C
0.0002188	3840.	17554615.	8.0073335	0.0017516	-0.004811	3.9684663	0.00000 C
0.0002288	3852.	16841065.	7.8994799	0.0018070	-0.005055	3.9854990	0.00000 C
0.0002388	3863.	16180874.	7.7978192	0.0018617	-0.005301	3.9959049	0.00000 C
0.0002488	3873.	15571831.	7.7061059	0.0019169	-0.005546	3.9999497	0.00000 C
0.0002588	3883.	15005595.	7.6207313	0.0019719	-0.005791	3.9989305	0.00000 C
0.0002688	3890.	14475728.	7.5382568	0.0020259	-0.006037	3.9956898	0.00000 C
0.0002788	3898.	13982136.	7.4634833	0.0020804	-0.006282	3.9997508	0.00000 C
0.0002888	3904.	13520975.	7.3953196	0.0021354	-0.006527	3.9967240	0.00000 C
0.0002988	3910.	13088263.	7.3317938	0.0021904	-0.006772	3.9998967	0.00000 C
0.0003088	3915.	12679368.	7.2688497	0.0022443	-0.007018	3.9961098	0.00000 C
0.0003188	3919.	12295211.	7.2109698	0.0022985	-0.007264	3.9996335	0.00000 C
0.0003288	3923.	11933326.	7.1581642	0.0023532	-0.007509	3.9935981	0.00000 C
0.0003388	3927.	11591901.	7.1095645	0.0024084	-0.007754	3.9984739	0.00000 C

0.0003488	3930.	11269390.	7.0647183	0.0024638	-0.007999	3.9993377	0.00000 C
0.0003588	3933.	10962369.	7.0200780	0.0025185	-0.008244	3.9948959	0.00000 C
0.0003688	3935.	10670842.	6.9767120	0.0025727	-0.008490	3.9988000	0.00000 C
0.0003788	3937.	10394268.	6.9364338	0.0026272	-0.008735	3.9992655	0.00000 C
0.0003888	3938.	10131150.	6.8994446	0.0026822	-0.008980	3.9930193	0.00000 C
0.0003988	3940.	9880913.	6.8642937	0.0027371	-0.009225	3.9976148	0.00000 C
0.0004088	3941.	9642601.	6.8327748	0.0027929	-0.009470	3.9998082	0.00000 C
0.0004188	3943.	9415124.	6.8028176	0.0028487	-0.009714	3.9936249	0.00000 C
0.0004288	3944.	9197857.	6.7755235	0.0029050	-0.009957	3.9937472	0.00000 C
0.0004388	3944.	8990241.	6.7497027	0.0029614	-0.010201	3.9978578	0.00000 C
0.0004488	3945.	8790672.	6.7213597	0.0030162	-0.010446	3.9997678	0.00000 C
0.0004588	3945.	8599460.	6.6950449	0.0030714	-0.010691	3.9952130	0.00000 C
0.0004688	3945.	8416116.	6.6698356	0.0031265	-0.010936	3.9897704	0.00000 C
0.0004788	3945.	8240322.	6.6466666	0.0031821	-0.011180	3.9947672	0.00000 C
0.0004888	3945.	8071722.	6.6255883	0.0032383	-0.011424	3.9981234	0.00000 C
0.0004988	3945.	7909883.	6.6053510	0.0032944	-0.011668	3.9998018	0.00000 C
0.0005088	3945.	7754406.	6.5861032	0.0033507	-0.011912	3.9954073	0.00000 C
0.0005188	3945.	7604924.	6.5681500	0.0034072	-0.012155	3.9865553	0.00000 C
0.0005288	3945.	7461096.	6.5521782	0.0034645	-0.012398	3.9914258	0.00000 C
0.0005388	3945.	7322607.	6.5365200	0.0035216	-0.012641	3.9957147	0.00000 C
0.0005488	3945.	7189165.	6.5218612	0.0035789	-0.012884	3.9985461	0.00000 C
0.0006088	3945.	6480582.	6.4956146	0.0039542	-0.014308	3.9988305	0.00000 C

Summary of Results for Nominal Moment Capacity for Section 3

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

Load No.	Axial Thrust kips	Nominal Mom. Cap. in-kip	Max. Comp. Strain	Max. Tens. Strain
1	338.000	3944.712	0.00300000	-0.01037372

Note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether
the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.75).

The above values should be multiplied by the appropriate strength reduction
factor to compute ultimate moment capacity according to ACI 318,
or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding
bending stiffnesses computed for common resistance factor values used for
reinforced concrete sections.

Axial Load No.	Resist. Factor	Nominal Ax. Thrust kips	Nominal Moment Cap in-kips	Ult. (Fac) Ax. Thrust kips	Ult. (Fac) Moment Cap in-kips	Bend. Stiff. at Ult Mom kip-in^2
1	0.65	338.000000	3945.	219.700000	2564.	102467058.
1	0.75	338.000000	3945.	253.500000	2959.	74196005.
1	0.90	338.000000	3945.	304.200000	3550.	34318498.

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	31386.
2	5.7000	4.9435	Yes	No	31386.	75384.
3	9.0000	9.8273	Yes	No	106770.	31829.
4	10.0000	10.8381	Yes	No	138600.	175402.
5	14.0000	14.0000	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 = 0.435600 inches
Rotation of pile head = 0.000E+00 radians
Axial load on pile head = 338000.0 lbs

Depth Deflect. Bending Shear Slope Total Bending Soil Res. Soil Spr. Distrib.

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	0.4356	-2280592.	45375.	0.00	48140.	1.29E+10	0.00	0.00	0.00
0.1930	0.4351	-2175411.	45320.	-4.00E-04	46377.	1.29E+10	-22.502	119.7693	0.00
0.3860	0.4337	-2070044.	45238.	-7.82E-04	44610.	1.29E+10	-47.993	256.2583	0.00
0.5790	0.4315	-1964643.	45095.	-0.00114	42843.	1.29E+10	-75.738	406.5052	0.00
0.7720	0.4284	-1859372.	44886.	-0.00149	41078.	1.29E+10	-104.953	567.3327	0.00
0.9650	0.4246	-1754403.	44608.	-0.00181	39319.	1.29E+10	-134.898	735.7891	0.00
1.1580	0.4200	-1649910.	44261.	-0.00212	37567.	1.29E+10	-164.841	908.8826	0.00
1.3510	0.4148	-1546069.	43845.	-0.00241	35826.	1.29E+10	-194.434	1086.	0.00
1.5440	0.4089	-1443054.	43361.	-0.00267	34099.	1.29E+10	-223.101	1264.	0.00
1.7370	0.4024	-1341032.	42814.	-0.00292	32388.	1.29E+10	-249.945	1439.	0.00
1.9300	0.3954	-1240162.	42205.	-0.00316	30697.	1.29E+10	-275.531	1614.	0.00
2.1230	0.3878	-1140596.	41537.	-0.00337	29028.	1.29E+10	-300.986	1798.	0.00
2.3160	0.3797	-1042484.	40814.	-0.00357	27383.	1.29E+10	-323.873	1975.	0.00
2.5090	0.3713	-945962.	40040.	-0.00375	25765.	1.29E+10	-344.046	2146.	0.00
2.7020	0.3624	-851153.	39221.	-0.00391	24175.	1.29E+10	-363.361	2322.	0.00
2.8950	0.3532	-758172.	38361.	-0.00405	22616.	1.29E+10	-379.403	2488.	0.00
3.0880	0.3436	-667121.	37468.	-0.00418	21090.	1.29E+10	-391.798	2641.	0.00
3.2810	0.3338	-578077.	36543.	-0.00429	19597.	1.29E+10	-406.632	2821.	0.00
3.4740	0.3237	-491132.	35588.	-0.00439	18139.	1.29E+10	-418.718	2995.	0.00
3.6670	0.3135	-406365.	34608.	-0.00447	16718.	1.29E+10	-427.175	3156.	0.00
3.8600	0.3030	-323831.	33604.	-0.00453	15334.	1.29E+10	-439.982	3363.	0.00
4.0530	0.2925	-243612.	32569.	-0.00459	13989.	1.29E+10	-453.519	3591.	0.00
4.2460	0.2818	-165792.	31507.	-0.00462	12685.	1.29E+10	-464.187	3815.	0.00
4.4390	0.2711	-90438.	30423.	-0.00464	11421.	1.29E+10	-471.708	4030.	0.00
4.6320	0.2603	-17601.	29326.	-0.00465	10200.	1.29E+10	-475.805	4234.	0.00
4.8250	0.2495	52686.	28223.	-0.00465	10788.	1.29E+10	-476.209	4420.	0.00
5.0180	0.2387	120411.	27118.	-0.00464	11924.	1.29E+10	-478.308	4640.	0.00
5.2110	0.2280	185554.	25992.	-0.00461	13016.	1.29E+10	-493.749	5015.	0.00
5.4040	0.2174	248022.	24833.	-0.00457	14063.	1.29E+10	-507.633	5408.	0.00
5.5970	0.2069	307732.	23643.	-0.00452	15064.	1.29E+10	-519.831	5820.	0.00
5.7900	0.1965	364611.	22353.	-0.00446	16018.	1.29E+10	-593.614	6998.	0.00
5.9830	0.1862	418254.	20958.	-0.00439	16917.	1.29E+10	-611.238	7602.	0.00
6.1760	0.1761	468560.	19525.	-0.00431	17761.	1.29E+10	-626.558	8239.	0.00
6.3690	0.1663	515440.	18059.	-0.00422	18547.	1.29E+10	-639.411	8907.	0.00
6.5620	0.1566	558817.	16566.	-0.00412	19274.	1.29E+10	-649.653	9609.	0.00
6.7550	0.1472	598631.	15053.	-0.00402	19941.	1.29E+10	-657.158	10343.	0.00
6.9480	0.1380	634836.	13525.	-0.00391	20548.	1.29E+10	-661.823	11110.	0.00
7.1410	0.1290	667401.	11980.	-0.00379	21094.	1.29E+10	-672.564	12071.	0.00
7.3340	0.1204	696265.	10411.	-0.00367	21578.	1.29E+10	-682.165	13122.	0.00
7.5270	0.1120	721372.	8823.	-0.00354	21999.	1.29E+10	-689.747	14257.	0.00
7.7200	0.1040	742678.	7219.	-0.00341	22356.	1.29E+10	-695.255	15484.	0.00
7.9130	0.09625	760150.	5605.	-0.00328	22649.	1.29E+10	-698.641	16811.	0.00
8.1060	0.08882	773768.	3985.	-0.00314	22878.	1.29E+10	-699.871	18249.	0.00
8.2990	0.08171	783523.	2366.	-0.00300	23041.	1.29E+10	-698.918	19809.	0.00
8.4920	0.07493	789418.	750.4881	-0.00286	23140.	1.29E+10	-695.766	21504.	0.00
8.6850	0.06848	791471.	-854.702	-0.00271	23175.	1.29E+10	-690.408	23349.	0.00

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
8.8780	0.06236	789709.	-2445.	-0.00257	23145.	1.29E+10	-682.845	25360.	0.00
9.0710	0.05657	784174.	-3827.	-0.00243	23052.	1.29E+10	-511.067	20924.	0.00
9.2640	0.05110	775786.	-4965.	-0.00229	22912.	1.29E+10	-471.500	21370.	0.00
9.4570	0.04596	764761.	-6013.	-0.00215	22727.	1.29E+10	-432.872	21815.	0.00
9.6500	0.04113	751306.	-6972.	-0.00202	22501.	1.29E+10	-395.326	22260.	0.00
9.8430	0.03662	735625.	-7845.	-0.00188	22238.	1.29E+10	-358.991	22705.	0.00
10.0360	0.03241	717914.	-8509.	-0.00175	21941.	1.29E+10	-214.687	15341.	0.00
10.2290	0.02850	698951.	-8981.	-0.00162	21623.	1.29E+10	-192.434	15636.	0.00
10.4220	0.02489	678858.	-9402.	-0.00150	21286.	1.29E+10	-171.186	15931.	0.00
10.6150	0.02155	657751.	-9775.	-0.00138	20933.	1.29E+10	-150.997	16226.	0.00
10.8080	0.01849	635742.	-10103.	-0.00126	20564.	1.29E+10	-131.912	16521.	0.00
11.0010	0.01570	612935.	-10387.	-0.00115	20181.	1.29E+10	-113.968	16816.	0.00
11.1940	0.01316	589431.	-10632.	-0.00104	19787.	1.29E+10	-97.197	17111.	0.00
11.3870	0.01086	565323.	-10839.	-9.40E-04	19383.	1.29E+10	-81.623	17406.	0.00
11.5800	0.00880	540697.	-11011.	-8.41E-04	18970.	1.29E+10	-67.262	17701.	0.00
11.7730	0.00697	515634.	-11152.	-7.46E-04	18550.	1.29E+10	-54.125	17996.	0.00
11.9660	0.00535	490209.	-11264.	-6.56E-04	18124.	1.29E+10	-42.217	18291.	0.00
12.1590	0.00393	464488.	-11349.	-5.70E-04	17692.	1.29E+10	-31.532	18586.	0.00
12.3520	0.00271	438533.	-11411.	-4.89E-04	17257.	1.29E+10	-22.063	18881.	0.00
12.5450	0.00167	412398.	-11452.	-4.12E-04	16819.	1.29E+10	-13.794	19176.	0.00
12.7380	7.97E-04	386130.	-11476.	-3.40E-04	16379.	1.29E+10	-6.704	19471.	0.00
12.9310	8.94E-05	359773.	-11485.	-2.73E-04	15937.	1.29E+10	-0.763	19766.	0.00
13.1240	-4.69E-04	333360.	-11481.	-2.11E-04	15494.	1.29E+10	4.0606	20061.	0.00
13.3170	-8.88E-04	306923.	-11467.	-1.54E-04	15051.	1.29E+10	7.8068	20356.	0.00
13.5100	-0.00118	280484.	-11446.	-1.01E-04	14608.	1.29E+10	10.5207	20651.	0.00
13.7030	-0.00135	254062.	-11420.	-5.27E-05	14165.	1.29E+10	12.2530	20946.	0.00
13.8960	-0.00142	227670.	-11390.	-9.41E-06	13722.	1.29E+10	13.0600	21241.	0.00
14.0890	-0.00140	201316.	-10955.	1.24E-05	0.00	1.72E+11	362.7319	600748.	0.00
14.2820	-0.00137	176906.	-10121.	1.50E-05	0.00	1.72E+11	357.7050	606245.	0.00
14.4750	-0.00133	154413.	-9301.	1.72E-05	0.00	1.72E+11	349.9986	609881.	0.00
14.6680	-0.00129	133795.	-8503.	1.91E-05	0.00	1.72E+11	339.3419	610718.	0.00
14.8610	-0.00124	114996.	-7731.	2.08E-05	0.00	1.72E+11	327.3780	611232.	0.00
15.0540	-0.00119	97952.	-6988.	2.23E-05	0.00	1.72E+11	314.4637	611782.	0.00
15.2470	-0.00114	82593.	-6275.	2.35E-05	0.00	1.72E+11	300.7321	612364.	0.00
15.4400	-0.00108	68847.	-5596.	2.45E-05	0.00	1.72E+11	286.3032	612972.	0.00
15.6330	-0.00102	56635.	-4950.	2.53E-05	0.00	1.72E+11	271.2850	613602.	0.00
15.8260	-9.64E-04	45879.	-4340.	2.60E-05	0.00	1.72E+11	255.7735	614249.	0.00
16.0190	-9.03E-04	36493.	-3766.	2.66E-05	0.00	1.72E+11	239.8538	614910.	0.00
16.2120	-8.41E-04	28394.	-3229.	2.70E-05	0.00	1.72E+11	223.6004	615583.	0.00
16.4050	-7.78E-04	21494.	-2730.	2.74E-05	0.00	1.72E+11	207.0777	616264.	0.00
16.5980	-7.15E-04	15704.	-2270.	2.76E-05	0.00	1.72E+11	190.3410	616951.	0.00
16.7910	-6.50E-04	10935.	-1849.	2.78E-05	0.00	1.72E+11	173.4369	617643.	0.00
16.9840	-5.86E-04	7097.	-1467.	2.79E-05	0.00	1.72E+11	156.4039	618337.	0.00
17.1770	-5.21E-04	4097.	-1125.	2.80E-05	0.00	1.72E+11	139.2734	619033.	0.00
17.3700	-4.56E-04	1844.	-821.893	2.80E-05	0.00	1.72E+11	122.0698	619729.	0.00
17.5630	-3.91E-04	246.0120	-559.164	2.80E-05	0.00	1.72E+11	104.8117	620426.	0.00
17.7560	-3.26E-04	-789.864	-336.452	2.80E-05	0.00	1.72E+11	87.5125	621121.	0.00
17.9490	-2.61E-04	-1356.	-153.844	2.80E-05	0.00	1.72E+11	70.1807	621815.	0.00
18.1420	-1.97E-04	-1546.	-11.407	2.80E-05	0.00	1.72E+11	52.8213	622509.	0.00

18.3350	-1.32E-04	-1453.	90.7947	2.80E-05	0.00	1.72E+11	35.4360	623201.	0.00
18.5280	-6.69E-05	-1170.	152.7016	2.80E-05	0.00	1.72E+11	18.0242	623891.	0.00
18.7210	-2.16E-06	-789.472	174.2493	2.80E-05	0.00	1.72E+11	0.5835	624581.	0.00
18.9140	6.26E-05	-406.222	155.4093	2.79E-05	0.00	1.72E+11	-16.853	623937.	0.00
19.1070	1.27E-04	-113.363	97.1422	2.79E-05	0.00	1.58E+11	-33.464	608986.	0.00
19.3000	1.92E-04	0.00	0.00	2.79E-05	0.00	1.58E+11	-50.424	304169.	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              =     0.43560000 inches
Computed slope at pile head       =       0.000000 radians
Maximum bending moment            =      -2280592. inch-lbs
Maximum shear force               =         45375. 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              =              7
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 Pile-head Rotation (Loading Type 5)
Displacement of pile head                           =     0.522720 inches
Rotation of pile head                               =    0.000E+00 radians
Axial load on pile head                             =     338000.0 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	0.5227	-2657154.	51867.	0.00	54454.	1.28E+10	0.00	0.00	0.00
0.1930	0.5222	-2536914.	51807.	-4.71E-04	52438.	1.28E+10	-24.246	107.5405	0.00
0.3860	0.5205	-2416445.	51719.	-9.18E-04	50418.	1.29E+10	-51.799	230.4681	0.00
0.5790	0.5179	-2295914.	51564.	-0.00134	48397.	1.29E+10	-81.891	366.2048	0.00
0.7720	0.5143	-2175498.	51338.	-0.00174	46378.	1.29E+10	-113.567	511.3937	0.00
0.9650	0.5098	-2055386.	51037.	-0.00212	44365.	1.29E+10	-146.040	663.4112	0.00
1.1580	0.5045	-1935768.	50662.	-0.00248	42359.	1.29E+10	-178.546	819.6699	0.00

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
1.3510	0.4983	-1816835.	50211.	-0.00282	40365.	1.29E+10	-210.680	979.1327	0.00
1.5440	0.4914	-1698777.	49687.	-0.00314	38386.	1.29E+10	-241.814	1140.	0.00
1.7370	0.4838	-1581777.	49093.	-0.00343	36424.	1.29E+10	-271.000	1297.	0.00
1.9300	0.4755	-1466008.	48433.	-0.00370	34483.	1.29E+10	-298.859	1456.	0.00
2.1230	0.4667	-1351635.	47709.	-0.00396	32566.	1.29E+10	-326.624	1621.	0.00
2.3160	0.4572	-1238825.	46923.	-0.00419	30675.	1.29E+10	-351.652	1781.	0.00
2.5090	0.4472	-1127726.	46083.	-0.00440	28812.	1.29E+10	-373.766	1936.	0.00
2.7020	0.4368	-1018474.	45193.	-0.00460	26980.	1.29E+10	-394.790	2093.	0.00
2.8950	0.4260	-911195.	44259.	-0.00477	25182.	1.29E+10	-412.286	2242.	0.00
3.0880	0.4147	-806000.	43288.	-0.00492	23418.	1.29E+10	-425.857	2378.	0.00
3.2810	0.4031	-702976.	42282.	-0.00506	21691.	1.29E+10	-442.699	2543.	0.00
3.4740	0.3913	-602228.	41241.	-0.00518	20002.	1.29E+10	-456.759	2704.	0.00
3.6670	0.3792	-503845.	40171.	-0.00528	18352.	1.29E+10	-467.046	2853.	0.00
3.8600	0.3668	-407896.	39072.	-0.00536	16744.	1.29E+10	-482.307	3045.	0.00
4.0530	0.3544	-314477.	37936.	-0.00542	15177.	1.29E+10	-498.569	3259.	0.00
4.2460	0.3417	-223687.	36766.	-0.00547	13655.	1.29E+10	-511.898	3469.	0.00
4.4390	0.3290	-135612.	35568.	-0.00550	12179.	1.29E+10	-521.997	3674.	0.00
4.6320	0.3162	-50318.	34352.	-0.00552	10749.	1.29E+10	-528.572	3871.	0.00
4.8250	0.3034	32148.	33124.	-0.00552	10444.	1.29E+10	-531.336	4055.	0.00
5.0180	0.2907	111759.	31889.	-0.00551	11779.	1.29E+10	-535.689	4268.	0.00
5.2110	0.2779	188482.	30628.	-0.00548	13065.	1.29E+10	-553.310	4611.	0.00
5.4040	0.2653	262210.	29328.	-0.00544	14301.	1.29E+10	-569.511	4972.	0.00
5.5970	0.2527	332846.	27992.	-0.00539	15485.	1.29E+10	-584.201	5354.	0.00
5.7900	0.2403	400302.	26545.	-0.00532	16616.	1.29E+10	-664.645	6406.	0.00
5.9830	0.2281	464137.	24981.	-0.00524	17687.	1.29E+10	-685.903	6965.	0.00
6.1760	0.2160	524227.	23371.	-0.00516	18694.	1.29E+10	-704.715	7555.	0.00
6.3690	0.2042	580464.	21720.	-0.00506	19637.	1.29E+10	-720.889	8177.	0.00
6.5620	0.1926	632752.	20035.	-0.00495	20513.	1.29E+10	-734.249	8829.	0.00
6.7550	0.1813	681012.	18323.	-0.00483	21323.	1.29E+10	-744.639	9514.	0.00
6.9480	0.1702	725183.	16590.	-0.00470	22063.	1.29E+10	-751.922	10230.	0.00
7.1410	0.1595	765218.	14833.	-0.00457	22734.	1.29E+10	-765.020	11109.	0.00
7.3340	0.1491	801043.	13048.	-0.00443	23335.	1.29E+10	-776.768	12068.	0.00
7.5270	0.1390	832588.	11238.	-0.00428	23864.	1.29E+10	-786.279	13103.	0.00
7.7200	0.1292	859798.	9408.	-0.00413	24320.	1.29E+10	-793.482	14220.	0.00
7.9130	0.1199	882632.	7565.	-0.00397	24703.	1.29E+10	-798.322	15426.	0.00
8.1060	0.1108	901059.	5713.	-0.00381	25012.	1.29E+10	-800.753	16732.	0.00
8.2990	0.1022	915064.	3859.	-0.00365	25247.	1.29E+10	-800.740	18147.	0.00
8.4920	0.09393	924646.	2007.	-0.00348	25407.	1.29E+10	-798.259	19681.	0.00
8.6850	0.08606	929815.	164.0809	-0.00332	25494.	1.29E+10	-793.298	21349.	0.00
8.8780	0.07857	930599.	-1665.	-0.00315	25507.	1.29E+10	-785.851	23165.	0.00
9.0710	0.07147	927037.	-3322.	-0.00298	25447.	1.29E+10	-645.696	20924.	0.00
9.2640	0.06475	919880.	-4762.	-0.00282	25327.	1.29E+10	-597.469	21370.	0.00
9.4570	0.05842	909390.	-6091.	-0.00265	25151.	1.29E+10	-550.268	21815.	0.00
9.6500	0.05247	895820.	-7312.	-0.00249	24924.	1.29E+10	-504.270	22260.	0.00
9.8430	0.04688	879419.	-8428.	-0.00233	24649.	1.29E+10	-459.639	22705.	0.00
10.0360	0.04167	860429.	-9280.	-0.00217	24331.	1.29E+10	-276.008	15341.	0.00
10.2290	0.03681	839838.	-9888.	-0.00202	23985.	1.29E+10	-248.525	15636.	0.00
10.4220	0.03230	817795.	-10433.	-0.00187	23616.	1.29E+10	-222.209	15931.	0.00
10.6150	0.02814	794445.	-10918.	-0.00173	23224.	1.29E+10	-197.130	16226.	0.00

10.8080	0.02430	769926.	-11347.	-0.00159	22813.	1.29E+10	-173.349	16521.	0.00
11.0010	0.02079	744369.	-11723.	-0.00145	22385.	1.29E+10	-150.917	16816.	0.00
11.1940	0.01758	717898.	-12048.	-0.00132	21941.	1.29E+10	-129.878	17111.	0.00
11.3870	0.01467	690629.	-12326.	-0.00119	21484.	1.29E+10	-110.268	17406.	0.00
11.5800	0.01205	662672.	-12560.	-0.00107	21015.	1.29E+10	-92.115	17701.	0.00
11.7730	0.00971	634127.	-12754.	-9.55E-04	20537.	1.29E+10	-75.438	17996.	0.00
11.9660	0.00763	605088.	-12912.	-8.44E-04	20050.	1.29E+10	-60.248	18291.	0.00
12.1590	0.00580	575641.	-13035.	-7.38E-04	19556.	1.29E+10	-46.550	18586.	0.00
12.3520	0.00421	545864.	-13129.	-6.37E-04	19057.	1.29E+10	-34.339	18881.	0.00
12.5450	0.00285	515825.	-13196.	-5.41E-04	18553.	1.29E+10	-23.605	19176.	0.00
12.7380	0.00170	485587.	-13240.	-4.51E-04	18046.	1.29E+10	-14.330	19471.	0.00
12.9310	7.60E-04	455204.	-13264.	-3.67E-04	17537.	1.29E+10	-6.487	19766.	0.00
13.1240	5.17E-06	424722.	-13272.	-2.88E-04	17026.	1.29E+10	-0.04475	20061.	0.00
13.3170	-5.73E-04	394181.	-13266.	-2.14E-04	16514.	1.29E+10	5.0358	20356.	0.00
13.5100	-9.87E-04	363610.	-13250.	-1.46E-04	16001.	1.29E+10	8.8006	20651.	0.00
13.7030	-0.00125	333036.	-13227.	-8.35E-05	15489.	1.29E+10	11.3020	20946.	0.00
13.8960	-0.00137	302476.	-13199.	-2.64E-05	14976.	1.29E+10	12.5989	21241.	0.00
14.0890	-0.00137	271940.	-12772.	2.63E-06	0.00	1.72E+11	356.1054	601178.	0.00
14.2820	-0.00136	243312.	-11947.	6.11E-06	0.00	1.72E+11	356.4350	606307.	0.00
14.4750	-0.00134	216593.	-11124.	9.21E-06	0.00	1.72E+11	353.7182	609722.	0.00
14.6680	-0.00132	191769.	-10312.	1.20E-05	0.00	1.72E+11	347.5864	610378.	0.00
14.8610	-0.00129	168808.	-9516.	1.44E-05	0.00	1.72E+11	339.6891	610727.	0.00
15.0540	-0.00125	147666.	-8740.	1.65E-05	0.00	1.72E+11	330.4207	611130.	0.00
15.2470	-0.00121	128296.	-7987.	1.84E-05	0.00	1.72E+11	319.9469	611581.	0.00
15.4400	-0.00117	110640.	-7260.	2.00E-05	0.00	1.72E+11	308.4189	612072.	0.00
15.6330	-0.00112	94638.	-6560.	2.14E-05	0.00	1.72E+11	295.9750	612599.	0.00
15.8260	-0.00107	80222.	-5890.	2.26E-05	0.00	1.72E+11	282.7405	613156.	0.00
16.0190	-0.00101	67321.	-5251.	2.36E-05	0.00	1.72E+11	268.8286	613739.	0.00
16.2120	-9.59E-04	55862.	-4645.	2.44E-05	0.00	1.72E+11	254.3408	614343.	0.00
16.4050	-9.01E-04	45767.	-4073.	2.51E-05	0.00	1.72E+11	239.3674	614964.	0.00
16.5980	-8.43E-04	36955.	-3537.	2.56E-05	0.00	1.72E+11	223.9885	615599.	0.00
16.7910	-7.83E-04	29344.	-3036.	2.61E-05	0.00	1.72E+11	208.2739	616245.	0.00
16.9840	-7.22E-04	22850.	-2572.	2.64E-05	0.00	1.72E+11	192.2845	616900.	0.00
17.1770	-6.60E-04	17387.	-2146.	2.67E-05	0.00	1.72E+11	176.0722	617562.	0.00
17.3700	-5.98E-04	12869.	-1757.	2.69E-05	0.00	1.72E+11	159.6811	618228.	0.00
17.5630	-5.36E-04	9206.	-1406.	2.71E-05	0.00	1.72E+11	143.1475	618898.	0.00
17.7560	-4.73E-04	6312.	-1094.	2.72E-05	0.00	1.72E+11	126.5013	619571.	0.00
17.9490	-4.10E-04	4096.	-820.545	2.72E-05	0.00	1.72E+11	109.7661	620244.	0.00
18.1420	-3.47E-04	2468.	-585.788	2.73E-05	0.00	1.72E+11	92.9600	620918.	0.00
18.3350	-2.84E-04	1340.	-390.021	2.73E-05	0.00	1.72E+11	76.0965	621592.	0.00
18.5280	-2.20E-04	619.1770	-233.365	2.73E-05	0.00	1.72E+11	59.1849	622266.	0.00
18.7210	-1.57E-04	216.0475	-115.925	2.73E-05	0.00	1.72E+11	42.2312	622939.	0.00
18.9140	-9.37E-05	39.4379	-37.795	2.73E-05	0.00	1.72E+11	25.2390	623611.	0.00
19.1070	-3.05E-05	-1.794	0.7205	2.73E-05	0.00	1.58E+11	8.0214	609969.	0.00
19.3000	3.28E-05	0.00	0.00	2.73E-05	0.00	1.58E+11	-8.644	304969.	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             =     0.52272000 inches
Computed slope at pile head      =       0.000000 radians
Maximum bending moment           =     -2657154. inch-lbs
Maximum shear force              =         51867. 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             =              7
Number of zero deflection points =              2
```

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

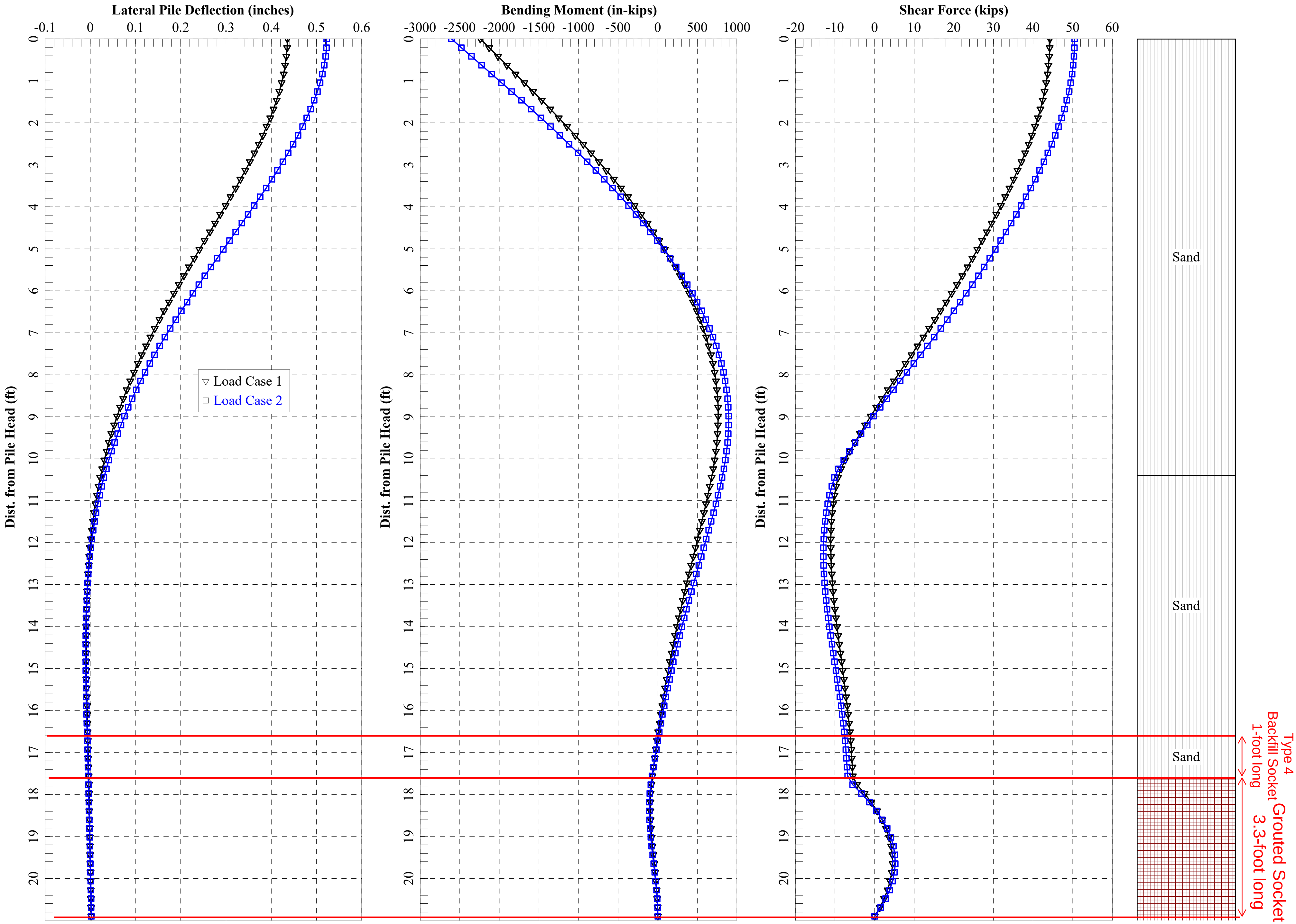
Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load 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 Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	y, in	0.4356	S, rad	0.00	338000.	0.4356	0.00	45375.	-2280592.
2	y, in	0.5227	S, rad	0.00	338000.	0.5227	0.00	51867.	-2657154.

Maximum pile-head deflection = 0.5227200000 inches
Maximum pile-head rotation = 0.0000000000 radians = 0.000000 deg.

The analysis ended normally.

Smelt Brook Bridge
Abutment 2 14x117 Piles



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

                     LPile for Windows, Version 2022-12.010

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

Path to file locations:
\Working\THORNTON TOMASETTI\2502334 MaineDOT Downeast Bridges Phase II\09_Engineering\02_Perry\07_Lpile\Pile Runs\No Scour No
Corrosion\

Name of input data file:
Perry Abutment 2 HP14x117 2025-07-08.lp12d

Name of output report file:
Perry Abutment 2 HP14x117 2025-07-08.lp12o

Name of plot output file:
Perry Abutment 2 HP14x117 2025-07-08.lp12p

Name of runtime message file:
Perry Abutment 2 HP14x117 2025-07-08.lp12r


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

               Date:  July 8, 2025               Time:  19:58:59


-------------------------------------------------------------------------------
                                 Problem Title
-------------------------------------------------------------------------------

Project Name: Smelt Brook Bridge #2774

Job Number: 2502334

Client: Thornton Tomasetti

Engineer: M. Johnescu

Description: Lateral Pile Analysis Abutment 2 HP14x117



-------------------------------------------------------------------------------
                          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
```

- 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                       =          3
Total length of pile                                  =      20.900 ft
Depth of ground surface below top of pile             =      0.0000 ft
```

Pile diameters used for p-y curve computations are defined using 6 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	14.9000
2	17.600	14.9000
3	17.600	30.0000
4	20.600	30.0000
5	20.600	30.0000
6	20.900	30.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

```
   Section 1 is a H weak axis steel pile
   Length of section                                  =    17.600000 ft
   Pile width                                         =    14.200000 in
```

Pile Section No. 2:

```
   Section 2 is a drilled shaft with casing and H section core/insert
   Length of section                                  =     3.000000 ft
   Section Diameter                                   =    30.000000 in
```

Pile Section No. 3:

```
   Section 3 is a round drilled shaft, bored pile, or CIDH pile
   Length of section                                  =     0.300000 ft
   Shaft Diameter                                     =    30.000000 in
```

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       =    10.400000 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                     =    34.000000 deg.
   Friction angle at bottom of layer                  =    34.000000 deg.
   Subgrade k at top of layer                         =   122.000000 pci
   Subgrade k at bottom of layer                      =   122.000000 pci
```

Layer 2 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer          =    10.400000 ft
   Distance from top of pile to bottom of layer       =    16.600000 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                     =    34.000000 deg.
   Friction angle at bottom of layer                  =    34.000000 deg.
   Subgrade k at top of layer                         =    75.000000 pci
   Subgrade k at bottom of layer                      =    75.000000 pci
```

Layer 3 is sand, p-y criteria by Reese et al., 1974

```
   Distance from top of pile to top of layer          =    16.600000 ft
   Distance from top of pile to bottom of layer       =    17.600000 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 = 32.000000 deg.
Friction angle at bottom of layer = 32.000000 deg.
Subgrade k at top of layer = 55.000000 pci
Subgrade k at bottom of layer = 55.000000 pci

Layer 4 is massive rock, p-y criteria by Liang et al., 2009

Distance from top of pile to top of layer = 17.600000 ft
Distance from top of pile to bottom of layer = 50.000000 ft
Effective unit weight at top of layer = 108.600000 pcf
Effective unit weight at bottom of layer = 108.600000 pcf
Uniaxial compressive strength at top of layer = 6411. psi
Uniaxial compressive strength at bottom of layer = 6411. psi
Poisson's ratio at top of layer = 0.290000
Poisson's ratio at bottom of layer = 0.290000
Option 1: Intact rock modulus at top of layer = 0.0000 psi
Intact rock modulus at bottom of layer = 0.0000 psi
Option 1: Geologic Strength Index for layer = 35.000000
Option 2: Rock mass modulus at top of layer = 185500. psi
Rock mass modulus at bottom of layer = 185500. psi
Option 2 will use the input value of rock mass modulus to compute the p-y curve in massive rock.
The rock type is (sedimentary) shales, Hoek-Brown Material Constant mi = 6

(Depth of the lowest soil layer extends 29.100 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	Rock Mass Modulus psi	Geologic Strength Index	Int. Rock Modulus psi	Hoek-Brown Material Index, mi	Poisson's Ratio
1	Sand	0.00	125.0000	34.0000	--	122.0000	--	--	0.00	0.00	0.00
	(Reese, et al.)	10.4000	125.0000	34.0000	--	122.0000	--	--	0.00	0.00	0.00
2	Sand	10.4000	62.6000	34.0000	--	75.0000	--	--	0.00	0.00	0.00
	(Reese, et al.)	16.6000	62.6000	34.0000	--	75.0000	--	--	0.00	0.00	0.00
3	Sand	16.6000	62.6000	32.0000	--	55.0000	--	--	0.00	0.00	0.00
	(Reese, et al.)	17.6000	62.6000	32.0000	--	55.0000	--	--	0.00	0.00	0.00
4	Massive	17.6000	108.6000	--	6411.	--	185500.	35.0000	0.00	6.0000	0.2900
	Rock	50.0000	108.6000	--	6411.	--		35.0000	0.00	6.0000	0.2900

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 = 0.435600 in	S = 0.0000 in/in	338000.	N.A.	Yes
2	5	y = 0.522720 in	S = 0.0000 in/in	338000.	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 = 3

Pile Section No. 1:

Dimensions and Properties of Steel H Weak Axis:

Length of Section	=	17.600000 ft
Flange Width	=	14.900000 in
Section Depth	=	14.200000 in
Flange Thickness	=	0.805000 in
Web Thickness	=	0.805000 in
Yield Stress of Pipe	=	50.000000 ksi
Elastic Modulus	=	29000. ksi
Cross-sectional Area	=	34.123950 sq. in.
Moment of Inertia	=	444.363799 in^4
Elastic Bending Stiffness	=	12886550. kip-in^2
Plastic Modulus, Z	=	91.398684in^3
Plastic Moment Capacity = Fy Z	=	4570.in-kip

Axial Structural Capacities:

Nom. Axial Structural Capacity = Fy As	=	1706.197 kips
Nominal Axial Tensile Capacity	=	-1706.197 kips

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

Number	Axial Thrust Force kips
1	338.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 338.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000456	58.7466414	12886018.	82.3695401	10.8801770	
0.00000912	117.4932829	12886018.	44.9097701	11.8552872	
0.00001368	176.2399243	12886018.	32.4231800	12.8303978	
0.00001824	234.9865658	12886018.	26.1798850	13.8055081	
0.00002279	293.7332072	12886018.	22.4339080	14.7806184	
0.00002735	352.4798486	12886018.	19.9365900	15.7557288	
0.00003191	411.2264901	12886018.	18.1527914	16.7308392	
0.00003647	469.9731315	12886018.	16.8149425	17.7059496	
0.00004103	528.7197729	12886018.	15.7743933	18.6810599	
0.00004559	587.4664144	12886018.	14.9419540	19.6561703	
0.00005015	646.2130558	12886018.	14.2608673	20.6312806	
0.00005471	704.9596973	12886018.	13.6932950	21.6063911	
0.00005927	763.7063387	12886018.	13.2130415	22.5815014	
0.00006383	822.4529801	12886018.	12.8013957	23.5566118	
0.00006838	881.1996216	12886018.	12.4446360	24.5317222	
0.00007294	939.9462630	12886018.	12.1324713	25.5068325	
0.00007750	998.6929045	12886018.	11.8570318	26.4819429	
0.00008206	1057.	12886018.	11.6121967	27.4570533	
0.00008662	1116.	12886018.	11.3931337	28.4321636	
0.00009118	1175.	12886018.	11.1959770	29.4072740	
0.00009574	1234.	12886018.	11.0175971	30.3823844	
0.0001003	1292.	12886018.	10.8554336	31.3574947	
0.0001049	1351.	12886018.	10.7073713	32.3326051	
0.0001094	1410.	12886018.	10.5716475	33.3077154	
0.0001140	1469.	12886018.	10.4467816	34.2828258	
0.0001185	1527.	12886018.	10.3315208	35.2579362	
0.0001231	1586.	12886018.	10.2247978	36.2330465	
0.0001277	1645.	12886018.	10.1256979	37.2081569	
0.0001322	1704.	12886018.	10.0334324	38.1832673	
0.0001368	1762.	12886018.	9.9473180	39.1583777	
0.0001413	1821.	12886018.	9.8667594	40.1334880	
0.0001459	1880.	12886018.	9.7912356	41.1085984	
0.0001504	1939.	12886018.	9.7202891	42.0837087	
0.0001550	1997.	12886018.	9.6535159	43.0588191	
0.0001596	2056.	12886018.	9.5905583	44.0339295	
0.0001641	2115.	12886018.	9.5310983	45.0090399	
0.0001687	2174.	12886018.	9.4748524	45.9841502	
0.0001732	2232.	12886018.	9.4215668	46.9592606	
0.0001778	2291.	12886018.	9.3710138	47.9343710	
0.0001869	2409.	12886018.	9.2773059	49.8845917	
0.0001960	2521.	12858940.	9.1960581	50.0000000	Y
0.0002052	2626.	12798181.	9.1271995	50.0000000	Y
0.0002143	2724.	12712785.	9.0686679	50.0000000	Y
0.0002234	2817.	12609239.	9.0188442	50.0000000	Y
0.0002325	2905.	12492687.	8.9763694	50.0000000	Y
0.0002416	2988.	12365452.	8.9404099	50.0000000	Y
0.0002507	3067.	12232788.	8.9096593	50.0000000	Y
0.0002599	3143.	12095201.	8.8836724	50.0000000	Y
0.0002690	3216.	11956154.	8.8614936	50.0000000	Y
0.0002781	3286.	11815055.	8.8429637	50.0000000	Y

0.0002872	3353.	11674191.	8.8273849	50.0000000	Y
0.0002963	3415.	11523717.	8.8123943	50.0000000	Y
0.0003054	3472.	11365458.	8.7978046	50.0000000	Y
0.0003146	3524.	11201760.	8.7835946	50.0000000	Y
0.0003237	3572.	11034440.	8.7697084	50.0000000	Y
0.0003328	3616.	10865046.	8.7560946	50.0000000	Y
0.0003419	3657.	10694896.	8.7427054	50.0000000	Y
0.0003510	3695.	10525105.	8.7294965	50.0000000	Y
0.0003602	3730.	10356041.	8.7166052	50.0000000	Y
0.0003693	3762.	10188400.	8.7040516	50.0000000	Y
0.0003784	3793.	10023433.	8.6916285	50.0000000	Y
0.0003875	3821.	9861248.	8.6794603	50.0000000	Y
0.0003966	3848.	9701670.	8.6677810	50.0000000	Y
0.0004057	3873.	9545581.	8.6560247	50.0000000	Y
0.0004149	3896.	9391591.	8.6446186	50.0000000	Y
0.0004240	3918.	9241864.	8.6333632	50.0000000	Y
0.0004331	3939.	9095233.	8.6225297	50.0000000	Y
0.0004422	3959.	8951699.	8.6115093	50.0000000	Y
0.0004513	3977.	8811781.	8.6011152	50.0000000	Y
0.0004605	3995.	8675311.	8.5904615	50.0000000	Y
0.0004696	4011.	8541626.	8.5804245	50.0000000	Y
0.0004787	4027.	8411829.	8.5703230	50.0000000	Y
0.0004878	4041.	8284768.	8.5604444	50.0000000	Y
0.0004969	4055.	8161113.	8.5508674	50.0000000	Y
0.0005060	4069.	8040641.	8.5411169	50.0000000	Y
0.0005152	4082.	7922849.	8.5319334	50.0000000	Y
0.0005243	4094.	7808122.	8.5227495	50.0000000	Y
0.0005334	4105.	7696454.	8.5135075	50.0000000	Y
0.0005425	4116.	7587489.	8.5048510	50.0000000	Y
0.0005790	4156.	7177238.	8.4706261	50.0000000	Y
0.0006155	4189.	6806076.	8.4387713	50.0000000	Y
0.0006519	4217.	6468428.	8.4084998	50.0000000	Y
0.0006884	4241.	6161017.	8.3801014	50.0000000	Y
0.0007249	4262.	5879897.	8.3536136	50.0000000	Y
0.0007613	4281.	5622502.	8.3283631	50.0000000	Y
0.0007978	4297.	5385837.	8.3046426	50.0000000	Y
0.0008343	4311.	5167859.	8.2822200	50.0000000	Y
0.0008708	4324.	4965920.	8.2607458	50.0000000	Y
0.0009072	4336.	4779028.	8.2401506	50.0000000	Y
0.0009437	4346.	4605422.	8.2212498	50.0000000	Y
0.0009802	4355.	4443484.	8.2025947	50.0000000	Y
0.0010166	4364.	4292679.	8.1849754	50.0000000	Y

Summary of Results for Nominal Moment Capacity for Section 1

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	338.0000000000	4364.

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	=	3.000000 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	=	14.900000 in
Depth of Core/Insert	=	14.200000 in
Flange Thickness of Core/Insert	=	0.805000 in
Web Thickness of Core/Insert	=	0.805000 in
Moment of Inertia of Steel Core/Insert	=	444.363799 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	=	672.734397 sq. in.
Cross-sectional Area of Steel Casing	=	0.0000 sq. in.
Cross-sectional Area of Steel Core/Insert	=	34.123950 sq. in.
Area of All Steel (Casing, Core/Insert, and Bars)	=	34.123950 sq. in.
Area Ratio of All Steel to Gross Area	=	4.83 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 = 3993.494 kips
Tensile Load for Cracking of Concrete = -393.967 kips
Nominal Axial Tensile Capacity = -1706.197 kips

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

Number	Axial Thrust Force kips
1	338.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 338.000 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
0.00000456	782.8761714	171723121.	34.6937687	0.0001582	0.00002140	0.6400313	0.00000	0.00000	3.5754402	
0.00000912	1564.	171528982.	24.9230970	0.0002272	-0.00004629	0.9007222	0.00000	0.00000	4.5680465	
0.00001368	2333.	170579709.	21.6877652	0.0002966	-0.000114	1.1517661	0.00000	0.00000	5.5677730	
0.00001824	2333.	127934782.	18.8268166	0.0003433	-0.000204	1.3140789	0.00000	0.00000	5.9107401	C
0.00002279	2534.	111184092.	17.4824496	0.0003985	-0.000285	1.5001533	0.00000	0.00000	6.4997154	C
0.00002735	2802.	102429466.	16.5445521	0.0004526	-0.000368	1.6758684	0.00000	0.00000	7.0556628	C
0.00003191	3056.	95759777.	15.8531125	0.0005059	-0.000451	1.8430432	0.00000	0.00000	7.5916992	C
0.00003647	3301.	90514066.	15.3231746	0.0005589	-0.000535	2.0027381	0.00000	0.00000	8.1157259	C
0.00004103	3541.	86295141.	14.9076175	0.0006117	-0.000619	2.1558956	0.00000	0.00000	-8.855540	C
0.00004559	3776.	82826814.	14.5754161	0.0006645	-0.000703	2.3029682	0.00000	0.00000	-10.278730	C
0.00005015	4007.	79904119.	14.3033012	0.0007173	-0.000787	2.4438914	0.00000	0.00000	-11.702341	C
0.00005471	4234.	77395296.	14.0766627	0.0007701	-0.000871	2.5787242	0.00000	0.00000	-13.125756	C
0.00005927	4458.	75212000.	13.8861653	0.0008230	-0.000955	2.7076302	0.00000	0.00000	-14.546978	C
0.00006383	4677.	73284035.	13.7239633	0.0008759	-0.001039	2.8305674	0.00000	0.00000	-15.966199	C
0.00006838	4894.	71563742.	13.5850599	0.0009290	-0.001123	2.9476104	0.00000	0.00000	-17.382105	C
0.00007294	5107.	70011582.	13.4650653	0.0009822	-0.001206	3.0587155	0.00000	0.00000	-18.794741	C
0.00007750	5317.	68601701.	13.3617839	0.0010356	-0.001289	3.1640141	0.00000	0.00000	-20.201541	C
0.00008206	5523.	67305267.	13.2710209	0.0010890	-0.001373	3.2632244	0.00000	0.00000	-21.605859	C
0.00008662	5726.	66107738.	13.1920462	0.0011427	-0.001456	3.3564995	0.00000	0.00000	-23.004565	C
0.00009118	5926.	64994247.	13.1233241	0.0011966	-0.001539	3.4438037	0.00000	0.00000	-24.397045	C
0.00009574	6123.	63952176.	13.0634353	0.0012507	-0.001621	3.5250663	0.00000	0.00000	-25.783171	C
0.0001003	6316.	62969608.	13.0104604	0.0013049	-0.001704	3.6001124	0.00000	0.00000	-27.165025	C
0.0001049	6505.	62039427.	12.9640571	0.0013594	-0.001786	3.6689603	0.00000	0.00000	-28.540903	C
0.0001094	6691.	61154985.	12.9236788	0.0014140	-0.001868	3.7315681	0.00000	0.00000	-29.909935	C
0.0001140	6874.	60310198.	12.8886486	0.0014690	-0.001950	3.7878552	0.00000	0.00000	-31.271968	C
0.0001185	7053.	59499898.	12.8583956	0.0015241	-0.002032	3.8377379	0.00000	0.00000	-32.626843	C
0.0001231	7228.	58719657.	12.8324354	0.0015796	-0.002113	3.8811295	0.00000	0.00000	-33.974395	C
0.0001277	7399.	57965660.	12.8103548	0.0016352	-0.002194	3.9179406	0.00000	0.00000	-35.314450	C
0.0001322	7567.	57234596.	12.7917990	0.0016912	-0.002275	3.9480782	0.00000	0.00000	-36.646829	C
0.0001368	7731.	56523566.	12.7764635	0.0017474	-0.002356	3.9714459	0.00000	0.00000	-37.971344	C
0.0001413	7890.	55830032.	12.7637945	0.0018039	-0.002436	3.9879438	0.00000	0.00000	-39.287793	C
0.0001459	8046.	55151735.	12.7527038	0.0018604	-0.002516	3.9974680	0.00000	0.00000	-40.595975	C
0.0001504	8197.	54486385.	12.7443241	0.0019173	-0.002596	3.9985262	0.00000	0.00000	-41.895872	C
0.0001550	8344.	53830547.	12.7425049	0.0019751	-0.002675	3.9991570	0.00000	0.00000		

```
-43.186838 C
    0.0001596         8486.      53182738.    12.7400946     0.0020328     -0.002754     3.9995059       0.00000       0.00000
-44.468190 C
    0.0001641         8623.      52542586.    12.7398494     0.0020909     -0.002833     3.9996772       0.00000       0.00000
-45.739877 C
    0.0001687         8756.      51910172.    12.7415828     0.0021493     -0.002911     3.9997357       0.00000       0.00000
-47.001949 C
    0.0001732         8885.      51285785.    12.7451144     0.0022080     -0.002989     3.9997076       0.00000       0.00000
-48.254530 C
    0.0001778         9009.      50669806.    12.7502672     0.0022670     -0.003067     3.9995797       0.00000       0.00000
-49.497817 C
    0.0001869         9237.      49417413.    12.7611819     0.0023853     -0.003222     3.9987228       0.00000       0.00000
-50.000000 CY
    0.0001960         9436.      48133462.    12.7712281     0.0025036     -0.003377     4.0000000       0.00000       0.00000
-50.000000 CY
    0.0002052         9611.      46846306.    12.7811290     0.0026221     -0.003532     3.9987374       0.00000       0.00000
-50.000000 CY
    0.0002143         9765.      45571260.    12.7905380     0.0027406     -0.003687     3.9997972       0.00000       0.00000
-50.000000 CY
    0.0002234         9900.      44319197.    12.7995220     0.0028593     -0.003842     3.9996057       0.00000       0.00000
-50.000000 CY
    0.0002325        10021.      43100463.    12.8085680     0.0029781     -0.003997     3.9966621       0.00000       0.00000
-50.000000 CY
    0.0002416        10129.      41920518.    12.8175362     0.0030970     -0.004152     3.9962487       0.00000       0.00000
-50.000000 CY
    0.0002507        10225.      40778563.    12.8261503     0.0032161     -0.004306     3.9958022       0.00000       0.00000
-50.000000 CY
    0.0002599        10311.      39679581.    12.8347318     0.0033352     -0.004461     3.9978873       0.00000       0.00000
-50.000000 CY
    0.0002690        10389.      38624638.    12.8434254     0.0034546     -0.004615     3.9999698       0.00000       0.00000
-50.000000 CY
    0.0002781        10460.      37613738.    12.8522550     0.0035742     -0.004769     3.9994398       0.00000       0.00000
-50.000000 CY
    0.0002872        10523.      36638828.    12.8602261     0.0036936     -0.004923     3.9977229       0.00000       0.00000
-50.000000 CY
    0.0002963        10581.      35708059.    12.8694659     0.0038136     -0.005076     3.9949775       0.00000       0.00000
-50.000000 CY
    0.0003054        10581.      34642147.    12.9110911     0.0039437     -0.005220     3.9999785       0.00000       0.00000
-50.000000 CY
    0.0003146        10581.      33638026.    12.9465200     0.0040726     -0.005364     3.9988902       0.00000       0.00000
-50.000000 CY
    0.0003237        10581.      32690476.    12.9851318     0.0042031     -0.005507     3.9956429       0.00000       0.00000
50.0000000 CY
    0.0003328        10581.      31794847.    13.0291387     0.0043361     -0.005648     3.9988201       0.00000       0.00000
50.0000000 CY
    0.0003419        10581.      30946984.    13.1174774     0.0044851     -0.005772     3.9996825       0.00000       0.00000
50.0000000 CY
    0.0003510        10581.      30143167.    13.1684908     0.0046227     -0.005909     3.9966786       0.00000       0.00000
50.0000000 CY
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    0.0003602        10581.      29380048.    13.2230950     0.0047624     -0.006042     3.9959577       0.00000       0.00000
50.0000000 CY
    0.0003693        10581.      28654615.    13.2797721     0.0049039     -0.006174     3.9990624       0.00000       0.00000
50.0000000 CY
    0.0003784        10581.      27964142.    13.3390408     0.0050474     -0.006304     3.9938214       0.00000       0.00000
50.0000000 CY
    0.0003875        10581.      27306163.    13.3983887     0.0051920     -0.006433     3.9999379       0.00000       0.00000
50.0000000 CY
    0.0003966        10581.      26678435.    13.4585141     0.0053380     -0.006561     3.9961684       0.00000       0.00000
50.0000000 CY
    0.0004057        10581.      26078919.    13.5206959     0.0054860     -0.006686     3.9972142       0.00000       0.00000
50.0000000 CY
    0.0004149        10581.      25505756.    13.5840675     0.0056355     -0.006810     3.9975444       0.00000       0.00000
50.0000000 CY
    0.0004240        10581.      24957245.    13.6495948     0.0057872     -0.006932     3.9932669       0.00000       0.00000
50.0000000 CY
    0.0004331        10581.      24431830.    13.6552542     0.0059141     -0.007079     3.9952603       0.00000       0.00000
50.0000000 CY
    0.0004422        10581.      23928081.    13.7187880     0.0060667     -0.007200     3.9995262       0.00000       0.00000
50.0000000 CY
    0.0004513        10581.      23444685.    13.7837918     0.0062211     -0.007319     3.9951594       0.00000       0.00000
50.0000000 CY
    0.0004605        10581.      22980434.    13.8497115     0.0063771     -0.007436     3.9995438       0.00000       0.00000
50.0000000 CY
    0.0004696        10581.      22534212.    13.8551324     0.0065060     -0.007581     3.9888722       0.00000       0.00000
50.0000000 CY
    0.0004787        10581.      22104989.    13.9213813     0.0066640     -0.007697     3.9987696       0.00000       0.00000
50.0000000 CY
    0.0004878        10581.      21691811.    13.9868929     0.0068229     -0.007811     3.9891390       0.00000       0.00000
50.0000000 CY
    0.0004969        10581.      21293797.    13.9916489     0.0069528     -0.007955     3.9934066       0.00000       0.00000
50.0000000 CY
    0.0005060        10581.      20910125.    14.0561973     0.0071130     -0.008068     3.9998729       0.00000       0.00000
50.0000000 CY
    0.0005152        10581.      20540034.    14.0606157     0.0072435     -0.008211     3.9920462       0.00000       0.00000
50.0000000 CY
    0.0005243        10581.      20182816.    14.1267238     0.0074063     -0.008322     3.9954793       0.00000       0.00000
50.0000000 CY


--------------------------------------------------------------------------------
   Summary of Results for Nominal Moment Capacity for Section 2
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                                          Nominal
Load              Axial                   Moment
 No.              Thrust                  Capacity
                   kips                    in-kips
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1	338.0000000000	10581.

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. 3:

Dimensions and Properties of Drilled Shaft (Bored Pile):

Length of Section	=	0.300000 ft
Shaft Diameter	=	30.000000 in
Number of Reinforcing Bars	=	0 bars
Yield Stress of Reinforcing Bars	=	0.0000 psi
Modulus of Elasticity of Reinforcing Bars	=	0.0000 psi
Gross Area of Shaft	=	706.858347 sq. in.
Total Area of Reinforcing Steel	=	0.0000 sq. in.
Area Ratio of Steel Reinforcement	=	0.00 percent
Offset of Center of Rebar Cage from Center of Pile	=	0.0000 in

Axial Structural Capacities:

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As	=	2403.318 kips
Tensile Load for Cracking of Concrete	=	-293.989 kips
Nominal Axial Tensile Capacity	=	0.000 kips

Concrete Properties:

Compressive Strength of Concrete	=	4000. psi
Modulus of Elasticity of Concrete	=	3604997. psi
Modulus of Rupture of Concrete	=	-474.34165 psi
Compression Strain at Peak Stress	=	0.001886
Tensile Strain at Fracture of Concrete	=	-0.0001154
Maximum Coarse Aggregate Size	=	0.750000 in

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

Number	Axial Thrust Force kips
1	338.000

Definitions of Run Messages and Notes:

C = concrete in section has cracked in tension.
Y = stress in reinforcing steel has reached yield stress.
T = ACI 318 criteria for tension-controlled section met, tensile strain in reinforcement exceeds 0.005 while simultaneously compressive strain in concrete more than 0.003. See ACI 318-14, Section 21.2.3.
Z = depth of tensile zone in concrete section is less than 10 percent of section depth.

Bending Stiffness (EI) = Computed Bending Moment / Curvature.
Position of neutral axis is measured from edge of compression side of pile.
Compressive stresses and strains are positive in sign.
Tensile stresses and strains are negative in sign.

Axial Thrust Force = 338.000 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	Run Msg
0.00000125	197.8111059	158248885.	108.0859395	0.0001351	0.00009761	0.5517540	0.00000	
0.00000250	395.6055596	158242224.	61.5727688	0.0001539	0.00007893	0.6247525	0.00000	
0.00000375	593.3667065	158231122.	46.0816245	0.0001728	0.00006031	0.6971615	0.00000	
0.00000500	791.0778875	158215578.	38.3459888	0.0001917	0.00004173	0.7689748	0.00000	
0.00000625	988.7224363	158195590.	33.7125590	0.0002107	0.00002320	0.8401860	0.00000	
0.00000750	1186.	158171157.	30.6302346	0.0002297	0.00000473	0.9107890	0.00000	
0.00000875	1384.	158140033.	28.4342025	0.0002488	-0.00001370	0.9807758	0.00000	
0.00001000	1581.	158079169.	26.7914757	0.0002679	-0.00003209	1.0501173	0.00000	
0.00001125	1777.	157967660.	25.5167666	0.0002871	-0.00005044	1.1187733	0.00000	
0.00001250	1973.	157801725.	24.4990781	0.0003062	-0.00006876	1.1867133	0.00000	
0.00001375	2167.	157585248.	23.6612944	0.0003253	-0.00008716	1.2539157	0.00000	
0.00001500	2360.	157324408.	22.9735046	0.0003446	-0.000105	1.3203648	0.00000	
0.00001625	2360.	145222530.	21.5419794	0.0003501	-0.000137	1.3384648	0.00000	C
0.00001750	2360.	134849492.	20.8696342	0.0003652	-0.000160	1.3900159	0.00000	C
0.00001875	2360.	125859526.	20.2663888	0.0003800	-0.000183	1.4397561	0.00000	C
0.00002000	2360.	117993306.	19.7208085	0.0003944	-0.000206	1.4878253	0.00000	C

0.00002125	2407.	113267581.	19.2245426	0.0004085	-0.000229	1.5343868	0.00000 C
0.00002250	2463.	109476394.	18.7708281	0.0004223	-0.000253	1.5795970	0.00000 C
0.00002375	2515.	105894333.	18.3529355	0.0004359	-0.000277	1.6234251	0.00000 C
0.00002500	2563.	102527892.	17.9667698	0.0004492	-0.000301	1.6660649	0.00000 C
0.00002625	2608.	99361465.	17.6088893	0.0004622	-0.000325	1.7075915	0.00000 C
0.00002750	2650.	96377077.	17.2754655	0.0004751	-0.000350	1.7480495	0.00000 C
0.00002875	2690.	93559692.	16.9638921	0.0004877	-0.000375	1.7874860	0.00000 C
0.00003000	2727.	90896593.	16.6716168	0.0005001	-0.000400	1.8259508	0.00000 C
0.00003125	2762.	88376900.	16.3967030	0.0005124	-0.000425	1.8634965	0.00000 C
0.00003250	2795.	85991209.	16.1375580	0.0005245	-0.000451	1.9001789	0.00000 C
0.00003375	2826.	83731309.	15.8928739	0.0005364	-0.000476	1.9360575	0.00000 C
0.00003500	2856.	81589960.	15.6615818	0.0005482	-0.000502	1.9711954	0.00000 C
0.00003625	2884.	79560714.	15.4428171	0.0005598	-0.000528	2.0056600	0.00000 C
0.00003750	2911.	77618206.	15.2334463	0.0005713	-0.000554	2.0392517	0.00000 C
0.00003875	2936.	75773605.	15.0346999	0.0005826	-0.000580	2.0722291	0.00000 C
0.00004000	2961.	74024109.	14.8462642	0.0005939	-0.000606	2.1046910	0.00000 C
0.00004125	2984.	72339939.	14.6645487	0.0006049	-0.000633	2.1362948	0.00000 C
0.00004250	3007.	70741364.	14.4920268	0.0006159	-0.000659	2.1674611	0.00000 C
0.00004375	3028.	69209155.	14.3263242	0.0006268	-0.000686	2.1979862	0.00000 C
0.00004500	3048.	67743845.	14.1675687	0.0006375	-0.000712	2.2279681	0.00000 C
0.00004625	3068.	66341268.	14.0153674	0.0006482	-0.000739	2.2574364	0.00000 C
0.00004750	3087.	64995113.	13.8688498	0.0006588	-0.000766	2.2863511	0.00000 C
0.00004875	3106.	63704172.	13.7280540	0.0006692	-0.000793	2.3147839	0.00000 C
0.00005125	3140.	61271696.	13.4615535	0.0006899	-0.000848	2.3701729	0.00000 C
0.00005375	3172.	59022225.	13.2136559	0.0007102	-0.000902	2.4237542	0.00000 C
0.00005625	3203.	56937683.	12.9828276	0.0007303	-0.000957	2.4756861	0.00000 C
0.00005875	3231.	54999588.	12.7665782	0.0007500	-0.001012	2.5260387	0.00000 C
0.00006125	3258.	53183821.	12.5623761	0.0007694	-0.001068	2.5745940	0.00000 C
0.00006375	3283.	51492126.	12.3710480	0.0007887	-0.001124	2.6218782	0.00000 C
0.00006625	3306.	49907738.	12.1907212	0.0008076	-0.001180	2.6678074	0.00000 C
0.00006875	3329.	48414972.	12.0189690	0.0008263	-0.001236	2.7122069	0.00000 C
0.00007125	3350.	47019107.	11.8583012	0.0008449	-0.001293	2.7556911	0.00000 C
0.00007375	3370.	45692630.	11.7030698	0.0008631	-0.001349	2.7974925	0.00000 C
0.00007625	3389.	44450815.	11.5582091	0.0008813	-0.001406	2.8386135	0.00000 C
0.00007875	3407.	43265913.	11.4174076	0.0008991	-0.001463	2.8781100	0.00000 C
0.00008125	3425.	42151794.	11.2854000	0.0009169	-0.001521	2.9169468	0.00000 C
0.00008375	3441.	41089312.	11.1576388	0.0009345	-0.001578	2.9544398	0.00000 C
0.00008625	3457.	40082372.	11.0361768	0.0009519	-0.001636	2.9910679	0.00000 C
0.00008875	3473.	39127142.	10.9206147	0.0009692	-0.001693	3.0268688	0.00000 C
0.00009125	3487.	38211157.	10.8078461	0.0009862	-0.001751	3.0613601	0.00000 C
0.00009375	3501.	37343382.	10.7014788	0.0010033	-0.001809	3.0953006	0.00000 C
0.00009625	3514.	36512878.	10.5985191	0.0010201	-0.001867	3.1282138	0.00000 C
0.00009875	3527.	35716708.	10.4986483	0.0010367	-0.001926	3.1601099	0.00000 C
0.0001013	3540.	34959304.	10.4040432	0.0010534	-0.001984	3.1914767	0.00000 C
0.0001038	3552.	34232855.	10.3124514	0.0010699	-0.002043	3.2219429	0.00000 C
0.0001063	3563.	33532905.	10.2227375	0.0010862	-0.002101	3.2513530	0.00000 C
0.0001088	3574.	32864660.	10.1374476	0.0011024	-0.002160	3.2802554	0.00000 C
0.0001113	3585.	32225979.	10.0562838	0.0011188	-0.002219	3.3086467	0.00000 C
0.0001138	3595.	31605419.	9.9750282	0.0011347	-0.002278	3.3357431	0.00000 C

0.0001163	3605.	31010340.	9.8971846	0.0011505	-0.002337	3.3622850	0.00000 C
0.0001188	3615.	30439916.	9.8228822	0.0011665	-0.002396	3.3883382	0.00000 C
0.0001213	3624.	29892615.	9.7519026	0.0011824	-0.002455	3.4138995	0.00000 C
0.0001238	3633.	29358648.	9.6801471	0.0011979	-0.002515	3.4382006	0.00000 C
0.0001263	3642.	28845251.	9.6114139	0.0012134	-0.002574	3.4620132	0.00000 C
0.0001288	3650.	28351450.	9.5455511	0.0012290	-0.002634	3.4853565	0.00000 C
0.0001313	3659.	27876122.	9.4824275	0.0012446	-0.002693	3.5082275	0.00000 C
0.0001338	3667.	27414834.	9.4201637	0.0012599	-0.002753	3.5302829	0.00000 C
0.0001363	3674.	26966410.	9.3584420	0.0012751	-0.002812	3.5514980	0.00000 C
0.0001388	3682.	26533854.	9.2991536	0.0012903	-0.002872	3.5722637	0.00000 C
0.0001413	3689.	26116322.	9.2421704	0.0013055	-0.002932	3.5925771	0.00000 C
0.0001438	3696.	25713025.	9.1873718	0.0013207	-0.002992	3.6124355	0.00000 C
0.0001463	3703.	25321482.	9.1336621	0.0013358	-0.003052	3.6316449	0.00000 C
0.0001488	3710.	24938729.	9.0795433	0.0013506	-0.003112	3.6499564	0.00000 C
0.0001588	3735.	23525903.	8.8818884	0.0014100	-0.003353	3.7188558	0.00000 C
0.0001688	3757.	22261938.	8.7004619	0.0014682	-0.003594	3.7789956	0.00000 C
0.0001788	3777.	21132181.	8.5390611	0.0015264	-0.003836	3.8318646	0.00000 C
0.0001888	3795.	20105890.	8.3869195	0.0015830	-0.004079	3.8764215	0.00000 C
0.0001988	3812.	19180199.	8.2523575	0.0016402	-0.004322	3.9144063	0.00000 C
0.0002088	3826.	18329765.	8.1229913	0.0016957	-0.004567	3.9446424	0.00000 C
0.0002188	3840.	17554615.	8.0073335	0.0017516	-0.004811	3.9684663	0.00000 C
0.0002288	3852.	16841065.	7.8994799	0.0018070	-0.005055	3.9854990	0.00000 C
0.0002388	3863.	16180874.	7.7978192	0.0018617	-0.005301	3.9959049	0.00000 C
0.0002488	3873.	15571831.	7.7061059	0.0019169	-0.005546	3.9999497	0.00000 C
0.0002588	3883.	15005595.	7.6207313	0.0019719	-0.005791	3.9989305	0.00000 C
0.0002688	3890.	14475728.	7.5382568	0.0020259	-0.006037	3.9956898	0.00000 C
0.0002788	3898.	13982136.	7.4634833	0.0020804	-0.006282	3.9997508	0.00000 C
0.0002888	3904.	13520975.	7.3953196	0.0021354	-0.006527	3.9967240	0.00000 C
0.0002988	3910.	13088263.	7.3317938	0.0021904	-0.006772	3.9998967	0.00000 C
0.0003088	3915.	12679368.	7.2688497	0.0022443	-0.007018	3.9961098	0.00000 C
0.0003188	3919.	12295211.	7.2109698	0.0022985	-0.007264	3.9996335	0.00000 C
0.0003288	3923.	11933326.	7.1581642	0.0023532	-0.007509	3.9935981	0.00000 C
0.0003388	3927.	11591901.	7.1095645	0.0024084	-0.007754	3.9984739	0.00000 C
0.0003488	3930.	11269390.	7.0647183	0.0024638	-0.007999	3.9993377	0.00000 C
0.0003588	3933.	10962369.	7.0200780	0.0025185	-0.008244	3.9948959	0.00000 C
0.0003688	3935.	10670842.	6.9767120	0.0025727	-0.008490	3.9988000	0.00000 C
0.0003788	3937.	10394268.	6.9364338	0.0026272	-0.008735	3.9992655	0.00000 C
0.0003888	3938.	10131150.	6.8994446	0.0026822	-0.008980	3.9930193	0.00000 C
0.0003988	3940.	9880913.	6.8642937	0.0027371	-0.009225	3.9976148	0.00000 C
0.0004088	3941.	9642601.	6.8327748	0.0027929	-0.009470	3.9998082	0.00000 C
0.0004188	3943.	9415124.	6.8028176	0.0028487	-0.009714	3.9936249	0.00000 C
0.0004288	3944.	9197857.	6.7755235	0.0029050	-0.009957	3.9937472	0.00000 C
0.0004388	3944.	8990241.	6.7497027	0.0029614	-0.010201	3.9978578	0.00000 C
0.0004488	3945.	8790672.	6.7213597	0.0030162	-0.010446	3.9997678	0.00000 C
0.0004588	3945.	8599460.	6.6950449	0.0030714	-0.010691	3.9952130	0.00000 C
0.0004688	3945.	8416116.	6.6698356	0.0031265	-0.010936	3.9897704	0.00000 C
0.0004788	3945.	8240322.	6.6466666	0.0031821	-0.011180	3.9947672	0.00000 C
0.0004888	3945.	8071722.	6.6255883	0.0032383	-0.011424	3.9981234	0.00000 C
0.0004988	3945.	7909883.	6.6053510	0.0032944	-0.011668	3.9998018	0.00000 C

0.0005088	3945.	7754406.	6.5861032	0.0033507	-0.011912	3.9954073	0.00000 C
0.0005188	3945.	7604924.	6.5681500	0.0034072	-0.012155	3.9865553	0.00000 C
0.0005288	3945.	7461096.	6.5521782	0.0034645	-0.012398	3.9914258	0.00000 C
0.0005388	3945.	7322607.	6.5365200	0.0035216	-0.012641	3.9957147	0.00000 C
0.0005488	3945.	7189165.	6.5218612	0.0035789	-0.012884	3.9985461	0.00000 C
0.0006088	3945.	6480582.	6.4956146	0.0039542	-0.014308	3.9988305	0.00000 C

Summary of Results for Nominal Moment Capacity for Section 3

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

Load No.	Axial Thrust kips	Nominal Mom. Cap. in-kip	Max. Comp. Strain	Max. Tens. Strain
1	338.000	3944.712	0.00300000	-0.01037372

Note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether
the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.75).

The above values should be multiplied by the appropriate strength reduction
factor to compute ultimate moment capacity according to ACI 318,
or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding
bending stiffnesses computed for common resistance factor values used for
reinforced concrete sections.

Axial Load No.	Resist. Factor	Nominal Ax. Thrust kips	Nominal Moment Cap in-kips	Ult. (Fac) Ax. Thrust kips	Ult. (Fac) Moment Cap in-kips	Bend. Stiff. at Ult Mom kip-in^2
1	0.65	338.000000	3945.	219.700000	2564.	102467058.
1	0.75	338.000000	3945.	253.500000	2959.	74196005.
1	0.90	338.000000	3945.	304.200000	3550.	34318498.

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	141891.
2	10.4000	10.4000	Yes	No	141891.	335159.
3	16.6000	18.3156	Yes	No	477050.	69195.
4	17.6000	17.6000	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 = 0.435600 inches
Rotation of pile head = 0.000E+00 radians
Axial load on pile head = 338000.0 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	0.4356	-2239929.	44242.	0.00	47459.	1.29E+10	0.00	0.00	0.00
0.2090	0.4351	-2128872.	44176.	-4.25E-04	45597.	1.29E+10	-24.512	141.3057	0.00
0.4180	0.4335	-2017619.	44080.	-8.29E-04	43732.	1.29E+10	-52.459	303.5198	0.00
0.6270	0.4309	-1906363.	43910.	-0.00121	41866.	1.29E+10	-82.906	482.5498	0.00
0.8360	0.4274	-1795313.	43662.	-0.00157	40004.	1.29E+10	-114.853	673.9673	0.00
1.0450	0.4230	-1684690.	43333.	-0.00191	38150.	1.29E+10	-147.383	873.8068	0.00
1.2540	0.4178	-1574716.	42923.	-0.00223	36306.	1.29E+10	-179.600	1078.	0.00
1.4630	0.4118	-1465612.	42433.	-0.00252	34477.	1.29E+10	-211.339	1287.	0.00
1.6720	0.4052	-1357596.	41865.	-0.00280	32666.	1.29E+10	-241.274	1494.	0.00
1.8810	0.3978	-1250873.	41226.	-0.00305	30877.	1.29E+10	-268.897	1695.	0.00
2.0900	0.3899	-1145635.	40516.	-0.00328	29112.	1.29E+10	-297.041	1911.	0.00
2.2990	0.3813	-1042076.	39739.	-0.00350	27376.	1.29E+10	-322.285	2120.	0.00
2.5080	0.3723	-940373.	38903.	-0.00369	25671.	1.29E+10	-344.335	2319.	0.00
2.7170	0.3628	-840680.	38014.	-0.00386	24000.	1.29E+10	-365.219	2524.	0.00

2.9260	0.3529	-743146.	37076.	-0.00402	22364.	1.29E+10	-382.238	2716.	0.00
3.1350	0.3427	-647894.	36100.	-0.00415	20767.	1.29E+10	-395.981	2898.	0.00
3.3440	0.3321	-555026.	35088.	-0.00427	19210.	1.29E+10	-411.793	3110.	0.00
3.5530	0.3213	-464656.	34040.	-0.00437	17695.	1.29E+10	-423.626	3307.	0.00
3.7620	0.3102	-376874.	32965.	-0.00445	16224.	1.29E+10	-433.259	3503.	0.00
3.9710	0.2989	-291755.	31858.	-0.00452	14797.	1.29E+10	-449.473	3771.	0.00
4.1800	0.2875	-209416.	30715.	-0.00456	13416.	1.29E+10	-462.484	4034.	0.00
4.3890	0.2760	-129950.	29543.	-0.00460	12084.	1.29E+10	-471.934	4288.	0.00
4.5980	0.2645	-53432.	28353.	-0.00462	10801.	1.29E+10	-477.471	4528.	0.00
4.8070	0.2529	20092.	27153.	-0.00462	10242.	1.29E+10	-478.746	4748.	0.00
5.0160	0.2413	90601.	25950.	-0.00461	11424.	1.29E+10	-480.885	4998.	0.00
5.2250	0.2298	158070.	24723.	-0.00458	12555.	1.29E+10	-497.915	5435.	0.00
5.4340	0.2183	222381.	23455.	-0.00455	13633.	1.29E+10	-513.122	5895.	0.00
5.6430	0.2070	283428.	22151.	-0.00450	14657.	1.29E+10	-526.338	6378.	0.00
5.8520	0.1958	341118.	20817.	-0.00444	15624.	1.29E+10	-537.405	6885.	0.00
6.0610	0.1847	395371.	19459.	-0.00437	16534.	1.29E+10	-546.181	7416.	0.00
6.2700	0.1739	446123.	18078.	-0.00428	17385.	1.29E+10	-554.703	8002.	0.00
6.4790	0.1632	493312.	16672.	-0.00419	18176.	1.29E+10	-566.480	8704.	0.00
6.6880	0.1528	536857.	15239.	-0.00409	18906.	1.29E+10	-576.568	9462.	0.00
6.8970	0.1427	576687.	13782.	-0.00398	19574.	1.29E+10	-584.883	10280.	0.00
7.1060	0.1328	612742.	12307.	-0.00387	20178.	1.29E+10	-591.350	11164.	0.00
7.3150	0.1233	644977.	10818.	-0.00375	20718.	1.29E+10	-595.899	12121.	0.00
7.5240	0.1141	673357.	9321.	-0.00362	21194.	1.29E+10	-598.470	13159.	0.00
7.7330	0.1052	697862.	7819.	-0.00348	21605.	1.29E+10	-599.008	14287.	0.00
7.9420	0.09659	718484.	6319.	-0.00335	21951.	1.29E+10	-597.467	15514.	0.00
8.1510	0.08837	735229.	4825.	-0.00320	22232.	1.29E+10	-593.807	16852.	0.00
8.3600	0.08052	748118.	3343.	-0.00306	22448.	1.29E+10	-587.997	18316.	0.00
8.5690	0.07302	757184.	1878.	-0.00291	22600.	1.29E+10	-580.009	19920.	0.00
8.7780	0.06590	762478.	436.2632	-0.00277	22688.	1.29E+10	-569.822	21686.	0.00
8.9870	0.05915	764061.	-977.297	-0.00262	22715.	1.29E+10	-557.419	23634.	0.00
9.1960	0.05277	762013.	-2357.	-0.00247	22681.	1.29E+10	-542.787	25795.	0.00
9.4050	0.04677	756424.	-3697.	-0.00232	22587.	1.29E+10	-525.909	28201.	0.00
9.6140	0.04113	747403.	-4992.	-0.00217	22436.	1.29E+10	-506.768	30898.	0.00
9.8230	0.03586	735070.	-6236.	-0.00203	22229.	1.29E+10	-485.339	33941.	0.00
10.0320	0.03095	719564.	-7415.	-0.00189	21969.	1.29E+10	-454.574	36835.	0.00
10.2410	0.02639	701079.	-8481.	-0.00175	21659.	1.29E+10	-395.664	37602.	0.00
10.4500	0.02217	679990.	-9239.	-0.00162	21305.	1.29E+10	-208.524	23588.	0.00
10.6590	0.01828	657478.	-9720.	-0.00149	20928.	1.29E+10	-175.409	24059.	0.00
10.8680	0.01472	633753.	-10121.	-0.00136	20530.	1.29E+10	-143.970	24531.	0.00
11.0770	0.01146	609019.	-10444.	-0.00124	20116.	1.29E+10	-114.275	25003.	0.00
11.2860	0.00850	583465.	-10696.	-0.00112	19687.	1.29E+10	-86.373	25475.	0.00
11.4950	0.00583	557271.	-10880.	-0.00101	19248.	1.29E+10	-60.306	25947.	0.00
11.7040	0.00343	530606.	-11001.	-9.06E-04	18801.	1.29E+10	-36.097	26418.	0.00
11.9130	0.00128	503627.	-11063.	-8.06E-04	18349.	1.29E+10	-13.761	26890.	0.00
12.1220	-6.14E-04	476478.	-11072.	-7.10E-04	17893.	1.29E+10	6.6982	27362.	0.00
12.3310	-0.00228	449292.	-11032.	-6.20E-04	17438.	1.29E+10	25.2906	27834.	0.00
12.5400	-0.00372	422192.	-10948.	-5.35E-04	16983.	1.29E+10	42.0341	28305.	0.00
12.7490	-0.00496	395286.	-10824.	-4.56E-04	16532.	1.29E+10	56.9569	28777.	0.00
12.9580	-0.00601	368673.	-10664.	-3.81E-04	16086.	1.29E+10	70.0956	29249.	0.00
13.1670	-0.00688	342441.	-10474.	-3.12E-04	15646.	1.29E+10	81.4955	29721.	0.00
13.3760	-0.00758	316664.	-10258.	-2.48E-04	15214.	1.29E+10	91.2092	30192.	0.00
13.5850	-0.00812	291409.	-10019.	-1.89E-04	14791.	1.29E+10	99.2960	30664.	0.00
13.7940	-0.00852	266730.	-9762.	-1.35E-04	14377.	1.29E+10	105.8219	31136.	0.00
14.0030	-0.00880	242673.	-9490.	-8.50E-05	13974.	1.29E+10	110.8584	31608.	0.00
14.2120	-0.00895	219274.	-9207.	-4.00E-05	13581.	1.29E+10	114.4823	32079.	0.00
14.4210	-0.00900	196558.	-8917.	4.19E-07	13200.	1.29E+10	116.7749	32551.	0.00
14.6300	-0.00895	174544.	-8623.	3.65E-05	12831.	1.29E+10	117.8218	33023.	0.00
14.8390	-0.00881	153243.	-8328.	6.84E-05	12474.	1.29E+10	117.7124	33495.	0.00
15.0480	-0.00861	132656.	-8034.	9.63E-05	12129.	1.29E+10	116.5394	33966.	0.00
15.2570	-0.00833	112781.	-7744.	1.20E-04	11796.	1.29E+10	114.3987	34438.	0.00
15.4660	-0.00800	93607.	-7461.	1.40E-04	11474.	1.29E+10	111.3886	34910.	0.00
15.6750	-0.00763	75118.	-7187.	1.57E-04	11164.	1.29E+10	107.6103	35382.	0.00
15.8840	-0.00722	57294.	-6922.	1.70E-04	10866.	1.29E+10	103.1668	35853.	0.00
16.0930	-0.00678	40109.	-6670.	1.79E-04	10578.	1.29E+10	98.1637	36325.	0.00
16.3020	-0.00632	23535.	-6430.	1.85E-04	10300.	1.29E+10	92.7080	36797.	0.00
16.5110	-0.00585	7540.	-6205.	1.88E-04	10031.	1.29E+10	86.9091	37269.	0.00
16.7200	-0.00537	-7910.	-6022.	1.88E-04	10038.	1.29E+10	59.3104	27676.	0.00
16.9290	-0.00490	-22985.	-5879.	1.85E-04	10290.	1.29E+10	54.7999	28022.	0.00
17.1380	-0.00445	-37711.	-5747.	1.79E-04	10537.	1.29E+10	50.2867	28368.	0.00
17.3470	-0.00401	-52115.	-5626.	1.71E-04	10779.	1.29E+10	45.8576	28714.	0.00
17.5560	-0.00359	-66222.	-5517.	1.59E-04	11015.	1.29E+10	41.6018	29060.	0.00
17.7650	-0.00321	-80057.	-4459.	1.52E-04	0.00	1.72E+11	801.7194	626831.	0.00
17.9740	-0.00283	-88847.	-2547.	1.51E-04	0.00	1.72E+11	722.9610	641150.	0.00
18.1830	-0.00245	-93089.	-845.400	1.49E-04	0.00	1.72E+11	634.1738	648775.	0.00
18.3920	-0.00208	-93341.	628.3504	1.48E-04	0.00	1.72E+11	541.0662	652872.	0.00
18.6010	-0.00171	-90189.	1868.	1.47E-04	0.00	1.72E+11	447.6346	656968.	0.00
18.8100	-0.00134	-84219.	2873.	1.45E-04	0.00	1.72E+11	353.8661	661063.	0.00
19.0190	-9.79E-04	-76023.	3643.	1.44E-04	0.00	1.72E+11	259.7199	665160.	0.00
19.2280	-6.19E-04	-66192.	4175.	1.43E-04	0.00	1.72E+11	165.1312	669260.	0.00
19.4370	-2.61E-04	-55322.	4470.	1.42E-04	0.00	1.72E+11	70.0155	673369.	0.00
19.6460	9.52E-05	-44010.	4526.	1.42E-04	0.00	1.72E+11	-25.642	675280.	0.00
19.8550	4.50E-04	-32860.	4343.	1.41E-04	0.00	1.72E+11	-120.337	671219.	0.00
20.0640	8.03E-04	-22465.	3924.	1.41E-04	0.00	1.72E+11	-213.588	667235.	0.00
20.2730	0.00116	-13414.	3273.	1.40E-04	0.00	1.72E+11	-305.532	663320.	0.00
20.4820	0.00151	-6285.	2393.	1.40E-04	0.00	1.72E+11	-396.285	659470.	0.00
20.6910	0.00186	-1648.	1300.	1.40E-04	0.00	1.58E+11	-475.128	641089.	0.00
20.9000	0.00221	0.00	0.00	1.40E-04	0.00	1.58E+11	-561.854	318760.	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 = 0.43560000 inches
Computed slope at pile head = 0.000000 radians
Maximum bending moment = -2239929. inch-lbs
Maximum shear force = 44242. 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 = 7
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 Pile-head Rotation (Loading Type 5)
Displacement of pile head = 0.522720 inches
Rotation of pile head = 0.000E+00 radians
Axial load on pile head = 338000.0 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	0.5227	-2605795.	50496.	0.00	53593.	1.28E+10	0.00	0.00	0.00
0.2090	0.5221	-2479029.	50425.	-4.98E-04	51467.	1.28E+10	-26.415	126.8946	0.00
0.4180	0.5202	-2352018.	50321.	-9.69E-04	49338.	1.29E+10	-56.637	273.0456	0.00
0.6270	0.5172	-2224975.	50138.	-0.00141	47208.	1.29E+10	-89.682	434.8705	0.00
0.8360	0.5131	-2098130.	49869.	-0.00184	45081.	1.29E+10	-124.304	607.5586	0.00
1.0450	0.5080	-1971719.	49513.	-0.00223	42962.	1.29E+10	-159.597	787.9150	0.00
1.2540	0.5019	-1845988.	49069.	-0.00260	40854.	1.29E+10	-194.593	972.3217	0.00
1.4630	0.4950	-1721176.	48538.	-0.00295	38762.	1.29E+10	-229.059	1161.	0.00
1.6720	0.4871	-1597520.	47923.	-0.00327	36688.	1.29E+10	-261.600	1347.	0.00
1.8810	0.4785	-1475247.	47229.	-0.00357	34638.	1.29E+10	-291.676	1529.	0.00
2.0900	0.4692	-1354565.	46459.	-0.00385	32615.	1.29E+10	-322.375	1723.	0.00
2.2990	0.4592	-1235687.	45616.	-0.00410	30622.	1.29E+10	-349.989	1911.	0.00
2.5080	0.4487	-1118807.	44707.	-0.00433	28662.	1.29E+10	-374.178	2092.	0.00
2.7170	0.4375	-1004095.	43740.	-0.00454	26739.	1.29E+10	-396.935	2275.	0.00
2.9260	0.4259	-891715.	42722.	-0.00472	24855.	1.29E+10	-415.528	2447.	0.00
3.1350	0.4138	-781802.	41660.	-0.00488	23012.	1.29E+10	-430.704	2610.	0.00
3.3440	0.4014	-674468.	40558.	-0.00502	21213.	1.29E+10	-448.805	2804.	0.00
3.5530	0.3886	-569846.	39414.	-0.00515	19459.	1.29E+10	-462.775	2986.	0.00
3.7620	0.3756	-468041.	38239.	-0.00525	17752.	1.29E+10	-474.583	3169.	0.00
3.9710	0.3623	-369145.	37025.	-0.00533	16094.	1.29E+10	-493.853	3418.	0.00
4.1800	0.3489	-273293.	35766.	-0.00539	14487.	1.29E+10	-509.863	3665.	0.00
4.3890	0.3353	-180604.	34472.	-0.00543	12933.	1.29E+10	-522.233	3906.	0.00
4.5980	0.3216	-91169.	33151.	-0.00546	11434.	1.29E+10	-530.586	4138.	0.00
4.8070	0.3079	-5057.	31816.	-0.00547	9990.	1.29E+10	-534.554	4354.	0.00
5.0160	0.2942	77693.	30469.	-0.00546	11208.	1.29E+10	-539.228	4597.	0.00
5.2250	0.2805	157039.	29092.	-0.00544	12538.	1.29E+10	-558.687	4995.	0.00
5.4340	0.2669	232845.	27669.	-0.00540	13809.	1.29E+10	-576.480	5417.	0.00
5.6430	0.2534	304986.	26203.	-0.00535	15018.	1.29E+10	-592.491	5864.	0.00
5.8520	0.2400	373350.	24699.	-0.00528	16164.	1.29E+10	-606.529	6337.	0.00
6.0610	0.2269	437838.	23164.	-0.00521	17246.	1.29E+10	-618.145	6833.	0.00
6.2700	0.2139	498365.	21599.	-0.00511	18260.	1.29E+10	-629.272	7377.	0.00
6.4790	0.2012	554852.	20004.	-0.00501	19207.	1.29E+10	-643.372	8018.	0.00
6.6880	0.1888	607200.	18375.	-0.00490	20085.	1.29E+10	-655.631	8709.	0.00
6.8970	0.1767	655324.	16717.	-0.00478	20892.	1.29E+10	-665.953	9454.	0.00
7.1060	0.1648	699151.	15037.	-0.00464	21627.	1.29E+10	-674.252	10258.	0.00
7.3150	0.1534	738622.	13338.	-0.00450	22288.	1.29E+10	-680.449	11127.	0.00
7.5240	0.1423	773690.	11626.	-0.00436	22876.	1.29E+10	-684.474	12068.	0.00
7.7330	0.1315	804326.	9907.	-0.00420	23390.	1.29E+10	-686.264	13087.	0.00
7.9420	0.1212	830513.	8187.	-0.00404	23829.	1.29E+10	-685.766	14194.	0.00
8.1510	0.1112	852248.	6471.	-0.00388	24193.	1.29E+10	-682.933	15399.	0.00
8.3600	0.1017	869548.	4764.	-0.00371	24484.	1.29E+10	-677.728	16712.	0.00
8.5690	0.09261	882441.	3074.	-0.00354	24700.	1.29E+10	-670.120	18149.	0.00
8.7780	0.08394	890973.	1406.	-0.00337	24843.	1.29E+10	-660.086	19723.	0.00
8.9870	0.07570	895207.	-233.830	-0.00320	24914.	1.29E+10	-647.607	21455.	0.00
9.1960	0.06790	895219.	-1839.	-0.00302	24914.	1.29E+10	-632.669	23367.	0.00
9.4050	0.06054	891104.	-3404.	-0.00285	24845.	1.29E+10	-615.261	25487.	0.00
9.6140	0.05362	882972.	-4922.	-0.00268	24709.	1.29E+10	-595.371	27848.	0.00
9.8230	0.04713	870949.	-6387.	-0.00250	24507.	1.29E+10	-572.981	30494.	0.00
10.0320	0.04106	855179.	-7793.	-0.00234	24243.	1.29E+10	-548.068	33480.	0.00
10.2410	0.03540	835820.	-9133.	-0.00217	23918.	1.29E+10	-520.589	36878.	0.00
10.4500	0.03016	813049.	-10142.	-0.00201	23536.	1.29E+10	-283.665	23588.	0.00
10.6590	0.02531	788359.	-10802.	-0.00186	23122.	1.29E+10	-242.843	24059.	0.00
10.8680	0.02085	762012.	-11362.	-0.00170	22681.	1.29E+10	-203.962	24531.	0.00
11.0770	0.01676	734256.	-11828.	-0.00156	22215.	1.29E+10	-167.110	25003.	0.00
11.2860	0.01303	705327.	-12203.	-0.00142	21730.	1.29E+10	-132.361	25475.	0.00
11.4950	0.00964	675450.	-12494.	-0.00128	21229.	1.29E+10	-99.769	25947.	0.00
11.7040	0.00659	644834.	-12706.	-0.00116	20716.	1.29E+10	-69.376	26418.	0.00
11.9130	0.00384	613675.	-12845.	-0.00103	20194.	1.29E+10	-41.208	26890.	0.00
12.1220	0.00140	582156.	-12916.	-9.18E-04	19665.	1.29E+10	-15.276	27362.	0.00
12.3310	-7.59E-04	550444.	-12925.	-8.07E-04	19134.	1.29E+10	8.4221	27834.	0.00
12.5400	-0.00265	518695.	-12877.	-7.03E-04	18601.	1.29E+10	29.8995	28305.	0.00
12.7490	-0.00429	487048.	-12777.	-6.05E-04	18071.	1.29E+10	49.1829	28777.	0.00
12.9580	-0.00569	455630.	-12633.	-5.14E-04	17544.	1.29E+10	66.3096	29249.	0.00
13.1670	-0.00686	424554.	-12447.	-4.28E-04	17023.	1.29E+10	81.3272	29721.	0.00
13.3760	-0.00783	393920.	-12227.	-3.48E-04	16509.	1.29E+10	94.2927	30192.	0.00
13.5850	-0.00861	363813.	-11977.	-2.75E-04	16005.	1.29E+10	105.2722	30664.	0.00
13.7940	-0.00921	334309.	-11701.	-2.07E-04	15510.	1.29E+10	114.3394	31136.	0.00
14.0030	-0.00965	305469.	-11406.	-1.44E-04	15026.	1.29E+10	121.5758	31608.	0.00
14.2120	-0.00993	277343.	-11094.	-8.77E-05	14555.	1.29E+10	127.0692	32079.	0.00
14.4210	-0.01009	249971.	-10770.	-3.64E-05	14096.	1.29E+10	130.9137	32551.	0.00
14.6300	-0.01012	223381.	-10439.	9.69E-06	13650.	1.29E+10	133.2089	33023.	0.00
14.8390	-0.01004	197592.	-10104.	5.07E-05	13218.	1.29E+10	134.0592	33495.	0.00
15.0480	-0.00986	172613.	-9768.	8.67E-05	12799.	1.29E+10	133.5737	33966.	0.00

15.2570	-0.00960	148446.	-9436.	1.18E-04	12394.	1.29E+10	131.8652	34438.	0.00
15.4660	-0.00927	125085.	-9108.	1.45E-04	12002.	1.29E+10	129.0505	34910.	0.00
15.6750	-0.00888	102514.	-8789.	1.67E-04	11624.	1.29E+10	125.2495	35382.	0.00
15.8840	-0.00844	80714.	-8481.	1.85E-04	11258.	1.29E+10	120.5853	35853.	0.00
16.0930	-0.00795	59660.	-8186.	1.98E-04	10905.	1.29E+10	115.1837	36325.	0.00
16.3020	-0.00744	39320.	-7904.	2.08E-04	10564.	1.29E+10	109.1734	36797.	0.00
16.5110	-0.00691	19660.	-7638.	2.14E-04	10235.	1.29E+10	102.6854	37269.	0.00
16.7200	-0.00637	643.1041	-7422.	2.16E-04	9916.	1.29E+10	70.2924	27676.	0.00
16.9290	-0.00583	-17932.	-7252.	2.14E-04	10206.	1.29E+10	65.1296	28022.	0.00
17.1380	-0.00530	-36094.	-7095.	2.09E-04	10510.	1.29E+10	59.9166	28368.	0.00
17.3470	-0.00478	-53874.	-6951.	2.00E-04	10808.	1.29E+10	54.7586	28714.	0.00
17.5560	-0.00429	-71300.	-6820.	1.88E-04	11100.	1.29E+10	49.7634	29060.	0.00
17.7650	-0.00384	-88401.	-5571.	1.80E-04	0.00	1.72E+11	946.4274	617888.	0.00
17.9740	-0.00339	-99549.	-3308.	1.79E-04	0.00	1.72E+11	858.1127	634564.	0.00
18.1830	-0.00295	-105297.	-1284.	1.77E-04	0.00	1.72E+11	755.6557	643487.	0.00
18.3920	-0.00250	-106291.	474.5115	1.76E-04	0.00	1.72E+11	646.8989	648274.	0.00
18.6010	-0.00206	-103215.	1960.	1.74E-04	0.00	1.72E+11	537.4758	653071.	0.00
18.8100	-0.00163	-96756.	3170.	1.73E-04	0.00	1.72E+11	427.3739	657881.	0.00
19.0190	-0.00120	-87609.	4103.	1.71E-04	0.00	1.72E+11	316.5473	662704.	0.00
19.2280	-7.70E-04	-76469.	4756.	1.70E-04	0.00	1.72E+11	204.9213	667544.	0.00
19.4370	-3.45E-04	-64039.	5129.	1.69E-04	0.00	1.72E+11	92.3968	672405.	0.00
19.6460	7.83E-05	-51027.	5219.	1.68E-04	0.00	1.72E+11	-21.087	675476.	0.00
19.8550	4.99E-04	-38147.	5025.	1.68E-04	0.00	1.72E+11	-133.529	670654.	0.00
20.0640	9.19E-04	-26107.	4551.	1.67E-04	0.00	1.72E+11	-244.018	665932.	0.00
20.2730	0.00134	-15601.	3803.	1.67E-04	0.00	1.72E+11	-352.724	661303.	0.00
20.4820	0.00176	-7313.	2784.	1.67E-04	0.00	1.72E+11	-459.795	656760.	0.00
20.6910	0.00217	-1918.	1514.	1.67E-04	0.00	1.58E+11	-552.834	637855.	0.00
20.9000	0.00259	0.00	0.00	1.67E-04	0.00	1.58E+11	-654.755	316830.	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            =     0.52272000 inches
Computed slope at pile head     =       0.000000 radians
Maximum bending moment          =      -2605795. inch-lbs
Maximum shear force             =         50496. 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            =              8
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 Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	y, in	0.4356	S, rad	0.00	338000.	0.4356	0.00	44242.	-2239929.
2	y, in	0.5227	S, rad	0.00	338000.	0.5227	0.00	50496.	-2605795.

Maximum pile-head deflection = 0.5227200000 inches
Maximum pile-head rotation   = 0.0000000000 radians = 0.000000 deg.

The analysis ended normally.

D.6. End Bearing Calculation for Rock Socketed Piles

GEI Consultants

Client: Thornton Tomasetti
Project: Smelt Brook Bridge (#2774)
Project No.: 2502334
Subject: Rock Socketed Piles Axial Resistance - Side Resistance (Abut. 1)

Prepared By: M. Johnescu
Date: 7/28/2025
Checked By: N. Betancur
Date: 8/8/2025

Objective: Calculate the axial resistance of rock socketed HP piles from side resistance based on subsurface data collected from the Phase 1 and 2 exploration programs for proposed Abutment 1.

References: 1) American Association of State Highway and Transportation Officials (AASHTO) "LRFD Bridge Design Specifications, 9th Edition, 2020"

Equations:

Ref. 1 Eqn. No.	Equation
10.8.3.5.4b-1	$$\frac{q_s}{p_a} = C\sqrt{\frac{q_u}{p_a}}$$
10.8.3.5.4b-2 (Only use for fractured rock that caves and cannot be drilled with some type of artificial support)	$$\frac{q_s}{p_a} = 0.65\alpha_E\sqrt{\frac{q_u}{p_a}}$$

where (10.8.3.5.4b-1):
- q_s = Nominal unit side resistance
- q_u = Uniaxial compressive strength of rock or compressive strength of concrete (f'c), whichever is lower
- C = Regression Coefficient taken as 1.0 for normal conditions
- p_a = Atmospheric pressure taken as 2.12 ksf

where (10.8.3.5.4b-2):
- q_s = Nominal unit side resistance
- q_u = Uniaxial compressive strength of rock or compressive strength of concrete (f'c), whichever is lower
- p_a = Atmospheric pressure taken as 2.12 ksf
- α_E = Joint Modification Factor, Table 10.8.3.5.4b-1

Table 10.8.3.5.4b-1—Estimation of α_E (O'Neill and Reese, 1999)

RDQ (%)	Joint Modification Factor, α_E	
	Closed Joints	Open or Gouge-Filled Joints
100	1.00	0.85
70	0.85	0.55
50	0.60	0.55
30	0.50	0.50
20	0.45	0.45

Variables:

Rock Type:	Shale		
q_u:	6,910	psi	Avg. from lab test results
f'_c	4,000	psi	Compressive strength of grout in socket
q_u:	4,000	psi	Use the lesser value of qu or f'c for calc
q_u:	576	ksf	
Weighted RQD:	27	%	Avg. from rock cores
Joint Modification Factor α_E:	0.5	dim	Table 10.8.3.5.4b-1
C:	1	dim	Regression Coefficient
p_a:	2.12	ksf	Atmospheric pressure
Rock Socket Length:	5.3	ft	Only the Grouted Portion of the Socket
Rock Socket Diameter:	2.5	ft	Based on HP Pile Size
Rock Socket Circumfrence:	7.85	ft	

Calculations:

q_s:	34.9	ksf	AASHTO Eq. 10.8.3.5.4b-1
R_s:	1,455	kip	Nominal Side Resistance
q_s:	11.4	ksf	AASHTO Eq. 10.8.3.5.4b-2
R_s:	473	kip	Nominal Side Resistance
R_s to be used:	473		Nominal Side Resistance

Side Resistance Summary:

Maximum Factored Load:	338	kip	From the client
Geotechnical Resistance Factor:	0.55	dim	AASHTO Table 10.5.5.2.4-1
Rqd. Geotechnical Nominal Resistance:	615	kip	

Notes:
Verify that side resistance should be used. The AASHTO and FHWA tabs give examples of when you should omit the use of side resistance.

GEI Consultants	**Client:** Thornton Tomasetti	**Prepared By:** M. Johnescu	
	Project: Smelt Brook Bridge (#2774)	**Date:** 7/28/2025	
	Project No.: 2502334	**Checked By:** N. Betancur	
	Subject: Rock Socketed Piles Axial Resistance - Tip Resistance (Abut. 1)	**Date:** 8/8/2025	

Objective: Calculate the axial resistance of rock socketed HP piles from tip resistance based on subsurface data collected from the Phase 1 and 2 exploration programs for proposed Abutment 1.

References: 1) American Association of State Highway and Transportation Officials (AASHTO) "LRFD Bridge Design Specifications, 9th Edition, 2020"
2) Hoek, E., et al (Hoek 2002) "Hoek-Brown Failure Criterion - 2002 Edition"

Equations:

Ref. 1 Eqn. No.	Equation	Where
10.8.3.5.4C-2	$q_p = A + q_u\left[m_b\left(\frac{A}{q_u}\right)+s\right]^a$	where: q_p = Nominal unit tip resistance A = Refer to eq. 10.8.3.5.4C-3 *s, a, m* s, a, m_b = Hoek-Brown strength parameters for the fractured rock mass determined by GSI q_u = Uniaxial compressive strength of intact rock
10.8.3.5.4C-3	$A = \sigma'_{vb} + q_u\left[m_b\frac{(\sigma'_{v,b})}{q_u}+s\right]^a$	where: q_u = Uniaxial compressive strength of intact rock s, a, m_b = Hoek-Brown strength parameters for the fractured rock mass determined by GSI σ'_{vb} = vertical effective stress at the socket bearing elevation "tip elevation" (ksf)
10.4.6.4-4	$m_b = m_i e^{\left(\frac{GSI-100}{28-14D}\right)}$	where: GSI = Geological Strength Index (AASHTO Fig. 10.4.6.4-1) D = Disturbance Factor (Hoek 2002, Table 1) m_i = Rock Group Constant (AASHTO Table 10.4.6.4-1)
10.4.6.4-2	$s = e^{\left(\frac{GSI-100}{9-3D}\right)}$	where: GSI = Geological Strength Index (AASHTO Fig. 10.4.6.4-1) D = Disturbance Factor (Hoek 2002, Table 1)
10.4.6.4-3	$a = \frac{1}{2}+\frac{1}{6}\left(e^{\frac{-GSI}{15}} - e^{\frac{-20}{3}}\right)$	where: GSI = Geological Strength Index (AASHTO Fig. 10.4.6.4-1)

Variables:

Rock Type:	**Shale**		
q_u:	**6,910**	psi	Avg. from lab test results
q_u:	995	ksf	Avg. from lab test results
GSI:	**35**		Fig. 10.4.6.4-1 (very blocky, poor, slickensided)
m_i:	**6**		Table 10.4.6.4-1, shale
D:	**0**		Table 1
Overburden Thickness:	**20.9**	ft	Borings BB-PSB-101 and -201
Depth to GWT:	**18.7**	ft	Boring BB-PSB-101
Avg. Unit Weight of Overburden:	**125**	pcf	
Avg. Unit Weight of Overburden Below GWT:	62.6	pcf	
Avg. Unit Weight of Bedrock Below GWT:	**108.6**	pcf	Avg. from lab test results
Approximate Rock Socket Length:	**10.3**	ft	
Shaft Diameter:	**2.5**	ft	

Calculations:

a:	0.51595	dim	AASHTO 10.4.6.4-3
s:	0.00073	dim	AASHTO 10.4.6.4-2
m_b:	0.5888	dim	AASHTO 10.4.6.4-4
σ'_{vb}:	3.6	ksf	Vertical effective stress
A:	52.0	ksf	AASHTO 10.8.3.5.4C-3
q_p:	219.2	ksf	AASHTO 10.8.3.5.4C-2
R_p:	1,076	kip	Nominal Tip Resistance
Maximum Factored Load:	**338**	kip	From the client
Geotechnical Resistance Factor:	**0.5**	dim	AASHTO Table 10.5.5.2.4-1
Rqd. Geotechnical Nominal Resistance:	676	kip	

Notes: Verify that tip resistance should be used. The AASHTO and FHWA tabs give examples of when tip resistance should be omitted.

Client: Thornton Tomasetti
Project: Smelt Brook Bridge (#2774)
Project No.: 2502334
Subject: Rock Socketed Piles Axial Resistance - Side Resistance (Abut. 2)

Prepared By: M. Johnescu **Date:** 7/28/2025
Checked By: N. Betancur **Date:** 8/8/2025

Objective: Calculate the axial resistance of rock socketed HP piles from side resistance based on subsurface data collected from the Phase 1 and 2 exploration programs for proposed Abutment 2.

References: 1) American Association of State Highway and Transportation Officials (AASHTO) "LRFD Bridge Design Specifications, 9th Edition, 2020"

Equations:

Ref. 1 Eqn. No.	Equation
10.8.3.5.4b-1	$\frac{q_s}{p_a} = C\sqrt{\frac{q_u}{p_a}}$ where: q_s = Nominal unit side resistance; q_u = Uniaxial compressive strength of rock or compressive strength of concrete (f'c), whichever is lower; C = Regression Coefficient taken as 1.0 for normal conditions; p_a = Atmospheric pressure taken as 2.12 ksf
10.8.3.5.4b-2 (Only use for fractured rock that caves and cannot be drilled with some type of artificial support)	$\frac{q_s}{p_a} = 0.65\alpha_E\sqrt{\frac{q_u}{p_a}}$ where: q_s = Nominal unit side resistance; q_u = Uniaxial compressive strength of rock or compressive strength of concrete (f'c), whichever is lower; p_a = Atmospheric pressure taken as 2.12 ksf; α_E = Joint Modification Factor, Table 10.8.3.5.4b-1

Table 10.8.3.5.4b-1—Estimation of α_E (O'Neill and Reese, 1999)

RDQ (%)	Joint Modification Factor, α_E Closed Joints	Open or Gouge-Filled Joints
100	1.00	0.85
70	0.85	0.55
50	0.60	0.55
30	0.50	0.50
20	0.45	0.45

Variables:

Rock Type:	Shale		
q_u:	6,910	psi	Avg. from lab test results
f'_c	4,000	psi	Compressive strength of grout in socket
q_u:	4,000	psi	Use the lesser value of qu or f'c for calc
q_u:	576	ksf	
Weighted RQD:	27	%	Avg. from rock cores
Joint Modification Factor α_E:	0.5	dim	Table 10.8.3.5.4b-1
C:	1	dim	Regression Coefficient
p_a:	2.12	ksf	Atmospheric pressure
Rock Socket Length:	3.3	ft	Only the Grouted Portion of the Socket
Rock Socket Diameter:	2.5	ft	Based on HP Pile Size
Rock Socket Circumfrence:	7.85	ft	

Calculations:

q_s:	34.9	ksf	AASHTO Eq. 10.8.3.5.4b-1
R_s:	906	kip	Nominal Side Resistance
q_s:	11.4	ksf	AASHTO Eq. 10.8.3.5.4b-2
R_s:	294	kip	Nominal Side Resistance
R_s to be used:	294		Nominal Side Resistance

Side Resistance Summary:

Maximum Factored Load:	338	kip	From the client
Geotechnical Resistance Factor:	0.55	dim	AASHTO Table 10.5.5.2.4-1
Rqd. Geotechnical Nominal Resistance:	615	kip	

Notes:
Verify that side resistance should be used. The AASHTO and FHWA tabs give examples of when you should omit the use of side resistance.

GEI Consultants

Client: Thornton Tomasetti
Project: Smelt Brook Bridge (#2774)
Project No.: 2502334
Subject: Rock Socketed Piles Axial Resistance - Tip Resistance (Abut. 2)

Prepared By: M. Johnescu
Date: 7/28/2025
Checked By: N. Betancur
Date: 8/8/2025

Objective: Calculate the axial resistance of rock socketed HP piles from tip resistance based on subsurface data collected from the Phase 1 and 2 exploration programs for proposed Abutment 2

References: 1) American Association of State Highway and Transportation Officials (AASHTO) "LRFD Bridge Design Specifications, 9th Edition, 2020"
2) Hoek, E., et al (Hoek 2002) "Hoek-Brown Failure Criterion - 2002 Edition"

Equations:

Ref. 1 Eqn. No.	Equation	Where
10.8.3.5.4C-2	$q_p = A + q_u\left[m_b\left(\frac{A}{q_u}\right)+s\right]^a$	where: q_p = Nominal unit tip resistance; A = Refer to eq. 10.8.3.5.4C-3; *s, a, m_b* = Hoek-Brown strength parameters for the fractured rock mass determined by GSI; q_u = Uniaxial compressive strength of intact rock
10.8.3.5.4C-3	$A = \sigma'_{vb} + q_u\left[m_b\frac{(\sigma'_{v,b})}{q_u}+s\right]^a$	where: q_u = Uniaxial compressive strength of intact rock; *s, a, m_b* = Hoek-Brown strength parameters for the fractured rock mass determined by GSI; σ'_{vb} = vertical effective stress at the socket bearing elevation "tip elevation" (ksf)
10.4.6.4-4	$m_b = m_i e^{\left(\frac{GSI-100}{28-14D}\right)}$	where: GSI = Geological Strength Index (AASHTO Fig. 10.4.6.4-1); D = Disturbance Factor (Hoek 2002, Table 1); m_i = Rock Group Constant (AASHTO Table 10.4.6.4-1)
10.4.6.4-2	$s = e^{\left(\frac{GSI-100}{9-3D}\right)}$	where: GSI = Geological Strength Index (AASHTO Fig. 10.4.6.4-1); D = Disturbance Factor (Hoek 2002, Table 1)
10.4.6.4-3	$a = \frac{1}{2}+\frac{1}{6}\left(e^{\frac{-GSI}{15}} - e^{\frac{-20}{3}}\right)$	where: GSI = Geological Strength Index (AASHTO Fig. 10.4.6.4-1)

Variables:

Rock Type:	**Shale**		
q_u:	**6,910**	psi	Avg. from lab test results
q_u:	995	ksf	Avg. from lab test results
GSI:	**35**		Fig. 10.4.6.4-1 (very blocky, poor, slickensided)
m_i:	**6**		Table 10.4.6.4-1, shale
D:	**0**		Table 1
Overburden Thickness:	**29.1**	ft	Borings BB-PSB-103 and -202A
Depth to GWT:	**24.3**	ft	Borings BB-PSB-103 and -202A
Avg. Unit Weight of Overburden:	**125**	pcf	
Avg. Unit Weight of Overburden Below GWT:	62.6	pcf	
Avg. Unit Weight of Bedrock Below GWT:	**108.6**	pcf	Avg. from lab test results
Approximate Rock Socket Length:	**4.3**	ft	
Shaft Diameter:	**2.5**	ft	

Calculations:

a:	0.51595	dim	AASHTO 10.4.6.4-3
s:	0.00073	dim	AASHTO 10.4.6.4-2
m_b:	0.5888	dim	AASHTO 10.4.6.4-4
σ'_{vb}:	3.8	ksf	Vertical effective stress
A:	53.3	ksf	AASHTO 10.8.3.5.4C-3
q_p:	222.6	ksf	AASHTO 10.8.3.5.4C-2
R_p:	**1,093**	kip	Nominal Tip Resistance
Maximum Factored Load:	**338**	kip	From the client
Geotechnical Resistance Factor:	**0.5**	dim	AASHTO Table 10.5.5.2.4-1
Rqd. Geotechnical Nominal Resistance:	**676**	kip	

Notes: Verify that tip resistance should be used. The AASHTO and FHWA tabs give examples of when tip resistance should be omitted.

From AASHTO LRFD 2020:

10.8.3.5.4c—Tip Resistance

End-bearing for drilled shafts in rock may be taken as follows:

- If the rock below the base of the drilled shaft to a depth of 2.0*B* is either intact or tightly jointed, i.e., no compressible material or gouge-filled seams, and the depth of the socket is greater than 1.5*B*:

$$q_p = 2.5q_u \qquad (10.8.3.5.4c\text{-}1)$$

- If the rock below the base of the shaft to a depth of 2.0*B* is jointed, the joints have random orientation, and the condition of the joints can be evaluated as:

$$q_p = A + q_u\left[m_b\left(\frac{A}{q_u}\right) + s\right]^a \qquad (10.8.3.5.4c\text{-}2)$$

In which:

$$A = \sigma'_{vb} + q_u\left[m_b\frac{(\sigma'_{v,b})}{q_u} + s\right]^a \qquad (10.8.3.5.4c\text{-}3)$$

where:

σ'_{vb} = vertical effective stress at the socket bearing elevation (tip elevation)

s, a, and m_b = Hoek–Brown strength parameters for the fractured rock mass determined from GSI (see Article 10.4.6.4)

q_u = uniaxial compressive strength of intact rock

Eq. 10.8.3.5.4c-1 should be used as an upper-bound limit to base resistance calculated by Eq. 10.8.2.5.4c-2, unless local experience or load tests can be used to validate higher values.

C10.8.3.5.4c

If end bearing in the rock is to be relied upon, and wet construction methods are used, bottom clean-out procedures such as airlifts should be specified to ensure removal of loose material before concrete placement.

The use of Eq. 10.8.3.5.4c-1 also requires that there are no solution cavities or voids below the base of the drilled shaft.

For further information, see Brown et al. (2010).

Bearing capacity theory provides a framework for evaluation of base resistance for cases where the bearing rock can be characterized by its GSI. Eq. 10.8.3.5.4c-2 (Turner and Ramey, 2010) is a lower bound solution for bearing resistance of a drilled shaft bearing on or socketed into a fractured rock mass. Fractured rock describes a rock mass intersected by multiple sets of intersecting joints such that the strength is controlled by the overall mass response and not by failure along pre-existing structural discontinuities. This generally applies to rock that can be characterized by the descriptive terms shown in Figure 10.4.6.4-1 (e.g., blocky, disintegrated).

From AASHTO LRFD 2020:

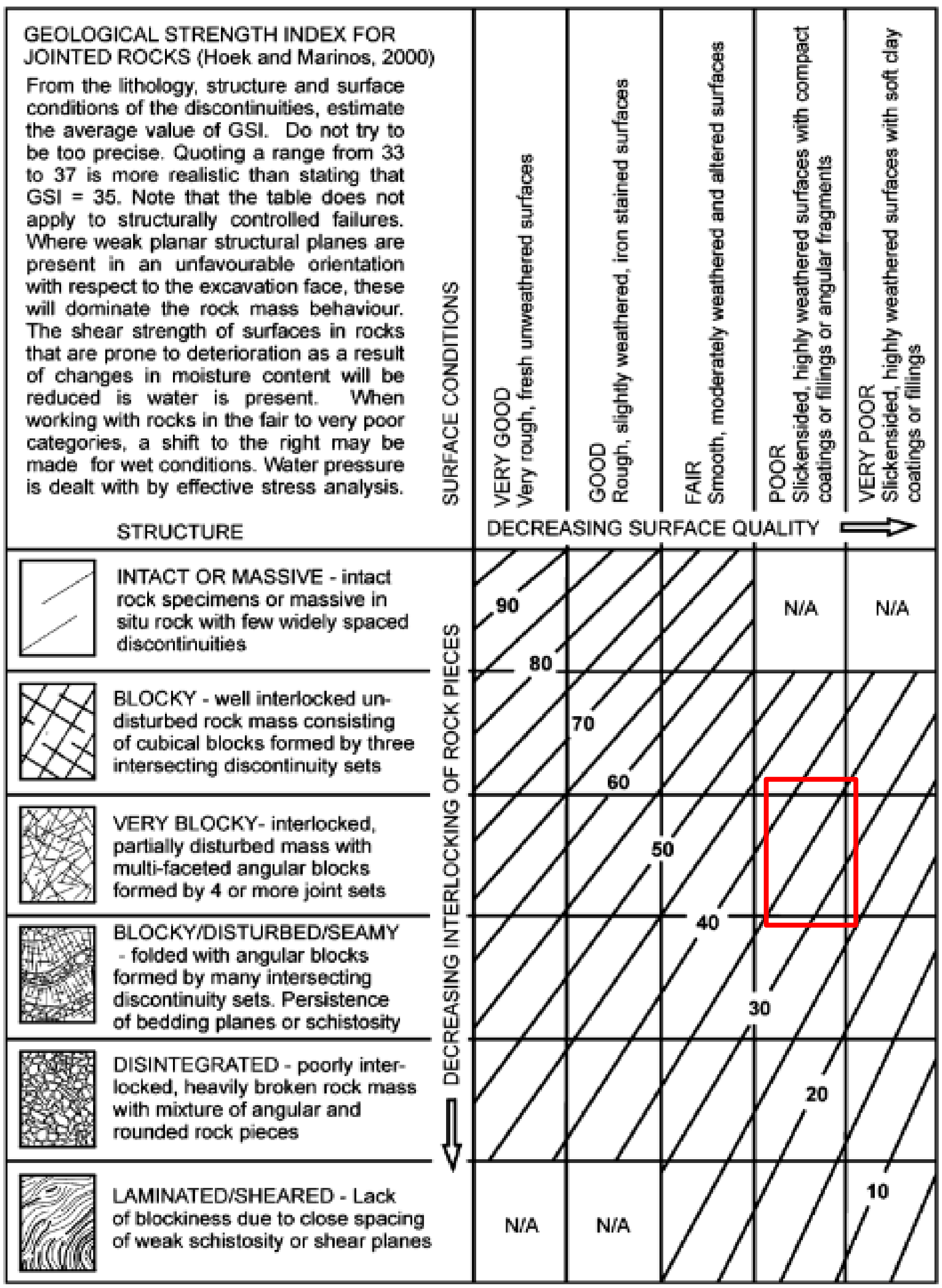


Figure 10.4.6.4-1—Determination of GSI for Jointed Rock Mass (Hoek and Marinos, 2000)

From AASHTO LRFD 2020:

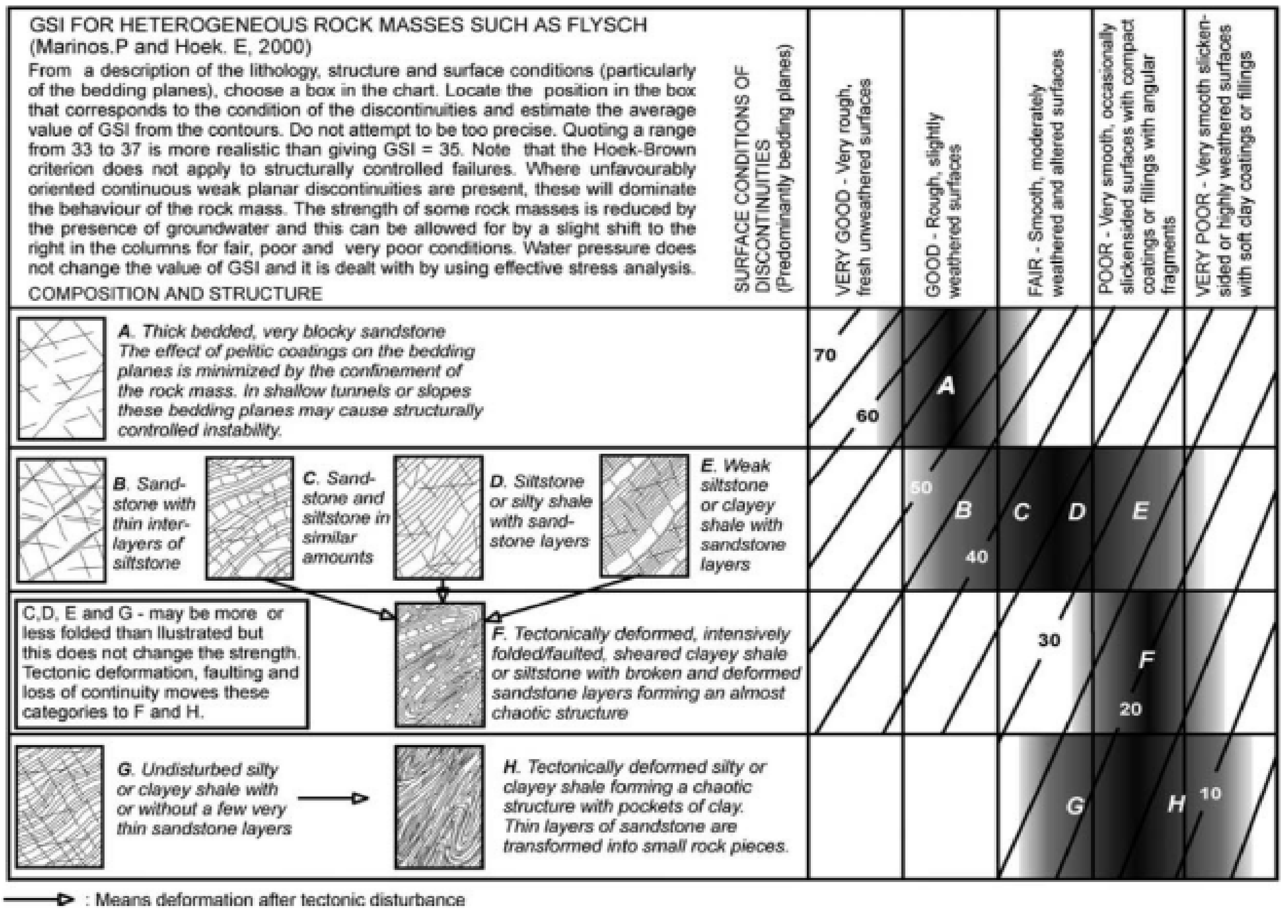


Figure 10.4.6.4-2—Determination of GSI for Tectonically Deformed Heterogeneous Rock Masses (Marinos and Hoek, 2000)

From AASHTO LRFD 2020:

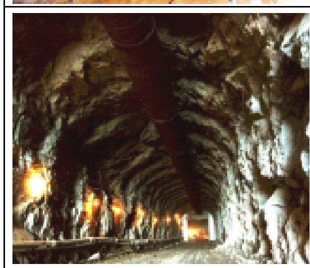
Table 10.4.6.4-1—Values of the Constant m_i by Rock Group (after Marinos and Hoek 2000; with updated values from Rocscience, Inc., 2007)

Rock type	Class	Group	Texture: Coarse	Texture: Medium	Texture: Fine	Texture: Very fine
SEDIMENTARY	Clastic		Conglomerate (21 ± 3) Breccia (19 ± 5)	Sandstone 17 ± 4	Siltstone 7 ± 2 Greywacke (18 ± 3)	Claystone 4 ± 2 Shale (6 ± 2) Marl (7 ± 2)
SEDIMENTARY	Non-Clastic	Carbonates	Crystalline Limestone (12 ± 3)	Sparitic Limestone (10 ± 5)	Micritic Limestone (8 ± 3)	Dolomite (9 ± 3)
SEDIMENTARY	Non-Clastic	Evaporites		Gypsum 10 ± 2	Anhydrite 12 ± 2	
SEDIMENTARY	Non-Clastic	Organic				Chalk 7 ± 2
METAMORPHIC	Non Foliated		Marble 9 ± 3	Hornfels (19 ± 4)) Metasandstone (19 ± 3)	Quartzite 20 ± 3	
METAMORPHIC	Slightly foliated		Migmatite (29 ± 3)	Amphibolite 26 ± 6	Gneiss 28 ± 5	
METAMORPHIC	Foliated*			Schist (10 ± 3)	Phyllite (7 ± 3)	Slate 7 ± 4
IGNEOUS	Plutonic	Light	Granite 32 ± 3 Granodiorite (29 ± 3)	Diorite 25 ± 5		
IGNEOUS	Plutonic	Dark	Gabbro 27 ± 3 Norite 20 ± 5	Dolerite (16 ± 5)		
IGNEOUS	Hypabyssal		Porphyries (20 ± 5)		Diabase (15 ± 5)	Peridotite (25 ± 5)
IGNEOUS	Volcanic	Lava		Rhyolite (25 ± 5) Andesite 25 ± 5	Dacite (25 ± 3)) Basalt (25 ± 5)	
IGNEOUS	Volcanic	Pyroclastic	Agglomerate (19 ± 3)	Volcanic breccia (19 ± 5)	Tuff (13 ± 5)	

* These values are for intact rock specimens tested normal to bedding or foliation. The value of m_i will be significantly different if failure occurs along a weakness plane.

From Hoek 2002:

Table 1: Guidelines for estimating disturbance factor *D*

Appearance of rock mass	Description of rock mass	Suggested value of *D*
	Excellent quality controlled blasting or excavation by Tunnel Boring Machine results in minimal disturbance to the confined rock mass surrounding a tunnel.	$D = 0$
	Mechanical or hand excavation in poor quality rock masses (no blasting) results in minimal disturbance to the surrounding rock mass. Where squeezing problems result in significant floor heave, disturbance can be severe unless a temporary invert, as shown in the photograph, is placed.	$D = 0$ $D = 0.5$ No invert
	Very poor quality blasting in a hard rock tunnel results in severe local damage, extending 2 or 3 m, in the surrounding rock mass.	$D = 0.8$
	Small scale blasting in civil engineering slopes results in modest rock mass damage, particularly if controlled blasting is used as shown on the left hand side of the photograph. However, stress relief results in some disturbance.	$D = 0.7$ Good blasting $D = 1.0$ Poor blasting
	Very large open pit mine slopes suffer significant disturbance due to heavy production blasting and also due to stress relief from overburden removal. In some softer rocks excavation can be carried out by ripping and dozing and the degree of damage to the slopes is less.	$D = 1.0$ Production blasting $D = 0.7$ Mechanical excavation

From AASHTO LRFD 2020:

Table 10.5.5.2.3-1—Resistance Factors for Driven Piles

Condition/Resistance Determination Method		Resistance Factor
Nominal Bearing Resistance of Single Pile—Dynamic Analysis and Static Load Test Methods, φ_{dyn}	Driving criteria established by successful static load test of at least one pile per site condition and dynamic testing* of at least two piles per site condition, but no less than 2% of the production piles	0.80
	Driving criteria established by successful static load test of at least one pile per site condition without dynamic testing	0.75
	Driving criteria established by dynamic testing* conducted on 100% of production piles	0.75
	Driving criteria established by dynamic testing,*, quality control by dynamic testing* of at least two piles per site condition, but no less than 2% of the production piles	0.65
	Wave equation analysis, without pile dynamic measurements or load test but with field confirmation of hammer performance	0.50
	FHWA-modified Gates dynamic pile formula (EOD condition only)	0.40
	EN (as defined in Article 10.7.3.8.5) dynamic pile formula (EOD condition only)	0.10
Nominal Bearing Resistance of Single Pile—Static Analysis Methods, φ_{stat}	Side Resistance and End Bearing: Clay and Mixed Soils	
	α-method (Tomlinson, 1987; Skempton, 1951)	0.35
	β-method (Esrig and Kirby, 1979; Skempton, 1951)	0.25
	λ-method (Vijayvergiya and Focht, 1972; Skempton, 1951)	0.40
	Side Resistance and End Bearing: Sand	
	Nordlund/Thurman Method (Hannigan et al., 2006)	0.45
	SPT-method (Meyerhof)	0.30
	CPT-method (Schmertmann, 1970)	0.50
	End bearing in rock (Canadian Geotech. Society, 1985)	0.45
Block Failure, φ_{bl}	Clay	0.60
Uplift Resistance of Single Piles, φ_{up}	Nordlund Method	0.35
	α-method	0.25
	β-method	0.20
	λ-method	0.30
	SPT-method	0.25
	CPT-method	0.40
	Static load test	0.60
	Dynamic test with signal matching	0.50
Group Uplift Resistance, φ_{ug}	All soils	0.50
Lateral Geotechnical Resistance of Single Pile or Pile Group	All soils and rock	1.0
Structural Limit State	Steel piles — See the provisions of Article 6.5.4.2	
	Concrete piles — See the provisions of Article 5.5.4.2	
	Timber piles — See the provisions of Articles 8.5.2.2 and 8.5.2.3	
Pile Drivability Analysis, φ_{da}	Steel piles — See the provisions of Article 6.5.4.2	
	Concrete piles — See the provisions of Article 5.5.4.2	
	Timber piles — See the provisions of Article 8.5.2.2	
	In all three Articles identified above, use φ identified as "resistance during pile driving"	

*Dynamic testing requires signal matching, and best estimates of nominal resistance are made from a restrike. Dynamic tests are calibrated to the static load test, when available.

From AASHTO LRFD 2020:

Table 10.5.5.2.4-1—Resistance Factors for Geotechnical Resistance of Drilled Shafts

Method/Soil/Condition			Resistance Factor
Nominal Axial Compressive Resistance of Single-Drilled Shafts, φ_{stat}	Side resistance in clay	α-method (Brown et al., 2010)	0.45
	Tip resistance in clay	Total Stress (Brown et al., 2010)	0.40
	Side resistance in sand	β-method (Brown et al., 2010)	0.55
	Tip resistance in sand	Brown et al. (2010)	0.50
	Side resistance in cohesive IGMs	Brown et al. (2010)	0.60
	Tip resistance in cohesive IGMs	Brown et al. (2010)	0.55
	Side resistance in rock	Kulhawy et al. (2005) Brown et al. (2010)	0.55
	Side resistance in rock	Carter and Kulhawy (1988)	0.50
	Tip resistance in rock	Canadian Geotechnical Society (1985) Pressuremeter Method (Canadian Geotechnical Society, 1985) Brown et al. (2010)	0.50
Block Failure, φ_{bl}	Clay		0.55
Uplift Resistance of Single-Drilled Shafts, φ_{up}	Clay	α-method (Brown et al., 2010)	0.35
	Sand	β-method (Brown et al., 2010)	0.45
	Rock	Kulhawy et al. (2005) Brown et al. (2010)	0.40
Group Uplift Resistance, φ_{ug}	Sand and clay		0.45
Horizontal Geotechnical Resistance of Single Shaft or Shaft Group	All materials		1.0
Static Load Test (compression), φ_{load}	All Materials		0.70
Static Load Test (uplift), φ_{upload}	All Materials		0.60