

GEOTECHNICAL DESIGN REPORT PENOBSCOT RIVER BRIDGE MAINEDOT WIN 16705.00 HOWLAND/ENFIELD, MAINE

PREPARED FOR:

T.Y. Lin International Falmouth, Maine

PREPARED BY:

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October 30, 2013 File No. 09.0025796.00 MaineDOT WIN 16705.00



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Re: Geotechnical Design Report Penobscot River Bridge, Route 6 and Route 155 over the Penobscot River Howland-Enfield, Maine

Dear Norm:

GZA GeoEnvironmental, Inc. (GZA) is pleased to provide you with this Draft Geotechnical Design Report prepared for the Penobscot River Bridge project. Our services were provided in accordance with our executed contract dated August 5, 2013, and the attached Limitations included in **Appendix A**.

It has been a pleasure serving you on this project. If you have any questions regarding the report, or if we can provide further assistance, please do not hesitate to contact the undersigned.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Jennifer R. Baron, P.E. Assistant Project Manager

Russell J. Morgan Consultant Reviewer



Christopher L. Snow, P.E. Associate Principal

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1.0 INTRODUCTION



GZA is providing geotechnical engineering services as a Subconsultant to T.Y. Lin International, Inc., who is under contract with the State of Maine, MaineDOT for design of the proposed bridge.

1.1 OBJECTIVES AND SCOPE OF SERVICES

The objectives of our work were to evaluate subsurface conditions and to provide geotechnical engineering recommendations for the proposed Penobscot River Bridge replacement. To meet these objectives, GZA completed the following Scope of Services:

- Conducted a site visit to observe surficial conditions; and reviewed existing bridge plans, and mapped surficial and bedrock geology of the site;
- Coordinated and observed a subsurface exploration program consisting of seven test borings;
- Conducted a laboratory testing program to evaluate engineering properties of the site soils and bedrock;
- Conducted geotechnical engineering analyses to evaluate foundations for the new bridge;
- Developed geotechnical engineering recommendations including foundation alternatives and foundation design recommendations for the preferred foundation type; and
- Prepared this report summarizing our findings and design recommendations.

1.2 BACKGROUND

The Penobscot River Bridge carries State Routes 6 and 155 over the Penobscot River from Howland, west of the river, to Enfield, east of the river, as shown on the *Locus Plan*, **Figure 1**. The existing bridge was originally constructed in 1896 and was rebuilt in 1934. The substructures were widened and the superstructure replaced in 1941. The current structure consists of an approximately 900-foot long, five-span, steel through-truss with a concrete deck. The 1941 bridge replacement plans indicated the original masonry abutments were reused to support the new bridge. The original abutment footings, which were founded on steeply sloping bedrock, were underpinned. Concrete footing extensions were constructed at the ends of the abutments and were founded on bedrock. Based on the 1896 plans, the four piers are believed to be supported on stone masonry placed directly on native soil within a timber form/cofferdam. In 1941, the original stone piers were widened at both ends with concrete. Riprap is present in front of each abutment and around each of the piers. The existing bridge location is shown on the *Boring Location Plans*, **Figures 2A and 2B**,

MaineDOT intends to replace the existing bridge with a new, approximately 940-foot-long, four-span bridge with stub abutments and three solid-shaft piers. The alignment of the replacement bridge is approximately 100 feet downstream from the current bridge location. The proposed baseline and bridge limits are shown on **Figures 2A** and **2B**.



2.0 SUBSURFACE EXPLORATIONS

2.1 PREVIOUS MAINEDOT SUBSURFACE EXPLORATIONS



MaineDOT completed a subsurface exploration program in 2010 consisting of five test borings (BB-HEPR-101 through BB-HEPR-105) drilled through the existing bridge and approaches. Subsurface conditions encountered at the test borings located at the bridge abutments consisted of sand and gravel fill overlying a silt and sand deposit (Glaciomarine), silty sand and gravel (Glacial Till), and Bedrock. Subsurface conditions at the existing pier locations consisted of sand and silt deposits with varying amounts of gravel (Alluvium), overlying sandy silt, sand and gravel (Glacial Till), and Bedrock. Logs of each boring are included in **Appendix B**.

2.2 GZA SUBSURFACE EXPLORATION

GZA completed a subsurface investigation program consisting of seven (7) test borings (BB-HEPR-201 through BB-HEPR-207). Four of the borings were completed in the river using a barge-mounted skid rig. The two test borings at the proposed eastern abutment were drilled by winching the skid rig off the barge onto the riverbank. The remaining test boring, at the proposed western abutment location, was drilled using a truck-mounted drill rig. The as-drilled boring locations and ground surface elevations were surveyed by MaineDOT. For the river borings the barge deck elevations were surveyed and the distance from the top of the barge deck to ground surface at each boring location was measured by GZA and used to assess the riverbed elevation. The boring locations are shown on **Figures 2A** and **2B**.

Test borings were drilled to depths of approximately 11.5 to 67 feet below ground surface. Six (6) of the seven (7) borings were terminated after coring approximately 6 to 24 feet into bedrock. Maine Test Boring of Hermon, Maine provided drilling services and coordinated utility clearance for the project. Drilling was completed between August 19, 2013 and August 29, 2013. GZA personnel monitored the drilling work and prepared logs of each boring that are included in **Appendix B**.

Test borings were drilled using a combination of 3- and 4-inch spun casing and drive and wash drilling techniques. Standard penetration testing (SPT) and split-spoon sampling were performed at 5-foot typical intervals using a 24-inch-long, 1-3/8-inch inside diameter sampler. Bedrock cores were obtained using a 2-inch nominal diameter, NQ2, core barrel.

3.0 LABORATORY TESTING

MaineDOT completed a laboratory soil testing program in conjunction with their 2010 Geotechnical Data Report. The program included 20 gradation analyses, one gradation analysis including hydrometer, and one set of Atterberg Limits. Results of the testing are included in **Appendix C.**

GZA retained Thielsch Engineering's Geotechnical Laboratory in Cranston, Rhode Island to complete a soil and bedrock testing program to assess the gradation and engineering characteristics of the soil and strength of the bedrock. The testing program consisted of six gradation analysis/AASHTO Classification/Frost Classification assessments on soil, and two

unconfined compression strength tests with strain measurements on bedrock core samples. Results of the testing are included in **Appendix** C.

4.0 SUBSURFACE CONDITIONS



4.1 SURFICIAL AND BEDROCK GEOLOGY

Surficial geologic units mapped in the Penobscot River Bridge area include Sand, Gravel and Silt Stream Alluvium, Marine Sand and Silty Clay (Presumpscot), and Silty Sand and Gravel Glacial Till overlying bedrock. Bedrock at the site is mapped as the Vassalboro Formation bedrock unit. The Vassalboro Formation is described as beds of fine to medium grained, feldspathic wacke, interbeds of dark gray phyllite, minor black carbonaceous phyllite and feldspathic coarse sand to granule conglomerate.

4.2 SUBSURFACE SOIL PROFILE

Four soil units were encountered in the test borings overlying bedrock: Fill, Sand and Silt, Glacial Till and Weathered/Decomposed Bedrock. The thicknesses and generalized description are presented in the following table, in descending order from existing ground surface. Detailed descriptions of the materials encountered at specific locations are provided in the boring logs in **Appendix B**.

Soil Unit	Approx. Encountered Thickness (ft)	Generalized Description	
Fill	4 to 20	 Medium dense to very dense, brown to gray, fine to medium SAND, some to little Gravel, some to trace Silt (SM). MaineDOT Frost Classification = II Encountered in borings BB-HEPR-201 and -207 	
Sand and Silt (Alluvium)	4.5 to 34	 Medium dense to very dense, brown to gray, gravelly, fine to coarse SAND, little to trace Silt (SM, GM). MaineDOT Frost Classification = 0, II Encountered in borings BB-HEPR-202, -203, -204, -205, -206 	
Glacial Till	5 to 25	 Very dense, gray, fine to medium SAND, with varying amounts of Gravel and Silt (SM, ML). MaineDOT Frost Classification = II Encountered in borings BB-HEPR-203, -204, -205 	
Weathered/ Decomposed Bedrock	7 to 11	 Dense, brown and gray, GRAVEL, little fine to medium Sand, trace Silt. (SM). MaineDOT Frost Classification = II Encountered in borings BB-HEPR-206 and -207 	
Top of Bedrock Elevation		Encountered Top of Rock: Approx. El. 67 to El. 134	

4.2.1 Bedrock

Bedrock was cored in six of the seven test borings and was classified as Phyllite. The Phyllite was described as hard, fresh to slightly weathered, fine grained, and gray/white. The primary joint set was closely to moderately spaced, low to high angle, planar to undulating, rough to smooth, fresh to discolored, and tight to wide. A secondary joint set was occasionally noted and was closely to moderately spaced, horizontal to moderately dipping, planar to stepped, rough to smooth, discolored, and partially open to open. Occasional silt and sand deposits were noted

on joint surfaces. The Rock Quality Designation (RQD) ranged from 0 to 87 percent, with an average RQD of 43 percent.

Two laboratory unconfined compressive strength and secant modulus tests were conducted on bedrock core samples. The test results are included in **Appendix C** and yielded an average unconfined compressive strength of 4.3 kips per square inch (ksi) and an average Young's modulus of 3,900 ksi.

4.2.2 Groundwater

Groundwater levels were not discernible during the recent abutment test borings. The test borings were drilled using drive-and-wash techniques, which introduce large volumes of water into the borehole during drilling. As a result, stabilized groundwater levels were not determined at either proposed abutment location. At the time of drilling the river level was approximately El. 128.

Groundwater was observed at the western abutment during the 2010 test boring program at approximately El. 138.5. Groundwater was not observed at the eastern abutment in 2010.

The groundwater observations were made at the times and under the conditions stated in the borings logs. Fluctuations in groundwater and river levels will occur due to variations in seasonal influences, precipitation amounts, and other factors. Consequently, water levels during and after construction are likely to vary from those encountered at the time the observations were made.

5.0 ENGINEERING EVALUATIONS

5.1 GENERAL

GZA conducted geotechnical engineering evaluations in accordance with 2012 AASHTO LRFD Bridge Design Specifications, 6th Edition (herein referred to as LRFD) and the Maine Department of Transportation Bridge Design Guide, 2003 Edition (MaineDOT BDG). The sections that follow describe the evaluations made and the geotechnical basis for evaluation of each element.

5.2 APPROACH EMBANKMENTS

Approach fills are proposed up to 28 feet above existing grades immediately behind the abutments. The maximum side slope angles are anticipated to be 2 horizontal to 1 vertical (2H:1V), or flatter, with loam and seed surface treatments. Steeper slopes may be utilized in conjunction with riprap scour protection along the riverbank. The new roadway alignment will maintain existing grade on the Enfield side and be approximately 4 feet above existing grade on the Howland side. The abutments will consist of stub abutments with new fill slopes beneath and in front of the abutments.

Subsurface conditions at both approaches include granular fill and dense glacial till overlying bedrock. These materials are expected to compress elastically as the new embankment fill is placed. Consequently, post-construction settlements are anticipated to be negligible.



The embankments will be constructed per MaineDOT standard specifications and details using engineered fill placed over fill and glacial till. In our experience, conventional earthfill embankments constructed over relatively dense overburden soils meet the minimum required safety factors for global stability.

5.3 EVALUATION OF FOUNDATION TYPES



5.3.1 Abutment Foundation Alternatives

Selection of the preferred foundation types is influenced by the nature and depth of overburden at the site. Both abutments will be constructed with a 14- to 20-foot-thick fill, alluvium and weathered rock layer beneath the bottom of the abutment. Both spread footings bearing on bedrock, and piles are feasible foundation types at the abutments. It is anticipated that a cofferdam and seal would be required to construct the footings since the bedrock level extends below the river level. The use of a higher-elevation stub abutment and piles will eliminate the need for a full cofferdam and seal system, therefore driven piles are the preferred foundation system at the abutments.

5.3.2 River Pier Foundation Alternatives

Dewatering of the river piers is anticipated to be achieved using cofferdams with tremie seals. The preliminary profile indicates the bottoms of seal elevations are at approximately El. 97, and the top of bedrock varies from as high as approximately El. 97 at Pier 1, to El. 67 to El. 70 at Piers 2 and 3. Since the bottom of tremie is roughly at the top of bedrock level at Pier 1, pile foundations would have no embedment below the tremie. Therefore, spread footing foundations bearing on sound, intact bedrock are the preferred foundation type at Pier 1.

At Piers 2 and 3 the pile embedments are anticipated to range from approximately 25 to 30 feet below the tremie base. Excavation to this depth is technically feasible. However, footings bearing on rock would be considerably more difficult to construct than pile foundations. Consequently, driven piles are considered the preferred foundation alternative at Piers 2 and 3.

5.4 SEISMIC DESIGN CONSIDERATIONS

The new abutments and most pier foundations (except for Pier 1) will bear on steel HP-section piles driven to bearing in dense soils or on bedrock.

The subsurface profile for seismic design includes the proposed approach fills (including backfill behind and beneath abutments) and existing glacial till and bedrock. Seismic site class was determined in general accordance with LRFD Table C3.10.3.1 using the average SPT N-value from the soil materials encountered in the borings. LRFD allows the assumption that rock within the upper 100 feet of the profile has an N-value equal to 100. However, the SPT N-value used to determine the site class was conservatively evaluated by including only the blow counts and thickness of soil above the rock, reducing the effective thickness of the profile and neglecting the bedrock in the upper 100 feet. On this basis, the SPT N-value fell between 15 and 50 blows per foot, and Abutments 1 and 2; and Piers 2 and 3 were assigned to Site Class D. Supporting calculations are provided in **Appendix E**.

The test boring data indicate that the fill, alluvium, and glacial till encountered at the site are sufficiently dense that the potential for liquefaction is very low.

Determination of the seismic Site Class for bedrock conditions is typically based on the shear wave velocity approach in accordance with LRFD Table C3.10.3.1-1. At Pier 1, and in the absence of site-specific shear wave velocity data, the Pier 1 should be assigned to Site Class B.

The United States Geological Survey software Seismic Design Parameters Version 2.10 was used to develop seismic parameters for design. Based on the bridge location, and the Site Classes B and D, the recommended AASHTO Response Spectrum for a 7 percent probability of exceedance in 75 years is as follows:

Site Class B - Fpga = 1.0, Fa = 1.0, Fv = 1.0Data are based on a 0.05 deg grid spacing.

		-	•
Period	Sa		
(sec)	(g)		
0.0	0.070	As,	Site Class B
0.2	0.153	SDs,	Site Class B
1.0	0.046	SD1,	Site Class B

Site Class D - Fpga = 1.60, Fa = 1.60, Fv = 2.40Data are based on a 0.05 deg grid spacing.

Period	Sa	_	-
(sec)	(g)		
0.0	0.112	As,	Site Class D
0.2	0.245	SDs,	Site Class D
1.0	0.112	SD1,	Site Class D

T.Y. Lin has indicated that based on a Site Class of D at the abutments, the bridge meets the criteria for design under Seismic Zone 1, per LRFD Section 3.10.6. Per LRFD Section 4.7.4, bridges in Seismic Zone 1 need not be analyzed for seismic loads, but the minimum requirements specified in LRFD Sections 4.7.4.4 and 3.10.9 apply.

5.5 SPREAD FOOTING DESIGN CONSIDERATIONS

Spread footing foundations bearing on sound, intact bedrock are the preferred foundation type at Pier 1.

5.5.1 LRFD Resistance Factors

LRFD factors should be applied to horizontal earth pressure (EH), vertical earth pressure (EV) and earth surcharge (ES) loads using the load factors for permanent loads (γ_p) provided in LRFD Table 3.4.1-2 for strength and extreme limit state design. The resistance factor for global stability of abutments and piers, ϕ , is 0.65.

Recommended LRFD resistance factors for strength limit state design of the spread footing foundation at Pier 1, from LRFD Table 10.5.5.2.2-1, are presented in the following table.

RESISTANCE FACTORS – STRENGTH LIMIT STATE					
Foundation Resistance Type Method/Condition Resistance Factor (o					
Bearing	Footings on Rock	0.45			
Sliding Tremie Concrete on Rock ¹		0.80			
Sliding	Cast-in-Place Concrete on Tremie Concrete ¹	0.80			

¹ Sliding resistance factor for concrete on rock or concrete is taken as equal to footing on sand.



Resistance factors for service and extreme limit state design (vessel impact, ice, $Q_{500scour}$, debris, and earthquake) should be taken as 1.0, except for uplift resistance of piles. The resistance factor for pile uplift for these conditions, ϕ_{up} , should be taken as 0.80.

5.5.2 Footing Bearing Resistance on Intact Bedrock



Bedrock at Pier 1 underlies medium dense to dense alluvial material. Footings will be founded directly on intact bedrock. Therefore, foundation design is controlled by the engineering properties of the bedrock.

Samples of bedrock collected during GZA's recent subsurface investigation were submitted for laboratory testing for use in determining the in-situ bedrock Rock Mass Rating (RMR). Using bedrock data obtained in test borings BB-HEPR-102 and BB-HEPR-203, GZA developed engineering parameters for the bedrock mass for the proposed footing at Pier 1, which are summarized below:

- RQD = Ranged from 61 to 67
- Average Unconfined Compressive Strength ($\sigma_{u,r}$) = 4.3 ksi
- RMR = 49 (Fair Rock Quality)
- Semi-empirical rock quality constants, m=0.26, s=0.00021 (by interpolation)

It is anticipated that the highly fractured (RQD = 0 to 11) rock encountered near the bedrock surface in borings BB-HEPR-102 and BB-HEPR-203 will be removed during subgrade preparation. Consequently, these data were not included in the analyses.

The RMR-based approach was used to calculate the nominal and factored bearing resistance for spread footings bearing on intact bedrock. Footings designed to bear on intact bedrock should be designed for a recommended nominal bearing resistance, q_n , is 55 kips per square foot (ksf). At the strength limit state, the recommended maximum factored bearing resistance is 25 ksf. To limit settlement, the bearing resistance of 25 ksf is also recommended for service limit state design. Supporting calculations are provided in **Appendix E**.

Pier 1 may be founded on intact bedrock. LRFD Article 10.6.2.4.4 indicates that footings bearing on rock with an RMR-based rock quality of Fair to very good are generally anticipated to experience ¹/₂ inch or less of elastic settlement.

5.6 PILE DESIGN CONSIDERATIONS

Steel H-piles are proposed to support the new abutments and Piers 2 and 3. The pile material should consist of ASTM A572, Grade 50 steel.

The axial geotechnical resistance of piles was calculated using the Nordlund method in accordance with LRFD Section 10.7. Supporting calculations are provided in **Appendix E**. The results indicate that the piles will gain support through a combination of side friction in the fill and glacial till and end bearing in glacial till or on bedrock. It is likely that the piles will drive onto or slightly into bedrock to achieve the required end resistance. The side friction distribution was also used as an input in preliminary wave equation analyses to assess the pile drivability. Since the piles will gain support in primarily dense granular soil and on bedrock, there is no reduction for group interaction in axial compression.

By utilizing steel H-piles for support of the abutments and Piers 2 and 3, total and differential settlement will be limited to elastic compression of the piles and should be less than $\frac{1}{2}$ inch.

The estimated pile cap bottom elevations are shown on the preliminary plans prepared by T.Y. Lin; the top of bedrock elevations based on the test borings and the estimated pile embedment lengths are summarized below.

Structure	Pile Cap /Tremie Seal Bottom Elevation (ft)	Estimated Top of Bedrock Elevation (ft)	Estimated Pile Length Below Cap or Tremie Seal (ft)
Abutment 1	139	125	14
Pier 1	97	97	NA – spread footing recommended
Pier 2	97	67	30
Pier 3	97	71	26
Abutment 2	149	130	19

The estimated pile lengths do not include the pile length embedded in the tremie seal or pile cap, batter, or additional length needed for installation or testing.

Piles should be designed at the strength limit state considering the structural resistance of the piles and a resistance factor of 0.50, per LRFD Section 10.7.3.2.3 for hard driving condition; the geotechnical resistance of the piles; and the potential loss of lateral support due to scour at the design flood event. In GZA's experience for end bearing piles on bedrock, the structural resistance or drivability resistance will control the geotechnical static resistance of the pile.

The pile driving criteria are expected to be established based on dynamic pile testing with signal matching analysis. The piles should be driven to a nominal capacity calculated by dividing the maximum factored pile load by a resistance factor of 0.65, per LRFD Table 10.5.5.2.3-1.

GZA considered the potential for downdrag loading for piles supporting the abutments. It is GZA's opinion that any settlement associated with filling at the abutments will occur prior to pile driving. Therefore, downdrag loading should not be included in the pile design.

It is understood that different pile sizes and layouts will be evaluated by T.Y. Lin in order to select the most efficient design. In order to support geotechnical aspects of the design development, GZA evaluated a range of pile sections suitable for support of the replacement bridge. Preliminary wave equation analyses were completed indicating that the factored geotechnical pile resistance for drivability is lower than the factored axial structural capacity, and therefore controls the design.

For the subsurface profiles at this site, GZA ran a selected number of wave equation analyses to assess the nominal geotechnical drivability resistance. The nominal geotechnical drivability resistance was established as the maximum axial capacity that could be achieved using the assumed pile hammer, while meeting MaineDOT preferred driving criteria: driving stresses not exceeding 0.9fy (or 45ksi), and penetration resistance between 3 to 15 blows per inch (preferably approximately 10). The results of those analyses indicate that the piles can reliably be installed to approximately 70 to 85 percent of the factored structural compressive resistance. The table that follows summarizes alternative pile sections for use on the project. Supporting calculations are provided in **Appendix E**.



Pile	Structural Axial Co	Resistance mpression	Geotechnical Resis Axial Co	stance for Drivability
Section ASTM A572 Grade 50	Nominal / Extreme Limit State P _{r.e.} (kips) (\$\$\phi\$ = 1.0\$)	Strength Limit State Hard Driving P _{r.s.} (kips) ($\phi_c = 0.50$)	Nominal / Extreme Limit State R _{ndr} (kips) (\$\$\phi\$ = 1.0\$)	Strength Limit State Hard Driving R_{ndr} (kips) ($\phi = 0.65$)
HP12x53	775	388	435	282
HP14x73	1070	535	553	359
HP14x89	1305	653	700	455
HP14x117	1720	860	900	585

It is anticipated that scour depth will not extend below the base of the tremie seals. However, if final estimated scour depth is determined to be below the tremie base, the factored structural compressive resistance of the piles should be reduced to account for any unbraced length of pile. Detailed pile design recommendations will be presented under separate cover after the final pile sections and footing layouts are established by T.Y. Lin.

5.7 EVALUATION OF ABUTMENT FOUNDATIONS

5.7.1 Frost Protection

Fill soils are anticipated to be present at the abutments, either as existing fill or imported backfill. Based on the MaineDOT BDG, Section 5.2.1, the Freezing Index for the site is 1900, and with low-moisture content (<10%) soils, the estimated depth of frost penetration is 5.5 feet.

5.7.2 Design Soil Profiles

GZA developed design subsurface profiles for use in evaluating abutment foundations. The profiles are summarized in the following tables.

DESIGN SUBSURFACE PROFILE - ABUTMENT 1							
Strata Approx. Bas Designation El. (ft-NAVD 88		Unit Weight (pcf)	Representative Φ ' (°)	Description			
Fill	134	125	32°	Brown, dense to very dense, SAND, some to little Gravel, little to trace Silt			
Bedrock				Gray/white, hard, fresh, fine grained, PHYLLITE			



	DESIGN SUBSURFACE PROFILE - ABUTMENT 2						
Strata Designation	Approx. Base El. (ft-NAVD 88)	Unit Weight (pcf)	Representative Φ' (°)	Description			
Fill (possible reworked material)	133	125	32°	Olive, medium dense, SAND, some Silt, little Gravel			
Weathered/ Decomposed Rock	130	130	34°	Brown to gray, very dense, clayey silt, some GRAVEL, little fine to medium Sand			
Bedrock				Gray/white, hard, fresh, fine grained, PHYLLITE			



We understand that the proposed abutments and wing walls will be free to rotate at the top. Therefore, the walls should be designed to resist active earth pressures. Passive resistance in front of the abutment footings should be ignored for sliding and overturning evaluations.

Lateral earth pressure evaluations for abutments and wing walls are based on the MaineDOT BDG and are summarized below:

- Battered piles will be used to resist lateral loads. Passive resistance on pile caps should be neglected.
- Imported fill material will be used as backfill behind the walls. The material will be specified as either Granular Borrow Underwater Backfill Material or Granular Borrow (MaineDOT Standard Specifications Section 703.19). Therefore, Soil Type 4 was used to develop earth pressure coefficients in accordance with Table 3-3 of the MaineDOT BDG.
- Live load horizontal surcharge pressures were evaluated in accordance with Table 3-4 of the MaineDOT BDG and LRFD Section 3.11.6.4 (the more stringent applies). The walls for the subject project require a surcharge equivalent to a fill height of 2 feet be used for design. If approach slabs are utilized, a surcharge load should not be applied over the length of the slab.

5.7.4 Lateral Resistance – Abutment Piles

Lateral loads on abutments may be reacted by a combination of bending and the horizontal component of battered piles. Final design of the foundations may be performed to evaluate pile top deflections and bending stresses under the combined loads using L-Pile[®] or FB-Pier[®] software. Analyses should take into account pile orientation, including pile batter.

Combined axial and bending stresses should be evaluated to ensure piles are not overstressed. Due to the relatively short abutment pile lengths (approximately 14 to 19 feet), a check should be performed to assess if piles achieve adequate fixity.

Recommended geotechnical parameters for use in lateral pile analyses are provided in the table below. We recommend the analyses be completed assuming a fixed-head pile condition.

FBPIER GEOTECHNICAL PARAMETERS - ABUTMENT 1							
Soil Model	El. Range (ft-NAVD 88)	Unit Weight (pcf)	Representative Φ' (°)	k (pounds per cubic inch)			
Reese Sand	Bottom of Cap to 134	125	32°	225			



FBPIER GEOTECHNICAL PARAMETERS - ABUTMENT 2										
Soil Model	El. Range (ft-NAVD 88)	Unit Weight (pcf)	Representative Φ ' (°)	k (pounds per cubic inch)						
Reese Sand	Bottom of Cap to 130	125	32°	225						
Reese Sand	El 130 to 122	130	34°	225						

5.8 EVALUATION OF PIER FOUNDATIONS

5.8.1 Design Soil Profiles – Pier 2 and 3 Foundations

GZA evaluated subsurface conditions and developed a representative design soil profile for Pier 2 and 3 evaluations as summarized in the table that follows.

	PIER 2 AND 3 PROFILE									
Strata Designation	Approx. Base El. (ft-NAVD 88)	Unit Weight (pcf)	Representative Φ' (°) or s _u (psf) for layer	Description						
Alluvial Deposit	89	120	34°	Brown to gray, medium to very dense, fine to coarse SAND, some to little Gravel, trace Silt						
Glacial Till	67	130	34°	Varying from gray, very dense, fine to medium sandy SILT, some to little Gravel to gray, very dense, fine to coarse SAND, little Silt, trace Gravel						
Bedrock				Gray/white, hard, fresh, fine grained, PHYLLITE						

5.8.2 Lateral Pile Resistance – Piers 2 and 3

Lateral loads on Piers 2 and 3 may be reacted a combination of bending and the horizontal component of battered piles. Final design of the foundations may be performed to evaluate pile top deflections and bending stresses under the combined loads using L-Pile[®] or FB-Pier[®] software. Analyses should take into account pile orientation, including pile batter.

Combined axial and bending stresses should be evaluated to ensure piles are not overstressed. A check should be performed to assess if piles achieve adequate fixity.

Recommended geotechnical parameters for use in lateral pile analyses are provided in the table below. We recommend the analyses be completed assuming a fixed-head pile condition.

FB-PIER GEOTECHNICAL PARAMETERS - PIERS 2 AND 3										
Soil Model	El. Range (ft-NAVD 88)	Unit Weight (pcf)	Representative Φ ' (°)	k (pounds per cubic inch)						
Reese Sand	Bottom of Seal to 89	120	34°	125						
Reese Sand	67 to 89	130	34°	125						



6.0 RECOMMENDATIONS

6.1 EMBANKMENT DESIGN CONSIDERATIONS

T.Y. Lin will be responsible for selection of scour countermeasures to be employed in front of the new abutments. If riprap slopes are selected, they should be constructed in accordance with MaineDOT Standard Detail 610(03), Plain Riprap Slope at Structures.

Embankment side slopes should be designed with MaineDOT typical slope angles of 2H:1V, and should be provided with loam and seed for permanent erosion protection.

6.2 RECOMMENDATIONS FOR FOUNDATIONS

6.2.1 Abutment and Wingwall Design

- Backfill behind new abutments and wingwalls should consist of MaineDOT 703.19 Granular Borrow for Underwater Backfill, MaineDOT BDG Type 4 soil. Recommended soil properties for Type 4 soils are as follows:
 - Internal Friction Angle of Soil = 32°
 - Soil Total Unit Weight = 125 pcf
 - Coefficient of Active Earth Pressure, $K_a = 0.31$, assuming $\beta = 0^{\circ}$
 - Coefficient of At-Rest Earth Pressure, $K_0 = 0.47$, assuming $\beta = 0^\circ$
- Live load surcharge should be applied as a uniform lateral surcharge pressure using the equivalent fill height (H_{eq}) values developed in accordance with LRFD Section 3.11.6.4. A minimum H_{eq} of 2 feet is recommended.
- Foundation drainage should be provided in accordance with Section 5.4.1.4 of the MaineDOT BDG. We recommend the use of French drains on the uphill side of abutments. The drains should outlet through a series of 4-inch diameter weep holes, spaced approximately 10-feet center-to-center.

6.2.2 Abutment and Pier Pile Design

- The proposed bridge abutments and Piers 2 and 3 may be supported on HP12x53, HP14x73, HP14x89, or HP14x117, ASTM A572 steel (50 ksi yield stress) piles driven to the required nominal resistance, anticipated to be developed in skin friction in glacial till and end-bearing on or near the bedrock surface.
- Pile installation should be controlled using wave equation analysis and field logging of the pile installation with final penetration resistance based on dynamic pile testing with signal matching analysis.

- The piles should be driven to a nominal resistance calculated by dividing the maximum factored pile load by a resistance factor of 0.65.
- Preliminary wave equation analyses should be completed to assess drivability of the selected pile section/s. Criteria for acceptability of the drivability analyses are that the piles can be driven to the required nominal resistance without exceeding the allowable driving stress (0.9Fy = 45 ksi for Grade 50 steel). The final penetration resistance must be within the MaineDOT range of 3 to 15 blows per inch. However, in GZA's experience, the preferred range of final penetration resistance is 6 to 10 blows per inch.
- Splices should be made in accordance with MaineDOT Standard Specification Section 501.09 Splicing Piles.
- To limit driving damage, the steel H-piles should be fitted with protective driving tips in accordance with MaineDOT Standard Specification Section 501.10 Pile Tips.

<u>6.2.3 Spread Footing Design – Pier 1</u>

- Pier 1 should be supported on spread footing foundations bearing on tremie concrete bearing on sound, intact bedrock. Footings designed to bear on intact bedrock should be designed for a nominal bearing resistance, q_n, of 55 ksf. At the strength limit state, footings should be designed for a maximum factored bearing resistance of 25 ksf. A bearing resistance of 25 ksf should be used for service limit state design.
- It is anticipated that the footing excavation will be completed in-the-wet within a braced cofferdam. The bedrock surface cleaned of loose soil and rock and sounded to assess the surface variation prior to placement of tremie concrete. Bearing surface preparation should be completed in accordance with an appropriate Special Provision to the contract. A typical Special Provision Section 511 is included in **Appendix D** for reference.
- The top of bedrock at Pier 1 is approximately Elevation 97. After removal of loose soil and rock, the prepared surface will be lower. We recommend the design bearing level at this location be set at or below El. 92 for purposes of design. It is important to note that the top of rock is not known for the entire foundation area until it is exposed. We expect that the bedrock bearing surface will be encountered above and possibly below the estimated level. Some construction-phase engineering should be anticipated to address the encountered conditions.
- Concrete used for cofferdam seals should consist of Class S Concrete, while concrete used for footings should consist of Class A Concrete, in accordance with MaineDOT BDG guidelines and MaineDOT Standard Specifications Section 502.05 Composition and Proportioning.
- For spread footing foundations bearing directly on bedrock, the lateral loads may be resisted by friction between the footing bottoms and the bedrock. The recommended base resistance against sliding is based on NAVFAC DM7.02-63, Table 1, which indicates the sliding resistance coefficient (tan δ) is 0.6 for cast-in-place concrete on clean, sound rock. Therefore, the nominal sliding resistance between footings and bedrock subgrades is equal to the vertical force multiplied by 0.7. The factored sliding resistance coefficient is 0.56 for Strength Limit State.
- Anchoring, doweling, benching or other means of improving sliding resistance are recommended at locations where the prepared bedrock surface is steeper than 4 horizontal to 1 vertical (4H:1V) in any direction. Based on available boring data the bedrock slope at Pier 1 is not expected to exceed 4H:1V.



Spread footings founded on bedrock should be checked for eccentricity with LRFD Section 10.6.3.3. Eccentricity of the footing reaction at the strength limit state should be limited such that the resultant reaction on the base of the footing is no further than 0.45 B from the centerline of the footing, where B is the principal dimension of the footing perpendicular to the axis of rotation.



7.1 FOUNDATION SUBGRADE PREPARATION

It is anticipated that the footing excavation for Pier 1 will be completed in-the-wet within a braced cofferdam. The bedrock surface should be cleaned of loose soil and rock and sounded to assess the surface variation prior to placement of tremie concrete. Bearing surface preparation should be completed in accordance with an appropriate Special Provision to the contract. A typical Special Provision Section 511 is included in **Appendix D** for reference.

GZA anticipates that bedrock bearing surface will be variable in terms of elevation, slope and localized weathering. All soil and loose, decomposed, highly weathered and fractured bedrock should be removed from the footing bearing surface prior to placement of concrete. It is possible that the depth and degree of weathering below the bedrock surface could be highly irregular due to the geologic setting.

7.2 PILE INSTALLATION CONTROL

We recommend that the pile installation be controlled using wave equation analysis and field logging of the pile installation and that final penetration resistance be based on dynamic pile testing with signal matching analysis. We recommend that two dynamic pile tests with signal matching be performed at each substructure, one on a plumb and one on a battered pile, at the end of initial drive and again at the beginning of restrike 24 hours later. If the results of the first restrike test indicate no loss of estimated capacity compared to the end of initial drive, a request for waiver of subsequent restrike tests could be made to MaineDOT.

7.3 TEMPORARY LATERAL SUPPORT AND DEWATERING

Excavation is required for the bridge foundations at the river pier locations. The river piers will be constructed within braced steel sheet pile cofferdams. After the sheet piling and wale systems are installed, the cofferdams will be excavated in the wet to base of tremie seal level, the foundation piling will be installed, and unreinforced concrete tremie seals will be poured. Once the seal concrete sets, the cofferdams may be unwatered to allow foundation construction to proceed in the dry. Unwatering of the cofferdams will be achieved by open pumping from the top of tremie seal level.

The contractor should be responsible for controlling groundwater, surface runoff, infiltration and water from all other sources by methods which preserve the undisturbed condition of the subgrade and permit foundation construction in-the-dry. Discharge of pumped groundwater and river water should comply with all local, State, and federal regulations.



7.4 REUSE OF ON-SITE MATERIALS

Based on the test boring results, the existing material at the abutments contains more than 10 percent passing the No. 200 sieve. Therefore, the excavated material does not meet the MaineDOT requirements for Granular Borrow and/or Granular Borrow for Underwater Backfill and is unsuitable for use as structural backfill.



If the contractor wishes to reuse excavated material as embankment fill or in other areas, we recommend that the proposed material be stockpiled and tested for grain size distribution. Stockpiled materials meeting the appropriate MaineDOT specifications may be reused on the project.

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FIGURES











OF 3





APPENDIX A

LIMITATIONS

LIMITATIONS

Explorations



- 1. The analyses and recommendations in this report are based in part upon the data obtained from subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations of this report.
- 2. The generalized soil profile described in the text 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 are probably more erratic. For specific information, refer to the boring logs.
- 3. Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in river level, rainfall, temperature, and other factors occurring since the time measurements were made.

Review

4. In the event that any changes in the nature, design, or location of the proposed structures are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by GZA GeoEnvironmental, Inc. It is recommended that this firm be provided the opportunity for a general review of final design and specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design and specifications.

Construction

5. It is recommended that this firm be retained to provide soil engineering services during construction of the excavation and foundation phases of the work. This is to observe compliance with the design concepts, specifications, and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to start of construction.

Use of Report

- 6. This soil and foundation engineering report has been prepared for this project by GZA GeoEnvironmental, Inc. If this report is used in preparing bids or cost estimates, the geotechnical assumptions should be reviewed by GZA.
- 7. This report has been prepared for this project by GZA GeoEnvironmental, Inc. for the exclusive use of the T.Y. Lin International for specific application to the Penobscot River Bridge project in Howland and Enfield, Maine in accordance with generally accepted soil and foundation engineering practices. No Warranty, express or implied, is made.



APPENDIX B

TEST BORING LOGS



Appendix B

Previous Test Boring Logs

	UNIFIE		ASSIFICA	TION SYSTEM		TERMS DESCRIBING DENSITY/CONSISTENCY					
MA			GROUP								
COARSE- GRAINED	GRAVELS	CLEAN GRAVELS	GW	Well-graded gravels, gravel- sand mixtures, little or no fines	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. Consistency is rated according to standard penetration resistance.						
GOILO	[:] of coarse : than No. 4 ze)	(little or no fines)	GP	Poorly-graded gravels, gravel sand mixtures, little or no fines	Descrip	Modified B <u>ative Term</u> race	urmister System <u>Port</u>	<u>ion of Total</u>)% - 10%			
is Ze)	ire than half ion is larger sieve si	GRAVEL WITH FINES	GM	Silty gravels, gravel-sand-sill mixtures.	s adjective (e.g	ittle ome . sandy, clayey)	1 2 3	1% - 20% 1% - 35% 6% - 50%			
of material 00 sieve si	(mc fracti	(Appreciable amount of fines)	GC	Clayey gravels, gravel-sand-clay mixtures.	Der Cohesio Very	<u>Density of</u> <u>Cohesionless Soils</u> Very loose		netration Resistance (blows per foot) 0 - 4 5 - 10			
e than half than No. 2	SANDS	CLEAN SANDS	SW	Well-graded sands, gravelly sands, little or no fines	Mediu De Very	m Dense ense Dense		11 - 30 31 - 50 > 50			
(mor larger	of coarse than No. [∠]	(little or no fines)	SP	Poorly-graded sands, gravelly sand, little or no fines.	Fine-grained soil	ls (more than half of n	naterial is smaller th	nan No. 20(
	than half o is smaller sieve size	SANDS WITH FINES	SM	Silty sands, sand-silt mixtures	sieve): Includes (² or silty clays; and strength as indica	 inorganic and orgar clayey silts. Constead. 	hic silts and clays; (sistency is rated acc	2) gravelly, sandy cording to shear			
	(more fraction	(Appreciable amount of fines)	SC	Clayey sands, sand-clay mixtures.	Consistency of Cohesive soils	SPT N-Value blows per foot	Undrained Shear Strength (psf)	<u>Field</u> Guidelines			
	SILTS AN	ID CLAYS	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity.	Very Soft Soft Medium Stiff	WOH, WOR, WOP, <2 2 - 4 5 - 8	0 - 250 250 - 500 500 - 1000	Fist easily Penetrates Thumb easily penetrates Thumb penetrates with moderate effort			
FINE- GRAINED SOILS	(liquid limit l	ess than 50)	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Stiff Very Stiff Hard	9 - 15 16 - 30 >30	1000 - 2000 2000 - 4000 over 4000	Indented by thumb with great effort Indented by thumbnai Indented by thumbnail with difficulty			
() ()	(14010 11111 1		OL	Organic silts and organic silty clays of low plasticity.	Rock Quality Des RQD =	signation (RQD): sum of the lengths	of intact pieces of	of core* > 100 mm			
f of material is 200 sieve siz	SILTS AND CLAYS		МН	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	<u>Rock M</u>	*Minimum Correlation of RQI ass Quality	NŎ rock core (1. D to Rock Mass (88 in. OD of core) Quality <u>RQD</u>			
re than half er than No.			СН	Inorganic clays of high plasticity, fat clays.	Ver F	y Poor Poor Fair Tood	<25% 26% - 50% 51% - 75% 75%				
(mo smallt	(liquid limit gr	eater than 50)	ОН	Organic clays of medium to high plasticity, organic silts	Excellent Desired Rock Observations: (in this order) Color (Munsell color chart)			% - 100%			
	HIGHLY (SO	ORGANIC ILS	Pt	Peat and other highly organic soils.	Texture (aphan Lithology (igned Hardness (very Weathering (fre	itic, fine-grained, et ous, sedimentary, m hard, hard, mod. h sh, very slight, sligl	c.) netamorphic, etc. ard, etc.) ht, moderate, mo) d. severe,			
Desired So	il Observat	ions: (in th	is order)		1	severe, etc.)					
Color (Muns Moisture (d	sell color cha rv. damp. m	art) oist wet sa	turated)		Geologic discor	ntinuities/jointing: -dip (horiz - 0-5, lo	w angle - 5-35 m	nod dipping -			
Density/Cor	nsistency (fr	om above ri	ght hand si	de)		35-55, steep	- 55-85, vertical	- 85-90)			
Name (sand	d, silty sand	clay, etc., i	ncluding po	rtions - trace, little, etc.)		-spacing (very clos	se - <5 cm, close	- 5-30 cm, mod.			
Plasticity (n	weii-graded, on-plastic. s	lightly plasti	iea, uniforn c, moderat	i, etc.) ely plastic, highly plastic)		ciose 30-100 cr -tightness (tight. or	n, wide - 1-3 m, v pen or healed)	/ery wide >3 m)			
Structure (la	ayering, frac	tures, crack	s, etc.)			-infilling (grain size	e, color, etc.)				
Bonding (we	eil, moderat	ely, loosely, iderate or s	etc., it appl trong if app	ncable) nlicable ASTM D 2488)	Formation (Wat	erville, Ellsworth, C	ape Elizabeth, e	tc.) r poor etc.)			
Geologic Or Unified Soil Groundwate	rigin (till, ma Classification er level	rine clay, all on Designat	luvium, etc. ion)	RQD and correlation to rock mass quality (very poor, poor, etc.) ref: AASHTO Standard Specification for Highway Bridges 17th Ed. Table 4.4.8.1.2A						
	Maina	Jonartma	nt of Tra	nsportation	Sample Cont	ainer Labeling I	Requirements	<u>.</u>			
	wanie I	Geotoch	nical Soc	nsportation tion	PIN Bridge Name	/ Town	Blow Counts Sample Reco	overv			
Ka	v to Soil	and Rock	Deecrin	tions and Terme	Boring Numbe	er	Date				
	Fie	ld Identific	cation Info	prmation	Sample Numl Sample Dept	ber n	Personnel Ini	tials			

]]	Main	e Dep	artment	of Transporta	tion	1	Project: Penobscot River Bridge #2660 carries Rout		Boring No.:	BB-HE	EPR-101		
		-	Soil/Rock Exp US CUSTOM	loration Log ARY UNITS			Locatio	155 о n: Ноу	ver Peno land-Ei	bbscot River nfield, Maine	PIN:	1670	05.00
Drille	er:		Northern Test	Boring	Ele	vation	(ft.)	157	5		Auger ID/OD:	5" Solid Stem	
Oper	ator:		Mike Nadeau/	Ty Whitworth	Dat	tum:		NA	/D88		Sampler:	Standard Split	Spoon
Logç	jed By:		B. Wilder		Rig	J Type:		Die	lrich D-	50 Track	Hammer Wt./Fall:	140#/30"	
Date	Start/Fi	nish:	8/16/10; 10:30)-16:30	Dril	lling M	lethod:	Cas	ed Wash	n Boring	Core Barrel:	NQ-2"	
Bori	ng Loca	tion:	N633293 E17	61886	Cas	sing ID)/OD:	HW			Water Level*:	19.0 ft bgs.	
Ham	mer Effi	ciency Fa	actor: 0.678		Har	mmer [·]	Туре:	Autom	atic 🛛	Hydraulic 🗆	Rope & Cathead □		
Definit D = Sp MD = 1 U = Tr MU = 1 V = In: <u>MV = 1</u>	ions: blit Spoon S Unsuccess hin Wall Tu Unsuccess situ Vane S <u>Unsuccess</u>	Sample ful Split Spo be Sample ful Thin Wal Shear Test, ful Insitu Va	on Sample attemp I Tube Sample att PP = Pocket Per ne Shear Test atte	R = Rock SSA = So ot HSA = Ho RC = Roll empt WOH = w vertormeter WOR/C = empt WOHP = \v/v Scample Information	Core Sar lid Stem J llow Ster er Cone eight of 1 weight of Veight of	mple Auger m Auger 140lb. ha of rods or <u>f one per</u>	mmer casing son		$S_u = Ins$ $T_v = Pool q_p = Unol N-uncorri Hammer N_{60} = SiN_{60} = (H)$	itu Field Vane Shear Strength (psf) ket Torvane Shear Strength (psf) confined Compressive Strength (ksf) ected = Raw field SPT N-value Efficiency Factor = Annual Calibrati PT N-uncorrected corrected for ham lammer Efficiency Factor/60%)*N-ur	S _{U(I} , WC LL = PL = on Value PI = mer efficiency G = ncorrected C =	ab) = Lab Vane Shear S = water content, percen Liquid Limit Plastic Limit Plastic Limit Plasticity Index Grain Size Analysis Consolidation Test	trength (psf) t
				Sample mormation	70				1				Laboratory
Depth (ft.)	Sample No.	Pen./Rec. (in.	Sample Dept l (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks			Testing Results/ AASHTO and Unified Class.
0							SSA	157.10		PAVEMENT.			
	1D	24/19	1.00 - 3.00	15/13/13/12	26	29		-		Brown, damp, medium dense silt, (Fill).	e, fine to coarse SAND,	some gravel, trace	G#237550 A-1-b, SW-SM WC=3.9%
- 5 -													
	2D	24/20	5.00 - 7.00	16/31/36/32	67	76		151.50		Black, damp, very dense, fin (Fill).	e to coarse SAND, little	6.00- e gravel, trace silt,	
- 10 -								149.00			less firsts and inc. (
	3D	24/15	10.00 - 12.00	3/3/2/2	5	6	20			and coarse sand, little silt (Fi	ill).	AND, trace grave	
							26	-					
							35 25						
- 15 -	/D	21/16	15.00 17.00	2/2/2/2	5	6	11			Similar to above.			G#207064
	40	24/10	15.00 - 17.00	3131212	5	0	16	-	10000 00000 000000 000000 0000000				A-2-4, SM WC=21.8%
							27						
							30						
							31		闘雛				
- 20 -	5D	24/12	20.00 - 22.00	11/9/8/10	17	19	52	137.50		Brown, wet, medium dense, trace organics, with brick pi	fine to coarse SAND, line coarse (Fill).	20.00- ttle gravel, some silt,	
							320						
							55	134.50				23.00	
							72						
25 Por	arkei						94						

Auto Hammer #283

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 1 of 2
* 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.	Boring No.: BB-HEPR-101

	Main	e Depa	artment	of Transporta	ntion	1	Project: Penobscot River Bridge #2660 carries Route				Boring No.:	BB-HE	PR-101
		<u>}</u>	Soil/Rock Exp US CUSTOM	loration Log ARY UNITS			Location	155 o 1: Hov	ver Peno vland-Ei	bbscot River nfield, Maine	PIN:	1670)5.00
Drill	er:		Northern Test	Boring	Ele	vation	(ft.)	157.	5		Auger ID/OD:	5" Solid Stem	
Ope	rator:		Mike Nadeau/	Ty Whitworth	Dat	um:	. ,	NA	VD88		Sampler:	Standard Split S	Spoon
Log	ged By:		B. Wilder	-	Rig	Type:		Die	lrich D-	50 Track	Hammer Wt./Fall	: 140#/30"	-
Date	Start/Fi	nish:	8/16/10; 10:30)-16:30	Dril	lling M	ethod:	Case	ed Wash	Boring	Core Barrel:	NQ-2"	
Bori	ng Locat	ion:	N633293 E17	61886	Cas	sing ID	D/OD: HW				Water Level*:	19.0 ft bgs.	
Hammer Efficiency Factor: 0.678 Hammer						nmer ⁻	Туре:	Autom	atic 🛛	Hydraulic 🗆	Rope & Cathead □		
Definitions: R = Rock Co D = Split Spoon Sample SSA = Solid MD = Unsuccessful Split Spoon Sample attempt HSA = Hollov U = Thin Wall Tube Sample RC = Roller (MU = Unsuccessful Thin Wall Tube Sample attempt WOH = weig V = Insitu Vane Shear Test, PP = Pocket Penetrometer WO1P = Weig MV = Unsuccessful Insitu Vane Shear Test attempt WO1P = Weig					Core Sar lid Stem Ilow Sten er Cone eight of 1 weight of Neight of	mple Auger n Auger 40lb. ha f rods or one per	mmer casing son		$S_{u} = Ins$ $T_{v} = Poo$ $q_{p} = Uno$ N-uncorr Hammer N ₆₀ = S N ₆₀ = (H	itu Field Vane Shear Strength (psf) ket Torvane Shear Strength (psf) confined Compressive Strength (ksf) rected = Raw field SPT N-value Efficiency Factor = Annual Calibrati PT N-uncorrected corrected for ham <u>lammer Efficiency Factor/60%)*N-un</u>	s v L ion Value F mer efficiency G ncorrected C	Su(lab) = Lab Vane Shear S VC = water content, percent L = Liquid Limit 2L = Plastic Limit 2I = Plastic Limit 3 = Grain Size Analysis 2 = Consolidation Test	trength (psf)
				Sample Information			1	<u> </u>	-				Laboratory
Depth (ft.)	Sample No.	Pen./Rec. (in.	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (pst) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	Graphic Log	Visual De	scription and Rema	ırks	Testing Results/ AASHTO and Unified Class.
25	6D	9.6/7	25.00 - 25.80	23/50(3.6")			60		0.00	Light brown, wet, very dense (Till)	e, fine to coarse SAN	D, some gravel and silt,	G#207066
							89			Cobble from 25.8-26.0 ft bg Roller Coned ahead to 30.3	s. ft bgs.		WC=9.7%
							60	129.70				27.80	
										Very dense from 27.8-30.3 f	t bgs., Weathered Ro	ck?	
- 30 ·								127.20					
	7D 	3.6/3.6	30.00 - 30.30	50(3.6") ROD = 16%			NQ-2	127.20	9120	Top of Intack Bedrock at Ele	ev. 127.2 ft.	50.50	
										Bedrock: Grey, fine-grained fractured, PHYLLITE, thin,	l, moderately hard, sli steep bedding planes,	ightly weathered, highly , joints very close,	
										[Vassalboro Formation]	stanning. Kock Mass	Quality is very Poor	
	R2	42/42	33.30 - 36.80	RQD = 0%						R1:Core Times (min:sec) 30 3-31 3 ft (6:00)			
										31.3-32.3 ft (5:15)			
- 35 -										Core Blocked	overy		
	R3	36/36	36.80 - 39.80	RQD = 0%						R2:CoreTimes (min:sec) 33.3-34.3 ft (4:20)			
									96	34.3-35.3 ft (3:16) 35.3-36.3 ft (4:30)			
										36.3-36.8 ft (5:00) 100% Re	covery		
									<u>990</u>	Cole Blocked			
- 40 -								117.70	19982	R3:CoreTimes (min:sec) 36.8-37.8 ft (5:00)			
										37.8-38.8 ft (6:30)			
										Core Blocked	covery		
										Bottom of Exploration	at 39.80 feet below	ground surface.	
												<u> </u>	
- 45 ·													
50 <u>Ren</u>	l arks:								I				
Au	to Hamme	r #283											

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 2 of 2
* 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.	Boring No.: BB-HEPR-101

Soliditor Soliditor Soliditor PIN: 16702.00 Differ: Mage: DOD. NA Soliditor NA Operator: Mage: DOD. NA Soliditor NA Destine: Mage: DOD. NA Soliditor NA Destine: Mage: DOD. NA Hammer Work: 1948.007 Destine: NG1998.00 Dot mile: Cond Wab Data Hammer Work: 1948.007 Destine: NG1998.01 Dot mile: Market Soliditor: Na Hammer Work: Na Destine: NG1998.01 NG1998.01 NG1998.01 Market Soliditor: Na Hammer Work: Hammer Work:		Main	e Depa	artment	nent of Transportation Project: Penobscot River Bridge #2660 carries Route		Boring No.:	BB-HE	EPR-102						
			<u>9</u> 1	Soil/Rock Exp US CUSTOM	loration Log ARY UNITS			Locatio	155 o n: Hov	er Peno land-En	bscot River field, Maine	PIN:	1670	05.00	
Operation Unity NAVEN Name Private Name Private <th< td=""><td>Drille</td><td>er:</td><td></td><td>MaineDOT</td><td></td><td>Ele</td><td>vation</td><td>(ft.)</td><td>126</td><td>8</td><td></td><td>Auger ID/OD:</td><td>N/A</td><td></td></th<>	Drille	er:		MaineDOT		Ele	vation	(ft.)	126	8		Auger ID/OD:	N/A		
Logade 7. Bate 7. Reg 7.000 CM6 40. Remme 7.	Ope	ator:		Giguere/Giles/	/Daggett	Dat	tum:		NA	VD88		Sampler:	Standard Split	Spoon	
Die Setzie Die Werk Weiter Robert Operational of the setzie No.24 No.24 <td>Loge</td> <td>jed By:</td> <td></td> <td>B. Schonewald</td> <td>d</td> <td>Rig</td> <td>g Type:</td> <td>:</td> <td>СМ</td> <td>E 45C</td> <td></td> <td>Hammer Wt./Fall:</td> <td>140#/30"</td> <td></td>	Loge	jed By:		B. Schonewald	d	Rig	g Type:	:	СМ	E 45C		Hammer Wt./Fall:	140#/30"		
Both Call Derive (Control Derive (Control <thderive (control<="" th=""> Derive (Control<</thderive>	Date	Start/Fi	nish:	8/16/10-8/17/1	10	Dri	illing M	ethod:	Case	ed Wash	Boring	Core Barrel: NQ-2"			
Hummer Weiser Hummer View Automation Hummer View	Bori	ng Loca	tion:	N633348.9 E1	762069	Cas	sing ID	/OD:	HW	& NW		Water Level*:	River Boring		
Distriction	Ham	mer Effi	ciency Fa	octor: 0.84		Ha	mmer [·]	Туре:	Autom	atic 🛛	Hydraulic 🗆	Rope & Cathead 🗆			
INTROPERTURNATION INTROPERTURNATION <th co<="" td=""><td>Definit D = S MD = U = T MU = V = In MV =</td><td>ions: olit Spoon S Unsuccess hin Wall Tul Unsuccess situ Vane S <u>Unsuccess</u></td><td>Sample ful Split Spo be Sample ful Thin Wall ihear Test, ful Insitu Var</td><td>on Sample attemp Tube Sample att PP = Pocket Per he Shear Test atte</td><td>R = Rock (SSA = Solit bt HSA = Hol RC = Rolle empt WOH = we hetrometer WOR/C = work work WO1P = work</td><td>Core Sa id Stem low Ster er Cone eight of 1 weight of Veight of</td><td>ample Auger m Auger 140lb. ha of rods or <u>f one per</u></td><td>mmer casing son</td><td></td><td>$S_{u} = InsitT_{v} = Poclq_{p} = UncN-uncorreHammerN60 = SFN60 = (H$</td><td>u Field Vane Shear Strength (psf) ket Torvane Shear Strength (psf) onfined Compressive Strength (ksf) acted = Raw field SPT N-value Efficiency Factor = Annual Calibrati PT N-uncorrected corrected for ham ammer Efficiency Factor/60%)*N-ur</td><td>Su(la WC = UL = PL = on Value PI = mer efficiency G = C tcorrected C = C</td><td>b) = Lab Vane Shear S water content, percen Liquid Limit Plastic Limit Plasticity Index Grain Size Analysis Consolidation Test</td><td>trength (psf) t</td></th>	<td>Definit D = S MD = U = T MU = V = In MV =</td> <td>ions: olit Spoon S Unsuccess hin Wall Tul Unsuccess situ Vane S <u>Unsuccess</u></td> <td>Sample ful Split Spo be Sample ful Thin Wall ihear Test, ful Insitu Var</td> <td>on Sample attemp Tube Sample att PP = Pocket Per he Shear Test atte</td> <td>R = Rock (SSA = Solit bt HSA = Hol RC = Rolle empt WOH = we hetrometer WOR/C = work work WO1P = work</td> <td>Core Sa id Stem low Ster er Cone eight of 1 weight of Veight of</td> <td>ample Auger m Auger 140lb. ha of rods or <u>f one per</u></td> <td>mmer casing son</td> <td></td> <td>$S_{u} = InsitT_{v} = Poclq_{p} = UncN-uncorreHammerN60 = SFN60 = (H$</td> <td>u Field Vane Shear Strength (psf) ket Torvane Shear Strength (psf) onfined Compressive Strength (ksf) acted = Raw field SPT N-value Efficiency Factor = Annual Calibrati PT N-uncorrected corrected for ham ammer Efficiency Factor/60%)*N-ur</td> <td>Su(la WC = UL = PL = on Value PI = mer efficiency G = C tcorrected C = C</td> <td>b) = Lab Vane Shear S water content, percen Liquid Limit Plastic Limit Plasticity Index Grain Size Analysis Consolidation Test</td> <td>trength (psf) t</td>	Definit D = S MD = U = T MU = V = In MV =	ions: olit Spoon S Unsuccess hin Wall Tul Unsuccess situ Vane S <u>Unsuccess</u>	Sample ful Split Spo be Sample ful Thin Wall ihear Test, ful Insitu Var	on Sample attemp Tube Sample att PP = Pocket Per he Shear Test atte	R = Rock (SSA = Solit bt HSA = Hol RC = Rolle empt WOH = we hetrometer WOR/C = work work WO1P = work	Core Sa id Stem low Ster er Cone eight of 1 weight of Veight of	ample Auger m Auger 140lb. ha of rods or <u>f one per</u>	mmer casing son		$S_{u} = InsitT_{v} = Poclq_{p} = UncN-uncorreHammerN60 = SFN60 = (H$	u Field Vane Shear Strength (psf) ket Torvane Shear Strength (psf) onfined Compressive Strength (ksf) acted = Raw field SPT N-value Efficiency Factor = Annual Calibrati PT N-uncorrected corrected for ham ammer Efficiency Factor/60%)*N-ur	Su(la WC = UL = PL = on Value PI = mer efficiency G = C tcorrected C = C	b) = Lab Vane Shear S water content, percen Liquid Limit Plastic Limit Plasticity Index Grain Size Analysis Consolidation Test	trength (psf) t
No. No. Second					Sample Information	-								Laboratory	
0 10 24/5 0.00 - 2.00 1/2/1/10 13 18 1 1 1 1 1 67 1 1 1 1 1 67 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 </th <th>Depth (ft.)</th> <th>Sample No.</th> <th>Pen./Rec. (in.)</th> <th>Sample Depth (ft.)</th> <th>Blows (/6 in.) Shear Strength (pst) or RQD (%)</th> <th>N-uncorrected</th> <th>N₆₀</th> <th>Casing Blows</th> <th>Elevation (ft.)</th> <th>Graphic Log</th> <th>Visual De</th> <th colspan="3">Visual Description and Remarks</th>	Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (pst) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	Graphic Log	Visual De	Visual Description and Remarks			
Image: Normal Sector Image: Normal Sector Image: Normal Sector	0	1D	24/5	0.00 - 2.00	1/2/11/10	13	18				Brown-grey, medium dense, (Alluvium).	fine to coarse sandy GR	AVEL, trace silt,	G#207067 A-1-a, GP	
Image:								67						WC=10.2%	
10 10<								78							
1 1								76	100.00				1.00		
No. Image: Normalized Sector Sec	5							129	122.80				4.00		
2D 24/11 6.00 22/14/12/11 26 36 72 1 1 1 1 71 1 1 1 1 71 1 1 1 1 71 1 1 1 1 1 1 1 1 1 1 1 1 1 20 24/9 11.00 - 13.00 14/19/17/20 36 50 73 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	- 3 -							118							
Image: second		2D	24/11	6.00 - 8.00	22/14/12/11	26	36	72			Grey, dense, fine to medium coarse sand, (Alluvium).	SAND, some gravel, litt	le to some silt, trace		
Image:								71							
10 11 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>64</td><td></td><td></td><td></td><td></td><td></td><td></td></td<>								64							
3D 24/9 11.00 - 13.00 14/19/17/20 36 50 73 3D 24/9 11.00 - 13.00 14/19/17/20 36 50 73 1 1 1 1 93 1 1 1 125 1 1 1 134 4D 24/12 16.00 - 18.00 16/36/33/34 69 97 123 4D 24/12 16.00 - 18.00 16/36/33/34 69 97 123 1 1 1 194 252 194 194 1 1 1 252 21.00 - 21.80 21/50(3.6") 101.80 104.80 103.90 104.80 103.90 104.80 103.90 11.80 11.23 11.80 104.80 103.90 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 <t< td=""><td>- 10 -</td><td></td><td></td><td></td><td></td><td></td><td></td><td>76</td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	- 10 -							76							
3D 24/9 11.00 - 13.00 14/19/17/20 36 50 73 1 1 1 93 93 1 1 1 93 1 1 1 93 1 1 125 1 1 134 4D 24/12 16.00 - 18.00 16/36/33/34 69 97 123 4D 24/12 16.00 - 18.00 16/36/33/34 69 97 123 1 1 1 252 1 1 2432 5D 9.6/3 21.00 - 21.80 21/50(3.6") 1 R1 45.6/32 22.00 - 25.80 RQD = 11% NQ-2 104.80 103.90 103.90 103.90 103.90 R1: Top 0.9 ft. Boulder underlain by Gravel. 22.00 22.00 22.00 R1: Top 0.9 ft. Boulder underlain by Gravel. 22.00 22.00 22.00 R1: Top 0.9 ft. Boulder underlain by Gravel. 22.00 22.00 22.00 R1: Top 0.9 ft. Boulder underlain by Gravel. 22.00 22.90								82			Grou dansa fina ta aparsa S	AND some gravel little	to some silt		
- 15 -		3D	24/9	11.00 - 13.00	14/19/17/20	36	50	73	-		(Alluvium).	AND, some graver, inde	to some sitt,		
- 15 - - - 125 - 15 - - - 134 4D 24/12 16.00 - 18.00 16/36/33/34 69 97 123 4D 24/12 16.00 - 18.00 16/36/33/34 69 97 123 - - - - 194 - - - 252 - - - 20 - - - - R1 45.6/32 22.00 - 25.80 RQD = 11% NQ-2 - - - - R1 45.6/32 22.00 - 25.80 RQD = 11% NQ-2 -								93							
15 13 134 134 4D 24/12 16.00 - 18.00 16/36/33/34 69 97 123 4D 24/12 16.00 - 18.00 16/36/33/34 69 97 123 1 1 1 194 194 194 194 1 1 1 252 1 1 270 1 1 1 270 1 1 1 81 45.6/32 22.00 - 21.80 21/50(3.6") 1 R1 45.6/32 22.00 - 25.80 RQD = 11% NQ-2 104.80 103.90 03.90 0 0 104.00 103.90 103.90 103.90 103.90 104.80 103.90 104.80 103.90 103.90 104.80 104.80 104.80 103.90 104.80 104.80 104.80 104.80 104.80 104.80 104.90 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 104.80 1								125	-						
4D 24/12 16.00 - 18.00 16/36/33/34 69 97 123 4D 24/12 16.00 - 18.00 16/36/33/34 69 97 123 1 1 194 194 194 194 194 194 1 1 1 252 252 10 21/20 (3.6") 252 1 1 1 432 432 50 9.6/3 21.00 - 21.80 21/50(3.6") R1 45.6/32 22.00 - 25.80 RQD = 11% NQ-2 104.80 104.80 104.80 103.90 R1: Top 0.9 ft. Boulder underlain by Gravel. 22.00- 22.00- 22.00- 22.00- 11.1 1.1.2 1.1.2 1.1.4	- 15 -							134	-						
4D 24/12 16.00 - 18.00 16/36/35/34 69 97 123 1 1 194 194 194 194 194 194 1 1 252 252 252 100 2100 2100 21/50(3.6") 104.80 R1 45.6/32 22.00 - 25.80 RQD = 11% NQ-2 104.80 103.90 103.90 104.80 103.90 R1: Top 0.9 ft. Boulder underlain by Gravel. 22.00- Top of Bedrock at Elev. 103.9 ft. 21.00 - 21.80 21.00 - 21.80 21.00 - 21.80 21.50(3.6") 104.80 R1 45.6/32 22.00 - 25.80 RQD = 11% NQ-2 104.80 103.90 103.90 R1: Top 0.9 ft. Boulder underlain by Gravel. 22.00- R1: Top 0.9 ft. Boulder underlain by Gravel. 22.00- 2			0.1%-					168	-		Grey, very dense, fine to coa	rse SAND, some gravel	, little silt,	G#207068	
20 194 20 252 5D 9.6/3 21.00 - 21.80 21/50(3.6") R1 45.6/32 22.00 - 25.80 RQD = 11% NQ-2 104.80 R1 45.6/32 22.00 - 25.80 RQD = 11% NQ-2 104.80 R1 45.6/32 22.00 - 25.80 RQD = 11% NQ-2 104.80 103.90 104.80 R1 45.6/32 22.00 - 25.80 RQD = 11% NQ-2 103.90 104.80 103.90 R1 45.6/32 22.00 - 25.80 RQD = 11% NQ-2 103.90 104.80 103.90 R1 Bedrock at Elev. 103.9 ft. 22.00- R1 Bedrock at Elev. 103.9 ft. 22.90- Top of Bedrock at Elev. 103.9 ft. 81 R1 Bedrock: Grave fine-grained medium hard firsh to elightly		4D	24/12	16.00 - 18.00	16/36/33/34	69	97	123	-		(Alluvium).			A-1-b, SW-SM WC=11.7%	
20 21 21.00 - 21.80 21/50(3.6") 432 5D 9.6/3 21.00 - 21.80 21/50(3.6") 104.80 R1 45.6/32 22.00 - 25.80 RQD = 11% NQ-2 104.80 103.90 Image: Construction of the state of th								194							
20 210 210 5D 9.6/3 21.00 - 21.80 21/50(3.6") R1 45.6/32 22.00 - 25.80 RQD = 11% 104.80 103.90 103.90 103.90 R1: Top 0.9 ft. Boulder underlain by Gravel. 22.00- C C C C C C R1 45.6/32 22.00 - 25.80 RQD = 11% 104.80 R1 45.6/32 22.00 - 25.80 RQD = 11% 104.80 R1 Brownish-grey, very dense, fine to coarse sandy GRAVEL, trace to little R1 Brownish-grey, very dense, fine to coarse sandy GRAVEL, trace to little R1 Brownish-grey, very dense, fine to coarse sandy GRAVEL, trace to little R1 Brownish-grey, very dense, fine to coarse sandy GRAVEL, trace to little R1 Brownish-grey, very dense, fine to coarse sandy GRAVEL, trace to little R1 Brownish-grey, very dense, fine to coarse sandy GRAVEL, trace to little R1 Betrock at Elev. 103.9 ft. R1 Betrock at Elev. 103.9 ft. R1 Betrock at Elev. 103.9 ft.								232							
5D 9.6/3 21.00 - 21.80 21/50(3.6") Image: Second se	- 20 -							432	-						
R1 45.6/32 22.00 - 25.80 RQD = 11% I04.80 Mathematical constraints (Christian). Image: NR_1 = 100 -		5D	9.6/3	21.00 - 21.80	21/50(3.6")				1		Brownish-grey, very dense, t	fine to coarse sandy GRA	VEL, trace to little		
103.90 103.90 22.00 R1: Top 0.9 ft. Boulder underlain by Gravel. 22.90 Top of Bedrock at Elev. 103.9 ft. 22.90 B1:Bedrock: Grey fine-grained medium hard fresh to slightly		R1	45.6/32	22.00 - 25.80	RQD = 11%			NQ-2	104.80		Attempt to roller cone ahead Casing, drive and washout to	, solid at 21.8 ft bgs. Tel- o 22.0 ft bgs.	escoped NW		
Top of Bedrock at Elev. 103.9 ft. B1:Bedrock: Grey fine-grained medium hard fresh to slightly									103.90		R1: Top 0.9 ft. Boulder unde	erlain by Gravel.	22.00		
KNW NE IVE DRAHDER, VIEW, HIG-ZEIMIRAL HRANDIT HARL, HEATHY MISTIN	25								1		Top of Bedrock at Elev. 103 R1:Bedrock: Grev. fine-grain	.9 ft. ned. medium hard. fresh	22.90- to slightly		

Remarks:

Bridge Deck to mudline, 33.1 ft. Bridge Deck Core 9 in, no asphalt.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 1 of 2
* 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.	Boring No.: BB-HEPR-102

	Main	e Dep	artment	of Transporta	tion		Project:	Penob	scot Riv	ver Bridge #2660 carries Route	Boring No.:	BB-HE	PR-102
		 	Soil/Rock Exp US CUSTOM/	loration Log ARY UNITS			Location	155 ov n: How	ver Penc vland-Ei	bbscot River nfield, Maine	PIN:	1670)5.00
Drill	er:		MaineDOT		Eleva	ation	(ft.)	126.	8		Auger ID/OD:	N/A	
Ope	rator:		Giguere/Giles/	/Daggett	Datu	m:		NA	VD88		Sampler:	Standard Split S	Spoon
Log	ged By:		B. Schonewald	1	Rig T	Гуре:	:	CM	E 45C		Hammer Wt./Fall:	140#/30"	
Date	Start/Fi	nish:	8/16/10-8/17/1	0	Drilli	ng M	lethod:	Case	ed Wash	n Boring	Core Barrel:	NQ-2"	
Bori	ng Loca	tion:	N633348.9 E1	762069	Casir	sing ID/OD: HW & NW				Water Level*:	River Boring		
Ham	mer Effi	ciency Fa	octor: 0.84		Hami	mer	Туре:	Autom	atic 🖂	Hydraulic 🗆	Rope & Cathead		
Defini D = S MD = U = T MU = V = In MV =	tions: plit Spoon S Unsuccess hin Wall Tul Unsuccess situ Vane S <u>Unsuccess</u>	Sample ful Split Spo be Sample ful Thin Wall Shear Test, ful Insitu Var	on Sample attemp Tube Sample atte PP = Pocket Per te Shear Test atte	R = Rock SSA = So bt HSA = Ho RC = Roll empt WOH = w vetrometer WOR/C = mpt WO1P = V Sample Information	Core Samp id Stem Au llow Stem A er Cone eight of 140 weight of ro Veight of or	ole uger Auger Olb. ha ods or ne per	immer casing son		$S_{u} = Ins$ $T_{v} = Poc$ $q_{p} = Unc$ $N-uncorri$ Hammer $N_{60} = Si$ $N_{60} = (H)$	itu Field Vane Shear Strength (psf) ket Torvane Shear Strength (psf) confined Compressive Strength (ksf) ected = Raw field SPT N-value Efficiency Factor = Annual Calibrati PT N-uncorrected corrected for ham tammer Efficiency Factor/60%)*N-un	Su(lab) = Lab Vane Shear Strength (psf) WC = water content, percent sf) LL = Liquid Limit PL = Plastic Limit ation Value PI = Plasticity Index mmer efficiency G = Grain Size Analysis uncorrected C = Consolidation Test		
Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (pst) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	Graphic Log	Visual De	scription and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.	
25	R2	22.8/20	25.80 - 27.70	RQD = 0%						weathered, thinly bedded, ca high angle to vertical, highly angle, planar to undulating, open, breaks along bedding. fractured at 24.8 ft. Rock M	Icereous muscovite PHY undulating on small scales smooth to rough, fresh to Mud seam at 23.1 to 23.4 fass Quality is Very Poor.	LLITE. Bedding le. Close, high discolored, tight to 4 ft. Highly [Vassalboro	
- 30 · - 35 ·				RQD = 50%				94.10		Formation] R1:Core Times (min:sec) 22.0-23.0 ft (2:10) 23.0-24.0 ft (2:10) 24.0-25.0 ft (3:55) 25.0-25.8 ft (8:15) 70% Rec R2:Bedrock: Same as R1, ex Recovery. Core Times not re R3:Bedrock: Grey, fine-grai calcareous muscovite PHYL undulating on small scale. C run and low angle middle ru breaks along bedding. Highl Poor. [Vassalboro Formatio R3:Core Times (min:sec) 28.0-29.0 ft (2:40) 29.0-30.0 ft (2:20) 30.0-31.0 ft (2:25) 31.0-32.7 ft (2:45) 100% Re	overy scept fresh, highly fractur ecorded. ned, medium hard, fresh, LITE. Bedding high angi lose to moderate, high an n, undulating, smooth to y fractured at 32.4 ft. Roo n] covery at 32.70 feet below gro	ed entire run. 80% thinly bedded, le to vertical, highly gle upper and lower rough, fresh, tight ck Mass Quality is 	
- 45 -													

Bridge Deck to mudline, 33.1 ft. Bridge Deck Core 9 in, no asphalt.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 2 of 2
* 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.	Boring No.: BB-HEPR-102

Maine Department of Transportat					ation	1	Project:	Penob	scot Riv	ver Bridge #2660 carries Route	Boring No.: BB-HE		EPR-103	
Soil/Rock Exploration Log US CUSTOMARY UNITS							Locatio	155 o 1: Hov	ver Penc vland-Er	bscot River nfield, Maine	PIN:	1670)5.00	
Driller: Northern Test Boring			Ele	vation	(ft.)	127	0		Auger ID/OD:	5" Solid Stem				
Operator: Mike Nadeau/Ty Whitworth			Dat	tum:		NA	VD88		Sampler:	Standard Split	Spoon			
Logged By: B. Wilder			Rig	Type:		Die	lrich D-	50 Track	Hammer Wt./Fall:	140#/30"				
Date	Start/Fi	nish:	8/17/10; 08:00	0-16:00	Dri	lling M	ethod:	Cas	ed Wash	Boring	Core Barrel:	NQ-2"		
Bori	ng Loca	tion:	N633430.5 E1	762334	Cas	sing ID	VOD:	HW			Water Level":	River Boring		
Defini	tions:	ciency Fa	actor: 0.678	R = Rock	Core Sar	mple	rype:	Autom	atic⊠ S _u = Insi	Hydraulic ⊔ itu Field Vane Shear Strength (psf)	Rope & Cathead \Box S _L	ı(lab) = Lab Vane Shear S	trength (psf)	
D = Split Spoon Sample SSA = Solid S MD = Unsuccessful Split Spoon Sample attempt HSA = Hollow U = Thin Wall Tube Sample RC = Roller C MU = Unsuccessful Thin Wall Tube Sample attempt WOH = weigh V = Insitu Vane Shear Test, PP = Pocket Penetrometer WOR/C = wei MV = Unsuccessful Insitu Vane Shear Test attempt WO1P = Weigh						Auger m Auger 140lb. ha of rods or <u>f one per</u>	mmer casing son		$T_V = Poc$ $q_p = Unc$ N-uncorr Hammer $N_{60} = SI$ $N_{60} = (F$	ket Torvane Shear Strength (psf) confined Compressive Strength (ksf) ected = Raw field SPT N-value Efficiency Factor = Annual Calibrati PT N-uncorrected corrected for ham lammer Efficiency Factor/60%)*N-ur	WC = water content, percent) LL = Liquid Limit PL = Plastic Limit tion Value PI = Plasticity Index mer efficiency G = Grain Size Analysis incorrected C = Consolidation Test			
		<u> </u>		Sample Information	77				-				Laboratory	
Depth (ft.)	Sample No.	Pen./Rec. (in.	Sample Depti (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks			l esting Results/ AASHTO and Unified Class.	
0	1D	24/8	0.00 - 2.00	6/9/17/10	26	29	32			Grey-brown, saturated, medi trace silt, (Alluvium).	ium dense, fine to coar	rse sandy GRAVEL,	G#207069 A-1-a, GW WC=0.0%	
							105						WC=9.9%	
	2D	24/13	3.50 - 5.50	26/31/20/18	51	58	152			Grev saturated very dense GRAVEL some fine to coarse sand trace.			C#207070	
							125			silt, (Alluvium). Roller Coned ahead from 3.5	5-8.5 ft bgs.	to coarse sand, trace	A-1-a, GW WC=7.7%	
- 5 -							88							
							84							
							91							
	3D	24/5	8.50 - 10.50	10/5/3/6	8	9	58			Similar to above, except loos	se.			
- 10 -							67							
							97							
							88							
	4D	24/4	13.50 - 15.50	5/7/8/7	15	17	51			Similar to above, except mee	dium dense.			
- 15 -							62							
							76							
							92	110.00				— — — — —17.00-		
	5D	24/15	18.50 - 20.50	12/21/32/33	53	60	70		2000 2000 2000 2000 2000 2000 2000 200	Grou wat yaru dansa fina t	o coerra SAND, como	graval trace silt	G#207071	
							41			(Alluvium). Roller Coned ahead to 23.5 f	ft bgs.	graver, trace sin,	A-1-b, SW-SM WC=11.5%	
- 20 -							38				0			
							61	1						
							143	105.00						
	6D	24/17	23.50 - 25.50	29/45/33/50	78	88	136			Similar to above but gravelly Roller Coned ahead to 28.5 f	y. ft bgs.			
25 Rem	arks:						92				<u>.</u>			

Auto Hammer #283 36.2 ft from Bridge Deck to Ground.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 1 of 3
* 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.	Boring No.: BB-HEPR-103

Maine Department of Transportation						Project: Penobscot River Bridge #2660 carries Route						Boring No.:	Soring No.: BB-HEI	
Soil/Rock Exploration Log US CUSTOMARY UNITS						155 over Penobscot River Location: Howland-Enfield, Maine						PIN:	16705.00	
Driller: Northern Test Boring					Fle	vation	(ft)	1	127.0			Auger ID/OD	5" Solid Stem	
Operator: Mike Nadeau/Tv Whitworth			Dat	um:	(11.)	1	NAVI	088		Sampler:	Standard Split	Spoon		
Logged By: B. Wilder			Rig	Type:		I	Diedri	ch D-:	50 Track	Hammer Wt./Fall:	140#/30"	- F		
Date Start/Finish: 8/17/10: 08:00-16:00			Dril	ling M	ethod:	(Cased	Wash	Boring	Core Barrel:	NQ-2"			
Bor	ing Loca	tion:	N633430.5 E1	762334	Cas	sing ID	/OD:	I	HW		0	Water Level*:	River Boring	
Har	nmer Effi	ciency Fa	actor: 0.678		Han	nmer '	Гуре:	Aut	tomati	c⊠	Hydraulic 🗆	Rope & Cathead □		
Definitions: R = Rock Core S D = Split Spoon Sample SSA = Solid Ste MD = Unsuccessful Split Spoon Sample attempt HSA = Hollow S U = Thin Wall Tube Sample RC = Roller Cor MU = Unsuccessful Thin Wall Tube Sample attempt WOH = weight C V = Insitu Vane Shear Test, PP = Pocket Penetrometer WOR/C = weight MV = Unsuccessful Insitu Vane Shear Test attempt						nple Auger n Auger 40lb. ha f rods or one per	mmer casing son		S T V N H N N	u = Insite $f = Pocu = Uncuncorrest uncorrest uncorrest$	tu Field Vane Shear Strength (psf) ket Torvane Shear Strength (psf) onfined Compressive Strength (ksf) ected = Raw field SPT N-value Efficiency Factor = Annual Calibrati PT N-uncorrected corrected for ham <u>ammer Efficiency Factor/60%)*N-ur</u>	S _{u(lab)} = Lab Vane Shear Strength (psf) WC = water content, percent LL = Liquid Limit PL = Plastic Limit mer efficiency ncorrected C = Consolidation Test		
				Sample Information				-	_					Laboratory
Depth (ft.)	Sample No.	Pen./Rec. (in.	Sample Deptr (ft.)	Blows (/6 in.) Shear Strength (pst) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation	(ft.)	Graphic Log	Visual De		Testing Results/ AASHTO and Unified Class.	
25							148							
							250	100	0.00				27.00	
							422	100	0.00				27.00	
	7D	18/16	28.50 - 30.00	22/33/50	83	94	350		0	0.000	Similar to 5D.	ft has		G#207072
- 30	<u> </u>						131		0	1000 1000	Koner Coned anead to 55.51	it bgs.		WC=10.1%
							112		Ċ					
							222			0.000				
							315	_	0.00					
	8D	16.8/14	33.50 - 34.90	31/39/56(4.8")			242	-		00000000000000000000000000000000000000	Similar to 5D. Roller Coned ahead to 38.5 f	ft bgs.		
- 35							225		0					
							232		9					
							OPEN UOLE	89	9.40		Open Hole, used 2 cups ACC	CU-VIS drilling mud.	37.60	
	9D	9.6/8	38.50 - 39.30	40/50(3.6")				-			Grey, wet, very dense, SILT,	, some fine to coarse sand,	little gravel,	
- 40									2		(Till). Roller Coned ahead to 43.5 f	ft bgs.		
									6					
									0					
								_						
	10D	15.6/12	43.50 - 44.80	23/43/50(3.6")					Q-set har		Similar to above. Roller Coned ahead to 49.0 f	ft bgs.		G#207073 A-4, SM
- 45								_				0		WC=7.9%
								-	000					
								-	0					
								-	10.00					
1	<u> </u>							-			Cobble from 48.5-48.9 ft bgs Similar to above	5.		
50	11D	13.2/7	49.00 - 50.10	15/40/30 (1.2")			$ \rangle /$				Roller Coned ahead to 50.1 f	ft bgs.		

Auto Hammer #283 36.2 ft from Bridge Deck to Ground.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 2 of 3
* 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.	Boring No.: BB-HEPR-103

Maine Department of Transportation					tion	Project: Penobscot River Bridge #2660 carries Route Boring No.:						BB-HE	3-HEPR-103	
Soil/Rock Exploration Log US CUSTOMARY UNITS						155 over Penobscot River Location: Howland-Enfield, Maine					PIN:	167	05.00	
Driller: Northern Test Boring			Elevation (ft.) 127.0						Auger ID/OD:	5" Solid Stem				
Operator: Mike Nadeau/Tv Whitworth		Datum:			NAV	VD88		Sampler:	Standard Split	Spoon				
Logaed By: B Wilder		Rig Typ	e:		Died	lrich D-	50 Track	Hammer Wt./Fall:	140#/30"	1				
Date	e Start/Fi	nish:	8/17/10; 08:00	-16:00	Drilling	Metho	od:	Case	ed Wasł	Boring	Core Barrel:	NQ-2"		
Bori	ng Loca	tion:	N633430.5 E1	762334	Casing	D/OD	:	HW		0	Water Level*:	River Boring		
Ham	mer Effi	ciency Fa	actor: 0.678		Hamme	r Type):	Automa	atic 🖂	Hydraulic 🗆	Rope & Cathead 🗆	-		
Definitions: R = Rock Core Sa D = Split Spoon Sample SSA = Solid Stem MD = Unsuccessful Split Spoon Sample attempt HSA = Hollow Ste U = Thin Wall Tube Sample RC = Roller Cone MU = Unsuccessful Thin Wall Tube Sample attempt WOH = weight of V = Insitu Vane Shear Test, PP = Pocket Penetrometer WOR/C = weight W = Unsuccessful Insitu Vane Shear Test attempt WOR/P = Weight c					Core Sample d Stem Auger ow Stem Auger r Cone ight of 140lb. h veight of rods 'eight of one p	er nammer or casin erson	Ig	$ \begin{array}{llllllllllllllllllllllllllllllllllll$					trength (psf) t	
Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (pst) or RQD (%)	N-uncorrected N ₆₀	Casino	Blows	Elevation (ft.)	Graphic Log	Visual De	scription and Remarks	50.10	Laboratory Testing Results/ AASHTO and Unified Class	
50								76.90		Top of Bedrock at Elev. 76.	9 ft.			
- 55 ·	R1 R2 R3	60/60 15.6/12 48/48	51.10 - 56.10 56.10 - 57.40 57.40 - 61.40	RQD = 93% RQD = 0% RQD = 90%			Q-2		2012)12/12/12/12/12/12/12/12/12/12/12/12/12/1	Roller Coned ahead into Bed Roller Coned ahead into Bed Bedrock: Grey, fine-grained steep bedding planes, joints weathered zone, otherwise n Mass Quality is Good in R1 Formation] R1:Core Times (min:sec) 51.1-52.1 ft (4:10) 52.1-53.1 ft (5:30) 53.1-54.1 ft (5:30) 55.1-55.1 ft (5:10) 55.1-55.1 ft (5:30) 100% Re R2:Core Times (min:sec) 56.1-57.1 ft (5:45) 57.1-57.4 ft (4:00) 80% Rec Core Blocked R3:Core Times not recorded	nock to 51.1 ft bgs. I, moderately hard, fresh, close to moderatrely close ninor silt in-filling, no iron and R3, and Very Poor in covery very 1. 100% Recovery	PHYLLITE, thin, e except R2 is a staining. Rock R2. [Vassalboro		
- 65 - - 70 - - 75 - Rem								65.60		Bottom of Exploration	a at 61.40 feet below grou	61.40 nd surface.		
Aut 36.2	i arks: to Hamme 2 ft from I	er #283 Bridge Dec	k to Ground.											

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 3 of 3												
* 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.	Boring No.: BB-HEPR-103												
Maine Department of Transportation					tion		Project	Peno	oscot Ri	ver Bridge #2660 carries Route	Boring No.:	BB-HE	EPR-104
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Soil/Rock Exploration Log US CUSTOMARY UNITS						Locatio	155 с n: Но	ver Pen wland-E	bbscot River nfield, Maine	PIN:	1670)5.00	
Drill	Driller: MaineDOT Elevation						(ft.)	123	.4		Auger ID/OD:	N/A	
Ope	rator:		Giguere/Giles	/Daggett	Datum	า:		NA	VD88		Sampler:	Standard Split	Spoon
Log	ged By:		B. Schonewald	d	Rig Ty	/pe:		CM	E 45C		Hammer Wt./Fall:	140#/30"	
Date	Start/Fi	nish:	8/17/10-8/18/1	10	Drillin	gМ	ethod:	Ca	ed Was	1 Boring	Core Barrel:	NQ-2"	
Bori	ng Loca	tion:	N633510 E17	62593	Casin	g ID	/OD:	HV	/ & NW		Water Level*:	River Boring	
Ham	mer Effi	ciency Fa	actor: 0.84		Hamm	ner ⁻	Гуре:	Auton	atic 🛛	Hydraulic 🗆	Rope & Cathead □		
Definitions: R = Rock Core D = Split Spoon Sample SSA = Solid Ste MD = Unsuccessful Split Spoon Sample attempt HSA = Hollow S U = Thin Wall Tube Sample RC = Roller Cor MU = Unsuccessful Thin Wall Tube Sample attempt WOH = weight V = Insitu Vane Shear Test, PP = Pocket Penetrometer WOR/C = weight WV = Unsuccessful Thit Wane Shear Test attempt WOHP = Weight						e jer uger b. ha ds or <u>e per</u>	mmer casing son		$S_{u} = In$ $T_{v} = Pc$ $q_{p} = Ur$ N-unco Hamme $N_{60} = S$ $N_{60} = ($	itu Field Vane Shear Strength (psf) cket Torvane Shear Strength (psf) confined Compressive Strength (psf) rected = Raw field SPT N-value r Efficiency Factor = Annual Calibrati PT N-uncorrected corrected for ham <u>tammer Efficiency Factor/60%)*N-ur</u>	Su WC LL PL on Value PI : mer efficiency G = <u>ncorrected C =</u>	ab) = Lab Vane Shear S = water content, percen = Liquid Limit = Plastic Limit = Plasticity Index ∈ Grain Size Analysis ∈ Consolidation Test	trength (psf) t
				Sample Information					-				Laboratory
Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (pst) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	Graphic Log	Visual De	scription and Remark	KS	Testing Results/ AASHTO and Unified Class.
0	1D	24/3	0.00 - 2.00	6/4/8/14	12	17	16			Brown, medium dense, GRA (River Alluvium).	VEL, some fine to coa	rse sand, trace silt,	G#207074 A-1-a, GP WC=10.1%
							52 62						
							94						
							131	118.9					
- 5 -							86						
							144			Grey, very dense, fine to coa	rse SAND, some grav	el and silt,	G#207075
	2D	16/4	7.00 - 8.33	38/47/50(4")			196 aWA			(Alluvium). aWashed Ahead of casing fr	om 8.0-22.0 ft bgs.		A-1-b, SM WC=8.3%
10													
10													
	3D	24/11	12.00 - 14.00	15/19/31/32	50	70				Greyish brown, very dense, a	fine to coarse SAND, li	ttle gravel, trace silt,	G#239827
										(Anuviuni).			WC=15.1%
- 15 -													
	4D	24/4	17.00 - 19.00	20/19/19/20	38	53				Brown, very dense, gravelly	, fine to coarse SAND,	trace silt, (Alluvium).	
										Switch to NW Casing at 19.0) ft bgs.		
20				<u> </u>			$\left \right $	4					
							$ \setminus /$						
	5D	24/13	22.00 - 24.00	22/23/32/21	55	77	45			Greyish brown, very dense, (Alluvium).	gravelly, fine to coarse	SAND, trace silt,	G#239828 A-1-a, SW-SM
							81	1					WC=10.3%
_ 25 _							108						

Remarks:

Bridge Deck to mudline, 42.3 ft. Bridge Deck Core lost through deck. Deck to waterline 38.2 ft.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 1 of 3
* 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.	Boring No.: BB-HEPR-104

	Maine Department of Transportati				tion	1	Project	Penot	scot Ri	ver Bridge #2660 carries Route	Boring No.:	BB-HE	EPR-104
			Soil/Rock Exp US CUSTOM	loration Log ARY UNITS			Locatio	155 o n: Hov	ver Pen vland-E	obscot River nfield, Maine	PIN:	1670	05.00
Drill	er:		MaineDOT		Ele	vation	(ft.)	123	4		Auger ID/OD:	N/A	
Ope	rator:		Giguere/Giles	/Daggett	Dat	tum:		NA	VD88		Sampler:	Standard Split	Spoon
Log	ged By:		B. Schonewald	d	Rig	J Type:		CM	E 45C		Hammer Wt./Fall	: 140#/30"	
Date	Start/Fi	inish:	8/17/10-8/18/1	10	Dri	lling M	ethod:	Cas	ed Was	1 Boring	Core Barrel:	NQ-2"	
Bori	ng Loca	tion:	N633510 E17	62593	Cas	sina ID	/OD:	HW	& NW	U	Water Level*:	River Boring	
Ham	mer Effi	iciency Fa	actor: 0.84		Hai	mmer '	Type:	Autom	atic 🕅	Hydraulic 🗆	Rope & Cathead		
Defin	tions:		0.01	R = Rock (Core Sa	mple		rutom	S _u = Ins	itu Field Vane Shear Strength (psf)	S	Su(lab) = Lab Vane Shear S	trength (psf)
D = S MD =	plit Spoon Unsuccess	Sample sful Split Spo	on Sample attemp	pt SSA = Sol HSA = Hol	id Stem Iow Ster	Auger m Auger			$T_V = Po$ $q_p = Un$	cket Torvane Shear Strength (psf) confined Compressive Strength (ksf)) V	VC = water content, percen L = Liquid Limit	t
U = T	hin Wall Tu	be Sample	Tubo Sampla att	RC = Rolle	er Cone	- 140lb ba	mmer		N-uncoi Hamme	rected = Raw field SPT N-value	ion Value P	PL = Plastic Limit	
V = Ir	isitu Vane S	Shear Test,	PP = Pocket Per	netrometer WOR/C =	weight o	of rods or	casing		N ₆₀ = S	PT N-uncorrected corrected for ham	mer efficiency G	6 = Grain Size Analysis	
<u>IVIV</u> =	Unsuccess	stul insitu vai	he Shear Test atte	Sample Information	veight of	r one per	son		$N_{60} = (1)$	ammer Efficiency Factor/60%)"N-u	ncorrected C	= Consolidation Test	l
			ے		q			1	1				Laboratory
Depth (ft.)	Sample No.	Pen./Rec. (in	Sample Dept (ft.)	Blows (/6 in.) Shear Strength (pst) or RQD (%)	N-uncorrecte	N ₆₀	Casing Blows	Elevation (ft.)	Graphic Log	Visual De	scription and Rema	ırks	Results/ AASHTO and Unified Class.
25							176						
							162						
	6D	8.4/5	27.00 - 27.70	40/50(2.4")			WASH			Greyish brown, very dense,	gravelly, fine to coars	se SAND, trace silt,	
							67	95.40	00.00	Roller Cone refusal at 27.8 f	t bgs. Attempt rock c	ore. Dropped through	
20							126		000000 000000 000000000000000000000000			28.00-	
50							153						
							166			Gray yary dansa SII T. son	a fina ta coarsa sand	trace gravel (Till)	C#220820
	7D	24/17	32.00 - 34.00	44/40/48/48	88	123	aWA	-	<u>50000</u>	^a Washed Ahead of casing fr	om 32.0-47.0 ft bgs.	, trace graver, (1111).	A-4, ML WC=11.6%
								-					
- 35 -								-					
								-	0012100				
	8D	9.6/1	37.00 - 37.80	59/56(3.6")				-	0000 0000 0000 0000	Same as above.			
								-	0.0.0				
- 40 -								83.40				— — — —40.00	
1													
									000				
	0.0	0.615	42.00 42.00	49/50(2,5%)						Grey, very dense, fine to coa	arse sandy SILT, trace	e gravel, (Till).	
	90	9.6/5	42.00 - 42.80	48/50(3.6")					000				
									0000				
									2.0 2.0 2.0				
- 45 -													
							/						
							$\uparrow \Downarrow$	1					
	10D	21.6/20	47.00 - 48.80	35/46/49/50(3.6)	95	133	aWA	1		Grey, very dense, fine to coa a Washed ahead to 52.0 ft be	arse sandy SILT, trace gs.	e gravel, (Till).	G#239830 A-4, SM
								1	0.000		-		WC=8.4%
1								1					
50	<u> </u>												

Remarks:

Bridge Deck to mudline, 42.3 ft. Bridge Deck Core lost through deck. Deck to waterline 38.2 ft.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 2 of 3
* 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.	Boring No.: BB-HEPR-104

	Main	e Dep	artment	of Transporta	tion		Project:	Penob	scot Riv	ver Bridge #2660 carries Route	Boring No.:	BB-HE	EPR-104
Soil/Rock Exploration Log US CUSTOMARY UNITS						Locatio	155 o 1: How	ver Penc vland-Ei	bscot River nfield, Maine	PIN:	1670	05.00	
Drill	er:		MaineDOT		Elevati	on	(ft.)	123	.4		Auger ID/OD:	N/A	
Ope	rator:		Giguere/Giles/	Daggett	Datum	:		NA	VD88		Sampler:	Standard Split	Spoon
Log	ged By:		B. Schonewald	d	Rig Ty	pe:		CM	E 45C		Hammer Wt./Fal	1: 140#/30"	
Date	Start/Fi	nish:	8/17/10-8/18/1	0	Drilling	g Me	ethod:	Cas	ed Wash	Boring	Core Barrel:	NQ-2"	
Bori	ng Loca	tion:	N633510 E176	62593	Casing	j ID/	OD:	HW	& NW		Water Level*:	River Boring	
Ham	mer Effi	ciency Fa	actor: 0.84		Hamm	er T	ype:	Autom	atic 🖂	Hydraulic 🗆	Rope & Cathead □		
Defini D = S MD = U = T MU = V = In MV =	tions: plit Spoon S Unsuccess hin Wall Tu Unsuccess situ Vane S <u>Unsuccess</u>	Sample sful Split Spo be Sample sful Thin Wal Shear Test, sful Insitu Val	on Sample attemp I Tube Sample att PP = Pocket Per ne Shear Test atte	R = Rock C SSA = Soli bt HSA = Hol RC = Rolle empt WOH = we verter WOR/C = work mpt WO1P = work Sample Information	Core Sample d Stem Auge low Stem Au r Cone ight of 140lb weight of rod /eight of one	er ger . han s or o pers	nmer casing on		$S_{u} = Ins$ $T_{v} = Poo$ $q_{p} = Uno$ $N-uncorri$ Hammer $N_{60} = Si$ $N_{60} = (H)$	tu Field Vane Shear Strength (psf) ket Torvane Shear Strength (psf) confined Compressive Strength (ksf) ected = Raw field SPT N-value Efficiency Factor = Annual Calibrat PT N-uncorrected corrected for ham lammer Efficiency Factor/60%)*N-u	ion Value F mer efficiency (ncorrected (S _{U(lab)} = Lab Vane Shear S WC = water content, percen LL = Liquid Limit PL = Plastic Limit PI = Plastic limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test	trength (psf) t
			£		σ								Laboratory
Depth (ft.)	Sample No.	Pen./Rec. (in	Sample Dept (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrecte	09 _{N1}	Casing Blows	Elevation (ft.)	Graphic Log	Visual De	scription and Rema	arks	AASHTO and Unified Class.
50													
							\ /			Casing and Roller Cone Ref	usal at 52.0 ft bgs.		
							$-\gamma$	71.40	月月月 (1993)			52.00	
	R1	60/54	52.00 - 57.00	RQD = 62%			NQ-2		012	Top of Bedrock at Elev. 71.4	4 ft.		
									1891	R1:Bedrock: Grey, fine-grai	ned, hard, fresh, thin	ly bedded calcereous	
									age -	muscovite PHYLLITE. Bed smaller scale Moderately sr	ding high angle, high	ly undulating on	
- 55 -										to undulating, rough, fresh, t	tight breaks along bec	dding. Upper foot more	
55									1970	fractured, (close spacing). R	ock Mass Quality is I	Fair. [Vassalboro	
										Formation			
										R1:Core Times (min:sec)			
	R2	60/60	57.00 - 62.00	RQD = 52%						53.0-54.0 ft (2:50)			
								1		54.0-55.0 ft (2:40)	a not recorded)		
									<u>U</u>	56.0-57.0 ft (2:35) 90% Rec	overy		
60									1	R2·Bedrock: Grev fine-grai	ned hard fresh thin	ly bedded calcereous	
00										muscovite PHYLLITE. Bed	ding high angle, high	ly undulating on small	
										scale. Close, high angle, und open breaks along bedding	lulating to stepped, ro Fractured at 57.0 to 5	ough, fresh, tight to 57 5 ft and 58 8 to 60 0	
							V	61.40	, <u>Alb</u>	ft. Rock Mass Quality is Fa	ir. [Vassalboro Form	nation]	
										R2:Core Times (min:sec)			
										57.0-58.0 ft (3:00)			
										58.0-59.0 ft (3:30) 59.0-60.0 ft (4:30)			
65										60.0-61.0 ft (4:00)			
0.5										61.0-62.0 ft (3:40) 100% Re	covery	62.00	
I	<u> </u>							1	1	Bottom of Exploration	at 62.00 feet below	ground surface.	
I	<u> </u>								1				
I									1				
I								1	1				
I								1	1				
70													
									1				
	<u> </u>					_							
I									1				
I	 							1	1				
I									1				
75													
Rem	arks:	1	1		<u> </u>					ļ			

Bridge Deck to mudline, 42.3 ft. Bridge Deck Core lost through deck. Deck to waterline 38.2 ft.

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 3 of 3
* 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.	Boring No.: BB-HEPR-104

	Main	e Dep	artment	of Transporta	tion		Project:	Penob	scot Riv	ver Bridge #2660 carries Route	Boring No.:	BB-HE	EPR-105
Soil/Rock Exploration Log US CUSTOMARY UNITS					Location	155 ov n: How	/er Peno /land-E	bbscot River nfield, Maine	PIN:	1670	05.00		
Drill	er:		Northern Test	Boring	oring Elevat			167.	4		Auger ID/OD:	5" Solid Stem	
Ope	rator:		Mike Nadeau/	Ty Whitworth	Datu	um:		NA	VD88		Sampler:	Standard Split	Spoon
Log	ged By:		B. Schonewald	1	Rig	Туре	:	Died	lrich D-	50 Track	Hammer Wt./Fall:	140#/30"	
Date	e Start/Fi	nish:	8/19/10; 08:00	-14:15	Drill	ling N	lethod:	Case	ed Wasł	n Boring	Core Barrel:	NQ-2"	
Bori	ng Locat	ion:	N633575.2 E1	762800	Casi	ing IC	0/OD:	HW			Water Level*:	None Observed	1
Han	mer Effi	ciency Fa	actor: 0.678		Ham	nmer	Туре:	Autom	atic 🖂	Hydraulic 🗆	Rope & Cathead 🗆		
Defin D = S MD = U = T MU = V = Ir MV =	itions: plit Spoon S Unsuccessi hin Wall Tut Unsuccessi isitu Vane S <u>Unsuccessi</u>	Sample ful Split Spo be Sample ful Thin Wal hear Test, ful Insitu Va	oon Sample attemp Il Tube Sample att PP = Pocket Per <u>ne Shear Test atte</u>	R = Rock (C SSA = Sol Sot HSA = Hol RC = Rolle WOH = we empt WOR/C = empt WOR/P = we	Core Sam id Stem A low Stem er Cone sight of 14 weight of 0 <u>/eight of 0</u>	nple Auger Auger Allb. ha rods or one per	immer r casing rson		$S_u = Ins$ $T_V = Poole q_p = Unole N-uncor Hammen N_{60} = S N_{60} = (Hammen)$	Itu Heid Vane Shear Strength (psr) sket Torvane Shear Strength (psr) confined Compressive Strength (ksr) rected = Raw field SPT N-value Efficiency Factor = Annual Calibrati PT N-uncorrected corrected for ham lammer Efficiency Factor/60%)*N-ur	Su(lab WC = - LL = Li PL = P on Value PI = PI mer efficiency G = Gr ncorrected C = Cc	₁ = Lab Vane Shear S water content, percen quid Limit lastic Limit asticity Index ain Size Analysis nsolidation Test	trength (pst) t
				Sample Information	77			<u> </u>					Laboratory
Depth (ft.)	Sample No.	Pen./Rec. (in.	Sample Deptr (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	Graphic Log	Visual De	scription and Remarks		Testing Results/ AASHTO and Unified Class.
0							SSA	100.00		ASPHALT.		0.00	
	1D	24/6	1.00 - 3.00	17/14/15/15	29	33		100.00		Brown, damp, dense, fine to	coarse SAND, some grav	el, trace silt, (Fill).	G#239831 A-1-b, SW-SM WC=2.7%
- 5	2D	24/2	5.00 - 7.00	8/8/9/8	17	19				Brown, dry, medium dense, piece of gravel in tip of spoo	gravelly fine to coarse SA n, (Fill).	ND, trace silt,	
- 10	3D	24/16	10.00 - 12.00	6/10/7/5	17	19	62 81			Brown, damp, medium dense silt, (Fill).	e, fine to coarse SAND, so	ome gravel, trace	G#239832 A-1-b, SW-SM WC=7.5%
							136 126			Possible old asphalt layer at	13.0 ft based on wash wat	er.	
							148						
- 15	4D/AB	24/12	15.00 - 17.00	8/5/6/7	11	12	38	152.40 152.20			Dist, CLAY-SILT mixed w	- — — — — 15.00 ⁻ vith fill.	G#239833
							45			4D/B (15.2-17.0) Brown, mo sand, mottled, (Glaciomarine	pist, stiff, CLAY-SILT, tra e).	ce fine to medium	WC=24.1%
							66				,		PL=21 PI=12
							81						
							72	148.40		Driller notes material change	e at 19.0 ft bgs.	19.00	
- 20	5D	24/10	20.00 - 22.00	2/2/2/3	4	5	40]		Dark brown and black, mois (Glaciomarine).	t, loose, fine to medium S.	AND, little silt,	G#239834 A-2-4, SM
							44						WC=18.5%
							53	1					
							60						
25							68						

Auto Hammer #283

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 1 of 3
* 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.	Boring No.: BB-HEPR-105

Maine Department of Transportatio					tion	l I	Project: Penobscot River Bridge #2660 carries Route Boring No.: BB-H							
	Soil/Rock Exploration Log US CUSTOMARY UNITS					Locatio	155 с on: Но	ver Pei vland-l	nobscot River Enfield, Maine	PIN:	1670)5.00		
Drill	er:		Northern Test	Boring	Ele	vation	(ft.)	167	4		Auger ID/OD:	5" Solid Stem		
Ope	rator:		Mike Nadeau/	Ty Whitworth	Dat	um:	()	NA	VD88		Sampler:	Standard Split	Spoon	
Logo	ged By:		B. Schonewald	1	Rig	Type		Die	drich I	0-50 Track	Hammer Wt./Fall:	140#/30"		
Date	Start/Fi	nish:	8/19/10; 08:00	-14:15	Dril	lling M	lethod:	Cas	ed Wa	sh Boring	Core Barrel:	NQ-2"		
Bori	ng Locat	tion:	N633575.2 E1	762800	Cas	sing ID)/OD:	HV	,	C	Water Level*:	None Observed	1	
Ham	mer Effi	ciency Fa	actor: 0.678		Har	mmer	Туре:	Auton	atic 🖂	Hydraulic 🗆	Rope & Cathead			
Definitions: R = Rock Core Sample D = Split Spoon Sample SSA = Solid Strem Aug MD = Unsuccessful Split Spoon Sample attempt HSA = Hollow Stem Aug U = Thin Wall Tube Sample RC = Roller Cone MU = Unsuccessful Thin Wall Tube Sample WOH = weight of 140lb V = Insitu Vane Shear Test, PP = Pocket Penetrometer WOR/C = weight of rod MV = Unsuccessful Insitu Vane Shear Test attempt WOIP = Weight of rod							mmer casing son		$S_{U} = Ir$ $T_{V} = P$ $q_{p} = U$ $N-unco$ $Hamm$ $N_{60} =$ $N_{60} =$	situ Field Vane Shear Strength (psf) bocket Torvane Shear Strength (psf) nconfined Compressive Strength (ksf) rrected = Raw field SPT N-value er Efficiency Factor = Annual Calibrat SPT N-uncorrected corrected for ham (Hammer Efficiency Factor/60%)*N-u	Su(lab) WC = V WC = V PL = P ion Value PI = PI mmer efficiency G = Gr ncorrected C = Co	= Lab Vane Shear S water content, percen quid Limit lastic Limit asticity Index ain Size Analysis nsolidation Test	trength (psf) t	
				Sample Information			1	-	4				Laboratory	
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 De	scription and Remarks		Testing Results/ AASHTO and Unified Class.	
25	6D	24/7	25.00 - 27.00	3/4/4/5	8	9	45			Same as above.				
							59							
							82	_						
							99	138.8)	Drilling behavior suggests n	naterial change at 28.6 ft, b	28.60 28.60 oney material.		
- 30 -	7D	24/7	20.00 22.00	11/15/17/19	22	26	194			Brown, dense, gravelly fine	to coarse SAND, some silt	, (Till).		
	/D	24/7	50.00 - 52.00	11/15/17/18	52	30	104	_						
							208							
							338	_						
25							286							
- 55 -	8D	24/12	35.00 - 37.00	39/21/38/36	59	67	aWA			Brown, very dense, gravelly ^a Washed Ahead to 39.8 ft b	, fine to coarse SAND, litle gs.	e silt, (Till).	G#239835 A-1-b, SM	
								_					wC=9.1%	
								_						
		60/54	20.00 44.00	DOD 25%) NO Ó							
- 40 -	KI	60/54	39.80 - 44.80	RQD = 35%			NQ-2	127.6		Top of Bedrock at Elev 127	6 ft			
										R1:Bedrock: Grey, fine-grai calcereous METASILTSTO	ned, hard, fresh to slught NE. Original bedding high	ly weathered, ly disturbed to not		
										discernible. Quartz inclusion	ns, close to moderately spa	aced, moderately		
								-		Rock Mass Quality is Poor.	[Vassalboro Formation]	open tractures.		
										D1(Core Times (minuses)				
	R2	42/38	44.80 - 48.30	RQD = 86%				1		39.8-40.8 ft (4:00)				
- 45 -								1		40.8-41.8 ft (6:30) 41 58-42 8 ft (7:40)				
							+ $+$	-		42.8-43.8 ft (6:40)				
										43.8-44.8 ft (8:30) 90% Rec	overy			
										R2:Bedrock: Same as R1, ex	scept original bedding not	discernible, more		
	R3	24/22	48 30 - 50 30	ROD - 71%			+	1		47.15 and 47.65 ft. Rock M	ass Quality is Good.	two unit ofeaks a		
	к <u>э</u>	24/22	+0.50 - 50.50	KQD = /1%			+++	-		90% Recovery				
50										R3:Bedrock: Same as R2, or	ne drill break at 49.6 ft. Ro	ock Mass Quality		
Rem	arks:													

Auto Hammer #283

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 2 of 3
* 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.	Boring No.: BB-HEPR-105

Sublex Supportion Log If water Periodset Water PIN: 16705.00 Differ: Notice It to Brows Elevation (fg.) 1774 Auger DODE: Sublex Support Su		Main	e Dep	artment	of Transport	ation		Project:	Penob	scot Riv	ver Bridge #2660 carries Route	Boring No.:	BB-HE	EPR-105
Differ: Northon The Working Elevation (H) 10.4 Ager (DOC): 's dot Sum' Logid By: 0. Abtenuel/Withworkin Big Type: Diable: NAV1081 Mammer WA-118:			-	Soil/Rock Exp US CUSTOM	oloration Log IARY UNITS			Locatio	155 ov n: How	ver Peno vland-E	bscot River nfield, Maine	PIN:	167	05.00
Operation: Mate Nation: 'y Wateworth Datum:: NAVU88 Sampler:: Sampler:: Sampler:: Sampler:: Sampler:: Note Sympo Deet Starting: 81 Million (000) 14.15 Onling Meeta: Core Starting: Note Starting: <th>Drill</th> <th>er:</th> <th></th> <th>Northern Test</th> <th>t Boring</th> <th>Elev</th> <th>vation</th> <th>(ft.)</th> <th>167.</th> <th>4</th> <th></th> <th>Auger ID/OD:</th> <th>5" Solid Stem</th> <th></th>	Drill	er:		Northern Test	t Boring	Elev	vation	(ft.)	167.	4		Auger ID/OD:	5" Solid Stem	
Logged by: 0. Standardiant Rig Type: Decide 50 Track Hammer Ward: Identify 100 Dot Start/Finish NH106 (500) Cond Wash Burding Ore Start? No. Observed Boring Location: NB3752 E1178200 Easing LOCO: HW Water Lower? No. Observed Boring Location: NB3752 E1178200 Easing LOCO: HW Water Lower? No. Observed Boring Location: NB3752 E1178200 Easing LOCO: HW Mater Lower? No. Observed Conderstandia Start Hammer MURC: HY Mater Lower? No. Observed No. Observed Conderstandia Start Lower? HY Mater Lower? No. Observed No.	Ope	rator:		Mike Nadeau	/Ty Whitworth	Dat	um:		NA	VD88		Sampler:	Standard Split	Spoon
Date SturpTimite: NUME Drilling Methods: Cand Weak Information Cond Weak Information <thcond information<="" td="" weak=""><td>Log</td><td>ged By:</td><td></td><td>B. Schonewal</td><td>ld</td><td>Rig</td><td>Type:</td><td></td><td>Diec</td><td>lrich D-</td><td>50 Track</td><td>Hammer Wt./Fall:</td><td>140#/30"</td><td>-</td></thcond>	Log	ged By:		B. Schonewal	ld	Rig	Type:		Diec	lrich D-	50 Track	Hammer Wt./Fall:	140#/30"	-
Instrume Efficiency Pactor: 0.013 Ensurement Efficiency Pactor: 0.013 Human Efficiency Pactor: Non: Observed Hemmany Efficiency Pactor: 0.015 Human Efficiency Pactor: 0.015 Human Efficiency Pactor: Data (Laborator) Lipolatical: Lipolatica: Lipolatica: Lipolatica: Lipolatica: Lipolatica: Lipolatica: Lipola: Lipolatica: Lipola:	Date	Start/Fi	inish:	8/19/10: 08:0	0-14:15	Dril	lina M	ethod:	Case	ed Wash	Boring	Core Barrel:	NO-2"	
Control Efficiency Factor: 0.078 Hammer Type: Automating Herdmail Rept A Calued E 0 - Set Stars Stars 8.9 - Set Stars Stars 9.9 - Set Stars Stars Stars Stars Stars 9.9 - Set Stars Stars Stars Stars 9.9 - Set Stars Stars Stars	Bori	ng Loca	tion:	N633575.2 E	1762800	Cas	ina ID	/OD:	HW		6	Water Level*:	None Observed	1
Optimizer Description Product of setting in the set i	Ham	mer Effi	iciency F	actor: 0.678		Han	nmer '	Type:	Autom	atic 🕅	Hydraulic 🗆	Rope & Cathead		-
University	Defini D = S MD = U = T MU = V = In MV =	itions: plit Spoon & Unsuccess hin Wall Tu Unsuccess situ Vane & Unsuccess	Sample sful Split Spo be Sample sful Thin Wa Shear Test, sful Insitu Va	con Sample attern Il Tube Sample at PP = Pocket Pe ane Shear Test att	R = Rock SSA = Si hpt HSA = H RC = Rol itempt WOH = v workrometer WOR/C = tempt WO1P =	Core San olid Stem / ollow Sten ller Cone veight of 1 = weight of Weight of	nple Auger n Auger 40lb. ha f rods or one per	mmer casing son		$S_{u} = Ins$ $T_{v} = Pot$ $q_{p} = Un$ $N-uncor$ $Hammer$ $N_{60} = S$ $N_{60} = (h$	tu Field Vane Shear Strength (psf) ket Torvane Shear Strength (psf) confined Compressive Strength (ksf ected = Raw field SPT N-value Efficiency Factor = Annual Calibrat PT N-uncorrected corrected for ham lammer Efficiency Factor/60%)*N-u	Su(lab WC = WC = WC = PL = P ion Value PI = PI inner efficiency G = Gr ncorrected C = Cc) = Lab Vane Shear S water content, percen iquid Limit lastic Limit asticity Index ain Size Analysis onsolidation Test	Strength (psf) t
0 0			<u>.</u>	£	Sample Information	g								Laboratory
30	Depth (ft.)	Sample No.	Pen./Rec. (in	Sample Dept (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrecte	N ₆₀	Casing Blows	Elevation (ft.)	Graphic Log	Visual De	escription and Remarks		Results/ AASHTO and Unified Class
Image:	50							V	117.10	8888	is Fair.		50.20	
									-		Bottom of Exploration	n at 50.30 feet below grou	nd surface.	
A 0 A 0														
- 5 - 5 - 1 - 1														
A 10														
So									_					
- 55														
Authorner 293	- 55 -													
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Auto Hammer #283	- 60 -													
Action with the second seco									-					
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70 1 1 1 1 70 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1														
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75 1 1 1 1 Remarks: 1 1 1 1	I								-					
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Auto Hammer #283	<u>75</u> <u>R</u> em	l narks:	1	1				1	I	<u>I</u>				I
	Ant	to Hamme	er #283											

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 3 of 3
* 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.	Boring No.: BB-HEPR-105

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Appendix B

GZA Test Boring Logs

Maine Department of Transportat Soil/Rock Exploration Log US CUSTOMARY UNITS						F	Projec	t: Peno	bscot Ri	iver Bridge, Route 155	Boring No.: BB-HEPR-201	
			Soil/Rock Ex	ploration Log IARY UNITS		L	ocatio	on: Ho	wland, I	Maine	PIN:16705	.00
Dri	ler:		Maine Test I	Boring	Elevatio	on ((ft.)	153	3.9'		Auger ID/OD:	N/A
Ор	erator:		Brad Enos		Datum:			NA	AVD88		Sampler:	Split Spoon
Log	ged By:		Joshua Szmy	rt.	Rig Typ	be:		CM	AE-45 (S	Skid)	Hammer Wt./Fall:	140/30"
Dat	e Start/F	inish:	8/29/13 - 8/2	9/13	Drilling	Me	ethod:	Ca	sed Was	shed	Core Barrel:	NQ2
Bo	ring Loc	ation:	N 633178, E	1761888	Casing	ID/	OD:	3"/	/3-1/2"		Water Level*:	River Boring
Hai	nmer Ef	ficiency I	actor: 0.6		Hamme	er T	ype:	Autor	natic 🗆	Hydraulic 🗆	Rope & Cathead ⊠	
Defin D = MD U = MU V = MV	hitions: Split Spoor = Unsucces Thin Wall T = Unsucces Insitu Vane <u>= Unsucces</u>	a Sample ssful Split Sp ube Sample ssful Thin W Shear Test ssful Insitu V	ooon Sample atte all Tube Sample ane Shear Test	R = Roci SSA = S SA = M RC = Ro attempt WOH = V WOR = V WOR = V WOP = Sample Information	Core Sample olid Stem Auge ollow Stem Auge ller Cone veight of 140lb. veight of rods <u>Weight of one</u>	er ger . har <u>pers</u>	nmer son		$S_{u} = Ins$ $T_{v} = Pc$ $q_{p} = Ur$ $N-unco$ $Hamme$ $N_{60} = S$ $N_{60} = ($	situ Field Vane Shear Strength (psf) pocket Torvane Shear Strength (psf) coonfined Compressive Strength (ks rrected = Raw field SPT N-value ar Efficiency Factor = Annual Calibra SPT N-uncorrected corrected for han Hammer Efficiency Factor/60%)*N-r	Su(lab) = Lab Vane Shea WC = wat f) LL = Liqui PL = Plas tion Value PI = Plas tion Value PI = Plas mmer efficiency G = Grain uncorrected C = Conse	r Strength (psf) er content, percent d Limit tic Limit icity Index Size Analysis <u>blidation Test</u>
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	n and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/12	0.0 - 2.0	12-14-19-24	33 33		WA	153.6	****	-ASPHALT-	03	-
										Dense, light brown, fine to m Gravel, trace Silt (SM).	edium SAND, some	
- 5 -		24/16								-FILL- Dense, brown, fine to coarse	SAND, some Gravel, little	SM
	2D	24/16	5.0 - 7.0	12-23-20-16	43 43		42 40 40			Silt. (SM)	A-1-b	
- 10 -							66 70					
10	3D	1/0	10.0 - 10.1	50/1"			WA			No Kecovery.		
							79					
1.5							71					
- 15 -	4D	24/12	15.0 - 17.0	29-46-41-53	87 87		40 63			Very dense, olive, fine to me little Silt. Iron staining 9" fro	dium SAND, little Gravel, m top of sample. (SM)	
							153					
						+						
- 20 -							94 161	133.9				-
20	5D	2/0	20.0 - 20.2	105/2"				155.9		No Recovery	Advanced relies bits of 5	
	R1	32/29	21.5 - 24.2	RQD = 34%			NQ		STANDULIN STANDULIN	bgs and set 3" ID casing. Hard, fresh, fine grained, gra are closely spaced, high angle with Silt deposits. Rock Mass Quality = Very P Rock Core Times (min/ft): 5.	Advanced roller bit to 21.5 y/white PHYLLITE. Joints e, planar, rough, fresh, tight, oor 0, 4.0, 3.5	
25	R2	24/22	24.2 - 26.2	RQD = 62%					0110	Hard, fresh, fine-grained, gra	y/white PHYLLITE. Joints	
Rei	narks:				l l		1	•	AN 111	are moderately upping, plan		
1. 2.	Encounte Encounte	red boulde red boulde	er at 9.8' bgs (a er at 12.2' bgs (pproximately 2.6' thick). approximately 1.0' thick).							

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 1 of 2
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.	Boring No.: BB-HEPR-201

	Maine Department of Transportat Soil/Rock Exploration Log US CUSTOMARY UNITS						Projec	t: Peno	bscot R	River Bridge, Route 155	Boring No.:BE	B-HEPR-201
		Soil/Rock Exploration Log US CUSTOMARY UNITS Maine Test Boring					Locati	on: Ho	wland,	Maine	PIN:167	05.00
Dril	ler:		Maine Test	Boring		Elevatio	n (ft.)	153	3.9'		Auger ID/OD:	N/A
Оре	erator:		Brad Enos			Datum:		NA	VD88		Sampler:	Split Spoon
Log	jged By	' :	Joshua Szm	yt		Rig Type	e:	CM	/IE-45 (Skid)	Hammer Wt./Fall:	140/30"
Dat	e Start/	Finish:	8/29/13 - 8/2	29/13		Drilling	Method:	: Ca	sed Wa	shed	Core Barrel:	NQ2
Bor	ing Loc	cation:	N 633178, E	E 1761888		Casing I	D/OD:	3"/	3-1/2"		Water Level*:	River Boring
Har	nmer Ef	fficiency	Factor: 0.6			Hammer	· Type:	Autor	natic 🗆	Hydraulic 🗆	Rope & Cathead ⊠	
Defir D = 3 MD = U = ⁻ MU = V = 1 MV =	hitions: Split Spool = Unsucce Thin Wall ⁻ = Unsucce nsitu Vane <u>= Unsucce</u>	n Sample essful Split S Tube Sample essful Thin W e Shear Test essful Insitu V	poon Sample att e /all Tube Sample t <u>/ane Shear Test</u>	empt eattempt attempt Sample Inform	R = Rock Co SSA = Solid HSA = Hollo RC = Roller WOH = weig WOR = weig WOIP = We ation	re Sample Stem Auger w Stem Aug Cone ht of 140lb. I ht of rods ight of one p	er hammer verson		$S_{U} = Ir$ $T_{V} = P$ $q_{p} = U$ $N-uncc$ $Hamm$ $N_{60} =$ $N_{60} =$	nsitu Field Vane Shear Strength (ps ocket Torvane Shear Strength (psf) inconfined Compressive Strength (k prrected = Raw field SPT N-value er Efficiency Factor = Annual Calibu SPT N-uncorrected corrected for ha (Hammer Efficiency Factor/60%)*N	f) S _{u(lab)} = Lab Vane S WC = sf) LL = ation Value PI = F ammer efficiency G = C <u>uncorrected C = C</u>	Shear Strength (psf) water content, percent Liquid Limit Plastic Limit Plasticity Index irain Size Analysis consolidation Test Laboratory Testing
ל Depth (ft.)	Sample No.	Pen./Rec. (i	Sample Dep (ft.)	Blows (/6 in Shear Strength (psf)	or RQD (%)	N60	Casing Blows	Elevation (ft.)	Graphic Loc	Visual Descriptio	on and Remarks	Results/ AASHTO and Unified Class.
23									ANS)	Rock Core Times (min/ft): 4	4.25, 4.25	
								127.7		Bottom of Exploration at surf	26.20 feet below ground ace.	26.2- 1
- 30 -			<u> </u>			_		4				
								1				
								-				
			+					1				
- 35 -								-				
								1				
								4				
								1				
- 40 -								-				
								4				
			1									
			+					-				
			<u> </u>	L		_		-				
- 45 -								1				
								1				
			<u> </u>					4				
								1				
			+					1				
50												
1. 2. Strat	narks: Encounte Encounte	ered bould ered bould	er at 9.8' bgs (a er at 12.2' bgs nt approximate b	approximately 2.6 (approximately 1.	5' thick). .0' thick). soil types; tra	nsitions may	be gradua				Page 2 of 2	
* Wa pre	ter level re sent at the	eadings have e time meas	e been made at t urements were n	imes and under con nade.	ditions stated	. Groundwa	ter fluctuat	tions may	occur du	ue to conditions other than those	Boring No.: BE	-HEPR-201

	Maine Department of Transportat Soil/Rock Exploration Log US CUSTOMARY UNITS						Projec	t: Peno	bscot R	iver Bridge, Route 155	Boring No.: BB-H	IEPR-202
		_	Soil/Rock Ex	ploration Log			Locati	on: Ho	wland, I	Maine	PIN:16705	.00
Dril	ler:		Maine Test I	Boring	E	evatio	l n (ft.)	12	5.7' (mu	dline)	Auger ID/OD:	N/A
Ope	erator:		Rich Leonar	d/Jay O'Leary	D	atum:	()	NA	VD88		Sampler:	Split Spoon
Log	ged By:		Joshua Szmy	yt .	Ri	ig Type):	CM	1E-45 (S	Skid)	Hammer Wt./Fall:	140/30"
Dat	e Start/F	-inish:	8/19/13 - 8/1	9/13	D	rilling I	Method:	Ca	sed Was	shed	Core Barrel:	NQ2
Bor	ing Loc	ation:	N 633217, E	1751966	C	asing I	D/OD:	4"/	4-1/2" 8	& 3"/3-1/2"	Water Level*:	River Boring
Har	nmer Ef	ficiency	Factor: 0.6		H	ammer	Туре:	Autor	natic 🗆	Hydraulic 🗆	Rope & Cathead ⊠	
Defir D = 5 MD = U = MU = V = 1 MV =	iitions: Split Spoor Unsucces Thin Wall T Unsucces nsitu Vane Unsucces	n Sample ssful Split Sp Tube Sample ssful Thin W Shear Test ssful Insitu V	poon Sample atte a lall Tube Sample <u>/ane Shear Test</u>	R = F SSA empt HSA RC = attempt WOH WOR attempt WO1	Rock Core S = Solid Ste = Hollow S Roller Con I = weight of = weight of P = Weight	Sample m Auger tem Auge ne of 140lb. h of rods <u>t of one p</u>	er nammer <u>erson</u>		$S_u = In$ $T_v = Pc$ $q_p = Ur$ N-unco Hamme $N_{60} = S$ <u>N_{60} = (</u>	situ Field Vane Shear Strength (psf post forvane Shear Strength (psf) nconfined Compressive Strength (ks; rrected = Raw field SPT N-value ar Efficiency Factor = Annual Calibra SPT N-uncorrected corrected for ha Hammer Efficiency Factor/60%)*N-	Su(lab) = Lab Vane Shea WC = wat sf) LL = Liqui PL = Plass ation Value PI = Plast mmer efficiency G = Grain uncorrected C = Const	r Strength (psf) er content, percent d Limit tic Limit icity Index Size Analysis Jildation Test
				Sample information								Laboratory
Depth (ft.)	Sample No.	Pen./Rec. (in.	Sample Dept ^t (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)	Graphic Log	Visual Descriptio	n and Remarks	Testing Results/ AASHTO and Unified Class.
0	1D	24/7	0.0 - 2.0	6-17-11-11	28	28	66			Medium dense, gray, fine to trace Silt	coarse, sandy GRAVEL,	
							81	1		-ALLUVIAL DEPOSIT- (G	M)	
					-							
							131					
							108					
							388	121.2			4.5	-
- 5 -	D 1	57/51	5.5 10.2	BOD 5%			NO	-	9199	Top of Bedrock at 4.5' bgs.	Advanced roller bit to 5.5'	
	KI	57/51	5.5 - 10.5	RQD = 5%			NQ		(US)	Hard, fresh, fine grained, gra	y/white PHYLLITE.	
									au a	moderately dipping, planar to	o undulating, rough to	
										smooth, fresh to discolored,	very tight to tight. Secondary	7
								1	<u>9</u> 9772	dipping, planar to stepped, ro	bugh to smooth, discolored,	
								-	9199	partially open to open. Rock Mass Ouality = Very P	oor	
- 10 -									(CE))	Rock Core Times (min/ft): 6	.5, 5.0, 5.25, 6.0, 6.0	
10	R2	60/56	10.3 - 15.3	RQD = 54%					9C			q _p = 3.49 ksi
										Hard, fresh to slightly weath white PHYLLITE. Joints are	ered, fine grained, gray/ every closely to moderately	_
								-		spaced, low to high angle, un	idulating to planar, fresh to	
										Rock Mass Quality = Fair	wide.	
										Rock Core Times (min/ft): 5	.5, 9.0, 6.75, 11.0, 8.0	
								1	199			
- 15 -								-	<i>GEN</i>			
	R3	60/51	15.3 - 20.3	RQD = 48%					au	Hard, fresh to slightly weath	ered, fine grained, gray/	
										white PHYLLITE. Joints are	closely spaced, low to high the discolored open	
								1	<i>[]]][]</i>	Rock Mass Quality = Poor		
									9199	Rock Core Times (min/ft): 9	.5, 7.25, 7.75, 9.25, 8.5	
							/	-	NG 610			
- 20 -									96			
20							V V	105.4	61 <i>11</i> 61	Bottom of Exploration at	20.3 20 30 feet below ground	-
										surfa	ice.	
								-				
								1				
25 Rer	narks:											L
1. 2. 3. Strat	Cobbles t Encounte Depth of ification lin ter level re	from 2.5' b red Bedro water = 2.	bgs to 4.5' bgs (ck at El 121.2' 3'.	(El 123.2' to 121.2'). and advanced roller b pundaries between soil typ mes and under conditions	it to El 12 pes; transiti s stated. G	20.2' bef	ore corin	g. Set 3' I. ions may	'-ID cas	ing before coring. e to conditions other than those	Page 1 of 1	
pre	sent at the	time measu	urements were m	nade.							Boring No.: BB-	HEPK-202

	Main	e Dep	artment	t of Transpor	tatio	n	Projec	t: Peno	bscot Ri	ver Bridge, Route 155	Boring No.: BB-H	IEPR-203
			Soil/Rock Ex	ploration Log			Locati	on: Ho	wland, N	Maine	PIN:16705	.00
Dril	ler:		Maine Test I	Boring	E	levatio	n (ft.)	123	.0' (mu	lline)	Auger ID/OD:	N/A
Оре	erator:		Rich Leonar	d/Jay O'Leary	D	atum:		NA	VD88		Sampler:	Split Spoon
Log	ged By		Joshua Szmy	νt	R	ig Type):	CM	IE-45 (S	Skid)	Hammer Wt./Fall:	140/30"
Dat	e Start/I	Finish:	8/20/13 - 8/2	2/13	D	rilling l	Method:	Cas	ed Was	hed	Core Barrel:	NQ2
Bor	ing Loc	ation:	N 633266, E	1762136	C	asing I	D/OD:	4"/4	4-1/2" &	z 3"/3-1/2"	Water Level*:	River Boring
Defir	nitions:	ficiency	Factor: 0.6	R = R	ock Core	Sample	Type.	Auton	$S_u = lns$	Hydraunc ⊔ situ Field Vane Shear Strength (psf	Rope & Cathead \boxtimes) $S_{u(lab)} = Lab Vane Shea$	r Strength (psf)
D = \$ MD = U = 7 MU = V = 1 MV =	Split Spoor = Unsucce Thin Wall 1 = Unsucce nsitu Vane = Unsucce	n Sample ssful Split S Fube Sample ssful Thin W Shear Test ssful Insitu V	poon Sample atte 9 /all Tube Sample : /ane Shear Test ;	sSA = empt HSA = RC = I attempt WOH WOR attempt WO1F	Solid Ste Hollow S Roller Cor weight o weight o = weight o	em Auger Stem Auge ne of 140lb. H of rods t of one p	er nammer erson		$T_V = Po$ $q_p = Un$ N-uncor Hamme $N_{60} = S$ $N_{60} = (1)$	cket Torvane Shear Strength (psf) confined Compressive Strength (ks rected = Raw field SPT N-value r Efficiency Factor = Annual Calibr: SPT N-uncorrected corrected for ha Hammer Efficiency Factor/60%)*N-	wC = wat sf) LL = Liqui PL = Plas ation Value PI = Plas mmer efficiency G = Grain uncorrected C = Conse	er content, percen d Limit tic Limit icity Index Size Analysis <u>blidation Test</u>
		<u> </u>		Sample Information	7							Laboratory
Depth (ft.)	Sample No.	Pen./Rec. (in.	Sample Dept (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	Graphic Log	Visual Descriptio	n and Remarks	Testing Results/ AASHTO and Unified Class
0	1D	24/8	0.0 - 2.0	5-13-11-17	24	24	29			Medium dense, brown, grave	elly, fine to coarse SAND,	
							38			trace Sht. (SW)		
							50					
							49	-				
							36					
							39					
- 5 -							41	118.0			5.0	
	20	24/5	60.80	19 17 48 30	65	65	34	-		Very dense, gray, fine to coa	rse SAND, some Gravel,	
	20	24/3	0.0 - 8.0	19-17-48-50	05	05	54			ALLUVIAL DEPOSIT- (SV	W-SM)	
							54					
							68					
							83					
- 10 -							99	1				
	3D	24/11	11.0 - 13.0	9-27-19-24	46	46	41			Dense, gray, fine to medium Silt. (SM)	SAND, little Gravel, trace	
							48					
							77	-				
- 15 -							111			Very dense, gray fine to coa	rse SAND, some Gravel	SW SM
	4D	24/10	15.0 - 17.0	9-22-36-40	58	58	50			trace Silt. (SW-SM)	ise brand, some Graver,	A-1-b
							76					
							119					
							111					
							112					
- 20 -							112	103.0				F
	5D	24/14	20.0 - 22.0	20-28-62-102	90	90	71	-		-GLACIAL TILL- (SM)	AVEL, trace Sht.	
							262					
							69					
							144	1				
							281					
25 Rer	narks						201					
1. 2. 3. 4. 5.	Rock in t Encounte Increased Encounte	tip of samp ered Cobbl d drilling e d drilling e ered casing	ble 1D split spo es from approx ffort after sam ffort at 13' bgs refusal at 21.6 t approximate bo	on. imately 2' bgs to 5.5' b ole 2D. ' bgs. Advanced roller undaries between soil type	gs. bit to 24	4.0' bgs a	and contin	nued driv	ving cas	ing to 24.5' bgs.	Page 1 of 2	
*Wa	ter level re sent at the	eadings have	been made at ti urements were m	mes and under conditions ade.	stated. G	Groundwa	ter fluctuat	 ions may	occur due	e to conditions other than those	Boring No.: BB-	HEPR-203

	Main	ie Dep	artment	t of Transp	portat	ion	Projec	t: Penc	bscot R	River Bridge, Route 155	Boring No.:BB-	HEPR-203
			Soil/Rock Ex	ploration Log			Locati	on: Ho	owland,	Maine	PIN:1670	5.00
Dril	ler:		Maine Test I	Boring		Elevatio	n (ft.)	12	3.0' (mu	udline)	Auger ID/OD:	N/A
Оре	erator:		Rich Leonar	rd/Jay O'Leary		Datum:		NA	AVD88		Sampler:	Split Spoon
Log	ged By	:	Joshua Szmy	yt		Rig Typ	e:	CN	ИЕ-45 (Skid)	Hammer Wt./Fall:	140/30"
Dat	e Start/I	Finish:	8/20/13 - 8/2	22/13		Drilling	Method	: Ca	sed Wa	shed	Core Barrel:	NQ2
Bor	ing Loc	ation:	N 633266, E	E 1762136		Casing I	D/OD:	4",	/4-1/2" 。	& 3"/3-1/2"	Water Level*:	River Boring
Har	nmer Ef	ficiency	Factor: 0.6			Hamme	r Type:	Autor	natic 🗆	Hydraulic 🗆	Rope & Cathead ⊠	
Defir D = \$ MD = U = ⁻ MU = V = I MV =	itions: Split Spoor - Unsucce Thin Wall 1 - Unsucce nsitu Vane - Unsucce	n Sample Issful Split S Tube Sampl Issful Thin W Shear Tes Issful Insitu V	poon Sample atte e /all Tube Sample t <u>/ane Shear Test</u>	empt F empt F eattempt V attempt V Sample Informa	R = Rock CcSSA = SolidISA = HollorRC = RollerVOH = weigVOR = weigVOR = weig	re Sample Stem Auger w Stem Aug Cone ht of 140lb. ht of rods ight of one p	er hammer berson		$S_{U} = Ir$ $T_{V} = P$ $q_{p} = U$ $N-unco$ $Hamm$ $N_{60} =$ $N_{60} =$	nsitu Field Vane Shear Strength (psf ocket Torvane Shear Strength (psf) nconfined Compressive Strength (k prrected = Raw field SPT N-value er Efficiency Factor = Annual Calibr SPT N-uncorrected corrected for ha (Hammer Efficiency Factor/60%)*N	f) S _u (lab) = Lab Vane She WC = w sf) LL = Liq PL = Pla ation Value PI = Pla ammer efficiency G = Gra -uncorrected C = Cor	ar Strength (psf) ater content, percer uid Limit stic Limit sticity Index in Size Analysis solidation Test
		<u>.</u>	£						1			Laboratory
Depth (ft.)	Sample No.	Pen./Rec. (in	Sample Dept (ft.)	Blows (/6 in.) Shear Strength (psf) or ROD (%)	N-uncorrecte	N ₆₀	Casing Blows	Elevation (ft.)	Graphic Log	Visual Descriptic	on and Remarks	Results/ AASHTO and Unified Class
25	6D	1/0	25.0 - 25.1	100/1"			>100	97.9	alta)	No Recovery. Split spoon re	fusal at 25.1' bgs25	1-
										Top of Bedrock at 25.1' bgs. and set 3" ID casing.	Advanced roller bit to 27.	0'
	R1	12/9	27.0 - 28.0	RQD = 0%			NQ			Hard, tresh, fine grained, gra are closely spaced. moderat	ay/white, PHYLLITE. Join ely dipping, fresh to	ts
	R2	60/60	28.0 - 33.0	RQD = 61%						discolored, planar, rough, op Rock Mass Quality = Very I Rock Coro Times (min/ft)	Poor	
										Rock Core Times (mm/n).		
- 30 -			+ +							Hard, fresh, fine grained, gra are closely to moderately sp	ay/white, PHYLLITE. Joint aced, high angle to vertical.	.5
								-		undulating to planar, rough,	fresh to discolored, tight.	
									<u>N</u> M	Rock Core Times (min/ft): 3	3.25, 4.0, 3.5, 2.5, 2.75	
									<i>M</i>			
	P 3	60/60	33.0.38.0	ROD - 67%								
	KJ	00/00	33.0 - 38.0	KQD = 0770				-		Hard, fresh to discolored, fin PHYLLITE. Primary joints	ne grained, gray/white, are moderately spaced, high	1
25										angle, undulating to stepped	, rough, discolored to fresh	,
55									<u>N</u>	to low angle, discolored, op	noderately spaced, norizont	ai
			+						1915	Rock Mass Quality = Fair	25 4 25 2 75 2 0 2 0	
							/			Rock Cole Thiles (hill/h).	.5, 4.25, 5.75, 2.0, 2.0	
							V	05.0			20	0
								85.0		Bottom of Exploration at	38.00 feet below ground	.0-
			+					-		surf	ace.	
- 40 -								4				
			1					1				
								-				
			1 1					1				
- 45 -								-				
			+					1	1			
								-	1			
									1			
									1			
50 Rer	narks:		<u> </u>	<u> </u>					1	I		
1. 2. 3.	Rock in t Encounte Increased	tip of samp ered Cobbl d drilling e	ble 1D split spo les from approx ffort after sam	oon. ximately 2' bgs to 5 ple 2D.	5.5' bgs.							
4. 5.	Increased Encounte	d drilling e ered casing	ffort at 13' bgs g refusal at 21.0	;. 6' bgs. Advanced re	oller bit to	24.0' bgs :	and conti	nued dri	ving ca	sing to 24.5' bgs.		
Strat * Wa	ification lin	nes represer eadings have	it approximate bo e been made at t	oundaries between so times and under condi	il types; trar tions stated	sitions may Groundwa	be gradua iter fluctuat	II. tions may	occur du	ue to conditions other than those	Page 2 of 2 Boring No.: BB-	HEPR-203

	Main	e Dep	t of Transpor	rtation Project: Penobscot River Bridge, Route 155					iver Bridge, Route 155	Boring No.: BB-HEPR-204		
			Soil/Rock Ex	ploration Log MARY UNITS			Locati	on: Ho	wland,	Maine	PIN: 16705	.00
Dri	ler:		Maine Test	Boring	Elev	atio	n (ft.)	123	3.2' (mu	dline)	Auger ID/OD:	N/A
Ор	erator:		Rich Leonar	d/Brad Enos	Datu	m:		NA	VD88		Sampler:	Split Spoon
Log	ged By	:	Joshua Szm	yt	Rig	Гуре	:	CM	/IE-45 (\$	Skid)	Hammer Wt./Fall:	140/30"
Dat	e Start/I	Finish:	8/22/13 - 8/2	26/13	Drill	ng I	Method:	Ca	sed Was	shed	Core Barrel:	NQ2
Bor	ing Loc	ation:	N 633347, E	E 1762385	Casi	ng l	D/OD:	4"/	4-1/2" 8	& 3"/3-1/2"	Water Level*:	River Boring
Har Defin D = 1 MD = U = 1 MU = V = 1 MV =	nmer Ef hitions: Split Spoor = Unsucce: Thin Wall 1 = Unsucce: nsitu Vane = Unsucce:	ficiency Sample ssful Split Sp Tube Sample ssful Thin W Shear Test ssful Insitu V	Factor: 0.6	R = Rc SSA = RC = F attempt WOH WOR attempt WO19 Somple Information	Ham bock Core Sam Solid Stem A Hollow Stem Roller Cone = weight of 14 = weight of ro = Weight of	mer ple uger Auge Olb. h ds one po	Type: er nammer erson	Auton	$\begin{array}{c} \text{natic} \square\\ S_u = \ln\\ T_v = Pc\\ q_p = Ur\\ N-unco\\ Hamme\\ N_{60} = 1\\ \hline\\ N_{60} = 1\\ \hline\end{array}$	Hydraulic situ Field Vane Shear Strength (psf ocket Torvane Shear Strength (psf) nconfined Compressive Strength (k: rrected = Raw field SPT N-value er Efficiency Factor = Annual Calibris SPT N-uncorrected corrected for ha (Hammer Efficiency Factor/60%)*N-	$\begin{array}{llllllllllllllllllllllllllllllllllll$	r Strength (psf) er content, percent d Limit lic Limit licity Index Size Analysis plidation 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 Descriptio	n and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0	1D	24/5	0.0 - 2.0	4-8-6-7	14	14	9			Medium dense, light brown, some Gravel, trace Silt.	medium to coarse SAND,	
							19			-ALLUVIAL DEPOSIT- (SI	(h	
							25					
							27	-				
							27			Medium dense, light brown,	gravelly, medium to coarse	
- 5 -	2D	24/11	4.0 - 6.0	16-10-15-16	25	25	16	-		SAND, trace Silt. (SM)		
							32					
							38					
							117					
							102	115.2			8.0	F
							102	-		No Recovery.		
- 10 -	3D	6/0	9.0 - 9.5	132/6"			WA					
	4D	13/6	11.0 - 12.1	14/45/100/1"						Very dense, gray, fine to coa trace Silt. (SM)	rse SAND, little Gravel,	
		2.1/2			10					Dense, gray, fine to coarse S	AND, some Gravel, trace	
- 15 -	5D	24/5	14.0 - 16.0	20-24-24-23	48	48	54	-		Silt. (SM)		
							78					
							84					
							88					
							130					
	6D	24/12	19.0 - 21.0	14-21-24-53	45	45	59			Dense, gray, fine to coarse S Silt.	AND, some Gravel, trace	
- 20 -							115			-ALLUVIAL DEPOSIT- (SI	(Iv	
							112	1				
							113	-				
							151					
							150					
25	7D	24/14	24.0 - 26.0	27-32-37-29	69	69	101			Very dense, gray, fine to coa trace Silt. (SW-SM)	rse SAND, some Gravel,	SW-SM A-1-b
Rer	narks:		1		· · · · · ·							•

Rock in tip of split spoon for sample 2D.
 Wash water change from brown to gray at 8' bgs.
 Encountered Cobbles from 9' bgs to 11' bgs. Probably pushed Cobble with sample 3D. Advance roller bit from 9' bgs to 11' bgs before advancing casing to 11' bgs.
 Encountered Boulder 12.1' bgs (0.8' thick). ler bit to 50.6' bgs and set 3" ID casing.

Page 1 of 3 Boring No.: BB-HEPR-204 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.

	Main	e Dep	artmen	t of Transpor	tatio	n Project: Penobscot River Bridge, Route 155 Boring						HEPR-204
			Soil/Rock Ex	ploration Log MARY UNITS			Locati	on: Ho	wland,	Maine	PIN:1670	5.00
Dri	ler:		Maine Test	Boring	EI	evatio	L n (ft.)	12	3.2' (mu	dline)	Auger ID/OD:	N/A
Op	erator:		Rich Leonar	d/Brad Enos	Da	atum:	. ,	NA	VD88	,	Sampler:	Split Spoon
Loc	ged By	:	Joshua Szm	vt	Ri	q Type):	CN	/IE-45 (\$	Skid)	Hammer Wt./Fall:	140/30"
Dat	e Start/l	Finish:	8/22/13 - 8/2	26/13	Di	illing I	Method:	Ca	sed Was	shed	Core Barrel:	NQ2
Bor	ing Loc	ation:	N 633347, E	E 1762385	Ca	asing I	D/OD:	4"/	4-1/2" 8	& 3"/3-1/2"	Water Level*:	River Boring
Har	nmer Ef	ficiency	Factor: 0.6		Ha	ammer	Type:	Autor	natic 🗆	Hydraulic 🗆	Rope & Cathead ⊠	T
Defin D = 1 MD = U = 1 MU = V = 1 MV =	nitions: Split Spoor - Unsucce Thin Wall 1 - Unsucce nsitu Vane - Unsucce	n Sample ssful Split S Fube Sample ssful Thin W Shear Test ssful Insitu V	poon Sample att e /all Tube Sample t <u>/ane Shear Test</u>	R = Rc SSA = empt HSA = RC = F attempt WOR attempt WO1F Sample Information	ock Core S Solid Ster Hollow St Roller Con = weight o = weight o <u>= Weight</u>	Gample m Auger tem Auge e f 140lb. h f rods of one pe	er nammer erson		$S_u = In$ $T_v = Pc$ $q_p = Ut$ $N-unco$ $Hamme$ $N_{60} = 1$	situ Field Vane Shear Strength (psf) coket Torvane Shear Strength (psf) nconfined Compressive Strength (ksr rrected = Raw field SPT N-value ar Efficiency Factor = Annual Calibra SPT N-uncorrected corrected for har (Hammer Efficiency Factor/60%)*N-	$\begin{array}{c} S_{u}(lab) = Lab \ Vane \ Sharphi \\ WC = w \\ sf) \qquad \qquad LL = Lit \\ PL = Pl \\ ation \ Value \qquad Pl = Pl \\ mmer \ efficiency \qquad G = Gr \\ uncorrected \qquad C = Con \\ \end{array}$	er Strength (psf) ater content, percent uid Limit stic Limit sticity Index in Size Analysis solidation Test
		<u>.</u>	÷.		σ							Laboratory
کم Depth (ft.)	Sample No.	Pen./Rec. (in	Sample Dept (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrecte	N ₆₀	Casing Blows	Elevation (ft.)	E Graphic Log	Visual Descriptio	n and Remarks	Results/ AASHTO and Unified Class.
25							96					
						92 183 WA						
	0.D	24/14	20.0 21.0	41 42 26 54	70	70				Very dense, gray, gravelly, f	ine to coarse SAND, trace	
- 30 -	8D	24/14	29.0 - 31.0	41-42-36-54	/8	/8				Silt. (GM)		
	0D	12/0	24.0 25.0	72/100/6"				89.2		No Recovery	34	.0-
- 35 -	9D	12/0	34.0 - 35.0	72/100/6"						No Recovery.		
	10D	15/12	36.0 - 37.3	32/70/73/3"						Very dense, gray, fine to mee Gravel. (ML)	dium, sandy SILT, some	
								-		Very dense, gray, fine to me	dium, sandy SILT, little	
- 40 -	11D	15/11	39.0 - 40.3	47/67/58/3"						Gravel. -GLACIAL TILL- (ML)		
	12D	24/12	44.0 - 46.0	28-35-34-46	73	73		79.2		Very dense, gray, fine SANE	— — — — — — — 44 D, little Silt, trace Gravel.	.0-
- 45 -				20-33-34-40						-GLACIAL TILL- (SM)	, ,	
	13D	24/11	49.0 - 51.0	8-56-63-89	>100		73	1		Very dense, gray, fine to mee Gravel. (SM)	dium SAND, little Silt, tra	:e
1. 2. 3.	narks: Rock in t Wash wa Encounte	ip of split ter change ered Cobbl	spoon for sam e from brown t les from 9' bgs	ple 2D. o gray at 8' bgs. to 11' bgs. Probably pu	shed Col	oble wit	h sample	3D. Ad	vance ro	oller bit from 9' bgs to 11' bgs b	before advancing casing to	11' bgs.
4.	Encounte	ered Bould	ler 12.1' bgs (0	.8' thick). ler bit to 50.6	' bgs and	set 3" I	ID casing					

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.

Page 2 of 3 Boring No.: BB-HEPR-204

	Main	e Dep	artment	t of Transpor	tation	l	Projec	t: Peno	bscot R	iver Bridge, Route 155	Boring No.: BB-H	IEPR-204
			Soil/Rock Ex	ploration Log //ARY UNITS			Locati	on: Ho	wland,	Maine	PIN:	5.00
Dril	ler:		Maine Test	Boring	Elev	/atio	n (ft.)	123	3.2' (mu	dline)	Auger ID/OD:	N/A
Оре	erator:		Rich Leonar	d/Brad Enos	Date	um:		NA	VD88		Sampler:	Split Spoon
Log	ged By	:	Joshua Szm	yt	Rig	Туре	:	CM	1E-45 (Skid)	Hammer Wt./Fall:	140/30"
Dat	e Start/l	Finish:	8/22/13 - 8/2	26/13	Dril	ling I	Method	Ca	sed Wa	shed	Core Barrel:	NQ2
Bor	ring Loc	ation:	N 633347, E	E 1762385	Cas	ing I	D/OD:	4"/	4-1/2" 8	& 3"/3-1/2"	Water Level*:	River Boring
Har	nmer Ef	ficiency	Factor: 0.6		Han	nmer	Type:	Autor	natic 🗆	Hydraulic 🗆	Rope & Cathead ⊠	
Defir D = 3 MD = U = 7 MU = V = 1 MV =	nitions: Split Spoor = Unsucce Thin Wall 1 = Unsucce nsitu Vane = Unsucce	n Sample Issful Split S Tube Sample Issful Thin W Shear Test Issful Insitu V	poon Sample atte e /all Tube Sample t /ane Shear Test	R = R SSA = RC = attempt WOH WOR attempt WOF	ock Core Sar Solid Stem / Hollow Sten Roller Cone = weight of 1 = weight of ro	mple Auger n Auge 40lb. h ods one p	er nammer erson		$S_{u} = In$ $T_{v} = Pe$ $q_{p} = Ue$ $N-uncc$ $Hamme$ $N_{60} = 1$	situ Field Vane Shear Strength (psf ocket Torvane Shear Strength (psf) nconfined Compressive Strength (ks yrrected = Raw field SPT N-value er Efficiency Factor = Annual Calibra SPT N-uncorrected corrected for ha (Hammer Efficiency Factor/60%)*N-) S _{u(lab)} = Lab Vane Shea WC = wa sf) LL = Liqu PL = Plas ation Value PI = Plas mmer efficiency G = Grair uncorrected C = Cons	r Strength (psf) er content, percent id Limit tic Limit icity Index size Analysis olidation Test
Jepth (ft.)	ample No.	en./Rec. (in.)	ample Depth t.)	ilows (/6 in.) hear trength ssf) r RQD (%)	l-uncorrected	leo	tasing slows	ilevation t.)	sraphic Log	Visual Descriptio	n and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50	S		C t	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	z	Z	Сm	Ш€	0			
	14D	24/13	54.0 - 56.0	43-47-61-69	>100		177 WA 86	-		Very dense, gray, fine to coa little Silt. (SM)	rse SAND, some Gravel,	SM A-1-b
- 55 -							151	-				
- 60 -	R1	60/60	56.6 - 61.6	RQD = 56%			NQ	66.8	N. C. M. C. M. D. C. M. C M. C. M. C M. C. M. C M. C. M. C.	Top of Bedrock at 56.4' bgs. bgs and set 3" ID casing. Hard, fresh, fine grained, y Joints are closely to moderat vertical, undulating, smooth to open. Rock Mass Quality = Fair Rock Core Times (min/ft): 1	56.4 Advanced roller bit to 56.6' white/gray PHYLLITE. ely spaced, high angle to n, fresh to discolored, tight .25, 1.5, 3.5, 3.0, 2.25	-
- 65 -	R2	60/58	61.6 - 66.6	RQD = 68%				-	APON APON APO APON APON APON APON APON APON	Hard, fresh, fine grained, w are closely spaced, moderate rough, fresh to discolored, o Rock Mass Quality = Fair Rock Core Times (min/ft): 2	hite/gray PHYLLITE. Joints ly dipping, undulating, pen to moderately wide. .0, 2.0, 3.5, 3.5, 4.75	; q _p = 4.18 ksi
							$ \rangle /$					
								56.6	91159	Bottom of Exploration at surfa	66.60 feet below ground ace.	ŗ
- 70 -								-				
75 Rer	narks:											
1. 2. 3. 4. Strat *Wa	Rock in t Wash wa Encounte Encounte	tip of split ater change ered Cobbl ered Bould nes represer eadings have	spoon for sam e from brown to es from 9' bgs er 12.1' bgs (0 nt approximate bc e been made at t	ple 2D. o gray at 8' bgs. to 11' bgs. Probably pu .8' thick). ler bit to 50.6 pundaries between soil typi mes and under conditions rade.	shed Cobb ' bgs and so es; transitions stated. Grou	le wit et 3" I s may I	h sample ID casing be gradua ter fluctua	3D. Ad g. I.	vance re occur du	oller bit from 9' bgs to 11' bgs b e to conditions other than those	Page 3 of 3 Boring No.: RR-F	1' bgs.

	Main	e Dep	artment	t of Transp	ortatio	n	Projec	Penobscot I	River Bridge, Route 155	Boring No.: BB-H	<u>HEPR-205</u>
			Soil/Rock Ex	ploration Log //ARY UNITS			Locatio	on: Howland,	Maine	PIN:16705	5.00
Dri	ler:		Maine Test !	Boring	Ek	evatior	ר ח (ft.)	122.3' (m	udline)	Auger ID/OD:	N/A
Ор	erator:		Brad Enos		Da	tum:	. ,	NAVD88	,	Sampler:	Split Spoon
Log	ged By	:	Joshua Szmy	yt	Ri	д Туре	:	CME-45	(Skid)	Hammer Wt./Fall:	140/30"
Dat	e Start/I	Finish:	8/26/13 - 8/2	26/13	Dr	illing N	lethod:	Cased Wa	ashed	Core Barrel:	NQ2
Bor	ing Loc	ation:	N 633424, E	1762636	Ca	ising II	D/OD:	4"/4-1/2"	& 3"/3-1/2"	Water Level*:	River Boring
Har	nmer Ef	ficiency	Factor: 0.6		Ha	mmer	Туре:	Automatic	Hydraulic	Rope & Cathead 🖂	Change at (a of)
D = 1 MD = U = 1 MU = V = 1 MV =	Split Spoor = Unsucce Thin Wall 1 = Unsucce nsitu Vane <u>= Unsucce</u>	n Sample ssful Split Sj rube Sample ssful Thin W Shear Test ssful Insitu V	poon Sample atte ∋ /all Tube Sample : /ane Shear Test	attempt WC SB attempt WC Sample Informati	A = Solid Ster $A = Solid Ster$ $A = Hollow Ster$ $A = Hollow Ster$ $A = Roller Constraints$ A	ample n Auger em Auge 140lb. h rods of one pe	r ammer erson	S _U = 1 T _V = F q _P = U N-unc Hamn N60 = <u>N60</u> =	Natur Field Varie Shear Strength (ps) hoconfined Compressive Strength (psf) hoconfined Compressive Strength (k orrected = Raw field SPT N-value her Efficiency Factor = Annual Calibi SPT N-uncorrected corrected for ha (Hammer Efficiency Factor/60%)'N	$\begin{array}{llllllllllllllllllllllllllllllllllll$	ler content, percent id Limit itic Limit licity Index I Size Analysis iolidation Test
t.)	No.	ic. (in.)	Depth	6 in.) (%)	rected			Log	Visual Descriptio	n and Remarks	Laboratory Testing Results/
Depth (f	Sample	Pen./Re	Sample (ft.)	Blows (/ Shear Strength (psf) or RQD	N-uncor	N ₆₀	Casing Blows	Elevatio (ft.) Graphic			and Unified Class.
0	1D	24/3	0.0 - 2.0	5-11-17-30	28	28	- 22		Medium dense, light brown, GRAVEL, trace Silt. (GM)	fine to medium, sandy	
					_		52	120.3		2.0)-
							40				
							132				
							261				
- 5 -	20	24/15	50.70	16 00 07 00		17			Dense, light brown, fine to r	nedium SAND, some	
	2D	24/15	5.0 - 7.0	16-20-27-28	47	47	69		Gravel, little Silt. (SM)		
							44				
							33				
							116				
			+				171				
- 10 -							1/1		Dense, light brown, fine to c	oarse SAND, trace Gravel,	
	3D	24/12	10.0 - 12.0	15-24-25-21	49	49	31		trace Silt.	M)	
							76		-ALLOVIAL DEFOSIT- (S	(1)	
							107				
							138				
- 15 -							161				
			<u> </u>				178		Dansa light brown fin- t-	oomo SAND, como Crossal	
	4D	24/11	16.0 - 18.0	13-22-23-18	45	45	WA		trace Silt. (SW-SM)	ourse bravel, some Gravel,	
- 20 -											
20-							148				
	5D	24/16	21.0 - 23.0	14-19-22-32	41	41	183		Dense, light brown, fine SA	ND, trace Gravel, trace Silt.	
							WA				
25					T T						
Rer	narks:	1	<u> </u>					K ETO EN EL	31		
1.	Increased	l drilling e	ffort at 33' bgs								

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.

Page 1 of 3 Boring No.: BB-HEPR-205

]	Main	ie Dep	partment	t of Transpor	rtation	l	Projec	t: Peno	bscot R	iver Bridge, Route 155	Boring No.: BB-	HEPR-205
			Soil/Rock Ex	ploration Log IARY UNITS	Location: Howland, Maine PIN: 167 Elevation (ft.) 122.3' (mudline) Auger ID/OD:						5.00	
Dril	ler:		Maine Test I	Boring	Elev	/atio	n (ft.)	12	2.3' (mu	dline)	Auger ID/OD:	N/A
Оре	erator:		Brad Enos		Date	um:		NA	VD88		Sampler:	Split Spoon
Log	iged By	:	Joshua Szmy	/t	Rig	Туре	: :	CM	4E-45 (\$	Skid)	Hammer Wt./Fall:	140/30"
Dat	e Start/	Finish:	8/26/13 - 8/2	26/13	Dril	ling l	Method	: Ca	sed Was	shed	Core Barrel:	NQ2
Bor	ing Loc	ation:	N 633424, E	1762636	Cas	ing I	D/OD:	4"/	4-1/2" 8	& 3"/3-1/2"	Water Level*:	River Boring
Han	nmer Ef	fficiency	Factor: 0.6		Han	nmer	Туре:	Autor	natic 🗆	Hydraulic 🗆	Rope & Cathead ⊠	
Defin D = \$ MD = U = 1 MU = V = h MV =	hitions: Split Spoor Unsucce Thin Wall ⁻ Unsucce nsitu Vane Unsucce	n Sample ssful Split S Tube Sampl ssful Thin W Shear Tes ssful Insitu V	poon Sample atte e Vall Tube Sample t <u>Vane Shear Test :</u>	R = R SSA = mpt HSA = RC = attempt WOH WOR attempt WO1	ock Core Sar = Solid Stem A = Hollow Sten Roller Cone = weight of 1 = weight of re P = Weight of	nple Auger n Auge 40lb. h ods one p	er nammer erson		$S_u = In$ $T_v = Pc$ $q_p = Ui$ N-unco Hamme $N_{60} = 3$	situ Field Vane Shear Strength (psf ocket Torvane Shear Strength (psf) nconfined Compressive Strength (kr yrrected = Raw field SPT N-value er Efficiency Factor = Annual Calibr SPT N-uncorrected corrected for ha (Hammer Efficiency Factor/60%)*N-) Su(lab) = Lab Vane Sho WC = w sf) LL = Lic PL = Pla ation Value PI = Pla immer efficiency G = Gra uncorrected C = Cor	ear Strength (psf) ater content, percent uid Limit astic Limit sticity Index in Size Analysis isolidation Test
				Sample Information	<u> </u>							Laboratory
Depth (ft.)	Sample No.	Pen./Rec. (in.	Sample Deptr (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrectec	N ₆₀	Casing Blows	Elevation (ft.)	Graphic Log	Visual Descriptic	n and Remarks	Testing Results/ AASHTO and Unified Class.
25												
	6D	24/9	26.0 - 28.0	43-49-31-29	80	80		95.7		Top 7": Dense, light brown, ∖trace Silt. (SM)	fine SAND, little Gravel,	
								-		Bottom 2": Dense, gray, fine Silt. (SM)	26 SAND, little Gravel, little	.6-
- 30 -	7D	24/7	31.0 - 33.0	86.72.62.73	>100			-		Very dense, gray, fine to coa		
								-		Gravel. -GLACIAL TILL- (SM)		
- 35 -	8D	24/10	36.0 - 38.0	29-38-40-54	78	78		-		Very dense, gray, silty, fine Gravel. (SM)	to medium SAND, trace	
- 40 -								-				
	9D	24/14	41.0 - 43.0	50-42-54-63	96	96				Very dense, gray, silty, fine Gravel. (SM)	to medium SAND, little	SM A-4
- 45 -								-				
40	10D	24/2	46.0 - 48.0	45-62-63-83	>100			-		Very dense, gray, gravelly, f	ine to medium SAND, little	e
								1		Sitt. (511)		
							/	1				
			+		<u> </u>			4				
50								1				
Ren 1.1	narks: Increased	d drilling e	ffort at 33' bgs.	pundaries between soil typ	es; transitions	s may	be gradua	al. tions may	occur du	ie to conditions other than those	Page 2 of 3	
vva pre	sent at the	e time meas	urements were m	nes and under conditions ade.	siaidu. Grol	uuwal	er nuctua	uons may	occur au	is to conditions other than those	Boring No.: BB-	HEPR-205

Maine Department of Transportation							Proje	ct: Peno	bscot R	iver Bridge, Route 155	Boring No.: BB-	HEPR-205		
			Soil/Rock Ex	<u>ploration Log</u> <u>IARY UNIT</u> S			Locat	tion: Ho	wland,	Maine	PIN:1670	5.00		
Dril	ler:		Maine Test I	Boring	Elev	atior	l n (ft.)	122	2.3' (mu	dline)	Auger ID/OD:	N/A		
Ope	erator:		Brad Enos		Datu	ım:	()	NA	VD88		Sampler:	Split Spoon		
Log	ged By	:	Joshua Szmy	/t	Rig	Туре	:	CM	/IE-45 (Skid)	Hammer Wt./Fall:	140/30"		
Dat	e Start/	Finish:	8/26/13 - 8/2	26/13	Drilli	ing N	Nethod	l: Ca	sed Wa	shed	Core Barrel:	NQ2		
Bor	ing Loc	ation:	N 633424, E	1762636	Casi	ng II	D/OD:	4"/	4-1/2" a	& 3"/3-1/2"	Water Level*:	River Boring		
Har	nmer Ef	ficiency	Factor: 0.6		Ham	mer	Type:	Autor	natic 🗆	Hydraulic 🗆	Rope & Cathead ⊠			
Defir D = 3 MD = U = 7 MU = V = 1 MV =	hitions: Split Spoor = Unsucce Thin Wall 1 = Unsucce Insitu Vane = Unsucce	n Sample Issful Split Sp Tube Sample Issful Thin W Shear Test Issful Insitu V	poon Sample atte all Tube Sample <u>/ane Shear Test a</u>	R = SS empt HS attempt WC attempt WC Sample Informati	A = Solid Stem A A = Solid Stem A A = Hollow Stem = Roller Cone DH = weight of 14 DR = weight of co DH = Weight of co	iple luger Auge 10lb. h ds <u>one pe</u>	er nammer erson		$S_{U} = Ir$ $T_{V} = P^{I}$ $q_{p} = U$ $N-unco$ $Hamm$ $N_{60} =$ $N_{60} =$	situ Field Vane Shear Strength (psf ocket Torvane Shear Strength (psf) nconfined Compressive Strength (k yrrected = Raw field SPT N-value er Efficiency Factor = Annual Calibr SPT N-uncorrected corrected for ha (Hammer Efficiency Factor/60%)*N	$ f) \qquad S_{U(lab)} = Lab Vane She WC = w sf) \qquad LL = Liq PL = Pla ation Value \qquad PI = Pla ammer efficiency \qquad G = Gra -uncorrected \qquad C = Cor$	ear Strength (psf) ater content, percent uid Limit astic Limit sticity Index in Size Analysis solidation 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 Descriptio	on and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.		
50	11D R1	9/6	51.0 - 51.8	42/70/2" ROD = 87%			NO	70.6		Very dense, gray, silty, fine Gravel. (SM) Top of Bedrock at 51.7' bgs.	to medium SAND, little 	.7- 0'		
- 55 -								_		bgs and set 3" ID casing. Hard, fresh, fine grained, Joints are very closely to clo dipping, undulating, rough, partially open. Rock Mass Quality = Good	gray/white PHYLLITE. sely spaced, moderately fresh to discolored, tight t	o		
	R2	53/52	57.0 - 61.4	ROD = 73%				-		Rock Core Times (min/ft): 6 Hard, fresh, fine grained, gra	Rock Core Times (min/ft): 6.0, 6.5, 6.5, 5.5, 3.0 Hard, fresh, fine grained, gray/white PHYLLITE. Joints re very closely to moderately spaced, moderately lipping, undulating, rough, fresh to discolored, tight to			
()								-		dipping, undulating, rough, moderately wide. Rock Mass Quality = Fair Rock Core Times (min/ft): 3				
- 00 -								60.9		Bottom of Exploration at	61.40 feet below ground	.4-		
								-		SULL	ace.			
- 65 -														
- 70 -														
75														
1. Strat	ification lin	d drilling e	ffort at 33' bgs.	nundaries between soil mes and under conditio	types; transitions	may I ndwat	be gradu	al. ations may	occur du	ie to conditions other than those	Page 3 of 3	HEDR-205		
pre	soon at the	- une meas	arements were m	aut.								121 K^{-203}		

Maine Department of Transporta					tatio	n	Projec	t: Peno	bscot R	iver Bridge, Route 155	Boring No.: BB-HEPR-206			
			Soil/Rock Ex	ploration Log MARY UNITS			Locati	on: Ho	wland,	Maine	PIN:1670	05.00		
Dril	ler:		Maine Test	Boring	EI	evatio	n (ft.)	134	4.8'		Auger ID/OD:	N/A		
Оре	erator:		Brad Enos		Da	atum:		NA	VD88		Sampler:	Split Spoon		
Log	ged By:	:	Joshua Szm	yt	Ri	д Туре	e:	CM	1E-45 (Skid)	Hammer Wt./Fall:	140/30"		
Dat	e Start/F	-inish:	8/28/13 - 8/2	28/13	Di	rilling I	Method:	Ca	sed Wa	shed	Core Barrel:	NQ2		
Bor	ing Loc	ation:	N 633514, E	E 1762794	Ca	asing I	D/OD:	3"/	3-1/2"	Water Level*:	NA			
Han	nmer Ef	ficiency	Factor: 0.6		Ha	ammer	Type:	Auton	Rope & Cathead ⊠					
Defir D = \$ MD = U = 1 MU = V = 1 MV =	Definitions: R = Roc D = Split Spoon Sample SSA = S MD = Unsuccessful Split Spoon Sample attempt HSA = H U = Thin Wall Tube Sample RC = Rc MU = Unsuccessful Thin Wall Tube Sample attempt WOH = V = Insitu Vane Shear Test WOR = MV = Unsuccessful Insitu Vane Shear Test attempt WOIP =						er nammer erson		$S_{u} = Ir$ $T_{v} = Pr$ $q_{p} = U$ $N-uncc$ $Hamm$ $N_{60} =$ $N_{60} =$	Isitu Field Vane Shear Strength (psl ocket Torvane Shear Strength (psf) nconfined Compressive Strength (k rrrected = Raw field SPT N-value er Efficiency Factor = Annual Calibr SPT N-uncorrected corrected for ha (Hammer Efficiency Factor/60%)*N	$\begin{array}{l} S_{u(lab)} = Lab \ Vane \ SI \\ WC = + \\ sf) \qquad \qquad LL = Li \\ PL = P \\ ation \ Value \qquad PI = PI \\ immer \ efficiency \qquad G = Gr \\ uncorrected \qquad C = Cc \end{array}$	near Strength (psf) water content, percent quid Limit lastic Limit asticity Index asticity Index ain Size Analysis unsolidation 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 Descriptic	on and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.		
0	1D	24/9	0.0 - 2.0	1-2-4-5	6	6	4			Loose, olive/brown, fine to a trace Silt, trace organics.	nedium SAND, little Grav	/el,		
							10			-ALLUVIAL DEPOSIT- (S	M)			
							10							
							19	-						
							44							
							WA	130.3				4.5		
- 5 -								10010		Dense, brown and gray, high	nly weathered/decomposed	1		
	2D	24/11	5.0 - 7.0	28-48-42-53	90	90				PHYLLITE.	, I			
- 10 -														
							$\vdash \forall \vdash$	122.2			1	1.5-		
								125.5		Bottom of Exploration at	11.50 feet below ground	1.5		
										surf	ace.			
								-						
1.5														
- 15 -														
								-						
								1						
								-						
- 20 -								1						
								-						
								1						
25														
25 Ren	narks:	I	1	1			I	I	1	1				
1.1 2.1 3.1	Drove ca Increased Increased	sing with l drilling e l drilling e	140 lb. hamme ffort at 4.5' bg ffort at 11.5' b	er. s. gs and wash water turne	d from t	orown to	o gray, pi	obable t	op of c	ompetent Bedrock.				
Ctrot	ification li-			undarias botwoon coil tra-	e: transiti	one moul	he gradue	1			Page 1 of 1			
* Wa pre	ter level re sent at the	adings have time meas	e been made at t urements were n	imes and under conditions s nade.	stated. G	roundwat	ter fluctuat	ions may	occur du	e to conditions other than those	Boring No.: BE	B-HEPR-206		

1	Maine Department of Transporta						Projec	t: Peno	bscot R	iver Bridge, Route 155	Boring No.: B	B-HEPR-20	
			Soil/Rock Ex	ploration Log IARY UNITS			Locatio	on: Ho	wland,	Maine	PIN: 16705.00		
Drill	er:		Maine Test I	Boring	Ele	evatio	n (ft.)	130	5.9'		Auger ID/OD:	N/A	
Ope	rator:		Brad Enos		Da	tum:		NA	VD88		Sampler:	Split Spoon	
Log	ged By		Joshua Szmy	۲t	Ri	д Туре):	CM	1E-45 (Skid)	Hammer Wt./Fall:	140/30"	
Date	e Start/I	-inish:	8/28/13 - 8/2	8/13	Dr	illing M	Method:	Ca	sed Wa	shed	Core Barrel:	NQ2	
Bori	ing Loc	ation:	N 633512, E	1762810	Ca	ising I	D/OD:	3"/	3-1/2"		Water Level*:	NA	
Ham	nmer Ef	ficiency	Factor: 0.6		На	mmer	Rope & Cathead ⊠						
Defin D = S MD = U = T MU = V = Ir MV =	itions: plit Spoor Unsucce hin Wall T Unsucce nsitu Vane <u>Unsucce</u>	n Sample ssful Split Sp Tube Sample ssful Thin W Shear Test <u>ssful Insitu V</u>	poon Sample atte all Tube Sample / <u>ane Shear Test a</u>	R = F SSA empt HSA RC = attempt WOF wont WOF attempt WO1 Sample Information	Rock Core S = Solid Sten = Hollow Ste Roller Cone I = weight of P = Weight of n	ample n Auger em Auge 140lb. h rods of one p	er nammer <u>erson</u>		$S_{U} = Ir$ $T_{V} = P$ $q_{p} = U$ $N-uncc$ $Hamm$ $N_{60} =$ $N_{60} =$	situ Field Vane Shear Strength (psf) ocket Torvane Shear Strength (psf) nconfined Compressive Strength (ks) rrected = Raw field SPT N-value er Efficiency Factor = Annual Calibra SPT N-uncorrected corrected for har (Hammer Efficiency Factor/60%)*N-	Su(lab) = Lab Vane WC if) LL ation Value PI = mmer efficiency G = uncorrected C =	e Shear Strength (psf) = water content, per- = Liquid Limit = Plastic Limit = Plasticity Index : Grain Size Analysis : 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 Descriptio	n and Remarks	Laborator Testing Results/ AASHTC and Unified Cla	
0	1D	24/0	0.0 - 2.0	1-4-4-5	8	8	WA			No Recovery.			
-	2D	24/11	2.0 - 4.0	4-8-19-18	27	27	34 42 	132.9		Medium dense, olive, damp, some Silt, little Gravel. (SM) -FILL- (Possible reworked m	fine to medium SAND haterial)), — 4.0∙	
- 5 -							WA			Very dense, brown to gray, f	ine to coarse SAND, so	ome SM	
-	3D	21/11	5.0 - 6.8	30-62-78-60/3"	>100					Gravel, little Silt. (Decompose Bedrock) (SM)	sed/highly weathered	A-1-b	
-	R1	60/12	6.8 - 11.8	RQD = 0%			NQ	130.1		Top of Bedrock at 6.8' bgs. Highly weathered PHYLLIT	E.	6.8-	
- 10	R2	48/21	11.8 - 15.8	RQD = 0%						Hard, fresh, fine grained, gra Primary joints are very close angle to vertical, undulating discolored, tight. Secondary spaced, moderately dipping, discolored, tight.	y/white PHYLLITE. ly to closely spaced, hi to planar, rough, fresh joints are very closely undulating to planar, re	gh to ough,	
- 15	R3	60/60	15.8 - 20.8	RQD = 20%				122.1		Rock Mass Quality = Very P Rock Core Times (min/ft): 7. Hard, fresh, fine grained, gra are very closely to moderatel dipping to vertical, undulatin wide, with Silt and Sand dep Rock Mass Quality = Very P Rock Core Times (min/ft): 2.	oor 25, 5.75, 4. 5, 4.0 y/white PHYLLITE. Ju y spaced, moderately g to planar, fresh, oper osits. oor 5, 2.5, 2.75, 3.25, 3.5	—14.8- oints 1 to	
- 20	R4	60/51	20.8 - 25.8	RQD = 22%						R4 same as R3. Rock Mass Quality = Very P Rock Core Times (min/ft): 2.	oor 25, 1.5, 1.75, 2.5, 2.75		
Ren	narks:	1	I				<u> </u>		Net Caller			I	
1. I 2. I 3. V	Drove ca Rock frag Wash wa	sing with a gments (de ter change	140 lb. hamme ecomposed/high from brown to	r. hly weathered Bedroc o gray during coring a	k) in tip of t approxim	split	poon for s 4.8' bgs.	sample 3	3D.	T	Page 1 of 2		

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.	Page 1 of 2
* 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.	Boring No.: BB-HEPR-207

Γ	Maine Department of Transporta					Proje	ct: Peno	bscot R	River Bridge, Route 155	Boring No.: BB-	HEPR-207				
			Soil/Rock Ex	ploration Log IARY UNITS		Locat	ion: Ho	wland,	Maine	PIN:1670	5.00				
Drill	er:		Maine Test J	Boring	Elevatio	n (ft.)	13	6.9'		Auger ID/OD:	N/A				
Ope	rator:		Brad Enos		Datum:	. ,	NA	AVD88		Sampler:	Split Spoon				
Log	ged By:		Joshua Szmy	yt	Rig Typ	e:	CM	ЛЕ-45 (Skid)	Hammer Wt./Fall:	140/30"				
Date	Start/F	inish:	8/28/13 - 8/2	28/13	Drilling	Method	l: Ca	sed Wa	shed	Core Barrel:	NQ2				
Bori	ng Loca	ation:	N 633512, E	1762810	Casing	Casing ID/OD: 3"/3-1/2" Water Level*:									
Ham	mer Ef	ficiency	Factor: 0.6		Hamme	Hammer Type: Automatic 🗆 Hydraulic 🗆 Rope & Cathead 🛛									
Defini D = S MD = U = T MU = V = In MV =	tions: plit Spoon Unsucces hin Wall T Unsucces situ Vane <u>Unsucces</u>	a Sample ssful Split Sp ube Sample ssful Thin W Shear Test ssful Insitu V	poon Sample atte i /all Tube Sample /ane Shear Test.	R = Ro SSA = ampt HSA = RC = R attempt WOH = wOR = attempt WO1 = Sample Information	ck Core Sample Solid Stem Auge Hollow Stem Aug Roller Cone = weight of 140lb. = Weight of rods = Weight of one p	r her hammer berson		$S_{U} = Ir$ $T_{V} = P$ $q_{p} = U$ $N-unco$ $Hamm$ $N_{60} =$ $N_{60} =$	nsitu Field Vane Shear Strength (psf locoket Torvane Shear Strength (psf) loconfined Compressive Strength (ks orrected = Raw field SPT N-value er Efficiency Factor = Annual Calibra SPT N-uncorrected corrected for ha (Hammer Efficiency Factor/60%)*N-	Su(lab) = Lab Vane Sh WC = w sf) LL = Lic PL = Pla ation Value PI = Pla mmer efficiency G = Grading uncorrected C = Cor	ar Strength (psf) ater content, percent uid Limit stic Limit sticity Index in Size Analysis isolidation 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 Descriptio	n and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.				
25	R5	55/50	25.8 - 30.3	RQD = 32%			-	and and a start of the second s	Hard, fresh, fine grained, gra are extremely closely to moc dipping to vertical, planar, rr Rock Mass Quality = Poor Rock Core Times (min/ft): 1	y/white PHYLLITE. Joint lerately spaced, moderately sugh, open to wide. .75, 2.25, 4.0, 7.5, 4.0	3				
- 30 -						¥	106.6		Bottom of Exploration at surfa	30.30 feet below ground ace.	.3-				
- 35 -							-								
- 40							-								
- 45							-								
Rem 1. E 2. R 3. V Stratif * Wate pres	arks: Drove cas Rock frag Vash war ication line er level re sent at the	sing with gments (de ter change es represen adings have time measu	140 lb. hamme: composed/higi from brown to tapproximate bc been made at ti urements were m	r. hly weathered Bedrock) o gray during coring at a pundaries between soil type imes and under conditions : nade.) in tip of split s approximately s; transitions may stated. Groundwa	spoon for 14.8' bgs v be gradu ater fluctua	sample : al. ations may	3D.	ue to conditions other than those	Page 2 of 2 Boring No.: BB-					



APPENDIX C

LABORATORY TESTING RESULTS



Appendix C

Previous Laboratory Testing Results

State of Maine - Department of Transportation Laboratory Testing Summary Sheet

Town(s):	Howland-EnfieldProject Number: 16705.00										
Boring & Sample	Northing Easting	Depth	Reference	G.S.D.C.	W.C.	L.L.	P.I.	Clas	ssification		
Identification Number	NAVD88	(Feet)	Number	Sheet	%			Unified	AASHTO	Frost	
BB-HEPR-101, 1D	633293 1761886	1.0-3.0	237550	1	3.9			SW-SM	A-1-b	0	
BB-HEPR-101, 4D	633293 1761886	15.0-17.0	207064	1	21.8			SM	A-2-4		
BB-HEPR-101, 6D	633293 1761886	25.0-25.8	207066	1	9.7			SM	A-2-4		
BB-HEPR-102, 1D	633348.9 1762069	0.0-2.0	207067	1	10.2			GP	A-1-a	0	
BB-HEPR-102, 4D	633348.9 1762069	16.0-18.0	207068	1	11.7			SW-SM	A-1-b	0	
BB-HEPR-103, 1D	633430.5 1762334	0.0-2.0	207069	2	9.9			GW	A-1-a	0	
BB-HEPR-103, 2D	633430.5 1762334	3.5-5.5	207070	2	7.7			GW	A-1-a	0	
BB-HEPR-103, 5D	633430.5 1762334	18.5-20.5	207071	2	11.5			SW-SM	A-1-b	0	
BB-HEPR-103, 7D	633430.5 1762334	28.5-30.0	207072	2	10.1			SW	A-1-a	0	
BB-HEPR-103, 10D	633430.5 1762334	43.5-44.8	207073	2	7.9			SM	A-4	IV	
BB-HEPR-104, 1D	633510 1762593	0.0-2.0	207074	3	10.1			GP	A-1-a	0	
BB-HEPR-104, 2D	633510 1762593	7.0-8.33	207075	3	8.3			SM	A-1-b		
BB-HEPR-104, 3D	633510 1762593	12.0-14.0	239827	3	15.1			SP-SM	A-1-b	0	
BB-HEPR-104, 5D	633510 1762593	22.0-24.0	239828	3	10.3			SW-SM	A-1-a	0	
BB-HEPR-104, 7D	633510 1762593	32.0-34.0	239829	3	11.6			ML	A-4	IV	
BB-HEPR-104, 10D	633510 1762593	47.0-48.8	239830	3	8.4			SM	A-4	IV	
BB-HEPR-105, 1D	633575.2 1762800	1.0-3.0	239831	4	2.7			SVV-SIVI	A-1-D	0	
BB-HEPR-105, 3D	633575.2 1762800	10.0-12.0	239832	4	1.5	22	40	5W-5M	A-1-D	0	
BB-HEPR-105, 4D/B	633575.2 1762800	15.0-17.0	239833	4	24.1	33	12		A-0		
BB-HEPR-105, 5D	633575.2 1762800	20.0-22.0	239834	4	18.5			SIVI	A-2-4		
DD-NEPK-100, 0D	633575.2 1762800	35.0-37.0	239030	4	9.1			SIVI	A-1-0	11	
Classification of the	ese soil samples is in ac	cordance with	AASHTO CI	assificatio	on Syste	em N	I-145	40. This cla	ssification	1	
is followed by the "	is followed by the "Frost Susceptibility Rating" from zero (non-frost susceptible) to Class IV (highly frost susceptible).										
The "Frost Suse	ceptibility Rating" is bas	ed upon the N	laineDOT an	d Corps of	Engine	ers	Class	sification Sy	stems.		
GSDC = Grain Size Distribu	ution Curve as determined	by AASHTO T	88-93 (1996)	and/or AS	TM D 4	22-63	3 (Rea	approved 19	98)		

WC = water content as determined by AASHTO T 265-93 and/or ASTM D 2216-98

LL = Liquid limit as determined by AASHTO T 89-96 and/or ASTM D 4318-98

PI = Plasticity Index as determined by AASHTO 90-96 and/or ASTM D4318-98



	Boring/Sample No.	Northing	Easting	Depth, ft	Description	W, %	LL	PL	ΡI	PIN
+	BB-HEPR-101/1D	633293	1761886	1.0-3.0	SAND, some gravel, trace silt.	3.9				016705.00
	BB-HEPR-101/4D	633293	1761886	15.0-17.0	SAND, little silt, trace gravel.	21.8				Town
	BB-HEPR-101/6D	633293	1761886	25.0-25.8	SAND, some silt, some gravel.	9.7				Howland Enfield
	BB-HEPR-102/1D	633348.9	1762069	0.0-2.0	Sandy GRAVEL, trace silt.	10.2				
	BB-HEPR-102/4D	633348.9	1762069	16.0-18.0	SAND, some gravel, little silt.	11.7				Reported by/Date
×										WHITE, TERRY A 9/29/2010



	Boring/Sample No.	Northing	Easting	Depth, ft	Description	W, %	LL	PL	PI	PIN
+	BB-HEPR-103/1D	633430.5	1762334	0.0-2.0	Sandy GRAVEL, trace silt.	9.9				016705.00
	BB-HEPR-103/2D	633430.5	1762334	3.5-5.5	GRAVEL, some sand, trace silt.	7.7				Town
	BB-HEPR-103/5D	633430.5	1762334	18.5-20.5	SAND, some gravel, trace silt.	11.5				Howland Enfield
	BB-HEPR-103/7D	633430.5	1762334	28.5-30.0	SAND, some gravel, trace silt.	10.1				Demanta d hu/Deta
	BB-HEPR-103/10D	633430.5	1762334	43.5-44.8	SILT, some sand, little gravel.	7.9				Reported by/Date
X										WHITE, TERRY A 9/29/2010



	Boring/Sample No.	Northing	Easting	Depth, ft	Description	W, %	LL	PL	PI	1	PIN
+	BB-HEPR-104/1D	633510	1762593	0.0-2.0	GRAVEL, some sand, trace silt.	10.1				0'	16705.00
	BB-HEPR-104/2D	633510	1762593	7.0-8.3	SAND, some gravel, some silt.	8.3					Town
	BB-HEPR-104/3D	633510	1762593	12.0-14.0	SAND, little gravel, trace silt.	15.1				н	owland Enfield
	BB-HEPR-104/5D	633510	1762593	22.0-24.0	Gravelly SAND, trace silt.	10.3					
	BB-HEPR-104/7D	633510	1762593	32.0-34.0	SILT, some sand, trace gravel.	11.6					Reported by/Date
×	BB-HEPR-104/10D	633510	1762593	47.0-48.8	Sandy SILT, trace gravel.	8.4				N	/HITE, TERRY A 9/29/2010



	Boring/Sample No.	Northing	Easting	Depth, ft	Description	W, %	LL	PL	ΡI		PIN
+	BB-HEPR-105/1D	633575.2	1762800	1.0-3.0	SAND, some gravel, trace silt.	2.7					016705.00
	BB-HEPR-105/3D	633575.2	1762800	10.0-12.0	SAND, some gravel, trace silt.	7.5					Town
	BB-HEPR-105/4DB	633575.2	1762800	15.2-17.0	CLAY-SILT, trace sand.	24.1	33	21	12		Howland Enfield
	BB-HEPR-105/5D	633575.2	1762800	20.0-22.0	SAND, little silt.	18.5					
	BB-HEPR-105/8D	633575.2	1762800	35.0-37.0	Gravelly SAND, little silt.	9.1					Reported by/Date
X]	WHITE, TERRY A 10/20/2010

TOWN	Howland,Enfield	Reference No.	239833
PIN	016705.00	Water Content, %	24.1
Sampled	8/19/2010	Plastic Limit	21
Boring No./Sample No.	BB-HEPR-105/4DB	Liquid Limit	33
Station		Plasticity Index	12
Depth	15.2-17.0	Tested By	BBURR





Appendix C

GZA Laboratory Testing Results



Penobscot River Bridge

Town(s): Howland, ME

GZA Project Number: 09.0025796.00

MDOT Project Number:

Boring & Sample	Station	Sample	Depth	Reference	Organic	W.C.	L.L.	P.I.	Cla	assificatic	on
Identification Number	(Feet)	No.	(Feet)	Number	%			l!	Unified	AASHTO	Frost
BB-HEPR-201		2D	5-7						SM	A-1-b	Π
BB-HEPR-203		4D	15-17						SW-SM	A-1-b	0
BB-HEPR-204		7D	24-26						SW-SM	A-1-b	0
BB-HEPR-204		14D	54-56						SM	A-1-b	Π
BB-HEPR-205		9D	41-43						SM	A-4	П
BB-HEPR-207		3D	5-6.8						SM	A-1-b	Π
	<u> </u>										
	L'										
	L'										
	<u> </u>										
	<u> </u>										
	<u> </u>								<u> </u>		
Classification of t is followed by the The "Frost	these soil sa e "Frost Sus Susceptibil	amples is in sceptibility F	accordance w Rating" from ze	ith AASHTO ro (non-fros	Classifica t suscepti	tion Sy ble) to	/stem I Class	M-145 IV (hi) Classi	-40. This cl ghly frost s fication Sy	lassificati usceptibl	on le).

GSDC = Grain Size Distribution Curve as determined by AASHTO T 88-93 (1996) and/or ASTM D 422-63 (Reapproved 1998)

WC = water content as determined by AASHTO T 265-93 and/or ASTM D 2216-98

LL = Liquid limit as determined by AASHTO T 89-96 and/or ASTM D 4318-98

PI = Plasticity Index as determined by AASHTO 90-96 and/or ASTM D4318-98












LABORATORY TESTING DATA SHEET

Projec	Project Name Penobscot River Bridge							Lo	cation	Howland	, ME	A SH		Rev	viewed By	Matthin Dulyla	
Proj	ect No.	09.002	25796	6.00				Assign	ed By	J. Baron							
Project M	anager	J. Bar	on				Кероп Date <u>9/5/2013</u>							Date Reviewed 9/5/2013			9 5 2013
						Samp	ple Data Comp					ression	Tests				
Boring No.	Sample No.	Depth Ft.	Lab No.	Water Content %	Do in.	L in.	(1) Unit Wt. PCF	(2) Wet Density PCF	Bulk Gs.	(3) Other Tests	(4) Strength PSI	(5) Strain %	(6) Conf. Stress	(7) E sec PSI EE+06	(8) Poisson's Ratio	στ PSI	Rock Formation or Description or Remarks
BB-HEPR- 202	R2	10.4- 10.8	1		1.980	4.630	171.2			U	3,488	0.09		3.45			Failed on foliation planes
BB-HEPR- 204	R2	62.0- 62.4	2		1.980	4.573	170.1			U	5,177	0.10		4.35			Failed on foliation planes
(1) Volume Determined By Measuring Dimensions						ons	(3) P=Pe	etrograp	hic PL	D=Point	Load (dia	netrica	(5) Str	ain at P	eak Devia	tor Stre	SS
(2) Determined by Measuring Dimensions and						PLA= Po	oint Load	(Axial) RST= $S_{\rm P}$	olitting Ten	sile	(6) Rep	6) Represents Confining Stress on Triaxial Tests				
Weight of Saturated Sample							U= Unconfined Compressive Strength (7) Rep (4) Taken at Peak Deviator Stress (8) Rep						Represents Secant Modulus at 50% of Total Failure Stress				
<u></u>							. /						\ / ⁻ I	represents secant roisson's Kauo at 50% of 10tal ranure Stress			



401-467-6454

Penobscot River Bridge Howland, ME



Rock Testing										
Boring No. BB-HEPR-202	File No. 09.002596.00									
Sample No. R2	Date: 9/5/2013									
Depth: 10.4-10.8'	Test No. U 1									

Penobscot River Bridge Howland, ME



Rock Testing										
Boring No. BB-HEPR-204	File No. 09.002596.00									
Sample No. R2	Date: 9/5/2013									
Depth: 62.0-62.4'	Test No. U 2									



APPENDIX D

SPECIAL PROVISION

SPECIAL PROVISION <u>SECTION 511</u> COFFERDAMS

Section 511 is deleted in its entirety and replaced with the following:

<u>511.01 Description</u> This work shall consist of the complete design, construction, maintenance and removal of cofferdams and other related work, including dewatering and inspection, required to allow for the excavation of foundation units, to permit and protect the construction of bridge or other structural units and to protect adjacent Roadways, embankments or other structural units, in accordance with the Contract.

511.02 Materials As specified in the cofferdam Working Drawings.

511.03 Cofferdam Construction

A. Working Drawings. The Contractor shall submit Working Drawings, showing the materials to be used and the proposed method of construction of cofferdams to the Department. Construction shall not start on cofferdams until such Working Drawings have been submitted. Any review of or comment on, or any lack of review of or comment on, these Working Drawings by the Department shall not result in any liability upon the Department and it shall not relieve the Contractor of the responsibility for the satisfactory functioning of the cofferdam.

B. Construction. Construct cofferdams in conformance with the submitted Working Drawings. Cofferdams shall, in general, be carried below the elevation of the bottom of footings to adequate depths to ensure stability and adequate heights to seal off water. Cofferdams shall be braced to withstand pressure without buckling, secured in place to prevent tipping or movement and be as watertight as necessary for the safe and proper construction of the substructure Work inside them. With the exception of construction of a concrete foundation seal placed under water, the interior dimensions of cofferdams shall provide sufficient clearance for the construction and inspection of forms and to permit pumping outside of forms. The Contractor shall be responsible for the righting and resetting of cofferdams that have tilted or moved laterally, as required for construction.

During the placing and curing of seal concrete, maintain the water level inside the cofferdam at the same level as the water outside the cofferdam, to prevent flow through the concrete.

No timber or bracing shall be used in cofferdams in such a way as to remain in the substructure Work.

Cofferdams shall be constructed to protect fresh concrete against damage from the sudden rising of the water body, to prevent damage by erosion and to prevent damage to adjacent Roadways, embankments or other structural units.

Unless otherwise noted, cofferdams, including all sheeting and bracing involved, shall be removed after the completion of the substructure Work in a manner that prevents disturbance or injury to the finished Work.

Cofferdams shall be constructed, dewatered and removed in accordance with the requirements of Section 656 - Temporary Soil Erosion and Water Pollution Control and related Special Provisions.

C. Inspection of Seal Cofferdams. Seal cofferdam excavations shall initially be inspected and approved by the Contractor.

For each seal cofferdam excavation, the Contractor shall submit a written procedure to the Resident for sediment/overburden removal and excavation inspection. For cofferdams where seal concrete is to be placed on bedrock, the inspection procedure shall describe the Contractor's final cleaning and inspection process for attaining cleanliness of each cofferdam excavation. For cofferdams where seal concrete is not excavated to bedrock, the procedure shall describe the Contractor's final cleaning and inspection process for attaining the bottom of seal elevation shown on the Plans.

The Contractor shall notify the Resident at least 48 hours prior to when each seal cofferdam excavation will be ready for final inspection by the Department. The Contractor shall allow adequate time for each occurrence of cofferdam excavation inspection by the Department. The Contractor shall provide and maintain access and equipment, such as steel probes, for the Resident and/or the Department's Dive Team to independently inspect each cofferdam excavation.

No seal concrete placement shall begin until the Department has approved the cofferdam excavation.

<u>511.04 Pumping</u> Pumping from the interior of any cofferdam shall be done in such a manner as to prevent any current of water that would carry away or segregate the concrete.

Pumping to dewater a sealed cofferdam shall not commence until the seal concrete has set sufficiently to withstand the hydrostatic pressure and meets the following minimum curing time, after the completion of the installation of the seal concrete:

- 1. When the temperature of the water body outside the cofferdam is greater than 40°F, a minimum of 5 days.
- 2. When the temperature of the water body outside the cofferdam is less than 40° F, a minimum of 7 days.

Procedures for the removal of all water and materials from cofferdams shall be described in the Soil Erosion and Water Pollution Control Plan as required in Section 656 Temporary Soil Erosion and Water Pollution Control and related Special Provisions.

<u>511.05 Method of Measurement</u> Cofferdams will be measured as one lump sum unit, as indicated on the Plans or called for in the Contract.

<u>511.06 Basis of Payment</u> The accepted quantity of cofferdam will be paid for at the Contract lump sum price for the respective cofferdam items, which price shall be full compensation for design, construction, maintenance, inspection and removal.

When required, the elevation of the bottom of the footing of any substructure unit may be lowered, without change in the price to be paid for cofferdams. However, if the average elevation of more than 25% of the area of the excavation is more than 3 feet below the elevation shown on the Plans, and if requested by the Contractor, then the additional costs incurred that are included in the cofferdam Pay Item will be paid for in accordance with Section 109.7 - Equitable Adjustments to Compensation. The Contractor shall immediately notify the Department when these additional costs commence. Failure of the Contractor to provide this notification will result in undocumented additional work that will be non-reimbursable. The Department will evaluate this additional work to determine an appropriate time extension, if warranted.

All costs for sedimentation control practices, including, but not limited to, constructing, maintaining, and removing sedimentation control structures, and pumping or transporting water and other materials for sedimentation control will not be paid for directly, but will be considered incidental to the cofferdam Pay Item(s).

All costs for related temporary soil erosion and water pollution controls, including inspection and maintenance, will not be paid for directly, but will be considered incidental to the cofferdam Pay Item(s).

All costs associated with preparation of Working Drawings, design calculations, written procedure for sediment/overburden removal and excavation inspection, and the inspection of the seal cofferdam excavation shall be considered incidental to the cofferdam Pay Item(s). There shall be no additional payment for repeated inspection by the Department of the same cofferdam excavation.

All costs for cofferdams and related temporary soil erosion and water pollution controls, including inspection and maintenance, will be considered incidental to related Pay Items, when a specific Pay Item for cofferdams is not included in the Contract.

Seal concrete will be evaluated under Section 502.

Payment will be made under:

Pay Item

Pay Unit

511.07 Cofferdam

Lump Sum



APPENDIX E

CALCULATIONS

Penobscot River Bridge

SEISMIC SITE CLASS DETERMINATION

Performed By: J. Baron Reviewed By: E. Lonstein

	BB-H	IEPR-201			BB-	HEPR-202			BB-I	HEPR-203			BB-H	IEPR-204			BB-HEP	R-205			BB-HE	PR-206			BB-HE	PR-207	
G.S. El.	153.9			G.S. El.	125.7			G.S. El.	123			G.S. El.	123.2			G.S. El.	122.3			G.S. El.	123.2			G.S. El.	123.2		
Depth (ff) Elevation (ft)	SPT N-value	di/Ni	Depth (ft)	Elevation (ft	SPT N-value	di/Ni	Depth (ft)	Elevation (ft)) SPT N-value	di/Ni	Depth (ft)	Elevation (ft)	SPT N-value	di/Ni	Depth (ft)	Elevation (ft)	SPT N-value	di/Ni	Depth (ft)	Elevation (ft)) SPT N-value	di/Ni	Depth (ft)	Elevation (ft)	SPT N-value	di/Ni
1.0	153	33	0.03	1.0	125	28	0.04	1.2	122	24	0.05	1.0	122	14	0.07	1.0	121	28	0.04	1.0	122	6	0.17	1.0	122	8	0.13
6.0	148	43	0.12	100.0	26	100	0.99	7.0	116	65	0.09	5.0	118	25	0.16	6.0	116	47	0.11	6.0	117	90	0.06	3.0	120	27	0.07
10.0	144	100	0.04					11.0	112	46	0.09	9.0	114	100	0.04	11.0	111	49	0.10	100.0	23	100	0.94	5.0	118	100	0.02
16.0	138	87	0.07					16.0	107	58	0.09	11.0	112	100	0.02	17.0	105	45	0.13					100.0	23	100	0.95
100.0	54	100	0.84					21.0	102	90	0.06	15.0	108	48	0.08	22.0	100	41	0.12								
				_				25.0	98	100	0.04	20.0	103	45	0.11	27.0	95	80	0.06								
								100.0	23	100	0.75	25.0	98	69	0.07	32.0	90	100	0.05								
												30.0	93	78	0.06	37.0	85	78	0.06								
												34.0	89	100	0.04	42.0	80	96	0.05								
												36.0	87	100	0.02	47.0	75	100	0.05								
												40.0	83	100	0.04	51.0	71	100	0.04								
												45.0	78	73	0.07	100.0	22	100	0.49								
												50.0	73	100	0.05					_							
												55.0	68	100	0.05]											
					Abutments ar	d Piers 2 and 3						100.0	23	100	0.45]											







Conclusions: Site Class D 15<N<50

Determination of N_{ch}:

Determine N_{ch} via the equation:

where: d_s = the total thickness of cohesionless soil layers in the top 100 feet.

d_i = the thickness of any layer between 0 and 100 feet.

N_i = the Standard Penetration Resistance (ASTM D 1586) not to exceed 100 blows/ft as directly measured in the field without corrections.



Objective

Assess nominal and factored bearing resistance of a foundation on rock at Pier 1 location.

Methodology

Use data from test borings and evaluate the nominal bearing resistance as follows:

- 1. Bedrock Properties From Test Borings
- 2. Calculation Of Rock Mass Rating
- 3. Determine Rock Property Constants s and m
- 4. Calculate Nominal Bearing Resistance of Bedrock q_n

References

1. American Association of State Highway and Transportation Officials, AASHTO LRFD Bridge Design Specifications: Customary U.S. Units, 5th edition, 2010. (AASHTO LRFD)

2. Wyllie, Duncan C., "Foundations on Rock", Second edition, 1992.

1. Rock Properties

Bedrock properties were obtained from rock core specimens and logs completed for the Penobscot River Bridge Project. The following table presents the data for the Pier 1 test boring where spread footings on bedrock will be utilized.

<u>Run</u>	<u>Depth</u>	<u>RQD(%)</u>	Rock Type	Joint Spacing Desc.	Corr. Spacing (in)	Apeture Desc	Corr. Apeture (in)
B102R1	22-26	11	Phyllite	Close	2.5-8	Tight-Open	0.004-0.1
B102R2	26-28	0	Phyllite	Close	2.5-8	Tight-Open	0.004-0.1
B102R1	28-33	50	Phyllite	Close to Moderate	2.5-24	Tight	0.004-0.01
B203R1	27-28	0	Phyllite	Close	2.5-8	Open	0.02-0.1
B203R2	28-33	61	Phyllite	Close to Moderate	2.5-24	Tight	0.004-0.01
B203R3	33-38	67	Phyllite	Moderate	8-24	Open	0.02-0.1

Anticipate that 0 RQD rock will be excavated to prepare footing - typical RQDs = 50, 61, 67



2. Calculation of Rock Mass Rating (RMR)

From AASHTO LRFD Table 10.4.6.4-1, determine the RMR.

Parameter 1- Uniaxial Compressive Strength

Uniaxial compressive strength tests were performed on two core specimens at or in the vicinity of the Penobscot River Bridge.

Boring	<u>Run</u>	<u>Depth</u>	Rock Type	<u>qp (ksi)</u>
202	R2	10.4-10.8	phyllite	3.49
204	R2	62-62.4	phyllite	5.18

Average 4.33 ksi

Representative unconfined compressive strength of intact rock. $\sigma_{n,r} := 4.33 ksi$

 $\sigma_{u,r} = 624 \cdot ksf$

From AASHTO LRFD Table 10.4.6.4-1

Relative Rating $RR_1 := 4$ for $\sigma_{u,r}$ =520 to 1080 ksf

Parameter 2- Drill Core Quality

Average RQD % = 50 - 67% From AASHTO LRFD Table 10.4.6.4-1 Relative Rating $RR_2 := 13$ for RQD = 50% to 75%

Parameter 3- Spacing of Joints

From Boring Logs, generally close to moderate = 2.5 in to 24 in

From AASHTO LRFD Table 10.4.6.4-1

Relative Rating $RR_3 := 10$ for 2 in to 1 ft spacing

Parameter 4- Condition of Joints

From boring logs, aperture generally less than 0.01 inches and hard joint walls.

From AASHTO LRFD Table 10.4.6.4-1

Relative Rating $RR_4 := 20$ for slightly rough surfaces, separation <0.05 in, hard joint wall rock

CI	GZA GooEnvironmental Inc		Engineers and	JOB: 09.0025796.00 Penobscot River Bridge								
GLY	477 Congress St. Suite 700		Scientists	SUBJECT: Bearing Resistance								
	Portland, Maine 04101			SHEET: <u>3 OF 9</u>								
	207-879-9190			CALCULATED BY: JRB 9-9-13								
	Fax 207-879-0099			CHECKED BY: <u>C. Snow</u>								
	http://www.gza.com			REVIEWED BY: <u>A.Blaisdell</u>								
	Parameter E. Ground Wat	or Condition										
			5									
	Groundwater Conditions											
	From AASHTO LRFD Table	e 10.4.6.4-1										
	Relative Rating	$RR_5 := 4$	for Moderate water pressur total vertical stress	re. joint water pressure = 0.2 to 0.5								
	Adjustment for joint orie	ntation (Para	meter 6)									
	The joint sets are generall embedded below bearing	ly high angle and glevel and steep j	generally rough and tight to contract to contract the second seco	open. Considering rock will remain Dint orientation is considered favorable.								
	From AASHTO LRFD Table	e 10.4.6.4-2										
	Relative Rating	$RR_6 := -2$	for foundations - fair cond	ditions								
	Total RMR Rating											
	$RMR := RR_1 + R$	$R_2 + RR_3 + RR_3$	$_4 + RR_5 + RR_6$									
	RMR = 49											
	From AASHTO LRFD Table	10.4.6.4-3 RMR=	41-60 is indicative of Fair Roo	ck Quality (Class No. 3)								



3. Determine Rock Property Constants s and m

From AASHTO LRFD Table 10.4.6.4-4 for Fair Quality Rock Mass

Categorized as rock type B (phyllite), RMR=49, using is and m values interpolated from the logarithmic trend of plotted values from AASHTO Table 10.4.6.4-4 (plots on sheet 10).

m:= .264

s:= .00021

4. Calculate Nominal and Factored Bearing Resistance of Bedrock q_n and q_R

From Wyllie "Foundations on Rock"

Eq. 5.4 Pg.138

$$q_{n} \coloneqq \mathbf{C_{fl}} \cdot \sqrt{s} \cdot \sigma_{u,r} \cdot \left[1 + \sqrt{m \cdot \left(\frac{1}{s}\right) + 1}\right]$$

Where

C_{f1} := 1.12 From Wyllie Table 5.4 Pg. 138 Correction factor for foundation shape for rectangular foundation:

s = 0.00021

m = 0.26

For L/B>5, use factor C_{fl} =1.05, For L/B=2, use factor C_{fl} =1.12, Estimate footing is roughly L/B=2, use 1.12

 $\sigma_{u,r} = 4.33 \cdot ksi$

Nominal Bearing Resistance

$$q_{n} \coloneqq C_{f1} \cdot \sqrt{s} \cdot \sigma_{u,r} \cdot \left[1 + \sqrt{m \cdot \left(s^{-\frac{1}{2}}\right) + 1}\right]$$

 $q_n = 54.5 \cdot ksf$ Say 55 ksf

Factored Bearing Resistance

Bearing Resistance Factor is specified in Table 10.5.5.2.2-1

 $\phi_{\mathbf{b}} \coloneqq 0.45$ Footing on rock

 $q_{\mathbf{R}} \coloneqq \phi_{\mathbf{b}} \cdot q_{\mathbf{n}}$

 $q_R = 24.5 \cdot ksf$ Say 25 ksf

GZA JOB: 09.0025796.00 Penobscot River Bridge Engineers and GeoEnvironmental, Inc Scientists SUBJECT: Bearing Resistance 477 Congress St, Suite 700 5 OF 9 SHEET: Portland, Maine 04101 CALCULATED BY: JRB 9-9-13 207-879-9190 CHECKED BY: C. Snow Fax 207-879-0099 REVIEWED BY: A.Blaisdell http://www.gza.com





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JOB: 09.0025796.00 Penobscot River Bridge SUBJECT: Bearing Resistance SHEET: 6 OF 9 CALCULATED BY: JRB 9-9-13 CHECKED BY: C. Snow REVIEWED BY: <u>A.Blaisdell</u>

Reference:M:\FILES\GEOTECH\Design Calculations\Units v7.xmcd



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JOB: 09.0025796.00 Penobscot River Bridge SUBJECT: Bearing Resistance SHEET: 7 OF 9 CALCULATED BY: JRB 9-9-13 CHECKED BY: C. Snow DEDUCEMED DY: A Disisdell

REVIEWED BY: <u>A.Blaisdell</u>

10-22

AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

Table 10.4.6.4-1 Geomechanics Classification of Rock Masses.

-	Paramet	er					Ranges of	Values				
	Strength of	Point load strength index	>175 ksf	85	–175 ksf	45–85 ksf	20-45 ksf	For com	this low	v range, unia e test is prefe	xial erred	
	intact rock material	Uniaxial compressive strength	>4320 ksf	21 432	160– 20 ksf	1080- 2160 ksf	520– 1080 ksf	215	15–520 70–21 ksf ksf		20–70 ksf	
ſ	Relative Rating		15		12	7	4		2	1	0	
Ī	Drill core quality	RQD	90% to 100	0%	75%	% to 90%	50% to	75%	25% to 50%		<25%	
ļ	Relative Rating		elative Rating 20			17	1	3		8	3	
l	Spacing of joints		>10 ft.		3	-10 ft.	1–3 f	t.	2	in1 ft.	<2 in.	
ļ	Relative Rating		30			25	2	.0		10	5	
	Condition of join	ondition of joints		gh us n it	 Sligi surfa Sepa <0.0 Harc rock 	htly rough aces aration 5 in. 1 joint wall	 Slightly rough surfaces Separatio <0.05 in. Soft join wall rock 	on t	 Sheken-sided surfaces or Gouge <0.2 in. thick or Joints open 0.05–0.2 in. Continuous 		 Soft gouge >0.2 in. thick or Joints oper >0.2 in. Continuous joints 	
	Relative Rating		25		20		12		6		0	
	Ground water conditions (use one of the three evaluation criteria as appropriate to the method of	Inflow per 30 ft. tunnel length	Inflow per 30 ft. tunnel length			<400 gal./	hr. 4	400–2000 gal./h		nr. >2	2000 gal./hr.	
	exploration)	Ratio = joint water pressure/ major principal stress	0			0.0–0.2		0.2–0.5			>0.5	
	General Conditions		Complete	ly Dr	y (Moist on interstitial v	ly Water) water)		Water under S derate pressure		evere water problems	
1	Relative Rating		10			7			4		0	



JOB: 09.0025796.00 Penobscot River Bridge SUBJECT: Bearing Resistance SHEET: 8 OF 9 CALCULATED BY: JRB 9-9-13 CHECKED BY: C. Snow REVIEWED BY: A.Blaisdell

Table 10.4.6.4-2 Geomechanics Rating Adjustment for Joint Orientations.

Strike a	nd Dip Orientations of Joints	Very Favorable	Favorable	Fair	Unfavorable	Very Unfavorable	
	Tunnels	0	-2	-5	-10	-12	
Ratings	Foundations	0	-2	-7	-15	-25	
	Slopes	0	-5	-25	-50	-60	

Table 10.4.6.4-3 Geomechanics Rock Mass Classes Determined From Total Ratings.

RMR Rating	100-81	80-61	60-41	40-21	<20
Class No.	I	II	III	IV	V
Description	Very good rock	Good rock	Fair rock	Poor rock	Very poor rock



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JOB: 09.0025796.00 Penobscot River Bridge SUBJECT: Bearing Resistance SHEET: 9 OF 9 CALCULATED BY: JRB 9-9-13 CHECKED BY: C. Snow

REVIEWED BY: <u>A.Blaisdell</u>

10-24

AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS

Table 10.4.6.4-4 Approximate relationship between rock-mass quality and material constants used in defining nonlinear strength (*Hoek and Brown*, 1988)

				Rock Typ	e	
Rock Quality	Constants	A = CarbodolonB = Lithifand siC = ArenacrystaD = Fine gandesE = Coarscrystanorite	onate rocks w nite, limeston ied argrillace late (normal aceous rocks al cleavage— grained polyr rite, dolerite, se grained polyr cline rocks— e, quartz-dior B	rith well deve e and marble cous rocks—n to cleavage) with strong c sandstone an ninerallic ign diabase and lyminerallic i -amphibolite, rite	loped crystal nudstone, silt rystals and po d quartzite eous crystalli rhyolite gneous & me gabbro gneis	cleavage— stone, shale oorly developed ne rocks— tamorphic ss, granite, E
INTACT ROCK SAMPLES	-	A	D	0	D	Ľ
Laboratory size specimens free from discontinuities CSIR rating: $RMR = 100$	m S	7.00 1.00	10.00 1.00	15.00 1.00	17.00 1.00	25.00 1.00
VERY GOOD QUALITY ROCK MASS Tightly interlocking undisturbed rock with unweathered joints at 3–10 ft. CSIR rating: <i>RMR</i> = 85	m s	2.40 0.082	3.43 0.082	5.14 0.082	5.82 0.082	8.567 0.082
GOOD QUALITY ROCK MASS Fresh to slightly weathered rock, slightly disturbed with joints at 3–10 ft. CSIR rating: <i>RMR</i> = 65	m s	0.575 0.00293	0.821 0.00293	1.231 0.00293	1.395 0.00293	2.052 0.00293
FAIR QUALITY ROCK MASS Several sets of moderately weathered joints spaced at $1-3$ ft. CSIR rating: <i>RMR</i> = 44	m s	0.128 0.00009	0.183 0.00009	0.275 0.00009	0.311 0.00009	0.458 0.00009
POOR QUALITY ROCK MASS Numerous weathered joints at 2 to 12 in.; some gouge. Clean compacted waste rock. CSIR rating: <i>RMR</i> = 23	m s	$0.029 \\ 3 \times 10^{-6}$	$0.041 \\ 3 \times 10^{-6}$	0.061 3 × 10 ⁻⁶	$0.069 \\ 3 \times 10^{-6}$	$0.102 \\ 3 \times 10^{-6}$
VERY POOR QUALITY ROCK MASS Numerous heavily weathered joints spaced <2 in. with gouge. Waste rock with fines. CSIR rating: <i>RMR</i> = 3	m s	$0.007 \\ 1 \times 10^{-7}$	$0.010 \\ 1 \times 10^{-7}$	0.015 1 × 10 ⁻⁷	$0.017 \\ 1 \times 10^{-7}$	$0.025 \\ 1 \times 10^{-7}$



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 JOB:
 09.0025796.00

 SUBJECT:
 H-Pile Axial Capacity

 SHEET:
 1 OF 3

 CALCULATED BY
 J.Baron
 10-17-13

 CHECKED BY
 C. Snow 10-30-13

Objective

Evaluate pile foundations including the axial geotechnical resistance of the pile .

Methodology

Evaluate proposed pile section for governing axial compression resistance as follows. Pile properties are for full section - no corrosion allowance.

- 1. Nominal Compressive Resistance
- 2. Factored Structural Compressive Resistance Strength Limit State
- 3. Factored Structural Compressive Resistance Extreme/Service Limit State
- 4. Geotechnical Resistance (Static Analysis)
- 5. Geotechnical Resistance (Drivability Analysis)
- 6. Factored Geotechnical Resistance Strength Limit State
- 7. Factored Geotechnical Resistance Extreme/Service Limit State

References

- 1. American Association of State Highway and Transportation Officials, AASHTO LRFD Bridge Design Specifications: Customary U.S. Units, 4th edition, 2007 with 2008 and 2009 interim Revisions. (AASHTO LRFD)
- 2. American Association of State Highway and Transportation Officials, AASHTO LRFD Bridge Design Specifications: Customary U.S. Units, 6th edition, 2012 with June 2012 errata. (AASHTO LRFD)
- 3. Preliminary Design Plans, Fairfield BRO 1448(38) prepared by McFarland-Johnson, Inc. dated 7/31/12.
- 4. Test borings B-1 through B-4 drilled by NH Boring and observed by GZA, March 2012.

Soil Properties

Soil Profile was interpolated based on borings BB-HEPR-201 through -207 The subsurface profile consists of Fill at the abutments, Alluvial at the piers, overlying Glacial Till and Bedrock. Bedrock was encountered approximately 14 to 19 feet below the bottom of pile cap elevation at the Abutments. Bedrock was encountered approximately 43 to 49 feet below the bottom of pile cap elevation at the Piers.

(34.4)

Structural Properties

Young's Modulus of Steel	$E_s \coloneqq 29000 \cdot ksi$	
Yield Strength of Steel	F _y := 50ksi	
Area of section	$A_{s} := \begin{pmatrix} 15.5 \\ 21.4 \\ 26.1 \end{pmatrix} in^{2}$	r HP 12 HP 14 HP 14 HP 14

X 53 X 73 X 89 X 117



JOB:09.0025796.00SUBJECT:H-Pile Axial CapacitySHEET:2 OF 3CALCULATED BYJ.Baron10-17-13CHECKED BYC. Snow 10-30-13

1. Nominal Compressive Resistance P_n

Nominal Compressive Resistance: $P_n := F_v \cdot A_s$

$P_{n} = \begin{pmatrix} 775\\ 1070\\ 1305\\ 1720 \end{pmatrix} \cdot k^{2}$	For	HP 12 X 53 HP 14 X 73 HP 14 X 89 HP 14 X 117
--	-----	---

2. Factored Structural Compressive Resistance - Strength Limit State:

Assuming that the bottom of the tremie elevation is below scour, buckling need not be considered.

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Factor for piles in compression under severe driving conditions:

From Article 6.5.4.2 $\phi_c := 0.5$

Factored Compressive Resistance for Strength Limit State:

 $P_{r.s} := \phi_c \cdot P_n$ AASHTO Eq. 6.9.2.1-1 pg. 6-81 $P_{r.s} = \begin{pmatrix} 388 \\ 535 \\ 653 \\ 860 \end{pmatrix} \cdot kip$ For HP 12 X 53
HP 14 X 73
HP 14 X 89
HP 14 X 117

3. Factored Structural Compressive Resistance - Service/Extreme Limit State:

Resistance Factors for Extreme Limit States:

From Article 10.5.5.1 and 10.5.5.3 $\phi := 1$

Factored Compressive Resistance for Service/Extreme Limit State:

 $P_{r.e} := \phi \cdot P_n$ $P_{r.e} = \begin{pmatrix} 775\\1070\\1305\\1720 \end{pmatrix} \cdot kip$ AASHTO Eq. 6.9.2.1-1 $P_{r.e} = \begin{pmatrix} 775\\1070\\1305\\1720 \end{pmatrix} \cdot kip$ $HP 14 \times 73$ $HP 14 \times 89$ $HP 14 \times 117$

4. Geotechnical Axial Resistance - Static Analysis

In GZA's experience for end bearing on rock, the structural resistance or drivability resistance will control this analysis.



JOB: 09.0025796.00 SUBJECT: H-Pile Axial Capacity SHEET: 3 OF 3 CALCULATED BY J.Baron 10-17-13 CHECKED BY C. Snow 10-30-13

5. Geotechnical Axial Resistance - Drivability Analysis

$$\begin{split} \sigma_{dr} &\coloneqq 0.9 \cdot \varphi_{da} \cdot f_y^{\bullet} & \text{AASHTO Eq. 10.7.8-1} \quad \text{Pg. 10-121} \\ f_y &\coloneqq F_y & \text{yield Strength of steel} \\ \varphi_{da} &\coloneqq 1.0 & \text{AASHTO Table 10.5.5.2.3-1, page 10-46, Refers to Article 6.5.4.2, Pg. 6-30} \\ \sigma_{dr} &\coloneqq 0.9 \cdot \varphi_{da} \cdot f_v & \sigma_{dr} &= 45 \cdot \text{ksi} & \text{Driving Stress in pile cannot exceed 45 ksi} \end{split}$$

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6. Factored Drivability Resistance - Strength Limit State:

Strength Limit State Factored Drivability Resistance:



7. Factored Drivability Resistance - Service/Extreme Limit States:

Service and Extreme Limit State Factored Drivability Resistance:

Resistance Factors for Extreme Limit States:

From Article 10.5.5.1 and 10.5.5.3
$$\phi_{serv ext} \coloneqq 1$$

$$R_{ndr_serv_ext} := R_{ndr} \cdot \phi_{serv_ext} \qquad R_{ndr_serv_ext} = \begin{pmatrix} 435\\553\\700\\900 \end{pmatrix} \cdot kip$$

Penobscot River Bridge Howland-Enfield, Maine 09.0025796.00

WEAP Analysis									
Hammer	E _{rated} (ft-lbs)	Fuel Setting	Pile Size	Location	Pile Length (ft)	R _{ult} (kips) @ 45ksi	Blow Count @ 45ksi		
Delmag D22-02	48,500	4	12x53	Abut 1	14	435	14		
Delmag D22-02	48,500	3	12x53	Abut 2	19	444	11		
Delmag D22-02	48,500	1	12x53	Pier	29	500	15		
Delmag D22-02	48,500	2	14x73	Abut 2	19	553	12		
Delmag D30-02	66,200	4	14x89	Abut 2	19	700	13		
Delmag D46-02	107,100	4	14x117	Abut 2	19	900	13		

ABUT1BOX.OUT

ÚÄÄÄÄÄÄÄÄ ULTIMATE STATIC PILE CAPACITY/Federal Highway Administration ÄÄÄÄÄÄÄÄÄ Nordlund (1963, 1979) and Tomlinson (1979, 1980) methods з 3 з : TYLin Project Name з : Howland Client з 3 Project Manager : File Name : abut1 JRB 3 Date : 10/28/13 Computed by з : JRB 3 3 з з Depth of Top of Pile = 0.00 ft. Pile length 14.00 ft. =з з Depth to Water Table = 6.00 ft. з Type of Pile 3 = H Pile з 3 HP 12x53 3 3 з з SKIN FRICTION CONTRIBUTION 3 з з 3 Layer Soil Thickness Effective Internal N-SPT Pile 3 Perimeter 3 Туре Stress Friction 3 3 (ft) (psf) Angle (ft) 3 з 3 з **Cohesionless** 1 812.60 32.00 14.00 3.97 з 3 з з з з Undrained Shear Adhesion Soil Pile Slidina Skin Layer з Resistance ³ Strength Friction Туре Taper 3 3 (psf) Angle (Kips) з з з 1 Cohesionless 24.10 16.30 ____ 3 з 3 з 3 з Total Side Friction 16.30 : 3 з з 3 POINT RESISTANCE CONTRIBUTION 3 3 Pile End Effective SPT з Internal Bearing End Bearing 3 3 value Stress at Friction Area Capacity Resistance 3 pile Tip Angle Factor (ft*ft) з Nq (psf) (Kips) 3 3 з 1250.80 43.00* 68.39 0.99 307.00 296.64 з 3 3 3 з Limiting End Bearing Resistance 🗄 667.67 3 3 з 3 3 3 Ultimate Static Pile Capacity : 312.94 ÀÄÄÄÄÄ Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu ÄÄÄÄÄÙ

 $\frac{16.3}{400} = -41.$

@Abut !!

GZA Geo Environmental, Inc. Route 155 Abutment 1

28-Oct-2013 GRLWEAP Version 2010



GZA Geo Er Route 155 A	nvironmental, Inc. Ibutment 1	12x53 pile	е	28-Oct-2013 GRLWEAP Version 2010		
	Maximum	Maximum				
Ultimate	Compression	Tension	Blow			
Capacity	Stress	Stress	Count	Stroke	Energy	
kips	ksi	ksi	blows/in	ft	kips-ft	
100.0	19.85	0.00	1.4	4.28	10.40	
200.0	28.49	0.00	3.8	5.14	9.06	
300.0	35.25	0.72	6.5	5.60	9.29	
400.0	42.91	0.21	11.0	6.10	10.05	
500.0	48.91	0.89	20.0	6.57	10.93	
600.0	52.95	2.38	46.1	6.96	11.61	
700.0	56.07	3.92	153.3	7.26	12.20	
800.0	57.52	4.78	9999.0	7.40	12.44	

435 kips at 45 ksi at 14 blows per inch

ABUT2BOX.OUT

ÚÄ 3 3	AAAAAA	Ä ULTIMA Nord	ATE STAT dlund (1	IC PILE CAP 963, 1979)	ACI ⁻ and	TY/Federal Tomlinson	Highway (1979, 1	Administra 980) metho	ition ÄÄÄÄÄÄÄ ods	ڬؚۣؗڵ؋ ٤
3 3 3 3	Projec File N Date	t Name ame	: RT 1 : Abut : 10/2	55 2 8/13		Client Project Compute	Manager d by	: MDOT : CLS : JRB		3 3 3 3
3 3 3 3	Depth Depth Type o	of Top o to Water f Pile	of Pile ⁻ Table	= 0.00 ft = 16.00 ft = H Pile	•	Pilo	e length	E	19.00 ft.	3 3 3 3
3	HP 1	2833								3
3				SKIN	FRT	CITON CONTI	KIR01ION-			3
3 3 3 3	Layer	Soil Type		Thickness (ft)	E1	ffective Stress (psf)	Internal Friction Angle	N-SPT	Pile Perimeter (ft)	3 3 3 3
3 3 3	1 2	Cohesior Cohesior	nless nless	16.00 3.00		1000.00 2101.40	32.00 34.00	90 90	3.97 3.97	3 3 3 3
3333	Layer	Soil ⊤ype	U	ndrained Sh Strength (psf)	ear	Adhesion	Pile Taper	Sliding Friction Angle	Skin Resistance (Kips)	3 2 3 3 3
3 3 3	1 2	Cohesior Cohesior	nless nless					24.10 25.61	22.92 10.60	3 3 3
3 3 3						То	tal Side	Friction	: 33.52	3 3 3
3				POINT R	ESIS	STANCE CON	TRIBUTION			3
333	Effect Stress pile T	ive at ip	Interna Frictio Angle	l SPT n Value		Pile End Area	Bear Capa Fac	ing city tor	End Bearing Resistance	g 3 3 3
3	(psf)	J .			(ft*ft)	N	q	(Kips)	3
3	2202.	80	42.71*	58.54		0.99	282.	47	479.24	3
333				L	imi	ting End B	earing Re	sistance	644.65	333
3				U	lti	mate Stati	c Pile Ca	pacity :	512.76	3
ÀÀ	ÄÄÄÄÄ H	it arrov	v keys t	o display n	ext	screen. <	F8> Print	. <f10> Ma</f10>	ain Menu ÄÄÄ	ÄÄÙ
				٩	A	but 2:				
							1.1	33.52	~ 81	
								400	01.	

GZA Geo Environmental, Inc. Route 155 Abutment 2

28-Oct-2013 GRLWEAP Version 2010



GZA Geo Environmental, Inc. Route 155 Abutment 2		12x53 pile		28-Oct-2013 GRLWEAP Version 2010		
Maximum Ultimate Compression Capacity Stress kips ksi		Maximum Tension Stress ksi	Blow Count blows/in	Stroke ft	Energy kips-ft	
100.0	21.36	0.00	1.2	4.59	12.92	
200.0	29.80	0.00	3.1	5.65	11.24	
300.0	37.00	0.96	5.2	6.23	11.64	
400.0	42.61	0.26	8.3	6.85	12.57	
500.0	47.99	0.30	14.8	7.34	13.30	
600.0	52.38	2.27	32.6	7.87	14.17	
700.0	55.37	4.26	133.4	8.29	14.90	
800.0	56.78	4.68	9999.0	8.45	15.17	
800.0 444 kir	56.78 os at 45 ksi at 11 bl	4.68 ows per inch	9999.0	8.45	15.17	

PIERSBOX.OUT

Ú/ 3 3 3 3 3	Projec File N Date	ÄÄ ULTIMA Norc It Name Name	TE STATI llund (19 : RT 15 : piers : 10/28	C PILE CAPA 63, 1979) a 5 /13	CITY/Federa and Tomlinso Client Projec Comput	l Highway n (1979, 1 t Manager ed by	Administra 980) metho : MDOT : CLS : JRB	ution ÄÄÄÄÄÄÄÄÄ ods 3 3 3 3 3
33333	Depth Depth Type C HP 1	of Top o to Water of Pile L2x53	of Pile = Table = =	0.00 ft. 0.00 ft. H Pile	Pi	le length	=	50.00 ft. 3 3 3 3
3				SKIN F	RICTION CON	ITRIBUTION		3
3 3 3 3	Layer	Soil Туре	т	hickness (ft)	Effective Stress (psf)	Internal Friction Angle	N-SPT	Pile ³ Perimeter ³ (ft) ³
333	1 2	Cohesior Cohesior	iless iless	25.00 25.00	720.00 2285.00	32.00 34.00		3.97 ³ 3.97 ³ 3.97 ³
3333	Layer	Soil Туре	Un	drained She Strength (psf)	ear Adhesio	on Pile Taper	Sliding Friction Angle	Skin ³ Resistance ³ (Kips) ³
3 3 3	1 2	Cohesior Cohesior	less less				24.11 25.62	25.82 ³ 96.18 ³ 3
3					Т	otal Side	Friction	: 121.99
3				POINT RE		NTRIBUTION		3
3 3 3 3	Effect	tive s at	Internal Friction	SPT Value	Pile Er Area	id Bear Capa	ing city	End Bearing ³ Resistance ³
3	(ps1	Γρ F)	Angre		(ft*ft)	rac N	lq	(Kips) ³
333	3130.	.00	41.72*	53.60	0.99	232.	20	3 551.87 3
3 3 3				Li	miting End	Bearing Re	sistance :	558.94 ³ 3
3				U	timate Stat	ic Pile Ca	pacity :	673.87 3
ÀÄ	ÄÄÄÄ H	Hit arrow	/ keys to	display ne	ext screen.	<f8> Print</f8>	:. <f10> Ma</f10>	in Menu ÄÄÄÄÄÙ

For Embednut Fim El. 97 - EL.70 $Q_{s} = 105$

 $\frac{105}{400} = -241.$

Page 1



GZA Geo Environmental, Inc. Route 155 Pier

28-Oct-2013 GRLWEAP Version 2010



GZA Geo Er Route 155 P	nvironmental, Inc. Pier	12x53 pile	е	28-Oct-2013 GRLWEAP Version 2010		
Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count blows/in	Stroke ft	Energy kips-ft	
100.0	24.04	0.40	0.8	5.42	19.49	
200.0	28.86	1.10	1.9	6.58	18.90	
300.0	35.04	3.57	3.4	7.58	20.94	
400.0	40.83	5.93	6.7	8.65	23.52	
500.0	44.49	7.50	15.2	9.50	25.86	
600.0	45.21	8.36	49.5	9.86	26.86	
700.0	44.74	8.76	9999.0	10.00	27.22	

ABUT2_14.OUT

ÚА з з		ÄÄ ULTIMA Nord	TE STAT	CC PILE CAPAG 963, 1979) ai	CITY/Federal nd Tomlinson	Highway / (1979, 19	Administra 980) metho	tion ÄÄÄÄÄÄÄÄÄ ds ³
3 3 3 3	Projec File M Date	ct Name Name	: RT 1 : Abut : 10/28	55 2 3/13	Client Project Computed	Manager d by	MDOT CLS JRB	3 3 3 3
3 3 3 3 3	Depth Depth Type o HP	of Top o to Water of Pile 14x73	of Pile = ' Table = -	= 0.00 ft. = 16.00 ft. = H Pile	Pile	e length	=	19.00 ft. 3 3 3 3 3
3				SKIN FI	RICTION CONTR	RIBUTION		3
3 3 3 3	Layer	Soil ⊤уре	-	Thickness (ft)	Effective Stress (psf)	Internal Friction Angle	N-SPT	Pile ³ Perimeter ³ (ft) ³
333	1 2	Cohesion Cohesion	iless iless	16.00 3.00	1000.00 2101.40	32.00 34.00		4.70 ³ 4.70 ³
3333	Layer	Soil Туре	Ur	ndrained Shea Strength (psf)	ar Adhesion	Pile Taper	Sliding Friction Angle	Skin ³ Resistance ³ (Kips) ³
3 3 3	1 2	Cohesion Cohesion	iless iless				25.15 26.72	30.65 ³ 14.33 ³ 3
3 3 3					То	tal Side	Friction	: 44.98 ³
3				POINT RE	SISTANCE CON	TRIBUTION		3
333	Effect Stress	tive s at	Interna Friction	l SPT n Value	Pile End Area	Bear Capa	ing city tor	End Bearing ³ Resistance ³
3	(ps	f)	Angre		(ft*ft)	N	q	(Kips) ³
3 3 3	2202	.80	42.71*	58.54	1.38	282.	47	670.45 ³
3				Liı	miting End B	earing Re	sistance :	901.85 ³ 3
3				٥J	timate Stati	c Pile Ca	pacity :	715.43 ³
ÀŻ	AAAA I	Hit arrow	v keys to	o display ne	xt screen. <	F8> Print	. <f10> Ma</f10>	in Menu ÄÄÄÄÄÙ
				(Abut 2		4498	
					(14873))	550	- = ~ 81.

GZA Geo Environmental, Inc. Route 155 Abutment 2

28-Oct-2013 GRLWEAP Version 2010



GZA Geo Er Route 155 A	nvironmental, Inc. Ibutment 2	14x73 pile	е	28-Oct-2013 GRLWEAP Version 2010		
Ultimate	Maximum Compression	Maximum Tension	Blow	Ofrication	F	
Capacity	Stress	Stress	Count	Stroke	Energy	
kips	ksi	ksi	blows/in	ft	kips-ft	
100.0	20.88	0.00	1.0	5.01	15.89	
200.0	26.55	0.00	2.6	6.31	13.81	
300.0	33.22	0.22	4.3	6.88	13.49	
400.0	38.72	0.68	6.3	7.40	13.88	
500.0	43.02	0.39	9.5	7.88	14.32	
600.0	46.75	1.44	14.4	8.43	15.16	
700.0	48.97	2.16	26.6	8.78	15.58	
800.0	50.98	2.67	67.0	9.12	16.32	
900.0	52.46	3.19	9999.0	9.39	16.89	

553 kips at 45 ksi at 12 blows per inch
GZA Geo Environmental, Inc. Route 155 Abutment 2

28-Oct-2013 GRLWEAP Version 2010



GZA Geo Environmental, Inc. Route 155 Abutment 2		14x89 pile		28-Oct-2013 GRLWEAP Version 2010	
	Maximum	Maximum			
Ultimate	Compression	Tension	Blow		
Capacity	Stress	Stress	Count	Stroke	Energy
kips	ksi	ksi	blows/in	ft	kips-ft
-					-
100.0	19.07	0.00	0.8	4.32	20.17
200.0	25.15	0.00	2.0	5.54	17.48
300.0	30.15	0.00	3.4	6.15	16.72
400.0	35.17	0.00	4.8	6.51	16.96
500.0	39.49	0.35	6.5	6.85	17.32
600.0	42.73	0.94	8.9	7.16	17.87
700.0	45.48	1.33	12.6	7.47	18.36
800.0	47.51	2.73	19.4	7.73	19.21
900.0	49.40	3.69	32.8	8.03	20.22
1000.0	51.11	4.70	69.2	8.32	21.19

GZA Geo Environmental, Inc. Route 155 Abutment 2

28-Oct-2013 GRLWEAP Version 2010



GZA Geo Environmental, Inc. Route 155 Abutment 2		14x117 pile		28-Oct-2013 GRLWEAP Version 2010	
	Maximum	Maximum			
Ultimate	Compression	Tension	Blow		
Capacity	Stress	Stress	Count	Stroke	Energy
kips	ksi	ksi	blows/in	ft	kips-ft
200.0	23.71	0.00	1.5	5.05	20.99
300.0	26.88	0.00	2.8	5.67	19.63
400.0	29.88	0.11	3.6	5.81	19.93
500.0	33.56	0.22	4.6	5.99	20.55
600.0	36.91	0.47	5.8	6.22	21.23
700.0	40.07	0.73	7.3	6.49	22.13
800.0	42.19	0.95	9.7	6.68	22.38
900.0	44.54	1.07	12.7	6.94	23.31
1000.0	46.54	1.59	16.7	7.18	24.26