

**MAINE DEPARTMENT OF TRANSPORTATION
BRIDGE PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE**

GEOTECHNICAL DESIGN REPORT

For the Replacement of:

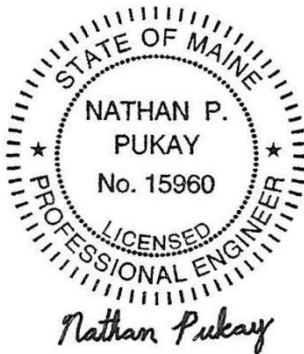
**RICE BRIDGE
STATE ROUTE 191 OVER RICE STREAM
TRESCOTT TOWNSHIP, MAINE**

Prepared by:

Nathan Pukay, P.E.
Transportation Engineer II

Reviewed by:

Laura Krusinski, P.E.
Senior Geotechnical Engineer



Washington County
WIN 26089.00

Soils Report 2026-19
Bridge No. 2714

Federal Project No. 02608900
March 6, 2026

Table of Contents

1.0	INTRODUCTION	1
2.0	GEOLOGIC SETTING	1
3.0	SUBSURFACE INVESTIGATION	2
4.0	LABORATORY TESTING	2
5.0	SUBSURFACE CONDITIONS	3
5.1	FILL.....	3
5.2	BEDROCK	4
5.3	GROUNDWATER	5
6.0	FOUNDATION ALTERNATIVES	5
7.0	GEOTECHNICAL DESIGN RECOMMENDATIONS.....	5
7.1	PRECAST CONCRETE FRAME DESIGN	5
7.1.1	SPREAD FOOTINGS ON BEDROCK	6
7.1.2	STEM WALL AND WINGWALL SPREAD FOOTING DESIGN.....	6
7.1.3	SLIDING	6
7.1.4	BEARING RESISTANCE AND ECCENTRICITY	7
7.1.5	EARTH PRESSURE AND SURCHARGE FORCES.....	8
7.2	BEDROCK SUBGRADE PREPARATION	10
7.3	SETTLEMENT	10
7.4	FROST PROTECTION.....	11
	SCOUR, RIPRAP AND TOE BUTTRESS	11
7.5		11
7.6	SEISMIC DESIGN CONSIDERATIONS	12
7.7	ROADWAY DRAINAGE.....	12
8.0	CONSTRUCTION CONSIDERATIONS.....	13
8.1	EXCAVATION AND DEWATERING.....	13
8.2	SUBGRADE PREPARATION	13
8.3	REUSE OF ON-SITE MATERIALS.....	14
8.4	RIPRAP TOE BUTTRESS.....	14
9.0	CLOSURE.....	14

Sheets

Sheet 1 – Location Map

Sheet 2 – Boring Location Plan

Sheet 3 – Interpretive Subsurface Profile

Sheet 4 – Boring Logs

Sheet 5 – Boring Logs

Appendices

Appendix A – Boring Logs

Appendix B – Rock Core Photographs

Appendix C – Laboratory Test Results

Appendix D – Calculations

Appendix E – Rock Block Stabilization Detail and Special Provision

1.0 INTRODUCTION

The purpose of this Geotechnical Design Report is to present subsurface information and provide geotechnical design recommendations for the replacement of Rice Bridge which carries State Route 191 over Rice Stream in Trescott Township, Maine. This report presents the subsurface information obtained at the site during the subsurface investigations, geotechnical design parameters, and construction recommendations for the new bridge.

The existing Rice Bridge was constructed in 1932 and is a 12-foot, single-span, concrete slab bridge founded on mass concrete abutments cast on bedrock. According to the 2021 Maine Department of Transportation (MaineDOT) Bridge Inspection Report, the bridge is in poor condition with longitudinal cracking in the bridge deck, a severe full-height vertical crack in the south abutment, and spalling and efflorescence across many of the bridge elements.

Available as-built drawings indicate the previous bridge consisted of a timber superstructure founded on stacked stone abutments.

The proposed replacement bridge consists of a 19-foot span by 5-foot rise, 48-foot long, 3-sided, precast concrete frame with cast-in-place concrete stem walls founded on spread footings on bedrock. The bridge will have flared, cast-in-place wingwalls on all four corners, also founded on bedrock. Plain and heavy riprap slopes will be constructed in front of the wingwalls and installed no steeper than 1.75H:1V (horizontal:vertical). The bridge approach slopes will generally be constructed no steeper than 2H:1V, except for the slopes at the northeast corner of the bridge, which will be constructed as steep as 1.5H:1V to avoid encroachment into Rice Stream. These oversteepened slopes will be armored with heavy riprap with rock-doweled toe buttresses for stability. The new bridge will be located on a horizontal and vertical alignment that approximately matches the existing.

Traffic will be maintained on a temporary detour built on the upstream side of the existing bridge.

2.0 GEOLOGIC SETTING

Rice Bridge carries State Route 191 over Rice Stream as shown on Sheet 1 – Location Map.

The Maine Geological Survey (MGS) Surficial Geology Map of the Moose River Quadrangle, Open-File No. 74-6 (1974), indicates the surficial soils in the vicinity of the bridge project consist of glacial marine deposits over shallow bedrock. Glacial marine deposits consist of silt, clay, and sand of the Presumpscot Formation.

The MGS Geologic Map of the Cutler and Moose River Quadrangles, Open-File No. 61-1 (1961) maps the bedrock in the vicinity of the project as bedded tuffs, argillites, shales, limestones and conglomerates of the Little River Formation. The MGS Bedrock Geology of Maine (1985) later renamed this bedrock formation to the Quoddy Formation.

3.0 SUBSURFACE INVESTIGATION

Seven test borings and three bridge probes were drilled to explore subsurface conditions at the site. Borings BB-TRS-101, BB-TRS-102 and BB-TRS-102A were drilled at the location of the proposed south stem wall footing and borings BB-TRS-103 and BB-TRS-104 were drilled at the location of the proposed north stem wall footing. Bridge probes BP-TRS-105, BP-TRS-106, and BP-TRS-107 were drilled along the left lane of the north approach to characterize the bedrock profile in consideration of visible bedrock outcrops. BB-TRS-201 and BB-TRS-202 were drilled behind the oversteepened slopes at the northeast corner of the bridge to evaluate whether glacial marine deposits were present. The borings and bridge probe locations are shown on Sheet 2 – Boring Location Plan.

The MaineDOT Drill Crew drilled the 100-series borings in June 2024 and the 200-series borings in December 2024. Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are presented in the boring logs provided in Appendix A – Boring Logs and on Sheets 4 and 5 – Boring Logs.

Bridge probes were performed by advancing a solid stem auger to refusal. Borings were performed by using a combination of solid stem auger, cased wash boring, and rock coring techniques. Soil samples were typically obtained at 5-foot intervals or continuously using Standard Penetration Test (SPT) methods. During SPT sampling, the sampler is driven 24 inches and the hammer blows for each 6-inch interval of penetration are recorded. The sum of the blows for the second and third intervals is the N-value, or standard penetration resistance. The drill rig is equipped with an automatic hammer to drive the split spoon. The hammer was calibrated per ASTM D4633 “Standard Test Method for Energy Measurement for Dynamic Penetrometers” to establish the hammer efficiency factors. All N-values discussed in this report are corrected N-values computed by applying the hammer efficiency factors. The hammer efficiency factors and both the raw field N-value and corrected N-value (N_{60}) are shown on the boring logs.

Bedrock was cored in the borings using NQ-2” core barrels and the Rock Quality Designation (RQD) of the cores were calculated. The MaineDOT geotechnical engineer selected the boring locations and drilling methods, designated type and depth of sampling techniques, identified field-testing requirements, and logged the subsurface conditions encountered in the borings. The borings were located in the field using taped measurements at the completion of the drilling program and then located by MaineDOT Survey.

4.0 LABORATORY TESTING

A laboratory testing program was conducted on selected soil and bedrock samples recovered from the test borings to assist in soil classification, evaluation of engineering properties of the soil and bedrock, and geologic assessment of the project site. Laboratory testing on soil samples consisted of five standard grain size analyses with natural water content, two grain size analyses with hydrometer and natural water content, and two Atterberg limits tests. Two bedrock core samples were tested for unconfined compressive strength and elastic moduli.

Soil laboratory testing was performed at the MaineDOT Lab in Bangor, Maine. Rock core testing was performed by GeoTesting Express (GTX) of Acton, Massachusetts. The results of soil and rock tests are included in Appendix C – Laboratory Test Results. Moisture content information and other soil and rock test results are also shown on the boring logs provided in Appendix A – Boring Logs and on Sheets 4 and 5 – Boring Logs.

5.0 SUBSURFACE CONDITIONS

Subsurface conditions encountered in the test borings generally consisted of Fill overlying Bedrock. The boring logs are provided in Appendix A – Boring Logs and on Sheets 4 and 5 – Boring Logs. A generalized subsurface profile is shown on Sheet 3 – Interpretive Subsurface Profile. The following paragraphs discuss the subsurface conditions encountered:

5.1 Fill

A layer of Fill was encountered in the test borings. The Fill was coarse-grained near the roadway surface, with the proportion of fine-grained material generally increasing with depth. The thickness of the Fill unit was approximately 1 to 14 feet. The fill materials encountered consisted of:

- Brown, SAND, some silt, little to some gravel;
- Brown, Gravelly SAND, trace to little silt;
- Brown, Sandy GRAVEL, trace to little silt;
- Brown to grey-brown, GRAVEL, little to some sand, trace to some silt;
- Brown, Gravelly SILT, some sand;
- Brown, SILT, some sand, little to some gravel, trace to little clay, trace organics; and
- Wood, cobbles and boulders.

Corrected SPT N-values in the coarse-grained Fill ranged from 3 to greater than 50 blows per foot (bpf) indicating the coarse-grained fill is very loose to very dense in consistency.

Corrected SPT N-values in the fine-grained Fill subunit ranged from 6 to 35 bpf indicating the subunit is medium stiff to hard in consistency.

Seven grain size analyses performed on samples recovered from the Fill unit indicated the material is classified as A-4, A-1-a, A-1-b, and A-2-4 under the AASHTO Soil Classification System and ML, SM, SW-SM, and SC-SM under the Unified Soil Classification System (USCS). The natural water contents of the samples tested ranged from 8 to 35 percent.

Atterberg limits tests were conducted on two samples of the cohesive Fill soils. The samples were determined to be non-plastic.

5.2 Bedrock

Bedrock was encountered and cored in four of the project borings. The table below summarizes borings in which bedrock was cored, the depth to bedrock, corresponding top of bedrock elevations and RQD's.

Boring	Station	Offset (feet)	Approximate Depth to Bedrock (feet)	Approximate Elevation of Bedrock Surface (feet)	RQD (%) (R1, R2, R3, R4, R5)
BB-TRS-101	9+9.7	6.5 Lt	13.8	13.7	0, 19, 0, 0, 75
BB-TRS-102A	9+18.9	8.7 Rt	11.6	15.9	22, 37, 40
BB-TRS-103	9+39.5	6.5 Lt	14.4	13.0	63, 0, 90
BB-TRS-104	9+46.3	6.7 Rt	12.0	15.4	78

Bedrock encountered at the site was variable and consisted of:

- Dark grey to black, very fine to fine-grained, ARGILLITE, moderately hard, fresh, competent, joints dipping at steep angles, spaced close to very close.
- Grey to dark grey, very fine to fine-grained, weakly calcareous, SHALE, hard, fresh, poorly competent, joints dipping at steep angles, closely spaced.
- Grey to greenish grey, very fine to fine-grained, TUFF, moderately hard, fresh, competent, joints dipping at low to steep angles, spaced close to very close.

In general, Argillite was the predominant bedrock unit encountered at the location of the proposed south footing(s). Shale and Tuff were encountered beneath the argillite at greater depths, within the deepest core run of BB-TRS-102A. Tuff was encountered at the location of the proposed north footing(s). The RQDs of all bedrock cores ranged from 0 to 90 percent, corresponding to a Rock Quality of very poor to good.

Detailed bedrock descriptions and RQD's are provided in Appendix A – Boring Logs and on Sheets 4 and 5 – Boring Logs. Rock core photographs are provided in Appendix B – Rock Core Photographs.

Unconfined compressive strength (UCS) testing was conducted on two samples of bedrock, the results of which are summarized in the following table.

Boring	Depth Below Ground Surface (ft)	Unconfined Compressive Strength (psi)	Young's Modulus, E ¹ (psi)	Unit Weight (pcf)	Rock Type
BB-TRS-101	22.21-22.59	15,289	9,980,000	167	Argillite
BB-TRS-103	23.81-24.19	10,150	7,880,000	193	Tuff

¹ The Young's Modulus values listed in the table are reported at the peak stress range. Reference the test reports in Appendix C – Laboratory Test Results for Young's Moduli reported at other stress ranges.

5.3 Groundwater

Groundwater was measured at depths ranging from 7 to 9 feet below the roadway surface upon completion of the borings. Note that water was introduced into the boreholes during drilling operations and the measured levels may not represent stabilized groundwater elevations. Groundwater levels will fluctuate with seasonal changes, precipitation, runoff, river levels, and construction activities.

6.0 FOUNDATION ALTERNATIVES

The Preliminary Design Report (PDR) (MaineDOT, 2025) investigated three bridge replacement options. The alternatives were:

- Buried precast arch on cast-in-place footings;
- Buried precast frame on cast-in-place footings; and
- Prestressed concrete slabs on cast-in-place abutments.

All replacement alternatives were founded on spread footings cast directly on bedrock. The precast arch alternative was eliminated due to geometric constraints associated with accommodating the 30-degree bridge skew and required wildlife shelf clearances. Of the two remaining alternatives, the precast frame was deemed more appropriate due to its lower cost, shorter construction time, and reduced maintenance.

7.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

The following subsections provide geotechnical design parameters and foundation recommendations for a buried, precast concrete frame with flared wingwalls on cast-in-place concrete spread footings on bedrock. These design recommendations are in accordance with AASHTO LRFD Bridge Design Specifications 9th Edition, 2020.

7.1 Precast Concrete Frame Design

Precast concrete frames are typically supplier-designed and are detailed on the contract plans with only basic layout and required hydraulic opening. The manufacturer selected by the Contractor is responsible for the design of the structure including determination of wall thickness, haunch thickness, and reinforcement. The structure shall be designed in accordance with MaineDOT Standard Specification 534 – Precast Structural Concrete, MaineDOT Bridge Design Guide (BDG) Section 8 – Buried Structures, and American Association of State Highway and Transportation Officials Load Resistance and Factor Design Bridge Design Specifications, 9th Edition, 2020.

The loading specified for the design of the frame shall be Modified HL-93 Strength I in which the HS-20 design truck wheel loads are increased by a factor of 1.25. The precast concrete frame shall be designed for all relevant strength and service limit states and load combinations specified in LRFD Article 3.4.1 and LRFD Section 12.

The top of the precast concrete frame stem walls shall be placed above Elev. 17.89, which is the Q1.1 flow elevation.

Concrete headwalls may be included in the buried structure design to retain riprap slopes and prevent riprap from dropping or eroding into the waterway. Nominal 1-foot by 1-foot concrete headwalls are recommended.

7.1.1 Spread Footings on Bedrock

The proposed replacement substructures will consist of a precast concrete frame with flared wingwalls founded on spread footings cast on bedrock. The test borings conducted nearest the location of the new bridge encountered the bedrock surface at Elevations ranging from 13.0 to 15.9 feet.

The borings generally indicate that the bedrock is moderately hard to hard, fresh, competent, with variable amounts of jointing and fracturing, and has RQD's correlating to a Rock Quality that is very poor to good. The bedrock type varies across the site, with Argillite encountered primarily at the location of the south footing(s) and Tuff encountered primarily at the location of the north footing(s). The contractor should expect that bedrock excavation of fractured and loose rock will be required in some areas and the thickness of the concrete footings may need to be adjusted as necessary to accommodate any deeper areas of the prepared bedrock subgrade.

7.1.2 Stem Wall and Wingwall Spread Footing Design

Spread footings supporting the precast concrete frame stem walls and wingwalls shall be designed for all relevant strength and service limit state load combinations specified in AASHTO LRFD Articles 3.4.1 and 11.5.5 and 12.5. Stem walls and spread footings shall be designed to resist all lateral earth loads, vehicular loads, deadloads, and lateral thrust forces transferred through the frame. The geotechnical design of spread footings at the strength limit state shall consider:

- Lateral Sliding
- Bearing Resistance
- Eccentricity

For the service limit state, a resistance factor, ϕ , of 1.0 shall be used to assess spread footing design for settlement, horizontal movement, bearing resistance, sliding, and eccentricity. The overall global stability of foundations is typically investigated at the Service I Load Combination and a resistance factor, ϕ , of 0.65. We do not anticipate shear failure along adversely oriented joint surfaces in the rock mass below the foundation; therefore, a global stability evaluation has been waived.

7.1.3 Sliding

The spread footings will be cast directly on bedrock. The table below presents the sliding resistance factors, ϕ_r , for spread footings on bedrock.

Resistance Factors for Sliding					
Substructure	Bearing Material	Condition	Limit State	Sliding Resistance Factor ϕ_t	LRFD Reference
Spread Footings	Bedrock	Cast-in-place concrete	Strength	0.80	Table 10.5.5.2.2-1 and BDG Table 5-3
			Service	1.0	Articles 10.5.5.1 and 11.5.7

The sliding resistance of footings to lateral loads shall be calculated using the coefficient of friction provided in the table below for mass concrete cast on clean sound bedrock.

Maximum Coefficients of Friction for Sliding						
Substructure	Interface Materials	Limit State	Friction Angle, δ_{soil}	Coefficient of Friction, $\tan \delta^1$ (dim.)	C^2	LRFD Reference
Spread footings cast on bedrock	Mass concrete on clean sound rock	All	35 °	0.60 ³	na	Table C3.11.5.3-1

Passive resistance of soil, riprap or bedrock at the toe of spread footings should be neglected and shall not contribute to resisting forces.

7.1.4 Bearing Resistance and Eccentricity

Nominal and factored bearing resistances were calculated for spread footings on bedrock using a Rock Mass Rating (RMR)-based empirical correlation⁴ in accordance with LRFD Article C10.4.6.4 and 10.6.2.6.2. RMR was evaluated in accordance with Table 10.4.6.4-1 of the 2012 LRFD code, whereas the current edition of LRFD does not include the RMR formulation. The table below summarizes the factored bearing resistances for spread footings.

¹ Use $\tan \phi_f = \tan \delta$ in LRFD Equation 10.6.3.4-2 to calculate resistance to sliding.

² LRFD Article 10.6.3.4 – C not applicable to concrete footings cast on bedrock.

³ Recommended coefficient of friction is reduced from the LRFD value under the assumption that the bedrock subgrade is prepared and inspected in-the-wet, and that at the time of concrete placement, more than 50 percent of the bottom area has less than 1 inch of sediment or loose soil, and no portion of the area has more than 2 inches of sediment or loose soil.

⁴ “Foundations on Rock” by Duncan Wyllie.

Bearing Resistances					
Substructure	Assumed Bearing Material	Limit State	Resistance Factor, ϕ_b	Factored Bearing Resistance (ksf)	LRFD Reference
Class A ¹ Spread Footings	Bedrock	Service	1.0	16	Article 10.5.5.1
		Strength	0.45	20	Table 10.5.5.2.2-1
		Bearing stress not to exceed $0.3f'_c$		170	Article 10.6.2.5.2

From a practical standpoint, footings shall have a minimum width of 3 feet wide regardless of the bearing resistance or bearing material.

Application of permanent and transient loads is specified in LRFD Article 11.5.6. The vertical stress distribution may be assumed to be triangular or trapezoidal over the effective base as shown in LRFD Figure 11.6.3.2-2 for footings on rock. In no instance shall bearing stress exceed the structural resistance of the structural concrete which may be taken as $0.3f'_c$.

For spread footings, the eccentricity limits for the resultant force are presented below.

Eccentricity Limits			
Substructure	Assumed Bearing Material	Location of Resultant Forces	LRFD Reference
Frame stem wall and wingwall spread footings	Bedrock	No further than 0.45 B from the centerline of the footing [correlates to within the middle nine-tenths (9/10) of the base width]	Articles 10.6.3.3 and 11.6.3.3

7.1.5 Earth Pressure and Surcharge Forces

The precast concrete frame will be installed on cast-in-place spread footings bearing on bedrock. As the precast frame walls are cast monolithically with the top slab and are not free to deflect, the earth pressure acting on the frame should be assumed to correspond to the at-rest condition. Similarly, headwalls that are fixed to the frame should be designed for at-rest earth pressure. Flared wingwalls will be free to rotate and should be designed for active earth pressure conditions. Earth pressure coefficients for the precast frame stem walls, headwalls, and wingwalls are provided in the following table.

¹ Class A concrete (4000 psi) is assumed for spread footings.

Earth Pressure Coefficients			
Substructure	Backfill Angle (β)	Condition	K^1
Precast Concrete Frame Stem Walls and Headwalls	0°	At-Rest	$K_0 = 0.47$
Southeast Wingwall	17.82°	Active	$K_a = 0.36$
Southwest Wingwall	19.46°	Active	$K_a = 0.37$
Northeast Wingwall	25.36°	Active	$K_a = 0.44$
Northwest Wingwall	16.56°	Active	$K_a = 0.35$

Backfill for the precast concrete frame and wingwalls shall conform to MaineDOT Specification 703.19 – Granular Borrow for Underwater Backfill with a maximum particle size of 4 inches. The gradation of this material specifies 7 percent or less of the material passing the No. 200 sieve. Limiting the amount of fines is intended to minimize frost action and eliminate the need to design for hydrostatic forces by promoting drainage behind the structure. The granular borrow backfill should be placed in lifts of 6- to 8-inches-thick loose measure and compacted to the manufacturer's specifications. To minimize future settlement, the backfill soil shall be compacted to no less than 92 percent of the AASHTO T-180 maximum dry density.

The designer may assume Soil Type 4 (BDG Section 3.6.1) for backfill material soil properties. The backfill properties are as follows:

- Internal Friction Angle (ϕ) = 32°
- Total Unit Weight (γ) = 125 pcf
- Soil-Concrete Interface Friction Angle (δ) = 17° (ref: LRFD Table 3.11.5.3-1)

Design of the stem walls and flared wingwalls shall consider LRFD Article 3.11.6.4 and Section 3.6.8 of the MaineDOT BDG which state that a live load surcharge should be applied when traffic loads are located within a horizontal distance equal to one-half of the wall height behind the back of the wall. The live load surcharge on flared wingwalls may be estimated as a uniform horizontal earth pressure due to an equivalent height of soil (h_{eq}) of 2.0 feet. The live load surcharge on the frame stem walls may be estimated as a uniform horizontal earth pressure due to an equivalent height of soil (h_{eq}) taken from LRFD Table 3.11.6.4-2. The table is reproduced below.

Stem Wall Height (feet)	h_{eq} (feet)
5	4.0
10	3.0
≥20	2.0

¹ Active earth pressure, K_a , was calculated using both the Rankine and Coulomb Methods. The Rankine method resulted in slightly higher K_a values, which are listed in this table. Use of the Rankine values provides a conservative recommendation that may be applied regardless of the heel length of the cantilever wall. At-rest earth pressure was determined as $K_0 = 1 - \sin(\phi)$.

The precast concrete frame and wingwall designs shall include a drainage system behind the wall stems to intercept any groundwater. Drainage behind the structure shall be in accordance with MaineDOT BDG Section 5.4.2.13. Conventional French Drains are the preferred system compared to other systems. A perforated drainage pipe should be installed at the bottom of the French Drain along precast concrete frame walls that do not have weepers. The drainage pipe should terminate at the flared cast-in-place wingwalls which shall have weepers installed.

7.2 Bedrock Subgrade Preparation

The borings encountered approximately 12 to 14 feet of overburden at the proposed foundation excavations. It is feasible that spread footings can be constructed to bear on bedrock using a combination of braced soil support systems and sloped cuts. Temporary excavations and soil support systems shall comply with OSHA safety requirements and be designed by a Professional Engineer when required.

The borings indicate that the RQD of the bedrock surface at the proposed footing locations will range from approximately 0 to 90 percent. The Contractor should be prepared to clear the bearing area of possibly significant quantities of weathered, loose, highly fractured, and potentially erodible bedrock during construction.

The nature, slope, and degree of fracturing in the bedrock bearing surfaces will not be evident until the foundation excavations for the precast frame and wingwalls are made. The bedrock surface shall be cleared of all loose fractured bedrock, loose decomposed bedrock, and soil. The final bearing surface shall be solid. Construction activities that create rock falls or open fissures is not permitted.

If bedrock is observed to slope steeper than 4H:1V at the subgrade elevation, the bedrock should be benched to create level steps or excavated to be completely level. The bedrock surface may be stepped along the centerline of bearing to create a workable bearing surface. Alternatively, anchoring or doweling the footings to bedrock may be utilized to resist sliding forces and improve stability. Dowels should be #9 reinforcing bars or larger and be embedded into the footings and bedrock by depths determined by the Engineer. The compressive strength of the in-situ bedrock has been estimated at 920 psi and may be used for dowel embedment calculations at all proposed footing locations.

7.3 Settlement

The vertical alignment of the new roadway will approximately match the existing. The bridge approach embankments will be constructed using granular borrow placed over generally medium dense to very dense granular fill and medium stiff to hard fine-grained fill. Any loose soils encountered at the subgrade elevation shall be thoroughly compacted prior to backfill operations. With these provisions, any settlement at the proposed bridge approaches is anticipated to be minimal and immediate.

All foundations will be constructed on bedrock. Based on our experience, for footings constructed on rock and designed for the service limit state using presumptive bearing resistance values in accordance with LRFD Table C10.6.2.5.1-1, elastic settlements can generally be assumed to be less than 1/2-inch.

7.4 Frost Protection

The stem wall and wingwall footings will be constructed directly on bedrock. For foundations bearing directly on bedrock, heave due to frost is not considered an issue and there are no embedment requirements for frost protection.

Any foundations placed on soil should be designed with an appropriate embedment for frost protection. According to MaineDOT BDG Figure 5-1, Maine Design Freezing Index Map, Trescott Township has a design freezing index (DFI) of approximately 1100 F-degree days. Fill soils are anticipated to be present at the bridge and embankments, either as silty fill or granular fill. Based on the coarse-grained fill with a water content of 10 percent, the estimated depth of frost penetration is approximately 5.8 feet.

It is recommended that foundations bearing on soil be designed with an embedment of approximately 5.8 feet for frost protection.

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

7.5 Scour, Riprap and Toe Buttress

For scour protection of the footings, construct the footings directly on bedrock surfaces cleaned of soil and all weathered, loose, highly fractured, and potentially erodible rock. All loose rock, highly fractured bedrock, or bedrock with gouge shall be removed by ripping. We anticipate that the remaining bedrock subgrade will be competent and is therefore not considered to be erodible or scourable. Therefore, no specific scour protection recommendations are needed for the foundations other than armoring with riprap.

Wingwalls shall extend far enough from the structure to protect the structural backfill from scour.

Where required, slopes shall be armored with a minimum 4-foot thick layer of heavy riprap conforming to MaineDOT Standard Specification 703.28 – Heavy Riprap. The riprap shall be underlain by a Class 1 Erosion Control Geotextile and a 1-foot layer of bedding material conforming to MaineDOT Standard Specification 703.19 Granular Borrow Material for Underwater Backfill. The toe of the riprap slopes shall be constructed according to MaineDOT Standard Detail 610(02).

In general, the riprap slopes shall be detailed and constructed no steeper than 1.75H:1V extending from the edge of the roadway down to the existing ground surface. Slopes as steep as 1.5H:1V are anticipated at the northeast corner of the bridge to maintain the existing stream alignment. Where riprap slopes are steeper than 1.75H:1V, or where the riprap toe intersects bedrock and prevents installation of the toe trench according to MaineDOT Standard Detail 610(02), a riprap toe buttress may be installed to stabilize the slope. The toe buttress shall consist of a series of rock blocks with a minimum dimension of 36 inches and anchored to the bedrock surface with rock dowels, wire rope cable lashing and anchors. Refer to the detail in Appendix E - Rock Block Stabilization Detail and Special Provision.

7.6 Seismic Design Considerations

The United States Geological Survey Seismic Design CD (Version 2.1) provided with the 2014 LRFD Code (7th Edition), and LRFD Articles 3.10.3.1 and 3.10.6 were used to develop parameters for seismic design. Based on site coordinates, the software provided the recommended AASHTO Response Spectra for a 7 percent probability of exceedance in 75 years. These results are summarized in the table below.

Seismic Design Parameters	
Parameter	Design Value
Peak Ground Acceleration (PGA)	0.074g
Acceleration Coefficient (A_s)	0.089g
S_{DS} (Period = 0.2 sec)	0.176g
S_{D1} (Period = 1.0 sec)	0.065g
Site Class	C
Seismic Zone	1

In conformance with LRFD Article 3.10.1, seismic analysis is not required for buried structures, except where they cross active faults. There are no known active faults in Maine; therefore, seismic analysis is not required.

In consideration of the cast-in-place wingwalls, LRFD Article 11.5.4.2 states that seismic analysis is not required for walls located in Seismic Zones 1 through 3, or for walls at sites where the site adjusted peak ground acceleration A_s , is less than or equal to 0.4g, unless one or more of the following is true:

- Liquefaction induced lateral spreading or slope failure, or seismically induced slope failure, due to the presence of sensitive clays that lose strength during seismic shaking, may impact the stability of the wall for the design earthquake.
- The wall supports another structure that is required to be designed for seismic loading and poor seismic performance of the wall could impact the seismic performance of that structure.
- The wall is part of a larger slope.

Based on these criteria, the no-analysis option applies, and seismic design of the wingwalls is not required.

7.7 Roadway Drainage

Bedrock was encountered at depths as shallow as 1-foot below existing grade along the north approach. Based on the project limits of the new roadway subbase gravel, conflicts with this shallow bedrock are not anticipated.

If the limits of the new roadway subbase gravel are extended, or if bedrock is encountered during construction when excavating for the roadway subbase gravel, the bedrock should be removed to provide a full 20 inches of aggregate subbase course for proper roadway drainage. Alternatively, the bedrock may be shattered blasted in accordance with MaineDOT Standard Specification 203.051.

8.0 CONSTRUCTION CONSIDERATIONS

8.1 Excavation and Dewatering

Concrete footings, stem-walls and wingwalls will be constructed in the footprints of the existing bridge substructures. The contractor shall be responsible for excavating the existing substructures in their entirety.

Excavations for the foundations will extend up to 14 feet below the existing grade. Temporary excavations and soil support systems shall comply with OSHA safety requirements and be designed by a Professional Engineer when required. Excavations will expose soils that may become saturated and water seepage may occur during construction. There may be localized sloughing and instability in some excavations and cut slopes. The contractor should control and divert groundwater and surface water infiltration using temporary ditches, sumps, granular drainage blankets and stone ditch protection.

The anticipated bedrock surface elevation ranges from approximately El. 13.0 to 15.9 feet at the footing locations, corresponding to depths up to approximately 5 feet below the Q1.1 water level (El. 17.89 ft) at Abutment No. 1, and 1 to 2 feet below the Q1.1 water level at Abutment No. 2. Depending on water conditions during construction, a cofferdam may be needed to divert water and construct stem wall and wingwall footings in the dry.

It is anticipated that there will be seepage of water from retained soil and fractures and joints exposed in the bedrock surface. Surface water should be diverted from the excavations throughout the period of construction. Water encountered at the base of the foundation excavation should be removed by pumping from sumps located in the corners of the excavation outside of the foundation footprint.

8.2 Subgrade Preparation

The subgrade for the footings shall consist of sound bedrock. The nature, slope and degree of fracturing in the bedrock bearing surface will not be evident until the foundation excavation is made. The bedrock subgrade surface shall be cleaned of all overburden soils and loose, dislodged bedrock fragments by conventional excavations methods and mechanical means. Mechanical means include expansive agents, hydraulic hoe ram, hydraulic splitters or wedging and prying. For locations where footings can be constructed in the dry, the final bearing surface of bedrock shall be washed with high pressure water and air prior to concrete being placed for the stem wall and wingwall footings. Otherwise, the condition of the bedrock subgrade prior to underwater concrete placement shall be prepared and inspected in accordance with Standard Specification 511 – Cofferdams.

Blasting, when required, should be conducted in accordance with Section 105.2.7 of the MaineDOT Standard Specifications. It is also recommended that the contractor conduct pre-and post-blast surveys, at the nearby residences, and bridge structures in accordance with industry standards at the time of the blast. Construction activities should not be permitted to disturb the bedrock mass or create any open fissures.

The slope of the bedrock subgrade shall be no steeper than 4H:1V or it shall be benched to create level steps or excavated to be completely level. Anchoring or doweling the footing to bedrock may be utilized to improve sliding resistance where the prepared bedrock surface is steeper than 4H:1V. Dowels should be #9 reinforcing bars or larger and be embedded into the footings and bedrock by depths determined by the Engineer.

The final bedrock surface shall be approved by the Resident prior to placement of footing concrete.

If bedrock is encountered when excavating for the roadway gravel subgrade, the bedrock should be removed to provide a full 20 inches of aggregate subbase course or shatter blasted in accordance with MaineDOT Standard Specification 203.051 to allow for roadway drainage.

8.3 Reuse of On-Site Materials

Soil samples recovered from the existing approach fills had approximately 7 to 55 percent passing the No. 200 sieve, indicating the existing fill does not meet MaineDOT specifications for Granular Borrow for Underwater Backfill. The existing fill soils may be considered suitable for use as Common Borrow, at the discretion of the Resident, provided the proposed material meets the requirements of Standard Specification 703.18.

The existing fine-grained fill materials should not be re-used to dress the embankment sideslopes.

8.4 Riprap Toe Buttress

Where riprap slopes are designed to be steeper than 1.75H:1V or a riprap toe trench cannot be installed in accordance with MaineDOT Standard Detail 610(02), a toe buttress should be constructed in accordance with Special Provision 513 (Rock Block Stabilization) which is included in Appendix E - Rock Block Stabilization Detail and Special Provision.

9.0 CLOSURE

This report has been prepared for the use of the MaineDOT Bridge Program for specific application to the proposed replacement of Rice Bridge in Trescott Township, Maine in accordance with generally accepted geotechnical and foundation engineering practices. No other intended use or warranty is expressed or implied.

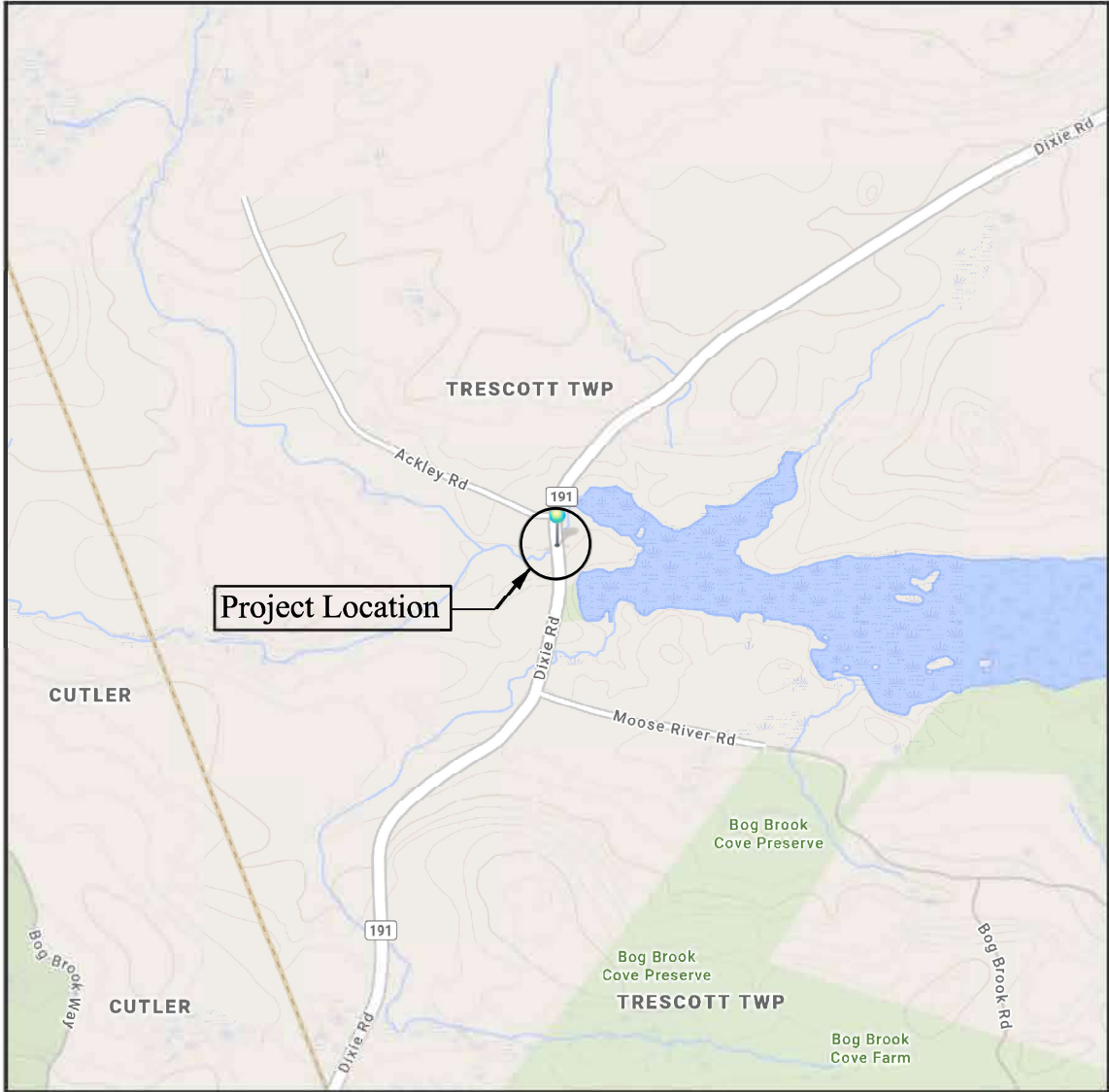
In the event that any changes in the nature, design, or location of the proposed project are planned, this report should be reviewed by a geotechnical engineer to assess the appropriateness of the conclusions and recommendations and to modify the recommendations as appropriate to reflect the changes in design. These analyses and recommendations are based in part upon limited subsurface investigations at discrete exploratory locations completed at the site. If variations from the conditions encountered during the investigation appear evident during construction, it may also become necessary to re-evaluate the recommendations made in this report.

It is recommended that the geotechnical engineer be provided the opportunity for a review of the design and specifications so that the earthwork and foundation recommendations and construction considerations in the report are properly interpreted and implemented in the design and specifications.

Sheets



TRESCOTT TOWNSHIP, MAINE

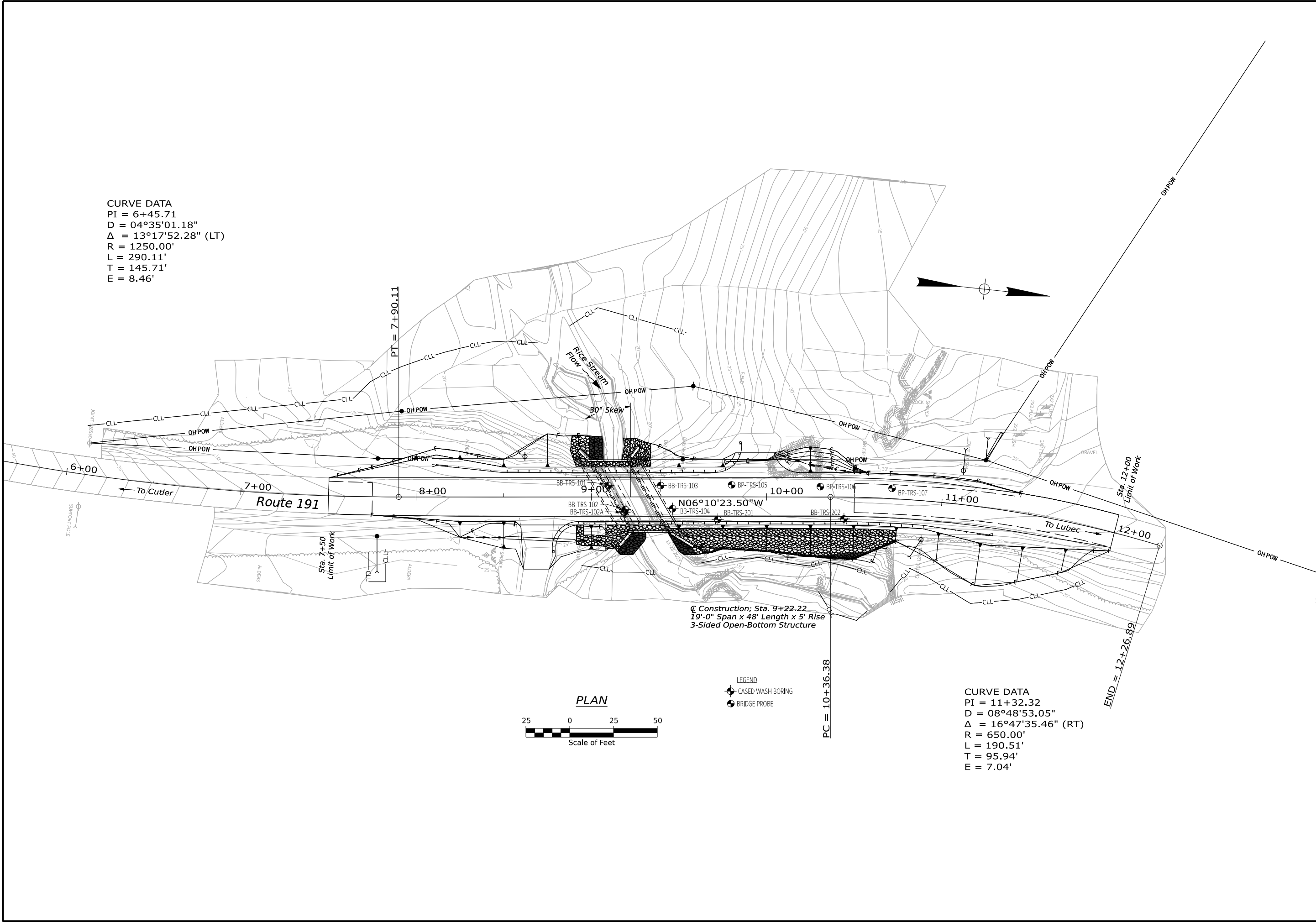


The Maine Department of Transportation provides this publication for information only. Reliance upon this information is at user risk. It is subject to revision and may be incomplete depending upon changing conditions. The Department assumes no liability if injuries or damages result from this information. This map is not intended to support emergency dispatch.

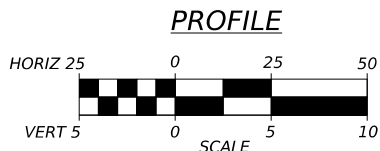
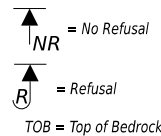
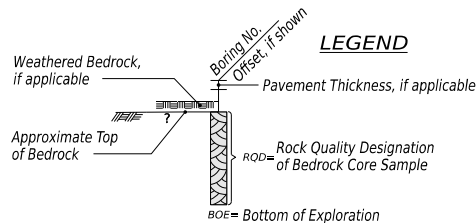
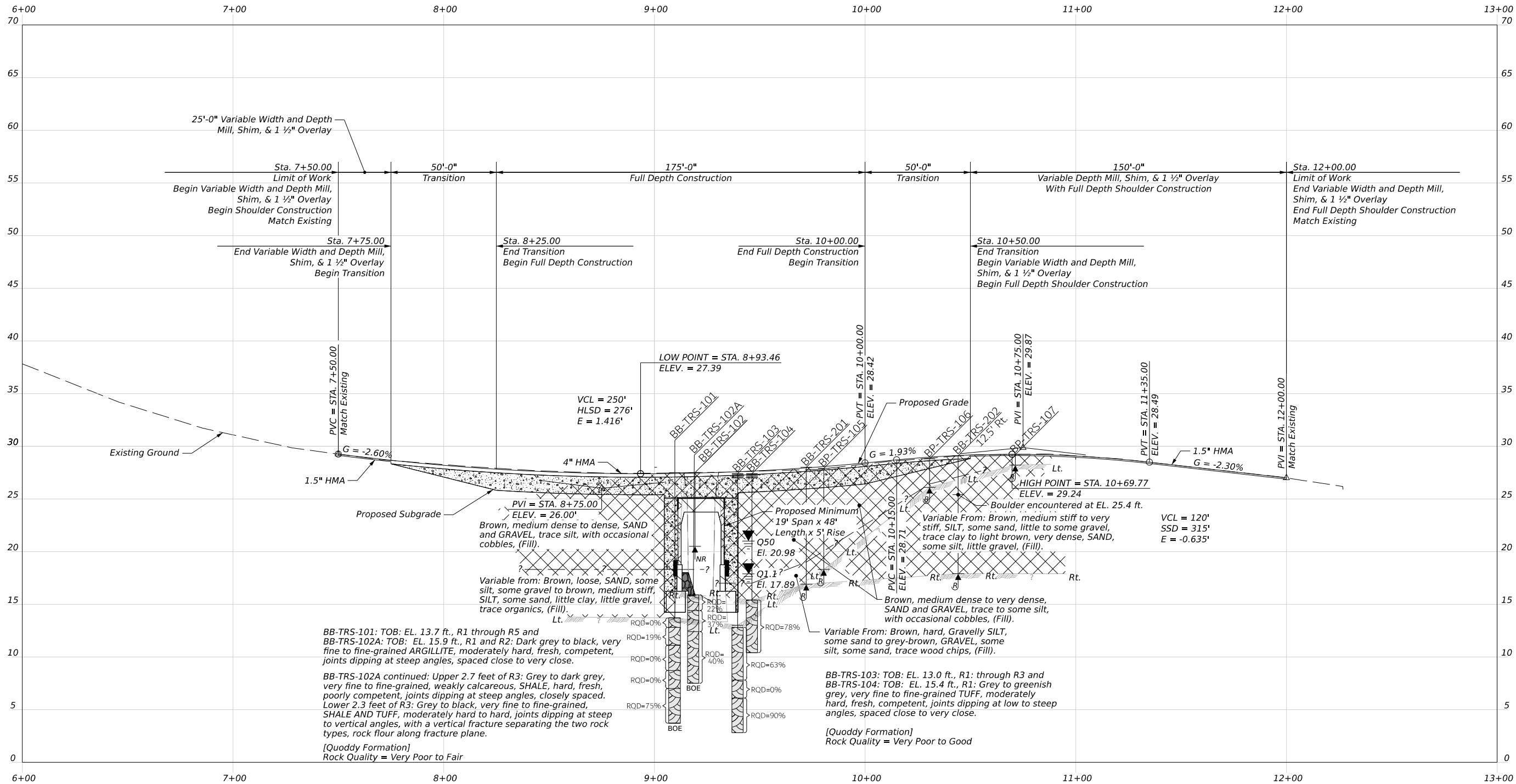
0.25 Miles
1 inch = 0.28 miles

Date: 2/20/2026
Time: 8:09:22 AM

SHEET NUMBER 1 OF 5	RICE BRIDGE NO. 2714 CROSSING RICE STREAM TRESCOTT TOWNSHIP	STATE OF MAINE DEPARTMENT OF TRANSPORTATION	
		Federal No. 2608900	
	LOCATION MAP	WIN 26089.00	BRIDGE PLANS



STATE OF MAINE DEPARTMENT OF TRANSPORTATION Federal Project No. 2608900					BORING LOCATION PLAN
	SIGNATURE				
	P.E. NUMBER				
	DATE				
RICE BRIDGE NO. 2714 CROSSING RICE STREAM TRESCOTT TOWNSHIP		PROJ. MANAGER	BY	DATE	
		ASPECTRUM FIELD			
		CHECKED/ENDORSED			
		DESIGNED/FIELDED	N. J. WHITE	JUL. 2025	
		DESIGNED/FIELDED			
		REVISIONS 1			
		REVISIONS 2			
		REVISIONS 3			
		REVISIONS 4			
		FIELD CHANGES			
SHEET NUMBER					
2					
OF 5					



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

STATE OF MAINE		DEPARTMENT OF TRANSPORTATION		Federal Project No. 2608900		WIN 26089.00	
RICE BRIDGE NO. 2714		CROSSING RICE STREAM		TRESCOTT TOWNSHIP		INTERPRETIVE SUBSURFACE PROFILE	
SHEET NUMBER		3		OF		5	
PROJ. MANAGER	CHECKED/REVIEWED	DESIGNED/DETAILS	BY	DATE	SIGNATURE	P.E. NUMBER	DATE
W. CASEY	N. PUKAY	T. WHITE	R. MAYER	OCT 2025			
REVISIONS 1	REVISIONS 2	REVISIONS 3	REVISIONS 4	FIELD CHANGES			

Maine Department of Transportation									
Soil/Borehole Exploration Log					US CUSTOMER UNITS				
Project: Rice Bridge #2714 carries Route 191 over Rice Stream					Location: Trescott Township, Maine				
Boring No.: BB-TRS-101					WIN: 26089.00				
Driller: MainDOT					Auger ID/OD: 5" Solid Stem				
Operator: Daggett/Andrie					Datum: NAVD88				
Logged By: N. Pukay					Rig Type: CME 45C				
Date Start/Finish: 6/3/2024: 08:30-14:45					Drilling Method: Cased Wash Boring				
Boring Location: 9+9.7, 6.5 ft Lt.					Core Barrels: ND-2				
Boring Location: 9+9.7, 6.5 ft Lt.					Water Level: 8.7 ft DGL - See Remarks				
Home Efficiency Factor: 0.962					Home Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐				
Definitions: S = Split Spoon Sample SS = Solid Stem Auger UC = Unconsolidated Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unconsolidated Thin Wall Tube Sample Attempt V = Field Vane Shear Test N = Penetration Resistance (Blows per Foot) R = Resistance (lb./sq. in.) W = Weight of Rod or Casing C = Corrosion Test					S _u = Peak/Retained Field Vane Undrained Shear Strength (psf) S _u = Lab Vane Undrained Shear Strength (psf) S _u = Unconsolidated Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unconsolidated Thin Wall Tube Sample Attempt V = Field Vane Shear Test N = Penetration Resistance (Blows per Foot) R = Resistance (lb./sq. in.) W = Weight of Rod or Casing C = Corrosion Test				
Sample Information					Visual Description and Remarks				
Sample No.					Pen./Rec. (ft.)				
Sample Depth (ft.)					Blow (ft. in. in. 100 lb. hammer)				
Blow (ft. in. in. 100 lb. hammer)					N-uncorrected				
N-uncorrected					N ₆₀				
N ₆₀					Casing				
Casing					Elevation (ft.)				
Elevation (ft.)					Gratic Log				
Gratic Log					Visual Description and Remarks				
Visual Description and Remarks					Unified Class				
Unified Class					Laboratory Testing Results/AASHTO and Unified Class				
Laboratory Testing Results/AASHTO and Unified Class					Notes				
Notes					Stratification lines represent approximate boundaries between soil types; transitions may be gradual.				
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.				
* 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 1				
Page 1 of 1					Boring No.: BB-TRS-101				
Boring No.: BB-TRS-101									

Maine Department of Transportation									
Soil/Borehole Exploration Log					US CUSTOMER UNITS				
Project: Rice Bridge #2714 carries Route 191 over Rice Stream					Location: Trescott Township, Maine				
Boring No.: BB-TRS-102					WIN: 26089.00				
Driller: MainDOT					Auger ID/OD: 5" Solid Stem				
Operator: Daggett/Andrie					Datum: NAVD88				
Logged By: N. Pukay					Rig Type: CME 45C				
Date Start/Finish: 6/4/2024: 12:30-13:00					Drilling Method: Cased Wash Boring				
Boring Location: 9+19.3, 7.2 ft Rt.					Core Barrels: ND-2				
Boring Location: 9+19.3, 7.2 ft Rt.					Water Level: 8.7 ft DGL - See Remarks				
Home Efficiency Factor: 0.962					Home Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐				
Definitions: S = Split Spoon Sample SS = Solid Stem Auger UC = Unconsolidated Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unconsolidated Thin Wall Tube Sample Attempt V = Field Vane Shear Test N = Penetration Resistance (Blows per Foot) R = Resistance (lb./sq. in.) W = Weight of Rod or Casing C = Corrosion Test					S _u = Peak/Retained Field Vane Undrained Shear Strength (psf) S _u = Lab Vane Undrained Shear Strength (psf) S _u = Unconsolidated Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unconsolidated Thin Wall Tube Sample Attempt V = Field Vane Shear Test N = Penetration Resistance (Blows per Foot) R = Resistance (lb./sq. in.) W = Weight of Rod or Casing C = Corrosion Test				
Sample Information					Visual Description and Remarks				
Sample No.					Pen./Rec. (ft.)				
Sample Depth (ft.)					Blow (ft. in. in. 100 lb. hammer)				
Blow (ft. in. in. 100 lb. hammer)					N-uncorrected				
N-uncorrected					N ₆₀				
N ₆₀					Casing				
Casing					Elevation (ft.)				
Elevation (ft.)					Gratic Log				
Gratic Log					Visual Description and Remarks				
Visual Description and Remarks					Unified Class				
Unified Class					Laboratory Testing Results/AASHTO and Unified Class				
Laboratory Testing Results/AASHTO and Unified Class					Notes				
Notes					Stratification lines represent approximate boundaries between soil types; transitions may be gradual.				
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.				
* 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 1				
Page 1 of 1					Boring No.: BB-TRS-102				
Boring No.: BB-TRS-102									

Maine Department of Transportation									
Soil/Borehole Exploration Log					US CUSTOMER UNITS				
Project: Rice Bridge #2714 carries Route 191 over Rice Stream					Location: Trescott Township, Maine				
Boring No.: BB-TRS-102A					WIN: 26089.00				
Driller: MainDOT					Auger ID/OD: 5" Solid Stem				
Operator: Daggett/Andrie					Datum: NAVD88				
Logged By: N. Pukay					Rig Type: CME 45C				
Date Start/Finish: 6/4/2024: 6:5-7:15					Drilling Method: Cased Wash Boring				
Boring Location: 9+19.3, 8.7 ft Rt.					Core Barrels: ND-2				
Boring Location: 9+19.3, 8.7 ft Rt.					Water Level: 8.7 ft DGL - See Remarks				
Home Efficiency Factor: 0.962					Home Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐				
Definitions: S = Split Spoon Sample SS = Solid Stem Auger UC = Unconsolidated Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unconsolidated Thin Wall Tube Sample Attempt V = Field Vane Shear Test N = Penetration Resistance (Blows per Foot) R = Resistance (lb./sq. in.) W = Weight of Rod or Casing C = Corrosion Test					S _u = Peak/Retained Field Vane Undrained Shear Strength (psf) S _u = Lab Vane Undrained Shear Strength (psf) S _u = Unconsolidated Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unconsolidated Thin Wall Tube Sample Attempt V = Field Vane Shear Test N = Penetration Resistance (Blows per Foot) R = Resistance (lb./sq. in.) W = Weight of Rod or Casing C = Corrosion Test				
Sample Information					Visual Description and Remarks				
Sample No.					Pen./Rec. (ft.)				
Sample Depth (ft.)					Blow (ft. in. in. 100 lb. hammer)				
Blow (ft. in. in. 100 lb. hammer)					N-uncorrected				
N-uncorrected					N ₆₀				
N ₆₀					Casing				
Casing					Elevation (ft.)				
Elevation (ft.)					Gratic Log				
Gratic Log					Visual Description and Remarks				
Visual Description and Remarks					Unified Class				
Unified Class					Laboratory Testing Results/AASHTO and Unified Class				
Laboratory Testing Results/AASHTO and Unified Class					Notes				
Notes					Stratification lines represent approximate boundaries between soil types; transitions may be gradual.				
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.				
* 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 1				
Page 1 of 1					Boring No.: BB-TRS-102A				
Boring No.: BB-TRS-102A									

Maine Department of Transportation										Project: Rice Bridge #2714 carries Route 191 over Rice Stream										Boring No.: BB-TRS-103																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Soil/Borehole Exploration Log										US CUSTOMER UNITS										Location: Trescott Township, Maine																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
WIN: 26089.00																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
Driller: MainDOT										Elevation (ft.): 27.4										Auger ID/OD: 5" Solid Stem																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Operator: Daggett/Andrie										Datum: NAVD88										Samplers: Standard Split Spoon																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Logged By: N. Pukay										Rig Type: CME 45C										Hammer wt./fall: 140w/30"																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Date Start/Finish: 6/4/2024: 08:15-10:45										Drilling Method: Cased Wash Boring										Core Barrels: ND-2"																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Boring Location: 9+39.5, 6.5 ft Lt.										Casing ID/OD: NW 13.0"/3.5"										Water Level: 8.0' TYP. Sigsbee CMB023A.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Home Efficiency Factor: 0.962										Hammer Type: Automatic ☐ Hydraulic ☐ Rope & Cathead ☐																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
Definitions: S = Split Spoon Sample SS = Solid Stem Auger UC = Unconsolidated Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unconsolidated Thin Wall Tube Sample Attempt V = Field Vane Shear Test N = Penetration Resistance (Blows per Foot) R = Resistance (lb./sq. in.) W =										N = Rod Core Sample SSA = Solid Stem Auger UC = Unconsolidated Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unconsolidated Thin Wall Tube Sample Attempt V = Field Vane Shear Test N = Penetration Resistance (Blows per Foot) R = Resistance (lb./sq. in.) W =										N = Penetration Resistance (Blows per Foot) SSA = Solid Stem Auger UC = Unconsolidated Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unconsolidated Thin Wall Tube Sample Attempt V = Field Vane Shear Test N = Penetration Resistance (Blows per Foot) R = Resistance (lb./sq. in.) W =																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Sample Information										Visual Description and Remarks										Laboratory Testing Results/ASHTO and Unified Class																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Depth (ft.)										Sample No.										Pen./Blow										Sample Depth (ft.)										Blow Count (blows/ft.)										Shear Strength (lb./sq. in.)										N-Value (blows/ft.)										R-Value (lb./sq. in.)										Casing ID/OD										Elevation (ft.)										Gratic Log										Visual Description and Remarks										Laboratory Testing Results/ASHTO and Unified Class																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
0										1										2										3										4										5										6										7										8										9										10										11										12										13										14										15										16										17										18										19										20										21										22										23										24										25										26										27										28										29										30										31										32										33										34										35										36										37										38										39										40										41										42										43										44										45										46										47										48										49										50										51										52										53										54										55										56										57										58										59										60										61										62										63										64										65										66										67										68										69										70										71										72										73										74										75										76										77										78										79										80										81										82										83										84										85										86										87										88										89										90										91										92										93										94										95										96										97										98										99										100										101										102										103										104										105										106										107										108										109										110										111										112										113										114										115										116										117										118										119										120										121										122										123										124										125										126										127										128										129										130										131										132										133										134										135										136										137										138										139										140										141										142										143										144										145										146										147										148										149										150										151										152										153										154										155										156										157										158										159										160										161										162										163										164										165										166										167										168										169										170										171										172										173										174										175										176										177										178										179										180										181										182										183										184										185										186										187										188										189										190										191										192										193										194										195										196										197										198										199										200										201										202										203										204										205										206										207										208										209										210										211										212										213										214										215										216										217										218										219										220										221										222										223										224										225										226										227										228										229										230										231										232										233										234										235										236										237										238										239										240										241										242										243										244										245										246										247										248										249										250										251										252										253										254										255										256										257										258										259										260										261										262										263										264										265										266										267										268										269										270										271										272										273										274										275										276										277										278										279										280										281										282										283										284										285										286										287										288										289										290										291										292										293										294										295										296										297										298										299										300										301										302										303										304										305										306										307										308										309										310										311										312										313										314										315										316										317										318										319										320										321										322										323										324										325										326										327										328										329										330										331										332										333										334										335										336										337										338										339										340										341										342										343										344										345										346										347										348										349										350										351										352										353										354										355										356										357										358										359										360										361										362										363										364										365										366										367										368										369										370										371										372										373										374										375										376										377										378										379										380										381										382										383										384										385										386										387										388										389										390										391										392										393										394										395										396										397										398										399										400										401										402										403										404										405										406										407										408										409										410										411										412										413										414										415										416										417										418										419										420										421										422										423										424										425										426										427										428										429										430										431										432										433										434										435										436										437										438										439										440										441										442										443										444										445										446										447										448										449										450										451										452										453										454										455										456										457										458										459										460										461										462										463										464										465										466										467										468										469										470										471										472										473										474										475										476										477										478										479										480										481										482										483										484										485										486										487										488										489										490										491										492										493										494										495										496										497										498										499										500										501										502										503										504										505										506										507										508										509										510										511										512										513										514										515										516										517										518										519										520										521										522										523										524										525										526										527										528										529										530										531										532										533										534										535										536										537										538										539										540										541										542										543										544										545										546										547										548										549										550										551										552										553										554										555										556										557										558										559										560										561										562										563										564										565										566										567										568										569										570										571										572										573										574										575										576										577										578										579										580										581										582										583										584										585										586										587										588										589										590										591										592										593										594										595										596										597										598										599										600										601										602										603										604										605										606										607										608										609										610										611										612										613										614										615										616										617										618										619										620										621										622										623										624										625										626										627										628										629										630										631										632										633										634										635										636										637										638										639										640										641										642										643										644										645										646										647										648										649										650										651										652										653										654										655										656										657										658										659										660										661										662										663										664										665										666										667										668										669										670										671										672										673										674										675										676										677										678										679										680										681										682										683										684										685										686										687										688										689										690										691										692										693										694										695										696										697										698										699										700										701										702										703										704										705										706										707										708										709										710										711										712										713										714										715										716										717										718										719										720										721										722										723										724										725										726										727										728										729										730										731										732										733										734										735										736										737										738										739										740										741										742										743										744										745										746										747										748										749										750										751										752										753										754										755										756										757										758										759										760										761										762										763										764										765										766										767										768										769										770										771										772										773										774										775										776										777										778										779										780										781										782										783										784										785										786										787										788										789										790										791										792										793										794										795										796										797										798										799										800										801										802										803										804										805										806										807										808										809										810										811										812										813										814										815										816										817										818										819										820										821										822										823										824										825										826										827										828										829										830										831										832										833										834										835										836										837										838										839										840										841										842										843										844										845										846										847										848										849										850										851										852										853										854										855										856										857										858										859										860										861										862										863										864										865										866										867										868										869										870										871										872										873										874										875										876										877										878										879										880										881										882										883										884										885										886										887										888										889										890										891										892										893										894										895										896										897										898										899										900										901										902										903										904										905										906										907										908										909										910										911										912										913										914										915										916										917										918										919										920										921										922										923										924										925										926										927										928										929										930										931										932										933										934										935										936										937										938										939										940										941										942										943										944										945										946										947										948</									

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMER LOGS				Project: Rice Bridge #2714 carries Route 191 over Rice Stream Location: Trescott Township, Maine		Boring No.: BP-TRS-105 WIN: 26089.00	
Driller: Walne007		Elevation (ft.): 27.9		Auger ID/OD: 5" Dia.			
Operator: Daggett/Andrie		Datum: NAVD83		Sampler: N/A			
Logged By: N. Pukay		Rig Type: CME 45C		Hammer Wt./Fall: N/A			
Date Start/Finish: 6/14/2024: 10:50-11:00		Drilling Method: Solid Stem Auger		Core Barrel: N/A			
Boring Location: 9+80.4, 6.9 ft Lt.		Casing ID/OD: N/A		Water Level: Not Observed			
Hammer Efficiency Factor: 0.962				Hammer Type: Automatic ☒ Hydraulic ☐		Rope & Cathrod ☐	
Definitions: S = Split-Spoon Sample R = Rock Core Sample % = Peak Reduced Field rate uncorrected Strength (psi) P = Pocket Sample Strength (psi) S ₁ = Split-Spoon Sample S ₂ = Solid Stem Auger S _u (psi) = 140 rate uncorrected Strength (psi) IC = Water Content, percent S ₁ = unconsolidated Split-Spoon Sample Arrester S ₂ = Solid Stem Auger S _u (psi) = 140 rate uncorrected Strength (psi) LC = Liquid Limit S ₁ = Thin Soil Tube Sample IC = Roller Cone Unconsolidated = Raw field SPT results PL = Plastic Limit W = Moisture (%) T ₂₀₀ = Sieve No. 200 R ₂₀₀ = Weight of #200, Hammer Hammer Efficiency Factor = Rig Specific actual Dilatation Value F ₂₀₀ = Finest Sieve Index F = Field Hole Shear Test PP = Pocket Penetrometer BWT = Weight of Rods or Casing SPT = SPT Uncorrected Corrected for Hammer Efficiency G = Grain Size Analysis W = unconsolidated Field Hole Shear Test WWT = Weight of the Penam G = Consolidation Test							
Depth (ft.)	Sample Information						Laboratory Testing Results/ASTM and Unified Class
	Sample No.	Pen./Roc. (in.)	Sample Depth (ft.)	Blows C/S (in.) Smoother Length of ROD (ft.)	Uncorrected	Casing ID (in.)	
0							Visual Description and Remarks No material descriptions.
5							
10							
15							
20							
25							
30							
35							
40							
45							
25 Remarks:							9.6 Auger ID/OD: 5" dia. on tip of auger. Presumed tip of bedrock at 9.6 ft bgs.
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.							

[illegible][illegible]

Appendix A

Boring Logs

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

TERMS DESCRIBING DENSITY/CONSISTENCY			
Coarse-grained soils (more than half of material is larger than No. 200 sieve); Includes (1) clean gravels; (2) Silty or Clayey gravels; and (3) Silty, Clayey or Gravelly sands. Density is rated according to standard penetration resistance (N-value).			
<u>Density of Cohesionless Soils</u> Very loose Loose Medium Dense Dense Very Dense		<u>Standard Penetration Resistance</u> <u>N₆₀-Value (blows per foot)</u> 0 - 4 5 - 10 11 - 30 31 - 50 > 50	
Fine-grained soils (more than half of material is smaller than No. 200 sieve); Includes (1) inorganic and organic silts and clays; (2) Gravelly, Sandy or Silty clays; and (3) Clayey silts. Consistency is rated according to undrained shear strength as indicated.			
<u>Consistency of Cohesive soils</u> Very Soft Soft Medium Stiff Stiff Very Stiff Hard	<u>SPT N₆₀-Value (blows per foot)</u> WOH, WOR, WOP, <2 2 - 4 5 - 8 9 - 15 16 - 30 >30	<u>Approximate Undrained Shear Strength (psf)</u> 0 - 250 250 - 500 500 - 1000 1000 - 2000 2000 - 4000 over 4000	<u>Field Guidelines</u> Fist easily penetrates Thumb easily penetrates Thumb penetrates with moderate effort Indented by thumb with great effort Indented by thumbnail Indented by thumbnail with difficulty

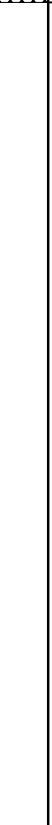
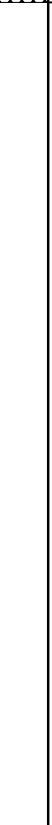
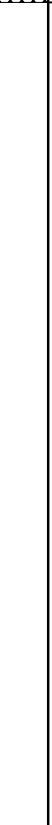
Rock Quality Designation (RQD):													
RQD (%) = $\frac{\text{sum of the lengths of intact pieces of core}^* > 4 \text{ inches}}{\text{length of core advance}}$ *Minimum NQ rock core (1.88 in. OD of core)													
Rock Quality Based on RQD <table border="1"> <thead> <tr> <th>Rock Quality</th> <th>RQD (%)</th> </tr> </thead> <tbody> <tr> <td>Very Poor</td> <td>≤25</td> </tr> <tr> <td>Poor</td> <td>26 - 50</td> </tr> <tr> <td>Fair</td> <td>51 - 75</td> </tr> <tr> <td>Good</td> <td>76 - 90</td> </tr> <tr> <td>Excellent</td> <td>91 - 100</td> </tr> </tbody> </table>		Rock Quality	RQD (%)	Very Poor	≤25	Poor	26 - 50	Fair	51 - 75	Good	76 - 90	Excellent	91 - 100
Rock Quality	RQD (%)												
Very Poor	≤25												
Poor	26 - 50												
Fair	51 - 75												
Good	76 - 90												
Excellent	91 - 100												
Desired Rock Observations (in this order, if applicable):													
Color (Munsell color chart) Texture (aphanitic, fine-grained, etc.) Rock Type (granite, schist, sandstone, etc.) Hardness (very hard, hard, mod. hard, etc.) Weathering (fresh, very slight, slight, moderate, mod. severe, severe, etc.) Geologic discontinuities/jointing: -dip (horiz - 0-5 deg., low angle - 5-35 deg., mod. dipping - 35-55 deg., steep - 55-85 deg., vertical - 85-90 deg.) -spacing (very close - <2 inch, close - 2-12 inch, mod. close - 1-3 feet, wide - 3-10 feet, very wide >10 feet) -tightness (tight, open, or healed) -infilling (grain size, color, etc.) Formation (Waterville, Ellsworth, Cape Elizabeth, etc.) RQD and correlation to rock quality (very poor, poor, etc.) ref: ASTM D6032 and FHWA NHI-16-072 GEC 5 - Geotechnical Site Characterization, Table 4-12 Recovery (inch/inch and percentage) Rock Core Rate (X.X ft - Y.Y ft (min:sec))													

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

Sample Container Labeling Requirements:	
WIN	Blow Counts
Bridge Name / Town	Sample Recovery
Boring Number	Date
Sample Number	Personnel Initials
Sample Depth	

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Rice Bridge #2714 carries Route 191 over Rice Stream Location: Trescott Township, Maine				Boring No.: BB-TRS-101 WIN: 26089.00																																																																																																																																																																																																																																																																									
Driller: MaineDOT				Elevation (ft.) 27.5				Auger ID/OD: 5" Solid Stem																																																																																																																																																																																																																																																																									
Operator: Daggett/Andrie				Datum: NAVD88				Sampler: Standard Split Spoon																																																																																																																																																																																																																																																																									
Logged By: N. Pukay				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"																																																																																																																																																																																																																																																																									
Date Start/Finish: 6/3/2024; 09:30-14:45				Drilling Method: Cased Wash Boring				Core Barrel: NQ-2"																																																																																																																																																																																																																																																																									
Boring Location: 9+9.7, 6.5 ft Lt.				Casing ID/OD: NW (3.0"/3.5")				Water Level*: 8.3 ft bgs. See remarks.																																																																																																																																																																																																																																																																									
Hammer Efficiency Factor: 0.962				Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐																																																																																																																																																																																																																																																																													
Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unsuccessful Thin Wall Tube Sample Attempt V = Field Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Field Vane Shear Test Attempt				R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of One Person				S _u = Peak/Remolded Field Vane Undrained Shear Strength (psf) S _u (lab) = Lab Vane Undrained Shear Strength (psf) q _p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw Field SPT N-value Hammer Efficiency Factor = Rig Specific Annual Calibration Value N ₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency N ₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected																																																																																																																																																																																																																																																																									
T _v = Pocket Torvane Shear Strength (psf) WC = Water Content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test																																																																																																																																																																																																																																																																																	
<table><tr><th colspan="8">Sample Information</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/ AASHTO and Unified Class.</th></tr><tr><th>Depth (ft.)</th><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (/6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing Blows</th><th>Elevation (ft.)</th></tr><tr><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>SSA</td><td>27.1</td><td rowspan="15"></td><td>5" HMA.</td><td rowspan="15"></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Occasional cobble.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Brown, moist, Sandy GRAVEL, trace silt, (Fill) on auger flights.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>5</td><td>MD</td><td>24/0</td><td>5.00 - 7.00</td><td>8/23/26/9</td><td>49</td><td>79</td><td>11</td><td></td><td>Very dense. Failed sample attempt due to sampler pushing a cobble.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>24</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>62</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>44</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>30</td><td></td><td></td></tr><tr><td>10</td><td>1D</td><td>24/4</td><td>10.00 - 12.00</td><td>2/2/3/3</td><td>5</td><td>8</td><td>14</td><td></td><td>Brown, wet, medium stiff, SILT, some sand, little clay, little gravel, trace organics, (Fill).</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>19</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>70</td><td></td><td></td></tr><tr><td></td><td>R1</td><td>10.8/10.8</td><td>13.80 - 14.70</td><td>RQD = 0%</td><td></td><td></td><td>a100</td><td></td><td>a100 blows for 0.8 ft.</td></tr><tr><td></td><td>R2</td><td>20.4/20.4</td><td>14.70 - 16.40</td><td>RQD = 19%</td><td></td><td></td><td>NQ-2</td><td>13.7</td><td>Top of Bedrock at Elev. 13.7 ft.</td></tr><tr><td>15</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>R1: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, competent, joints dipping at steep angles, very closely spaced, low fissility. [Quoddy Formation] Rock Quality = Very Poor R1: Core Times (min:sec) 13.8-14.7 ft (2:56) core blocked 100% Recovery</td></tr><tr><td></td><td>R3</td><td>28.8/28.8</td><td>16.40 - 18.80</td><td>RQD = 0%</td><td></td><td></td><td></td><td></td><td>R2: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, competent, joints dipping at steep angles, very closely spaced, highly fractured, low fissility. [Quoddy Formation] Rock Quality = Very Poor R2: Core Times (min:sec) 14.7-14.8 ft (0:15) 14.8-15.8 ft (2:10) 15.8-16.4 ft (2:50) core blocked 100% Recovery</td></tr><tr><td></td><td>R4</td><td>20.4/20.4</td><td>18.80 - 20.50</td><td>RQD = 0%</td><td></td><td></td><td></td><td></td><td>R3: Bedrock: Similar to R2. [Quoddy Formation]</td></tr><tr><td>20</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td>R5</td><td>39.6/36</td><td>20.50 - 23.80</td><td>RQD = 75%</td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>25</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>												Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.	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.)	0							SSA	27.1		5" HMA.											Occasional cobble.																				Brown, moist, Sandy GRAVEL, trace silt, (Fill) on auger flights.											5	MD	24/0	5.00 - 7.00	8/23/26/9	49	79	11		Very dense. Failed sample attempt due to sampler pushing a cobble.								24										62										44										30			10	1D	24/4	10.00 - 12.00	2/2/3/3	5	8	14		Brown, wet, medium stiff, SILT, some sand, little clay, little gravel, trace organics, (Fill).								19										70				R1	10.8/10.8	13.80 - 14.70	RQD = 0%			a100		a100 blows for 0.8 ft.		R2	20.4/20.4	14.70 - 16.40	RQD = 19%			NQ-2	13.7	Top of Bedrock at Elev. 13.7 ft.	15									R1: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, competent, joints dipping at steep angles, very closely spaced, low fissility. [Quoddy Formation] Rock Quality = Very Poor R1: Core Times (min:sec) 13.8-14.7 ft (2:56) core blocked 100% Recovery		R3	28.8/28.8	16.40 - 18.80	RQD = 0%					R2: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, competent, joints dipping at steep angles, very closely spaced, highly fractured, low fissility. [Quoddy Formation] Rock Quality = Very Poor R2: Core Times (min:sec) 14.7-14.8 ft (0:15) 14.8-15.8 ft (2:10) 15.8-16.4 ft (2:50) core blocked 100% Recovery		R4	20.4/20.4	18.80 - 20.50	RQD = 0%					R3: Bedrock: Similar to R2. [Quoddy Formation]	20											R5	39.6/36	20.50 - 23.80	RQD = 75%																																				25									
Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.																																																																																																																																																																																																																																																																							
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.)																																																																																																																																																																																																																																																																						
0							SSA	27.1		5" HMA.																																																																																																																																																																																																																																																																							
										Occasional cobble.																																																																																																																																																																																																																																																																							
										Brown, moist, Sandy GRAVEL, trace silt, (Fill) on auger flights.																																																																																																																																																																																																																																																																							
5	MD	24/0	5.00 - 7.00	8/23/26/9	49	79	11			Very dense. Failed sample attempt due to sampler pushing a cobble.																																																																																																																																																																																																																																																																							
							24																																																																																																																																																																																																																																																																										
							62																																																																																																																																																																																																																																																																										
							44																																																																																																																																																																																																																																																																										
							30																																																																																																																																																																																																																																																																										
10	1D	24/4	10.00 - 12.00	2/2/3/3	5	8	14			Brown, wet, medium stiff, SILT, some sand, little clay, little gravel, trace organics, (Fill).																																																																																																																																																																																																																																																																							
							19																																																																																																																																																																																																																																																																										
							70																																																																																																																																																																																																																																																																										
	R1	10.8/10.8	13.80 - 14.70	RQD = 0%			a100			a100 blows for 0.8 ft.																																																																																																																																																																																																																																																																							
	R2	20.4/20.4	14.70 - 16.40	RQD = 19%			NQ-2	13.7		Top of Bedrock at Elev. 13.7 ft.																																																																																																																																																																																																																																																																							
15									R1: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, competent, joints dipping at steep angles, very closely spaced, low fissility. [Quoddy Formation] Rock Quality = Very Poor R1: Core Times (min:sec) 13.8-14.7 ft (2:56) core blocked 100% Recovery																																																																																																																																																																																																																																																																								
	R3	28.8/28.8	16.40 - 18.80	RQD = 0%					R2: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, competent, joints dipping at steep angles, very closely spaced, highly fractured, low fissility. [Quoddy Formation] Rock Quality = Very Poor R2: Core Times (min:sec) 14.7-14.8 ft (0:15) 14.8-15.8 ft (2:10) 15.8-16.4 ft (2:50) core blocked 100% Recovery																																																																																																																																																																																																																																																																								
	R4	20.4/20.4	18.80 - 20.50	RQD = 0%					R3: Bedrock: Similar to R2. [Quoddy Formation]																																																																																																																																																																																																																																																																								
20																																																																																																																																																																																																																																																																																	
	R5	39.6/36	20.50 - 23.80	RQD = 75%																																																																																																																																																																																																																																																																													
25																																																																																																																																																																																																																																																																																	
Remarks: 1) Water level measured immediately after drilling.																																																																																																																																																																																																																																																																																	
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-TRS-101																																																																																																																																																																																																																																																																							

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Rice Bridge #2714 carries Route 191 over Rice Stream Location: Trescott Township, Maine				Boring No.: BB-TRS-101 WIN: 26089.00																																																																																																																																																																																																																																																																													
Driller: MaineDOT				Elevation (ft.) 27.5				Auger ID/OD: 5" Solid Stem																																																																																																																																																																																																																																																																													
Operator: Daggett/Andrle				Datum: NAVD88				Sampler: Standard Split Spoon																																																																																																																																																																																																																																																																													
Logged By: N. Pukay				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"																																																																																																																																																																																																																																																																													
Date Start/Finish: 6/3/2024; 09:30-14:45				Drilling Method: Cased Wash Boring				Core Barrel: NQ-2"																																																																																																																																																																																																																																																																													
Boring Location: 9+9.7, 6.5 ft Lt.				Casing ID/OD: NW (3.0"/3.5")				Water Level*: 8.3 ft bgs. See remarks.																																																																																																																																																																																																																																																																													
Hammer Efficiency Factor: 0.962				Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐																																																																																																																																																																																																																																																																																	
Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unsuccessful Thin Wall Tube Sample Attempt V = Field Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Field Vane Shear Test Attempt				R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140 lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of One Person				S _u = Peak/Remolded Field Vane Undrained Shear Strength (psf) S _u (lab) = Lab Vane Undrained Shear Strength (psf) q _p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw Field SPT N-value Hammer Efficiency Factor = Rig Specific Annual Calibration Value N ₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency N ₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected				T _v = Pocket Torvane Shear Strength (psf) WC = Water Content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test																																																																																																																																																																																																																																																																									
<table><thead><tr><th rowspan="2">Depth (ft.)</th><th colspan="8">Sample Information</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/ AASHTO and Unified Class.</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows ((6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing Blows</th><th>Elevation (ft.)</th></tr></thead><tbody><tr><td>25</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="20">Rock Quality = Very Poor R3: Core Times (min:sec) 16.4-16.8 ft (1:09) 16.8-17.8 ft (4:10) 17.8-18.8 ft (4:34) 100% Recovery R4: Bedrock: Similar to R2. [Quoddy Formation] Rock Quality = Very Poor R4: Core Time (min:sec) 18.8-19.8 ft (4:15) 19.8-20.5 ft (4:34) core blocked 100% Recovery R5: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, joints dipping at steep angles, closely spaced, low fissility, fissility decreases with depth. [Quoddy Formation] Rock Quality = Fair R5: Core Times (min:sec) 20.5-20.8 ft (0:22) 20.8-21.8 ft (3:15) 21.8-22.8 ft (4:48) 22.8-23.8 ft (3:54) 90% Recovery Bottom of Exploration at 23.8 feet below ground surface.</td><td rowspan="20"></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>50</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></tbody></table>												Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows ((6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	25											Rock Quality = Very Poor R3: Core Times (min:sec) 16.4-16.8 ft (1:09) 16.8-17.8 ft (4:10) 17.8-18.8 ft (4:34) 100% Recovery R4: Bedrock: Similar to R2. [Quoddy Formation] Rock Quality = Very Poor R4: Core Time (min:sec) 18.8-19.8 ft (4:15) 19.8-20.5 ft (4:34) core blocked 100% Recovery R5: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, joints dipping at steep angles, closely spaced, low fissility, fissility decreases with depth. [Quoddy Formation] Rock Quality = Fair R5: Core Times (min:sec) 20.5-20.8 ft (0:22) 20.8-21.8 ft (3:15) 21.8-22.8 ft (4:48) 22.8-23.8 ft (3:54) 90% Recovery Bottom of Exploration at 23.8 feet below ground surface.																																																																																																																																																																																																																														50												
Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.																																																																																																																																																																																																																																																																										
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows ((6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)																																																																																																																																																																																																																																																																													
25											Rock Quality = Very Poor R3: Core Times (min:sec) 16.4-16.8 ft (1:09) 16.8-17.8 ft (4:10) 17.8-18.8 ft (4:34) 100% Recovery R4: Bedrock: Similar to R2. [Quoddy Formation] Rock Quality = Very Poor R4: Core Time (min:sec) 18.8-19.8 ft (4:15) 19.8-20.5 ft (4:34) core blocked 100% Recovery R5: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, joints dipping at steep angles, closely spaced, low fissility, fissility decreases with depth. [Quoddy Formation] Rock Quality = Fair R5: Core Times (min:sec) 20.5-20.8 ft (0:22) 20.8-21.8 ft (3:15) 21.8-22.8 ft (4:48) 22.8-23.8 ft (3:54) 90% Recovery Bottom of Exploration at 23.8 feet below ground surface.																																																																																																																																																																																																																																																																										
50																																																																																																																																																																																																																																																																																					
Remarks: 1) Water level measured immediately after drilling.																																																																																																																																																																																																																																																																																					
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-TRS-101																																																																																																																																																																																																																																																																											

Maine Department of Transportation						Project: Rice Bridge #2714 carries Route 191 over Rice Stream Location: Trescott Township, Maine		Boring No.: BB-TRS-102																																																																																																																																																																																																																																																											
Soil/Rock Exploration Log US CUSTOMARY UNITS																																																																																																																																																																																																																																																																			
Driller: MaineDOT						Elevation (ft.): 27.5		Auger ID/OD: 5" Solid Stem																																																																																																																																																																																																																																																											
Operator: Daggett/Andrle						Datum: NAVD88		Sampler: Standard Split Spoon																																																																																																																																																																																																																																																											
Logged By: N. Pukay						Rig Type: CME 45C		Hammer Wt./Fall: 140#/30"																																																																																																																																																																																																																																																											
Date Start/Finish: 6/4/2024; 12:30-13:00						Drilling Method: Cased Wash Boring		Core Barrel: NQ-2"																																																																																																																																																																																																																																																											
Boring Location: 9+19.3, 7.2 ft Rt.						Casing ID/OD: NW (3.0"/3.5")		Water Level*: Not Observed																																																																																																																																																																																																																																																											
Hammer Efficiency Factor: 0.962						Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐																																																																																																																																																																																																																																																													
Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unsuccessful Thin Wall Tube Sample Attempt V = Field Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Field Vane Shear Test Attempt						R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of One Person																																																																																																																																																																																																																																																													
						S _u = Peak/Remolded Field Vane Undrained Shear Strength (psf) S _{u(lab)} = Lab Vane Undrained Shear Strength (psf) q _p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw Field SPT N-value Hammer Efficiency Factor = Rig Specific Annual Calibration Value N ₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency N ₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected																																																																																																																																																																																																																																																													
						T _v = Pocket Torvane Shear Strength (psf) WC = Water Content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test																																																																																																																																																																																																																																																													
<table border="1"><thead><tr><th rowspan="2">Depth (ft.)</th><th colspan="8">Sample Information</th><th rowspan="2">Elevation (ft.)</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/AASHTO and Unified Class.</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing Blows</th></tr></thead><tbody><tr><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>SSA</td><td>27.1</td><td rowspan="5"></td><td>5" HMA.</td><td rowspan="5">0.4-</td></tr><tr><td></td><td>A1</td><td></td><td>1.00 - 2.00</td><td></td><td></td><td></td><td>↘</td><td></td><td>Auger Flight Sample: Brown, dry, Sandy GRAVEL, trace silt, (Fill)</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>21</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>46</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>72</td><td></td><td></td></tr><tr><td>5</td><td>MD</td><td>24/0</td><td>5.00 - 7.00</td><td>9/6/3/6</td><td>9</td><td>14</td><td></td><td></td><td rowspan="15"></td><td>Medium dense.</td><td rowspan="15">7.0-</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>25</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></tbody></table>												Depth (ft.)	Sample Information								Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/AASHTO and Unified Class.	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	0							SSA	27.1		5" HMA.	0.4-		A1		1.00 - 2.00				↘		Auger Flight Sample: Brown, dry, Sandy GRAVEL, trace silt, (Fill)								21										46										72			5	MD	24/0	5.00 - 7.00	9/6/3/6	9	14				Medium dense.	7.0-																																																																																																																																																							25												Remarks:	
Depth (ft.)	Sample Information								Elevation (ft.)	Graphic Log	Visual Description and Remarks		Laboratory Testing Results/AASHTO and Unified Class.																																																																																																																																																																																																																																																						
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows																																																																																																																																																																																																																																																												
0							SSA	27.1		5" HMA.	0.4-																																																																																																																																																																																																																																																								
	A1		1.00 - 2.00				↘			Auger Flight Sample: Brown, dry, Sandy GRAVEL, trace silt, (Fill)																																																																																																																																																																																																																																																									
							21																																																																																																																																																																																																																																																												
							46																																																																																																																																																																																																																																																												
							72																																																																																																																																																																																																																																																												
5	MD	24/0	5.00 - 7.00	9/6/3/6	9	14				Medium dense.	7.0-																																																																																																																																																																																																																																																								
25																																																																																																																																																																																																																																																																			
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.																																																																																																																																																																																																																																																																			
Page 1 of 1																																																																																																																																																																																																																																																																			
Boring No.: BB-TRS-102																																																																																																																																																																																																																																																																			

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Rice Bridge #2714 carries Route 191 over Rice Stream Location: Trescott Township, Maine		Boring No.: BB-TRS-102A WIN: 26089.00																																																																																																																																																																																																																																		
Driller: MaineDOT		Elevation (ft.): 27.5		Auger ID/OD: 5" Solid Stem																																																																																																																																																																																																																																				
Operator: Daggett/Andrie		Datum: NAVD88		Sampler: Standard Split Spoon																																																																																																																																																																																																																																				
Logged By: N. Pukay		Rig Type: CME 45C		Hammer Wt./Fall: 140#/30"																																																																																																																																																																																																																																				
Date Start/Finish: 6/4/2024-6/5/2024		Drilling Method: Cased Wash Boring		Core Barrel: NQ-2"																																																																																																																																																																																																																																				
Boring Location: 9+18.9, 8.7 ft Rt.		Casing ID/OD: HW(4"/4.5"), NW(3"/3.5")		Water Level*: Not Observed																																																																																																																																																																																																																																				
Hammer Efficiency Factor: 0.962		Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐																																																																																																																																																																																																																																						
Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unsuccessful Thin Wall Tube Sample Attempt V = Field Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Field Vane Shear Test Attempt		R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of One Person		S _u = Peak/Remolded Field Vane Undrained Shear Strength (psf) S _{u(lab)} = Lab Vane Undrained Shear Strength (psf) q _p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw Field SPT N-value Hammer Efficiency Factor = Rig Specific Annual Calibration Value N ₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency N ₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected																																																																																																																																																																																																																																				
		T _v = Pocket Torvane Shear Strength (psf) WC = Water Content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test																																																																																																																																																																																																																																						
<table><tr><th rowspan="2">Depth (ft.)</th><th colspan="7">Sample Information</th><th rowspan="2">Elevation (ft.)</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/ AASHTO and Unified Class.</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing Blows</th></tr><tr><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>SSA</td><td>27.1</td><td></td><td>5" HMA.</td><td rowspan="4">G#380892 A-1-a, SW-SM WC=7.7%</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td>A1</td><td></td><td>3.00 - 5.00</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Auger Flight Sample: Brown, moist, Gravelly SAND, trace silt, (Fill).</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>5</td><td>MD</td><td>24/0</td><td>5.00 - 7.00</td><td>5/5/6/5</td><td>11</td><td>18</td><td>57</td><td></td><td></td><td>Medium dense. Rock in tip of spoon. Set HW casing at 5.0 ft bgs. after sample attempt.</td><td rowspan="4">G#380893 A-2-4, SM WC=20.6%</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>88</td><td></td><td></td><td></td></tr><tr><td></td><td>1D</td><td>24/2</td><td>7.00 - 9.00</td><td>10/16/5/8</td><td>21</td><td>34</td><td>40</td><td></td><td></td><td>Brown, wet, dense, GRAVEL, little sand, trace silt, (Fill). Set in NW casing after 1D sample.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>34</td><td></td><td></td><td></td></tr><tr><td>10</td><td>2D</td><td>24/10</td><td>9.20 - 11.20</td><td>5/3/3/7</td><td>6</td><td>10</td><td>20</td><td></td><td></td><td>Brown, wet, loose, SAND, some silt, some gravel, (Fill).</td><td rowspan="4">G#380893 A-2-4, SM WC=20.6%</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>24</td><td></td><td></td><td></td></tr><tr><td></td><td>R1</td><td>18/18</td><td>11.60 - 13.10</td><td>RQD = 22%</td><td></td><td></td><td>a76 NQ-2</td><td>15.9</td><td></td><td>a76 blows for 0.6 ft.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>15</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Top of Bedrock at Elev. 15.9 ft. R1: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, competent, joints dipping at steep angles, very closely spaced, low fissility, some calcite-rich beds, one quartz/calcite annealed fracture. [Quoddy Formation] Rock Quality = Very Poor R1: Core Times (min:sec) 11.6-12.6 ft (2:14) 12.6-13.1 ft (3:04) core blocked 100% Recovery</td><td rowspan="4">G#380893 A-2-4, SM WC=20.6%</td></tr><tr><td></td><td>R2</td><td>24/24</td><td>13.10 - 15.10</td><td>RQD = 37%</td><td></td><td></td><td></td><td></td><td></td><td>R2: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, competent, joints dipping at steep angles, very closely spaced, low fissility, then grey, very fine to fine-grained ARGILLITE, moderately hard, fresh, joints dipping at steep angles, very closely spaced, with increasing fissility. [Quoddy Formation] Rock Quality = Poor R2: Core Times (min:sec) 13.1-13.6 ft (1:23) 13.6-14.6 ft (3:22) 14.6-15.1 ft (2:39) core blocked 100% Recovery</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td>R3</td><td>58.8/58.8</td><td>15.10 - 20.00</td><td>RQD = 40%</td><td></td><td></td><td></td><td></td><td></td><td>R3: Bedrock: Grey to dark grey, very fine to fine-grained, weakly calcareous, SHALE, hard, fresh, poorly competent, joints dipping at steep angles, closely spaced, with increasing fissility, then grey to</td></tr><tr><td>20</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>7.5</td><td></td><td></td><td></td></tr><tr><td>25</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>										Depth (ft.)	Sample Information							Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	0							SSA	27.1		5" HMA.	G#380892 A-1-a, SW-SM WC=7.7%													A1		3.00 - 5.00							Auger Flight Sample: Brown, moist, Gravelly SAND, trace silt, (Fill).												5	MD	24/0	5.00 - 7.00	5/5/6/5	11	18	57			Medium dense. Rock in tip of spoon. Set HW casing at 5.0 ft bgs. after sample attempt.	G#380893 A-2-4, SM WC=20.6%								88					1D	24/2	7.00 - 9.00	10/16/5/8	21	34	40			Brown, wet, dense, GRAVEL, little sand, trace silt, (Fill). Set in NW casing after 1D sample.								34				10	2D	24/10	9.20 - 11.20	5/3/3/7	6	10	20			Brown, wet, loose, SAND, some silt, some gravel, (Fill).	G#380893 A-2-4, SM WC=20.6%								24					R1	18/18	11.60 - 13.10	RQD = 22%			a76 NQ-2	15.9		a76 blows for 0.6 ft.												15										Top of Bedrock at Elev. 15.9 ft. R1: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, competent, joints dipping at steep angles, very closely spaced, low fissility, some calcite-rich beds, one quartz/calcite annealed fracture. [Quoddy Formation] Rock Quality = Very Poor R1: Core Times (min:sec) 11.6-12.6 ft (2:14) 12.6-13.1 ft (3:04) core blocked 100% Recovery	G#380893 A-2-4, SM WC=20.6%		R2	24/24	13.10 - 15.10	RQD = 37%						R2: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, competent, joints dipping at steep angles, very closely spaced, low fissility, then grey, very fine to fine-grained ARGILLITE, moderately hard, fresh, joints dipping at steep angles, very closely spaced, with increasing fissility. [Quoddy Formation] Rock Quality = Poor R2: Core Times (min:sec) 13.1-13.6 ft (1:23) 13.6-14.6 ft (3:22) 14.6-15.1 ft (2:39) core blocked 100% Recovery													R3	58.8/58.8	15.10 - 20.00	RQD = 40%						R3: Bedrock: Grey to dark grey, very fine to fine-grained, weakly calcareous, SHALE, hard, fresh, poorly competent, joints dipping at steep angles, closely spaced, with increasing fissility, then grey to	20								7.5				25											
Depth (ft.)	Sample Information							Elevation (ft.)	Graphic Log		Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.																																																																																																																																																																																																																												
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows																																																																																																																																																																																																																																	
0							SSA	27.1		5" HMA.	G#380892 A-1-a, SW-SM WC=7.7%																																																																																																																																																																																																																													
	A1		3.00 - 5.00							Auger Flight Sample: Brown, moist, Gravelly SAND, trace silt, (Fill).																																																																																																																																																																																																																														
5	MD	24/0	5.00 - 7.00	5/5/6/5	11	18	57			Medium dense. Rock in tip of spoon. Set HW casing at 5.0 ft bgs. after sample attempt.	G#380893 A-2-4, SM WC=20.6%																																																																																																																																																																																																																													
							88																																																																																																																																																																																																																																	
	1D	24/2	7.00 - 9.00	10/16/5/8	21	34	40			Brown, wet, dense, GRAVEL, little sand, trace silt, (Fill). Set in NW casing after 1D sample.																																																																																																																																																																																																																														
							34																																																																																																																																																																																																																																	
10	2D	24/10	9.20 - 11.20	5/3/3/7	6	10	20			Brown, wet, loose, SAND, some silt, some gravel, (Fill).	G#380893 A-2-4, SM WC=20.6%																																																																																																																																																																																																																													
							24																																																																																																																																																																																																																																	
	R1	18/18	11.60 - 13.10	RQD = 22%			a76 NQ-2	15.9		a76 blows for 0.6 ft.																																																																																																																																																																																																																														
15										Top of Bedrock at Elev. 15.9 ft. R1: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, competent, joints dipping at steep angles, very closely spaced, low fissility, some calcite-rich beds, one quartz/calcite annealed fracture. [Quoddy Formation] Rock Quality = Very Poor R1: Core Times (min:sec) 11.6-12.6 ft (2:14) 12.6-13.1 ft (3:04) core blocked 100% Recovery	G#380893 A-2-4, SM WC=20.6%																																																																																																																																																																																																																													
	R2	24/24	13.10 - 15.10	RQD = 37%						R2: Bedrock: Dark grey to black, very fine to fine-grained ARGILLITE, moderately hard, fresh, competent, joints dipping at steep angles, very closely spaced, low fissility, then grey, very fine to fine-grained ARGILLITE, moderately hard, fresh, joints dipping at steep angles, very closely spaced, with increasing fissility. [Quoddy Formation] Rock Quality = Poor R2: Core Times (min:sec) 13.1-13.6 ft (1:23) 13.6-14.6 ft (3:22) 14.6-15.1 ft (2:39) core blocked 100% Recovery																																																																																																																																																																																																																														
	R3	58.8/58.8	15.10 - 20.00	RQD = 40%						R3: Bedrock: Grey to dark grey, very fine to fine-grained, weakly calcareous, SHALE, hard, fresh, poorly competent, joints dipping at steep angles, closely spaced, with increasing fissility, then grey to																																																																																																																																																																																																																														
20								7.5																																																																																																																																																																																																																																
25																																																																																																																																																																																																																																								
Remarks:																																																																																																																																																																																																																																								
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 2																																																																																																																																																																																																																														
										Boring No.: BB-TRS-102A																																																																																																																																																																																																																														

Maine Department of Transportation						Project: Rice Bridge #2714 carries Route 191 over Rice Stream							Boring No.: BB-TRS-102A																	
Soil/Rock Exploration Log						Location: Trescott Township, Maine							WIN: 26089.00																	
US CUSTOMARY UNITS																														
Driller: MainesDOT						Elevation (ft.) 27.5							Auger ID/OD: 5" Solid Stem																	
Operator: Daggett/Andrie						Datum: NAVD88							Sampler: Standard Split Spoon																	
Logged By: N. Pukay						Rig Type: CME 45C							Hammer Wt./Fall: 140#/30"																	
Date Start/Finish: 6/4/2024-6/5/2024						Drilling Method: Cased Wash Boring							Core Barrel: NQ-2"																	
Boring Location: 9+18.9, 8.7 ft Rt.						Casing ID/OD: HW(4"/4.5"), NW(3"/3.5")							Water Level*: Not Observed																	
Hammer Efficiency Factor: 0.962						Hammer Type: Automatic☒ Hydraulic☐ Rope & Cathead☐																								
Definitions:						R = Rock Core Sample							S _H = Peak/Remolded Field Vane Undrained Shear Strength (psf)							T _V = Pocket Torvane Shear Strength (psf)										
D = Split Spoon Sample						SSA = Solid Stem Auger							S _{U(lab)} = Lab Vane Undrained Shear Strength (psf)							WC = Water Content, percent										
MD = Unsuccessful Split Spoon Sample Attempt						HSA = Hollow Stem Auger							q _p = Unconfined Compressive Strength (ksf)							LL = Liquid Limit										
U = Thin Wall Tube Sample						RC = Roller Cone							N-uncorrected = Raw Field SPT N-value							PL = Plastic Limit										
MU = Unsuccessful Thin Wall Tube Sample Attempt						WOH = Weight of 140 lb. Hammer							Hammer Efficiency Factor = Rig Specific Annual Calibration Value							PI = Plasticity Index										
V = Field Vane Shear Test,						WOR/C = Weight of Rods or Casing							N ₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency							G = Grain Size Analysis										
MV = Unsuccessful Field Vane Shear Test Attempt						WOP1P = Weight of One Person							N ₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected							C = Consolidation Test										
Sample Information																			Visual Description and Remarks											Laboratory Testing Results/AASHTO and Unified Class.
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																				
25											black, very fine to fine-grained, SHALE and TUFF, moderately hard to hard, joints dipping at steep to vertical angles, with a vertical fracture separating the two rock types, rock flour along fracture plane. [Quoddy Formation] Rock Quality = Poor R3: Core Times (min:sec) 15.1-15.6 ft (1:15) 15.6-16.6 ft (3:12) 16.6-17.6 ft (2:32) 17.6-18.6 ft (3:25) 18.6-19.6 ft (3:15) 19.6-20.0 ft (2:05) 100% Recovery																			
30																														
35																														
40																														
45																														
50																														
Remarks:																														
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-TRS-102A											

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Rice Bridge #2714 carries Route 191 over Rice Stream Location: Trescott Township, Maine				Boring No.: BB-TRS-103 WIN: 26089.00																																																																																																																																																																																																																																								
Driller: MaineDOT				Elevation (ft.): 27.4				Auger ID/OD: 5" Solid Stem																																																																																																																																																																																																																																								
Operator: Daggett/Andrie				Datum: NAVD88				Sampler: Standard Split Spoon																																																																																																																																																																																																																																								
Logged By: N. Pukay				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"																																																																																																																																																																																																																																								
Date Start/Finish: 6/4/2024; 08:15-10:45				Drilling Method: Cased Wash Boring				Core Barrel: NQ-2"																																																																																																																																																																																																																																								
Boring Location: 9+39.5, 6.5 ft Lt.				Casing ID/OD: NW (3.0"/3.5")				Water Level*: 8.0 ft bgs. See remarks.																																																																																																																																																																																																																																								
Hammer Efficiency Factor: 0.962				Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐																																																																																																																																																																																																																																												
Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unsuccessful Thin Wall Tube Sample Attempt V = Field Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Field Vane Shear Test Attempt				R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of One Person				S _u = Peak/Remolded Field Vane Undrained Shear Strength (psf) S _{u(lab)} = Lab Vane Undrained Shear Strength (psf) q _p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw Field SPT N-value Hammer Efficiency Factor = Rig Specific Annual Calibration Value N ₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency N ₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected																																																																																																																																																																																																																																								
				T _v = Pocket Torvane Shear Strength (psf) WC = Water Content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test																																																																																																																																																																																																																																												
<table><tr><th rowspan="2">Depth (ft.)</th><th colspan="7">Sample Information</th><th rowspan="2">Elevation (ft.)</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/ AASHTO and Unified Class.</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing Blows</th></tr></table>												Depth (ft.)	Sample Information							Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows																																																																																																																																																																																																																		
Depth (ft.)	Sample Information							Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.																																																																																																																																																																																																																																					
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows																																																																																																																																																																																																																																									
<table><tr><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>SSA</td><td>27.0</td><td rowspan="10"></td><td>5" HMA.</td><td rowspan="10">-0.4</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Occasional Cobble.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>5</td><td>1D</td><td>24/2</td><td>5.00 - 7.00</td><td>7/8/26/9</td><td>34</td><td>55</td><td>21</td><td></td><td></td><td>Brown, wet, very dense, Sandy GRAVEL, little silt, (Fill). Broken cobble in tip of spoon.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>18</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>46</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>29</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>33</td><td></td><td></td><td></td></tr><tr><td>10</td><td>2D</td><td>24/1</td><td>10.00 - 12.00</td><td>3/4/18/13</td><td>22</td><td>35</td><td>17</td><td></td><td></td><td>Brown, wet, hard, Gravelly SILT, some sand, (Fill).</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>35</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>72</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>136</td><td></td><td></td><td></td></tr><tr><td>15</td><td>R1</td><td>60/60</td><td>14.60 - 19.60</td><td>RQD = 63%</td><td></td><td></td><td>a96</td><td></td><td>13.0</td><td>a96 blows for 0.4 ft.</td><td>-14.4</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>NQ-2</td><td></td><td></td><td>Top of Bedrock at Elev. 13.0 ft. R1: Bedrock: Grey to greenish grey, very fine to fine-grained TUFF, moderately hard, fresh, competent, joints dipping at low to moderate angles, closely spaced. [Quoddy Formation] Rock Quality = Fair Core Times (min:sec) 14.6-15.6 ft (1:56) 15.6-16.6 ft (2:09) 16.6-17.6 ft (2:11) 17.6-18.6 ft (1:59) 18.6-19.6 ft (2:23) 100% Recovery</td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>20</td><td>R2</td><td>20.4/17</td><td>19.60 - 21.30</td><td>RQD = 0%</td><td></td><td></td><td></td><td></td><td></td><td>R2: Bedrock: Grey to greenish grey, very fine to fine-grained TUFF, moderately hard, fresh, competent, joints dipping at moderate angles, very closely spaced. [Quoddy Formation] Rock Quality = Very Poor R2: core Times (min:sec) 19.6-20.6 ft (2:16) 20.6-21.3 ft (3:44) core blocked</td><td>#320290 23.81-24.19 q_p=10,150 psi</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>25</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>2.8</td><td></td><td></td></tr></table>												0								SSA	27.0		5" HMA.	-0.4											Occasional Cobble.																							5	1D	24/2	5.00 - 7.00	7/8/26/9	34	55	21			Brown, wet, very dense, Sandy GRAVEL, little silt, (Fill). Broken cobble in tip of spoon.								18											46											29											33				10	2D	24/1	10.00 - 12.00	3/4/18/13	22	35	17			Brown, wet, hard, Gravelly SILT, some sand, (Fill).								35											72											136				15	R1	60/60	14.60 - 19.60	RQD = 63%			a96		13.0	a96 blows for 0.4 ft.	-14.4								NQ-2			Top of Bedrock at Elev. 13.0 ft. R1: Bedrock: Grey to greenish grey, very fine to fine-grained TUFF, moderately hard, fresh, competent, joints dipping at low to moderate angles, closely spaced. [Quoddy Formation] Rock Quality = Fair Core Times (min:sec) 14.6-15.6 ft (1:56) 15.6-16.6 ft (2:09) 16.6-17.6 ft (2:11) 17.6-18.6 ft (1:59) 18.6-19.6 ft (2:23) 100% Recovery														20	R2	20.4/17	19.60 - 21.30	RQD = 0%						R2: Bedrock: Grey to greenish grey, very fine to fine-grained TUFF, moderately hard, fresh, competent, joints dipping at moderate angles, very closely spaced. [Quoddy Formation] Rock Quality = Very Poor R2: core Times (min:sec) 19.6-20.6 ft (2:16) 20.6-21.3 ft (3:44) core blocked	#320290 23.81-24.19 q _p =10,150 psi																									25									2.8		
0								SSA	27.0		5" HMA.	-0.4																																																																																																																																																																																																																																				
											Occasional Cobble.																																																																																																																																																																																																																																					
5	1D	24/2	5.00 - 7.00	7/8/26/9	34	55	21				Brown, wet, very dense, Sandy GRAVEL, little silt, (Fill). Broken cobble in tip of spoon.																																																																																																																																																																																																																																					
							18																																																																																																																																																																																																																																									
							46																																																																																																																																																																																																																																									
							29																																																																																																																																																																																																																																									
							33																																																																																																																																																																																																																																									
10	2D	24/1	10.00 - 12.00	3/4/18/13	22	35	17				Brown, wet, hard, Gravelly SILT, some sand, (Fill).																																																																																																																																																																																																																																					
							35																																																																																																																																																																																																																																									
							72																																																																																																																																																																																																																																									
							136																																																																																																																																																																																																																																									
15	R1	60/60	14.60 - 19.60	RQD = 63%			a96		13.0	a96 blows for 0.4 ft.	-14.4																																																																																																																																																																																																																																					
							NQ-2			Top of Bedrock at Elev. 13.0 ft. R1: Bedrock: Grey to greenish grey, very fine to fine-grained TUFF, moderately hard, fresh, competent, joints dipping at low to moderate angles, closely spaced. [Quoddy Formation] Rock Quality = Fair Core Times (min:sec) 14.6-15.6 ft (1:56) 15.6-16.6 ft (2:09) 16.6-17.6 ft (2:11) 17.6-18.6 ft (1:59) 18.6-19.6 ft (2:23) 100% Recovery																																																																																																																																																																																																																																						
20	R2	20.4/17	19.60 - 21.30	RQD = 0%						R2: Bedrock: Grey to greenish grey, very fine to fine-grained TUFF, moderately hard, fresh, competent, joints dipping at moderate angles, very closely spaced. [Quoddy Formation] Rock Quality = Very Poor R2: core Times (min:sec) 19.6-20.6 ft (2:16) 20.6-21.3 ft (3:44) core blocked	#320290 23.81-24.19 q _p =10,150 psi																																																																																																																																																																																																																																					
25									2.8																																																																																																																																																																																																																																							
Remarks: 1) Water level measured immediately after drilling.																																																																																																																																																																																																																																																
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-TRS-103																																																																																																																																																																																																																																						

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Rice Bridge #2714 carries Route 191 over Rice Stream Location: Trescott Township, Maine				Boring No.: BB-TRS-103 WIN: 26089.00						
Driller: MaineDOT				Elevation (ft.): 27.4				Auger ID/OD: 5" Solid Stem						
Operator: Daggett/Andrle				Datum: NAVD88				Sampler: Standard Split Spoon						
Logged By: N. Pukay				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"						
Date Start/Finish: 6/4/2024; 08:15-10:45				Drilling Method: Cased Wash Boring				Core Barrel: NQ-2"						
Boring Location: 9+39.5, 6.5 ft Lt.				Casing ID/OD: NW (3.0"/3.5")				Water Level*: 8.0 ft bgs. See remarks.						
Hammer Efficiency Factor: 0.962				Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐										
Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unsuccessful Thin Wall Tube Sample Attempt V = Field Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Field Vane Shear Test Attempt R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140 lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of One Person S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf) S_u(lab) = Lab Vane Undrained Shear Strength (psf) q_p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw Field SPT N-value Hammer Efficiency Factor = Rig Specific Annual Calibration Value N₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency N₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected T_v = Pocket Torvane Shear Strength (psf) WC = Water Content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test														
Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.			
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)						
	25												83% Recovery	
													R3: Bedrock: Grey to greenish grey, very fine to fine-grained TUFF, moderately hard, fresh, competent, joints dipping at moderate angles, closely spaced.	
													[Quoddy Formation]	
													Rock Quality = Good	
													R3: Core Times (min:sec)	
													21.3-21.6 ft (0:25)	
													21.6-22.6 ft (2:09)	
													22.6-23.6 ft (2:12)	
													23.6-24.6 ft (2:06)	
													95% Recovery	
													Bottom of Exploration at 24.6 feet below ground surface.	
	50													
	Remarks: 1) Water level measured immediately after drilling.													
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-TRS-103				

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Rice Bridge #2714 carries Route 191 over Rice Stream Location: Trescott Township, Maine				Boring No.: BB-TRS-104 WIN: 26089.00																																																																																																																																																																																																																																																																																																																								
Driller: MaineDOT				Elevation (ft.) 27.4				Auger ID/OD: 5" Solid Stem																																																																																																																																																																																																																																																																																																																								
Operator: Daggett/Andrle				Datum: NAVD88				Sampler: Standard Split Spoon																																																																																																																																																																																																																																																																																																																								
Logged By: N. Pukay				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"																																																																																																																																																																																																																																																																																																																								
Date Start/Finish: 6/5/2024; 10:15-12:00				Drilling Method: Cased Wash Boring				Core Barrel: NQ-2"																																																																																																																																																																																																																																																																																																																								
Boring Location: 9+46.3, 6.7 ft Rt.				Casing ID/OD: HW(4"/4.5"), NW(3"/3.5")				Water Level*: Not Observed																																																																																																																																																																																																																																																																																																																								
Hammer Efficiency Factor: 0.962				Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐																																																																																																																																																																																																																																																																																																																												
Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unsuccessful Thin Wall Tube Sample Attempt V = Field Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Field Vane Shear Test Attempt				R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of One Person				S _u = Peak/Remolded Field Vane Undrained Shear Strength (psf) S _{u(lab)} = Lab Vane Undrained Shear Strength (psf) q _p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw Field SPT N-value Hammer Efficiency Factor = Rig Specific Annual Calibration Value N ₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency N ₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected																																																																																																																																																																																																																																																																																																																								
				T _v = Pocket Torvane Shear Strength (psf) WC = Water Content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test																																																																																																																																																																																																																																																																																																																												
<table><tr><th rowspan="2">Depth (ft.)</th><th colspan="8">Sample Information</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/ AASHTO and Unified Class.</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing Blows</th><th>Elevation (ft.)</th></tr><tr><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>SSA</td><td>27.0</td><td rowspan="15"></td><td>5" HMA</td><td rowspan="15">G#380894 A-1-b, SM WC=10.1%</td></tr><tr><td></td><td>1D</td><td>24/7</td><td>1.00 - 3.00</td><td>11/39/15/7</td><td>54</td><td>87</td><td></td><td></td><td>Brown, dry, very dense, Sandy GRAVEL, trace silt, (Fill).</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>5</td><td>2D/A</td><td>24/6</td><td>5.00 - 7.00</td><td>7/8/10/10</td><td>18</td><td>29</td><td>4</td><td></td><td>2D (Top 3") Brown, moist, medium dense, Sandy GRAVEL, trace silt, (Fill).</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>15</td><td></td><td>2D/A (Bottom 3") Brown, moist, medium dense, SAND, some silt, some gravel, (Fill).</td></tr><tr><td></td><td>3D</td><td>24/5</td><td>7.00 - 9.00</td><td>14/12/10/11</td><td>22</td><td>35</td><td>13</td><td></td><td>3D: Brown, moist, dense, Gravelly SAND, little silt, (Fill).</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>23</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>21</td><td></td><td></td></tr><tr><td>10</td><td>4D</td><td>15.6/6</td><td>10.70 - 12.00</td><td>3/10/59(3.6")</td><td>---</td><td></td><td>10</td><td></td><td>Grey-brown, wet, GRAVEL, some silt, some sand, trace wood chips, (Fill). Bedrock in tip of spoon.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>43</td><td></td><td></td></tr><tr><td></td><td>R1</td><td>60/60</td><td>12.00 - 17.00</td><td>RQD = 78%</td><td></td><td></td><td>NQ-2</td><td>15.4</td><td>Top of Bedrock at Elev. 15.4 ft.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>R1: Bedrock: Grey to greenish grey, very fine to fine-grained TUFF, moderately hard, fresh, competent, joints dipping at steep angles, closely spaced, with a fracture zone near the bottom of run.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>[Quoddy Formation]</td></tr><tr><td>15</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Rock Quality = Good</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>R1: Core Times (min:sec)</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>12.0-13.0 ft (2:24)</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>13.0-14.0 ft (2:39)</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>14.0-15.0 ft (2:56)</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>15.0-16.0 ft (2:35)</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>16.0-17.0 ft (2:59)</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>100% Recovery</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Bottom of Exploration at 17.0 feet below ground surface.</td></tr><tr><td>20</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>25</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>												Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	0							SSA	27.0		5" HMA	G#380894 A-1-b, SM WC=10.1%		1D	24/7	1.00 - 3.00	11/39/15/7	54	87			Brown, dry, very dense, Sandy GRAVEL, trace silt, (Fill).																					5	2D/A	24/6	5.00 - 7.00	7/8/10/10	18	29	4		2D (Top 3") Brown, moist, medium dense, Sandy GRAVEL, trace silt, (Fill).								15		2D/A (Bottom 3") Brown, moist, medium dense, SAND, some silt, some gravel, (Fill).		3D	24/5	7.00 - 9.00	14/12/10/11	22	35	13		3D: Brown, moist, dense, Gravelly SAND, little silt, (Fill).								23										21			10	4D	15.6/6	10.70 - 12.00	3/10/59(3.6")	---		10		Grey-brown, wet, GRAVEL, some silt, some sand, trace wood chips, (Fill). Bedrock in tip of spoon.								43				R1	60/60	12.00 - 17.00	RQD = 78%			NQ-2	15.4	Top of Bedrock at Elev. 15.4 ft.										R1: Bedrock: Grey to greenish grey, very fine to fine-grained TUFF, moderately hard, fresh, competent, joints dipping at steep angles, closely spaced, with a fracture zone near the bottom of run.										[Quoddy Formation]	15									Rock Quality = Good										R1: Core Times (min:sec)										12.0-13.0 ft (2:24)										13.0-14.0 ft (2:39)										14.0-15.0 ft (2:56)										15.0-16.0 ft (2:35)										16.0-17.0 ft (2:59)										100% Recovery										Bottom of Exploration at 17.0 feet below ground surface.	20																																												25											Remarks:	
Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.																																																																																																																																																																																																																																																																																																																					
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)																																																																																																																																																																																																																																																																																																																								
0							SSA	27.0		5" HMA	G#380894 A-1-b, SM WC=10.1%																																																																																																																																																																																																																																																																																																																					
	1D	24/7	1.00 - 3.00	11/39/15/7	54	87				Brown, dry, very dense, Sandy GRAVEL, trace silt, (Fill).																																																																																																																																																																																																																																																																																																																						
5	2D/A	24/6	5.00 - 7.00	7/8/10/10	18	29	4			2D (Top 3") Brown, moist, medium dense, Sandy GRAVEL, trace silt, (Fill).																																																																																																																																																																																																																																																																																																																						
							15			2D/A (Bottom 3") Brown, moist, medium dense, SAND, some silt, some gravel, (Fill).																																																																																																																																																																																																																																																																																																																						
	3D	24/5	7.00 - 9.00	14/12/10/11	22	35	13			3D: Brown, moist, dense, Gravelly SAND, little silt, (Fill).																																																																																																																																																																																																																																																																																																																						
							23																																																																																																																																																																																																																																																																																																																									
							21																																																																																																																																																																																																																																																																																																																									
10	4D	15.6/6	10.70 - 12.00	3/10/59(3.6")	---		10			Grey-brown, wet, GRAVEL, some silt, some sand, trace wood chips, (Fill). Bedrock in tip of spoon.																																																																																																																																																																																																																																																																																																																						
							43																																																																																																																																																																																																																																																																																																																									
	R1	60/60	12.00 - 17.00	RQD = 78%			NQ-2	15.4		Top of Bedrock at Elev. 15.4 ft.																																																																																																																																																																																																																																																																																																																						
										R1: Bedrock: Grey to greenish grey, very fine to fine-grained TUFF, moderately hard, fresh, competent, joints dipping at steep angles, closely spaced, with a fracture zone near the bottom of run.																																																																																																																																																																																																																																																																																																																						
										[Quoddy Formation]																																																																																																																																																																																																																																																																																																																						
15										Rock Quality = Good																																																																																																																																																																																																																																																																																																																						
									R1: Core Times (min:sec)																																																																																																																																																																																																																																																																																																																							
									12.0-13.0 ft (2:24)																																																																																																																																																																																																																																																																																																																							
									13.0-14.0 ft (2:39)																																																																																																																																																																																																																																																																																																																							
									14.0-15.0 ft (2:56)																																																																																																																																																																																																																																																																																																																							
									15.0-16.0 ft (2:35)																																																																																																																																																																																																																																																																																																																							
									16.0-17.0 ft (2:59)																																																																																																																																																																																																																																																																																																																							
									100% Recovery																																																																																																																																																																																																																																																																																																																							
									Bottom of Exploration at 17.0 feet below ground surface.																																																																																																																																																																																																																																																																																																																							
20																																																																																																																																																																																																																																																																																																																																
25																																																																																																																																																																																																																																																																																																																																
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 1 of 1																																																																																																																																																																																																																																																																																																																						
* 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-TRS-104																																																																																																																																																																																																																																																																																																																						

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Rice Bridge #2714 carries Route 191 over Rice Stream Location: Trescott Township, Maine				Boring No.: BP-TRS-105 WIN: 26089.00				
Driller: MaineDOT			Elevation (ft.): 27.9			Auger ID/OD: 5" Dia.						
Operator: Daggett/Andrie			Datum: NAVD88			Sampler: N/A						
Logged By: N. Pukay			Rig Type: CME 45C			Hammer Wt./Fall: N/A						
Date Start/Finish: 6/14/2024; 10:50-11:00			Drilling Method: Solid Stem Auger			Core Barrel: N/A						
Boring Location: 9+80.4, 6.9 ft Lt.			Casing ID/OD: N/A			Water Level*: Not Observed						
Hammer Efficiency Factor: 0.962			Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐									
Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unsuccessful Thin Wall Tube Sample Attempt V = Field Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Field Vane Shear Test Attempt R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of One Person S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf) S_{u(lab)} = Lab Vane Undrained Shear Strength (psf) q_p = Unconfined Compressive Strength (ksf) N_{uncorrected} = Raw Field SPT N-value Hammer Efficiency Factor = Rig Specific Annual Calibration Value N₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency N₆₀ = (Hammer Efficiency Factor/60%)*N_{uncorrected} T_v = Pocket Torvane Shear Strength (psf) WC = Water Content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test												
Depth (ft.)	Sample Information								Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing	Blows				
0								SSA	27.9		No material descriptions.	
5												
10									18.3			
15												
20												
25												
Remarks:												
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.											Page 1 of 1	
* 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.: BP-TRS-105	

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Rice Bridge #2714 carries Route 191 over Rice Stream Location: Trescott Township, Maine				Boring No.: BP-TRS-106 WIN: 26089.00		
Driller: MaineDOT		Elevation (ft.): 28.8		Auger ID/OD: 5" Dia.						
Operator: Daggett/Andrie		Datum: NAVD88		Sampler: N/A						
Logged By: N. Pukay		Rig Type: CME 45C		Hammer Wt./Fall: N/A						
Date Start/Finish: 6/14/2024; 11:00-11:10		Drilling Method: Solid Stem Auger		Core Barrel: N/A						
Boring Location: 10+30.6, 5.9 ft Lt.		Casing ID/OD: N/A		Water Level*: Not Observed						
Hammer Efficiency Factor: 0.962		Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐								
Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unsuccessful Thin Wall Tube Sample Attempt V = Field Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Field Vane Shear Test Attempt		R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of One Person		Su = Peak/Remolded Field Vane Undrained Shear Strength (psf) Su(lab) = Lab Vane Undrained Shear Strength (psf) qp = Unconfined Compressive Strength (ksf) N-uncorrected = Raw Field SPT N-value Hammer Efficiency Factor = Rig Specific Annual Calibration Value N60 = SPT N-uncorrected Corrected for Hammer Efficiency N60 = (Hammer Efficiency Factor/60%)*N-uncorrected		Tv = Pocket Torvane Shear Strength (psf) WC = Water Content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test				
Depth (ft.)	Sample Information								Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing Blows	Elevation (ft.)		
0							SSA	26.1	No material descriptions.	
25										
Remarks:										
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 1 of 1
* 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.: BP-TRS-106

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Rice Bridge #2714 carries Route 191 over Rice Stream Location: Trescott Township, Maine				Boring No.: BP-TRS-107 WIN: 26089.00				
Driller: MaineDOT				Elevation (ft.): 29.2				Auger ID/OD: 5" Dia.				
Operator: Daggett/Andrie				Datum: NAVD88				Sampler: N/A				
Logged By: N. Pukay				Rig Type: CME 45C				Hammer Wt./Fall: N/A				
Date Start/Finish: 6/14/2024; 11:00-11:15				Drilling Method: Solid Stem Auger				Core Barrel: N/A				
Boring Location: 10+71.3, 5.9 ft Lt.				Casing ID/OD: N/A				Water Level*: Not Observed				
Hammer Efficiency Factor: 0.962				Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐								
Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unsuccessful Thin Wall Tube Sample Attempt V = Field Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Field Vane Shear Test Attempt R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of One Person S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf) S_{u(lab)} = Lab Vane Undrained Shear Strength (psf) q_p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw Field SPT N-value Hammer Efficiency Factor = Rig Specific Annual Calibration Value N₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency N₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected T_v = Pocket Torvane Shear Strength (psf) WC = Water Content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test												
Depth (ft.)	Sample Information								Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows					
0							SSA	28.8		5" HMA.	Bottom of Exploration at 1.0 feet below ground surface. Auger REFUSAL, Presumed top of bedrock at 1.0 ft bgs.	
								28.2		No material descriptions.		
5												
10												
15												
20												
25												
Remarks:												
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 1 of 1		
* 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.: BP-TRS-107		

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Rice Bridge #2714 carries Route 191 over Rice Stream Location: Trescott Township, Maine				Boring No.: BB-TRS-201 WIN: 26089.00																																																																																																																																																																																																																																						
Driller: MaineDOT				Elevation (ft.): 28.0				Auger ID/OD: 5" Dia.																																																																																																																																																																																																																																						
Operator: Daggett/Andrie				Datum: NAVD88				Sampler: Standard Split Spoon																																																																																																																																																																																																																																						
Logged By: N. Pukay				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"																																																																																																																																																																																																																																						
Date Start/Finish: 12/9/2024; 12:05-13:15				Drilling Method: Solid Stem Auger				Core Barrel: N/A																																																																																																																																																																																																																																						
Boring Location: 9+72.1., 12.0 ft Rt.				Casing ID/OD: N/A				Water Level*: 8.5 ft bgs.																																																																																																																																																																																																																																						
Hammer Efficiency Factor: 0.862				Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐																																																																																																																																																																																																																																										
Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unsuccessful Thin Wall Tube Sample Attempt V = Field Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Field Vane Shear Test Attempt R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of One Person S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf) S_u(lab) = Lab Vane Undrained Shear Strength (psf) q_p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw Field SPT N-value Hammer Efficiency Factor = Rig Specific Annual Calibration Value N₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency N₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected T_v = Pocket Torvane Shear Strength (psf) WC = Water Content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test																																																																																																																																																																																																																																														
<table><tr><th rowspan="2">Depth (ft.)</th><th colspan="8">Sample Information</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/AASHTO and Unified Class.</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing Blows</th><th>Elevation (ft.)</th></tr><tr><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>SSA</td><td></td><td rowspan="10"></td><td rowspan="10">Brown, moist, very loose, SAND, some gravel, some silt, (Fill).</td><td rowspan="10"></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>5</td><td>1D</td><td>24/5</td><td>4.00 - 6.00</td><td>1/1/1/1</td><td>2</td><td>3</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td>2D</td><td>24/3</td><td>6.50 - 8.50</td><td>3/3/11/6</td><td>14</td><td>20</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td>3D/A</td><td>24/13</td><td>8.50 - 10.50</td><td>2/5/2/3</td><td>7</td><td>10</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>10</td><td>4D</td><td>7.2/5</td><td>10.50 - 11.10</td><td>24/50(1.2")</td><td>---</td><td></td><td></td><td>16.9</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="10"></td><td rowspan="10">3D (Top 3"): Brown, wet, SAND, some gravel, some silt, (Fill). 3D/A (Bottom 10"): Brown, wet, stiff, SILT, some sand, some gravel, trace clay, (Fill). 4D: Similar to 3D/A. Bedrock in tip of spoon. Bottom of Exploration at 11.1 feet below ground surface. Spoon refusal. Presumed Top of Bedrock.</td><td rowspan="10">G#380922 A-4, ML WC=27.9% Non-Plastic</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>25</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>												Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/AASHTO and Unified Class.	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	0							SSA			Brown, moist, very loose, SAND, some gravel, some silt, (Fill).																													5	1D	24/5	4.00 - 6.00	1/1/1/1	2	3													2D	24/3	6.50 - 8.50	3/3/11/6	14	20													3D/A	24/13	8.50 - 10.50	2/5/2/3	7	10												10	4D	7.2/5	10.50 - 11.10	24/50(1.2")	---			16.9											3D (Top 3"): Brown, wet, SAND, some gravel, some silt, (Fill). 3D/A (Bottom 10"): Brown, wet, stiff, SILT, some sand, some gravel, trace clay, (Fill). 4D: Similar to 3D/A. Bedrock in tip of spoon. Bottom of Exploration at 11.1 feet below ground surface. Spoon refusal. Presumed Top of Bedrock.	G#380922 A-4, ML WC=27.9% Non-Plastic																																																																																		25											
Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/AASHTO and Unified Class.																																																																																																																																																																																																																																			
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)																																																																																																																																																																																																																																						
0							SSA			Brown, moist, very loose, SAND, some gravel, some silt, (Fill).																																																																																																																																																																																																																																				
5	1D	24/5	4.00 - 6.00	1/1/1/1	2	3																																																																																																																																																																																																																																								
	2D	24/3	6.50 - 8.50	3/3/11/6	14	20																																																																																																																																																																																																																																								
	3D/A	24/13	8.50 - 10.50	2/5/2/3	7	10																																																																																																																																																																																																																																								
10	4D	7.2/5	10.50 - 11.10	24/50(1.2")	---			16.9																																																																																																																																																																																																																																						
										3D (Top 3"): Brown, wet, SAND, some gravel, some silt, (Fill). 3D/A (Bottom 10"): Brown, wet, stiff, SILT, some sand, some gravel, trace clay, (Fill). 4D: Similar to 3D/A. Bedrock in tip of spoon. Bottom of Exploration at 11.1 feet below ground surface. Spoon refusal. Presumed Top of Bedrock.	G#380922 A-4, ML WC=27.9% Non-Plastic																																																																																																																																																																																																																																			
25																																																																																																																																																																																																																																														
Remarks:																																																																																																																																																																																																																																														
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 1 of 1																																																																																																																																																																																																																																				
* 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-TRS-201																																																																																																																																																																																																																																				

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Rice Bridge #2714 carries Route 191 over Rice Stream Location: Trescott Township, Maine				Boring No.: BB-TRS-202 WIN: 26089.00																																																																																																																																																																																																																																																																																																															
Driller: MaineDOT				Elevation (ft.): 29.1				Auger ID/OD: 5" Dia.																																																																																																																																																																																																																																																																																																															
Operator: Daggett/Andrie				Datum: NAVD88				Sampler: Standard Split Spoon																																																																																																																																																																																																																																																																																																															
Logged By: N. Pukay				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"																																																																																																																																																																																																																																																																																																															
Date Start/Finish: 12/9/2024; 10:45-12:00				Drilling Method: Solid Stem Auger				Core Barrel: N/A																																																																																																																																																																																																																																																																																																															
Boring Location: 10+44.2, 12.5 ft Rt.				Casing ID/OD: N/A				Water Level*: 7.0 ft bgs.																																																																																																																																																																																																																																																																																																															
Hammer Efficiency Factor: 0.862				Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐																																																																																																																																																																																																																																																																																																																			
Definitions: D = Split Spoon Sample MD = Unsuccessful Split Spoon Sample Attempt U = Thin Wall Tube Sample MU = Unsuccessful Thin Wall Tube Sample Attempt V = Field Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Field Vane Shear Test Attempt				R = Rock Core Sample SSA = Solid Stem Auger HSA = Hollow Stem Auger RC = Roller Cone WOH = Weight of 140lb. Hammer WOR/C = Weight of Rods or Casing WO1P = Weight of One Person				S _u = Peak/Remolded Field Vane Undrained Shear Strength (psf) S _{u(lab)} = Lab Vane Undrained Shear Strength (psf) q _p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw Field SPT N-value Hammer Efficiency Factor = Rig Specific Annual Calibration Value N ₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency N ₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected																																																																																																																																																																																																																																																																																																															
								T _v = Pocket Torvane Shear Strength (psf) WC = Water Content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test																																																																																																																																																																																																																																																																																																															
<table><tr><th rowspan="2">Depth (ft.)</th><th colspan="8">Sample Information</th><th rowspan="2">Elevation (ft.)</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/ AASHTO and Unified Class.</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing</th><th>Blows</th></tr></table>												Depth (ft.)	Sample Information								Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing	Blows																																																																																																																																																																																																																																																																																							
Depth (ft.)	Sample Information								Elevation (ft.)	Graphic Log	Visual Description and Remarks		Laboratory Testing Results/ AASHTO and Unified Class.																																																																																																																																																																																																																																																																																																										
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing	Blows																																																																																																																																																																																																																																																																																																															
<table><tr><td rowspan="6">0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="6"></td><td rowspan="6">Brown, moist, very stiff, SILT, some sand, some gravel, trace clay, (Fill). Boulder encountered at 3.7 ft bgs. SSA shifted to the side of the boulder. 2D: Similar to 1D. Cobble at 4.5 ft bgs, fragments in sample spoon.</td><td rowspan="6"></td></tr><tr><td>1D</td><td>24/8</td><td>2.00 - 4.00</td><td>6/8/7/8</td><td>15</td><td>22</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>2D</td><td>24/5</td><td>4.00 - 6.00</td><td>4/23/7/4</td><td>30</td><td>43</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>3D</td><td>24/4</td><td>6.00 - 8.00</td><td>2/2/2/3</td><td>4</td><td>6</td><td></td><td></td></tr><tr><td rowspan="3">5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="3"></td><td rowspan="3">Brown, wet, medium stiff, SILT, some sand, some gravel, trace clay, (Fill). Similar to 3D, except very stiff. Cobble fragments in tip of spoon. Failed 55x110 mm vane attempt at 8.0 ft bgs., would not push.</td><td rowspan="3">G#380923 A-4, SC-SM WC=23.9% Non-Plastic</td></tr><tr><td>4D/MV</td><td>24/11</td><td>8.00 - 10.00</td><td>3/4/13/31</td><td>17</td><td>24</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td rowspan="2">10</td><td>5D/A</td><td>18/9</td><td>10.00 - 11.50</td><td>5/51/50</td><td>101</td><td>145</td><td></td><td></td><td></td><td></td><td rowspan="2"></td><td rowspan="2">5D (Top 5"): Brown, wet, SILT, some sand, little gravel, trace clay, (Fill). 5D/A (Bottom 4"): Light brown, wet, very dense, SAND, some silt, little gravel, (Fill).</td><td rowspan="2">G#380924 A-2-4, SM WC=8.8%</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td rowspan="10">15</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="10"></td><td rowspan="10">Bottom of Exploration at 11.2 feet below ground surface. Auger Refusal. Presumed Top of Bedrock.</td><td rowspan="10"></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td rowspan="6">20</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="6"></td><td rowspan="6"></td><td rowspan="6"></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td rowspan="6">25</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="6"></td><td rowspan="6"></td><td rowspan="6"></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>												0												Brown, moist, very stiff, SILT, some sand, some gravel, trace clay, (Fill). Boulder encountered at 3.7 ft bgs. SSA shifted to the side of the boulder. 2D: Similar to 1D. Cobble at 4.5 ft bgs, fragments in sample spoon.		1D	24/8	2.00 - 4.00	6/8/7/8	15	22											2D	24/5	4.00 - 6.00	4/23/7/4	30	43											3D	24/4	6.00 - 8.00	2/2/2/3	4	6			5												Brown, wet, medium stiff, SILT, some sand, some gravel, trace clay, (Fill). Similar to 3D, except very stiff. Cobble fragments in tip of spoon. Failed 55x110 mm vane attempt at 8.0 ft bgs., would not push.	G#380923 A-4, SC-SM WC=23.9% Non-Plastic	4D/MV	24/11	8.00 - 10.00	3/4/13/31	17	24											10	5D/A	18/9	10.00 - 11.50	5/51/50	101	145						5D (Top 5"): Brown, wet, SILT, some sand, little gravel, trace clay, (Fill). 5D/A (Bottom 4"): Light brown, wet, very dense, SAND, some silt, little gravel, (Fill).	G#380924 A-2-4, SM WC=8.8%									15												Bottom of Exploration at 11.2 feet below ground surface. Auger Refusal. Presumed Top of Bedrock.																																																																										20																																																						25																																																					
0													Brown, moist, very stiff, SILT, some sand, some gravel, trace clay, (Fill). Boulder encountered at 3.7 ft bgs. SSA shifted to the side of the boulder. 2D: Similar to 1D. Cobble at 4.5 ft bgs, fragments in sample spoon.																																																																																																																																																																																																																																																																																																										
	1D	24/8	2.00 - 4.00	6/8/7/8	15	22																																																																																																																																																																																																																																																																																																																	
	2D	24/5	4.00 - 6.00	4/23/7/4	30	43																																																																																																																																																																																																																																																																																																																	
	3D	24/4	6.00 - 8.00	2/2/2/3	4	6																																																																																																																																																																																																																																																																																																																	
5												Brown, wet, medium stiff, SILT, some sand, some gravel, trace clay, (Fill). Similar to 3D, except very stiff. Cobble fragments in tip of spoon. Failed 55x110 mm vane attempt at 8.0 ft bgs., would not push.	G#380923 A-4, SC-SM WC=23.9% Non-Plastic																																																																																																																																																																																																																																																																																																										
	4D/MV	24/11	8.00 - 10.00	3/4/13/31	17	24																																																																																																																																																																																																																																																																																																																	
10	5D/A	18/9	10.00 - 11.50	5/51/50	101	145						5D (Top 5"): Brown, wet, SILT, some sand, little gravel, trace clay, (Fill). 5D/A (Bottom 4"): Light brown, wet, very dense, SAND, some silt, little gravel, (Fill).	G#380924 A-2-4, SM WC=8.8%																																																																																																																																																																																																																																																																																																										
15												Bottom of Exploration at 11.2 feet below ground surface. Auger Refusal. Presumed Top of Bedrock.																																																																																																																																																																																																																																																																																																											
20																																																																																																																																																																																																																																																																																																																							
25																																																																																																																																																																																																																																																																																																																							
Remarks:																																																																																																																																																																																																																																																																																																																							
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 1																																																																																																																																																																																																																																																																																																																							
Boring No.: BB-TRS-202																																																																																																																																																																																																																																																																																																																							

Appendix B

Rock Core Photographs



MaineDOT

Rice Bridge #2714 Carries Route 191 Over Rice Stream

Trescott Township, ME

Rock Core Photographs

Boring No.	Run	Depth (ft)	Penetration (in)	Recovery (in)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-TRS-101	R1	13.80-14.70	10.8	10.8	0	0	ARGILLITE	1
BB-TRS-101	R2	14.70-16.40	20.4	20.4	4	19	ARGILLITE	1
BB-TRS-101	R3	16.40-18.80	28.8	28.8	0	0	ARGILLITE	1
BB-TRS-101	R4	18.80-20.50	20.4	20.4	0	0	ARGILLITE	2
BB-TRS-101	R5	20.50-23.80	39.6	36.0	30	75	ARGILLITE	2
BB-TRS-103	R1	14.60-19.60	60.0	60.0	38	63	TUFF	3
BB-TRS-103	R2	19.60-21.30	20.4	17.0	0	0	TUFF	4
BB-TRS-103	R3	21.30-24.60	39.6	38.0	36	90	TUFF	4



- Notes:** 1. "Box row" indicates the section of the box where the core run is contained: 1 = top, 4 = bottom.
2. Top of each core run is on the left and increases with depth to the right.
3. Transition between core runs is marked by wooden blocks.



MaineDOT

Rice Bridge #2714 Carries Route 191 Over Rice Stream

Trescott Township, ME

Rock Core Photographs

Boring No.	Run	Depth (ft)	Penetration (in)	Recovery (in)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-TRS-102A	R1	11.6-13.1	18.0	18.0	4	22	ARGILLITE	1
BB-TRS-102A	R2	13.1-15.1	24.0	24.0	9	37	ARGILLITE	1
BB-TRS-102A	R3	15.1-20.0	58.8	58.8	24	40	SHALE/TUFF	2
BB-TRS-104	R1	12.0-17.0	60.0	60.0	47	78	TUFF	3



- Notes:** 1. "Box row" indicates the section of the box where the core run is contained: 1 = top, 4 = bottom.
2. Top of each core run is on the left and increases with depth to the right.
3. Transition between core runs is marked by wooden blocks.

Appendix C

Laboratory Test Results

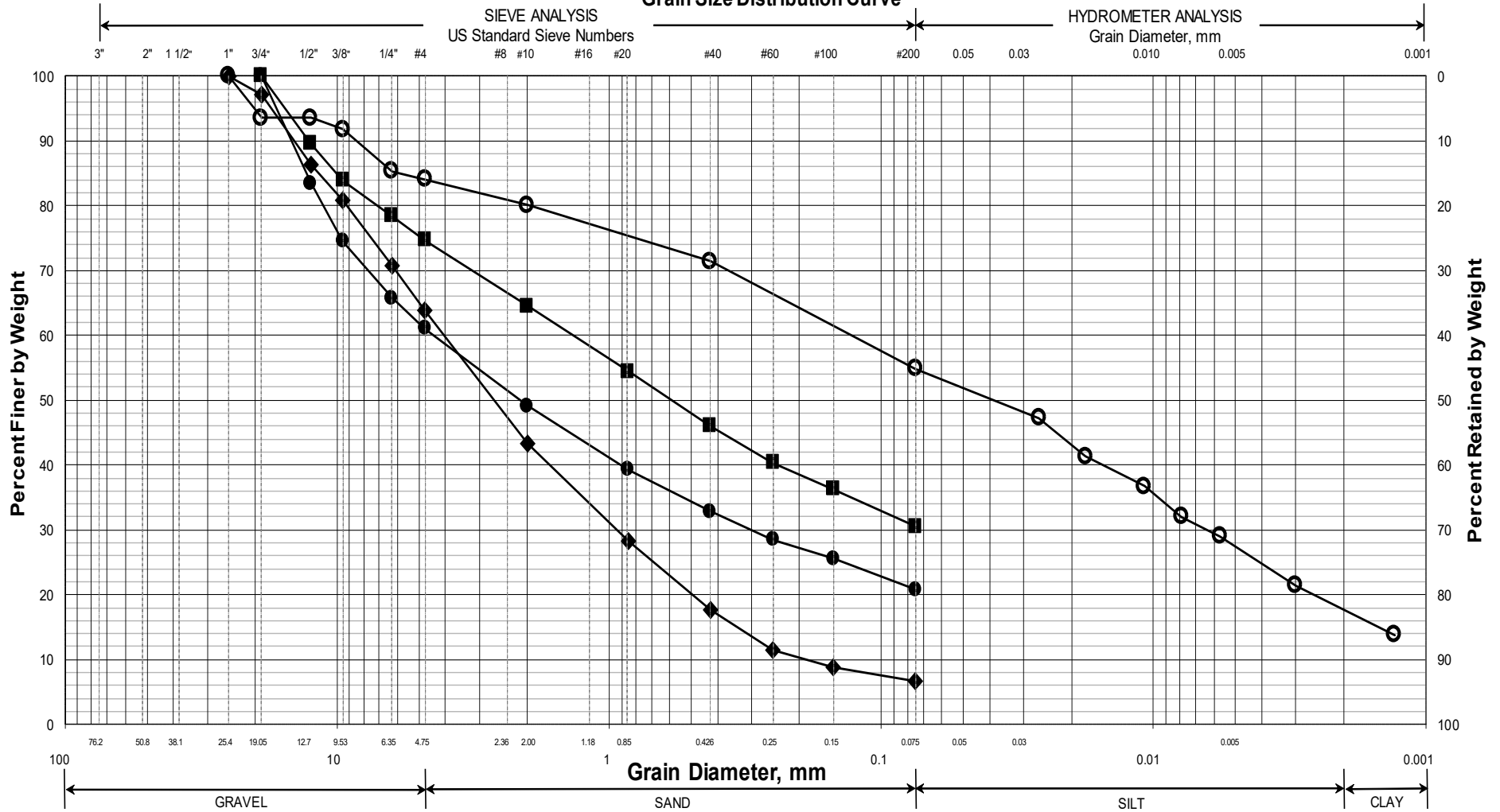
Town(s): **Trescott Twp.**

[illegible]

The "Frost Susceptibility Rating" is based upon the MaineDOT and Corps of Engineers Classification Systems.

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

Maine Department of Transportation Grain Size Distribution Curve

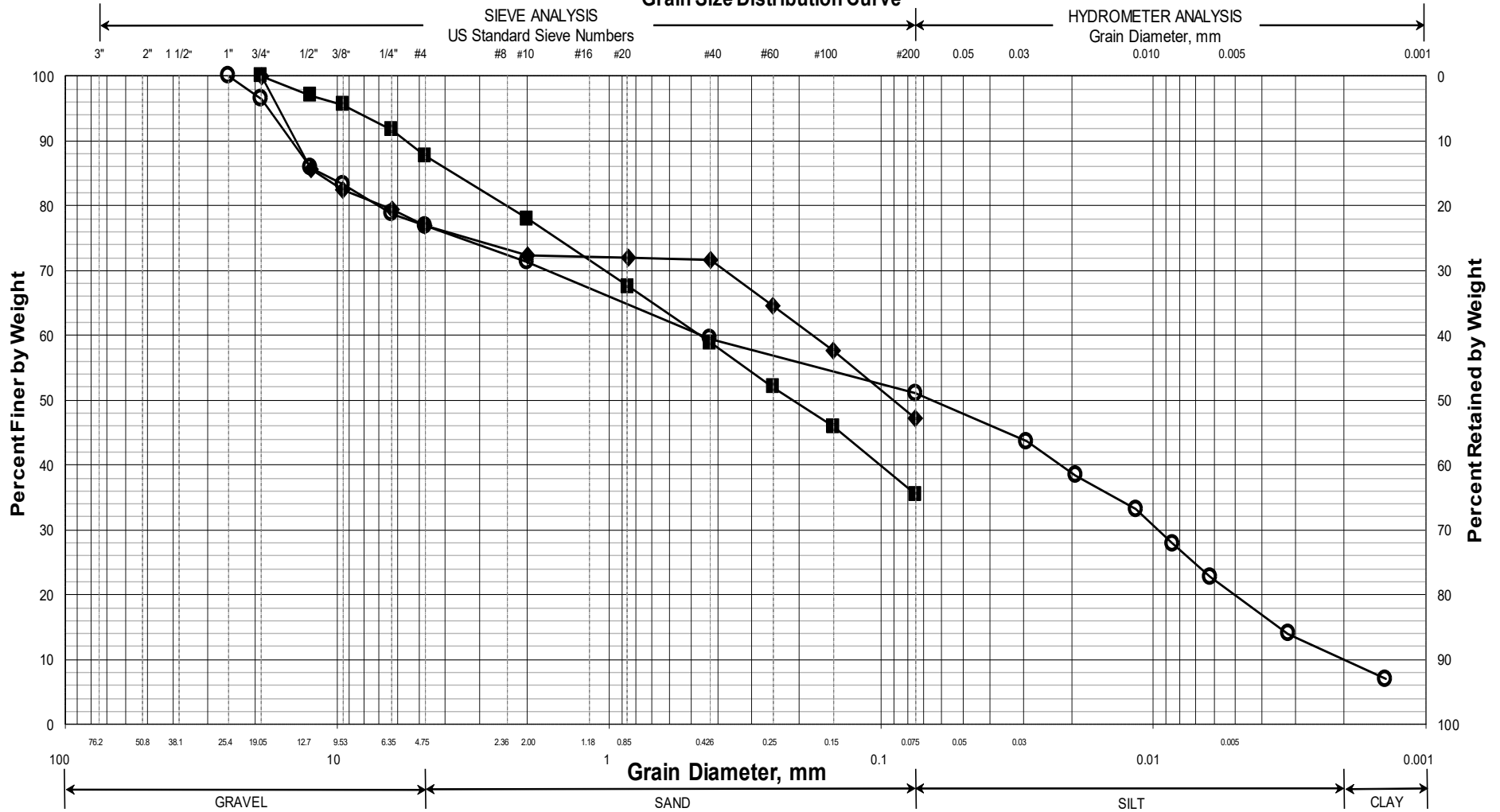


UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	BB-TRS-101/1D	9+9.7	6.5 LT	10.0-12.0	SILT, some sand, little clay, little gravel.	34.9			
◆	BB-TRS-102A/A1	9+18.9	8.7 RT	3.0-5.0	Gravelly SAND, trace silt.	7.7			
■	BB-TRS-102A/2D	9+18.9	8.7 RT	9.2-11.2	SAND, some silt, some gravel.	20.6			
●	BB-TRS-104/3D	9+46.3	6.7 RT	7.0-9.0	Gravelly SAND, little silt.	10.1			
▲									
X									

WIN
026089.00
Town
Trescott Twp
Reported by/Date
WHITE, TERRY A 12/4/2025

Maine Department of Transportation Grain Size Distribution Curve





GEOTECHNICAL TEST REPORT

Central Laboratory

SAMPLE INFORMATION

Reference No. **380922** Boring No./Sample No. **BB-TRS-201/3DA** Sample Description **GEOTECHNICAL (DISTURBED)** Sampled **12/9/2024** Received **12/13/2024**

Sample Type: **GEOTECHNICAL** Location: Station: **TBD** Offset, ft: Dbfg, ft: **9.5-10.5**

WIN/Town **026089.00 - TRECOTT TWP** Sampler: **NATHAN PUKAY**

TEST RESULTS

Sieve Analysis (T 88)

Wash Method

SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	100.0
¾ in. [19.0 mm]	96.5
½ in. [12.5 mm]	85.9
⅜ in. [9.5 mm]	83.3
¼ in. [6.3 mm]	78.8
No. 4 [4.75 mm]	76.9
No. 10 [2.00 mm]	71.3
No. 20 [0.850 mm]	
No. 40 [0.425 mm]	59.5
No. 60 [0.250 mm]	
No. 100 [0.150 mm]	
No. 200 [0.075 mm]	51.1
[0.0292 mm]	43.6
[0.0193 mm]	38.4
[0.0116 mm]	33.2
[0.0085 mm]	27.9
[0.0062 mm]	22.7
[0.0032 mm]	14.0
[0.0014 mm]	7.0

Miscellaneous Tests

Liquid Limit @ 25 blows (T 89), %	
Plastic Limit (T 90), %	
Plasticity Index (T 90), %	NP
Specific Gravity, Corrected to 20°C (T 100)	2.54
Loss on Ignition, % (T 267)	
Water Content (T 265), %	27.9

Consolidation (T 216)

Trimmings, Water Content, %					
	Initial	Final		Void Ratio	% Strain
Water Content, %			Pmin		
Dry Density, lbs/ft³			Pp		
Void Ratio			Pmax		
Saturation, %			Cc/C'c		

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth taken in tube, ft	3 In.		6 In.		Water Content, %	Description of Material Sampled at the Various Tube Depths
	U. Shear	Remold	U. Shear	Remold		
	tons/ft²	tons/ft²	tons/ft²	tons/ft²		

Comments:

AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE**

Date Reported: **1/6/2025**

Paper Copy: Lab File; Project File; Geotech File



GEOTECHNICAL TEST REPORT

Central Laboratory

SAMPLE INFORMATION

Reference No. **380923** Boring No./Sample No. **BB-TRS-202/3D** Sample Description **GEOTECHNICAL (DISTURBED)** Sampled **12/9/2024** Received **12/13/2024**

Sample Type: **GEOTECHNICAL** Location: Station: **TBD** Offset, ft: Dbfg, ft: **6.0-8.0**

WIN/Town **026089.00 - TRESCOTT TWP** Sampler: **NATHAN PUKAY**

TEST RESULTS

Sieve Analysis (T 27, T 11)

Wash Method

Procedure A

SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	100.0
½ in. [12.5 mm]	85.7
⅜ in. [9.5 mm]	82.5
¼ in. [6.3 mm]	79.5
No. 4 [4.75 mm]	77.0
No. 10 [2.00 mm]	72.3
No. 20 [0.850 mm]	72.0
No. 40 [0.425 mm]	71.6
No. 60 [0.250 mm]	64.5
No. 100 [0.150 mm]	57.6
No. 200 [0.075 mm]	47.3

Miscellaneous Tests

Liquid Limit @ 25 blows (T 89), %	
Plastic Limit (T 90), %	
Plasticity Index (T 90), %	NP
Specific Gravity, Corrected to 20°C (T 100)	
Loss on Ignition, % (T 267)	
Water Content (T 265), %	23.9

Consolidation (T 216)

Trimmings, Water Content, %					
	Initial	Final		Void Ratio	% Strain
Water Content, %			Pmin		
Dry Density, lbs/ft³			Pp		
Void Ratio			Pmax		
Saturation, %			Cc/C'c		

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth taken in tube, ft	3 In.		6 In.		Water Content, %	Description of Material Sampled at the Various Tube Depths
	U. Shear	Remold	U. Shear	Remold		
	tons/ft²	tons/ft²	tons/ft²	tons/ft²		

Comments:

Please prioritize Atterberg Limits. Insufficient material for Hydro, ran regular Gradation.

AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE**

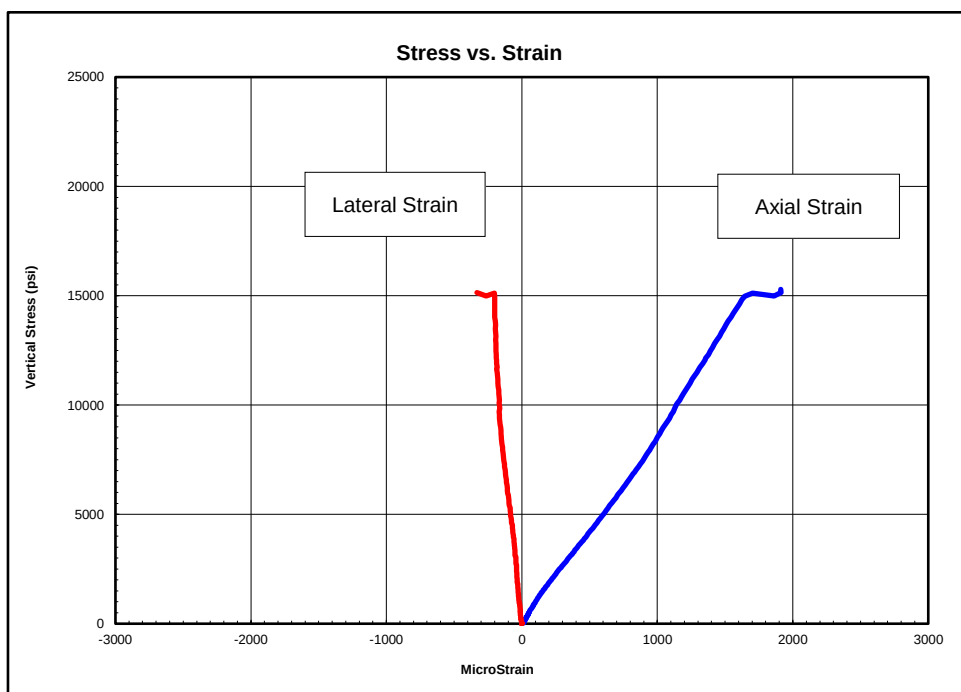
Date Reported: **1/6/2025**

Paper Copy: Lab File; Project File; Geotech File



Client:	Maine Department of Transportation
Project Name:	Rice Bridge #2714
Project Location:	Trescott Township, ME
GTX #:	320290
Test Date:	12/30/2024
Tested By:	gp
Checked By:	jsc
Boring ID:	BB-TRS-101
Sample ID:	R5
Depth, ft:	22.21-22.59
Sample Type:	rock core
Sample Description:	See photographs Intact material and discontinuity failure Best Effort end preparation performed

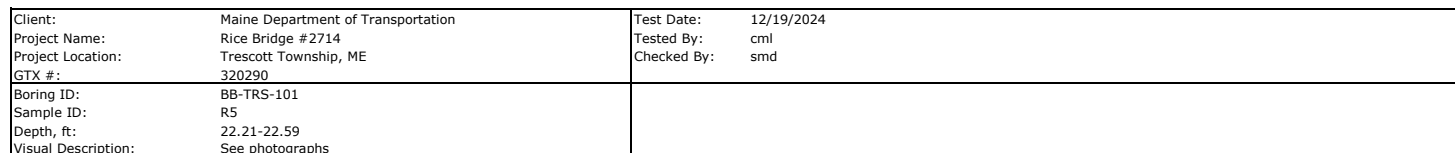
Compressive Strength and Elastic Moduli of Rock by ASTM D7012 - Method D



Peak Compressive Stress: 15,289 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
1500-5600	7,800,000	0.13
5600-9700	9,180,000	0.17
9700-13800	9,980,000	0.09

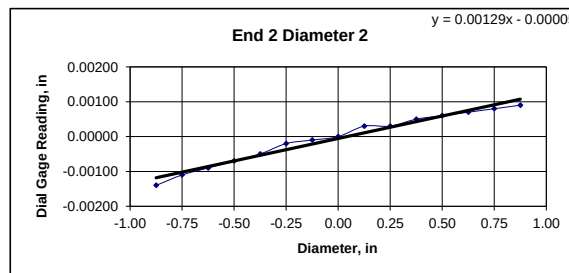
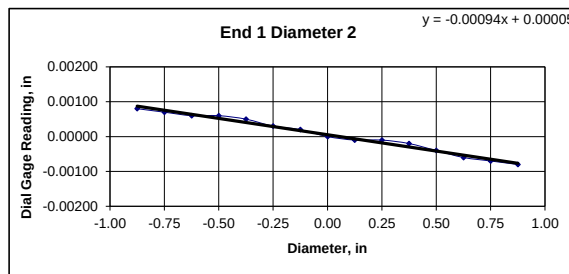
Notes: Test specimen tested at the approximate as-received moisture content and at standard laboratory temperature.
The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.
Young's Modulus and Poisson's Ratio calculated using the tangent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



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

BULK DENSITY				DEVIATION FROM STRAIGHTNESS (Procedure S1)			
	1	2	Average				
Specimen Length, in:	4.42	4.43	4.43	Maximum gap between side of core and reference surface plate:			
Specimen Diameter, in:	1.97	1.98	1.98	Is the maximum gap ≤ 0.02 in.? YES			
Specimen Mass, g:	595.56						
Bulk Density, lb/ft ³	167	Minimum Diameter Tolerance Met?	YES	<i>Maximum difference must be < 0.020 in.</i>			
Length to Diameter Ratio:	2.2	Length to Diameter Ratio Tolerance Met?	YES	Straightness Tolerance Met? YES			

END FLATNESS AND PARALLELISM (Procedure FP1)															
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00080	0.00080	0.00070	0.00050	0.00030	0.00030	0.00020	0.00000	0.00000	-0.00020	-0.00030	-0.00050	-0.00080	-0.00100	-0.00110
Diameter 2, in (rotated 90°)	0.00080	0.00070	0.00060	0.00060	0.00050	0.00030	0.00020	0.00000	-0.00010	-0.00010	-0.00020	-0.00040	-0.00060	-0.00070	-0.00080
Difference between max and min readings, in: 0° = 0.00190 90° = 0.00160															
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875
Diameter 1, in	0.00090	0.00090	0.00090	0.00070	0.00040	0.00030	0.00010	0.00000	0.00000	-0.00020	-0.00040	-0.00050	-0.00090	-0.00120	-0.00130
Diameter 2, in (rotated 90°)	-0.00140	-0.00110	-0.00090	-0.00070	-0.00050	-0.00020	-0.00010	0.00000	0.00030	0.00030	0.00050	0.00060	0.00070	0.00080	0.00090
Difference between max and min readings, in: 0° = 0.0022 90° = 0.0023 Maximum difference must be < 0.0020 in. Difference = ± 0.00115															
Flatness Tolerance Met? NO															



DIAMETER 1		
End 1:	Slope of Best Fit Line	0.00110
	Angle of Best Fit Line:	0.06319
End 2:	Slope of Best Fit Line	0.00129
	Angle of Best Fit Line:	0.07416
Maximum Angular Difference:		0.01097
Parallelism Tolerance Met?		NO
Spherically Seated		

DIAMETER 2		
End 1:	Slope of Best Fit Line	0.00094
	Angle of Best Fit Line:	0.05369
End 2:	Slope of Best Fit Line	0.00129
	Angle of Best Fit Line:	0.07383
Maximum Angular Difference:		0.02014
Parallelism Tolerance Met?		NO
Spherically Seated		

PERPENDICULARITY (Procedure P1)		(Calculated from End Flatness and Parallelism measurements above)			Perpendicularity Tolerance Met?	Maximum angle of departure must be $\leq 0.25^\circ$
END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°		
Diameter 1, in	0.00190	1.975	0.00096	0.055	YES	Perpendicularity Tolerance Met? YES
Diameter 2, in (rotated 90°)	0.00160	1.975	0.00081	0.046	YES	
END 2						
Diameter 1, in	0.00220	1.975	0.00111	0.064	YES	
Diameter 2, in (rotated 90°)	0.00230	1.975	0.00116	0.067	YES	



Client:	Maine Department of Transportation	Test Date:	12/19/2024
Project Name:	Rice Bridge #2714	Tested By:	cml
Project Location:	Trescott Township, ME	Checked By:	smd
GTX #:	320290		
Boring ID:	BB-TRS-101	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	R5		
Depth (ft):	22.21-22.59		
Visual Description:	See photographs		

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

END FLATNESS

END 1

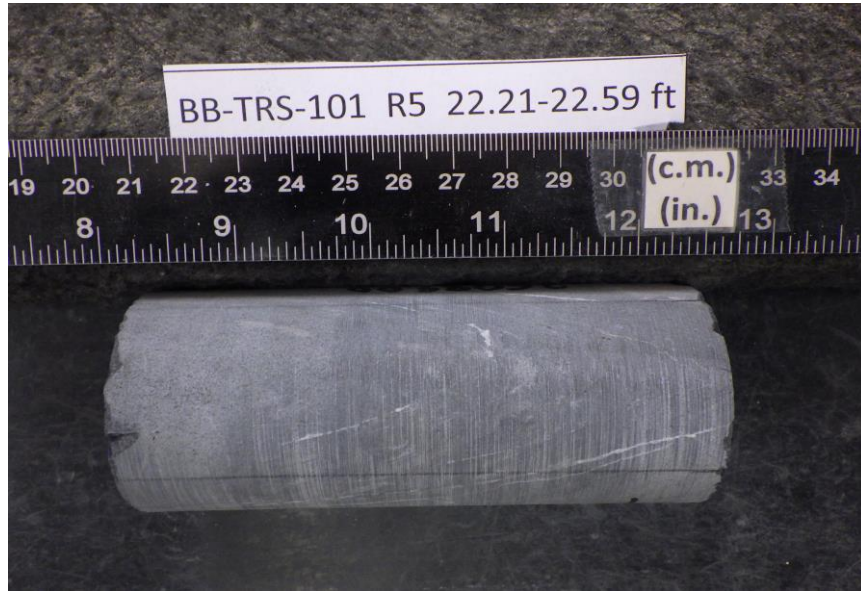
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES

END 2

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

End Flatness Tolerance Met? YES

Client:	Maine Department of Transportation
Project Name:	Rice Bridge #2714
Project Location:	Trescott Township, ME
GTX #:	320290
Test Date:	12/30/2024
Tested By:	gp
Checked By:	smd
Boring ID:	BB-TRS-101
Sample ID:	R5
Depth, ft:	22.21-22.59



After cutting and grinding

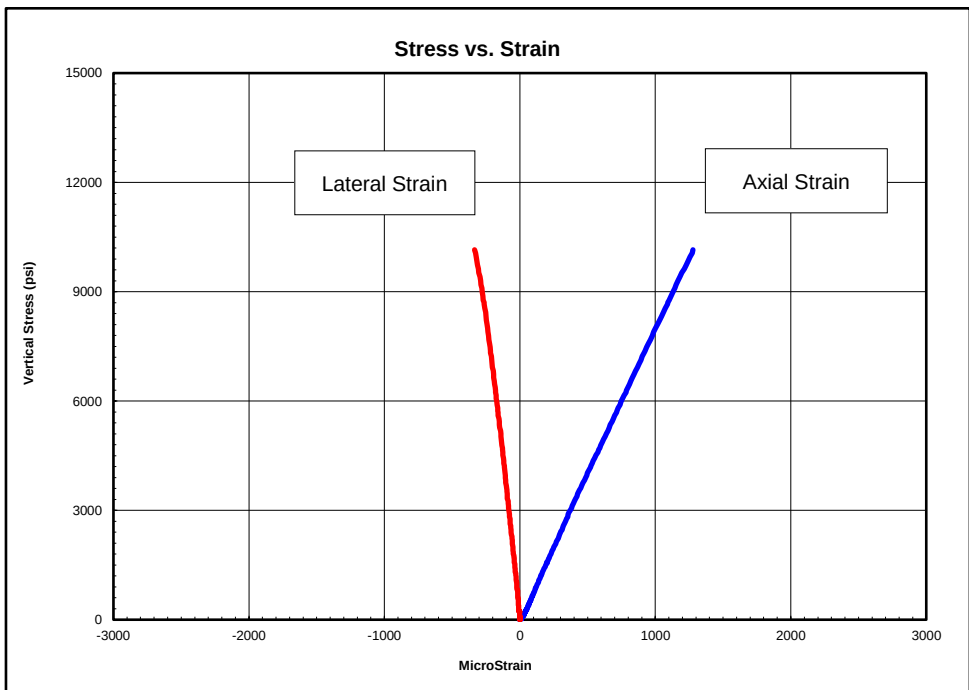


After break



Client:	Maine Department of Transportation
Project Name:	Rice Bridge #2714
Project Location:	Trescott Township, ME
GTX #:	320290
Test Date:	12/30/2024
Tested By:	gp
Checked By:	jsc
Boring ID:	BB-TRS-103
Sample ID:	R3
Depth, ft:	23.81-24.19
Sample Type:	rock core
Sample Description:	See photographs Intact material failure Best Effort end preparation performed

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



Peak Compressive Stress: 10,150 psi

Stress Range, psi	Young's Modulus, psi	Poisson's Ratio
1000-3700	8,290,000	0.24
3700-6400	7,900,000	0.24
6400-9100	7,880,000	0.28

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

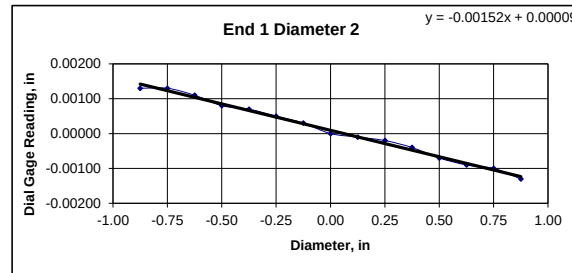
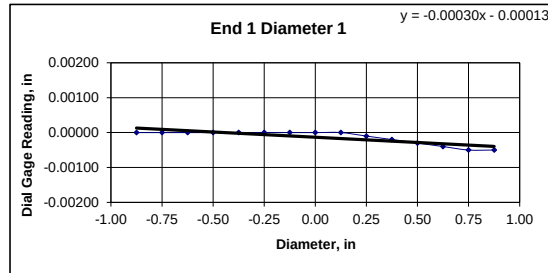


Client:	Maine Department of Transportation	Test Date:	12/19/2024
Project Name:	Rice Bridge #2714	Tested By:	cml
Project Location:	Trescott Township, ME	Checked By:	smd
GTx #:	320290		
Boring ID:	BB-TRS-103		
Sample ID:	R3		
Depth, ft:	23.81-24.19		
Visual Description:	See photographs		

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

BULK DENSITY				DEVIATION FROM STRAIGHTNESS (Procedure S1)	
	1	2	Average	Maximum gap between side of core and reference surface plate: Is the maximum gap ≤ 0.02 in.?	
Specimen Length, in:	4.37	4.37	4.37	YES	
Specimen Diameter, in:	1.97	1.97	1.97	Maximum difference must be < 0.020 in.	
Specimen Mass, g:	677.09			Straightness Tolerance Met?	
Bulk Density, lb/ft ³	193			YES	
Length to Diameter Ratio:	2.2				
		Minimum Diameter Tolerance Met?	YES		
		Length to Diameter Ratio Tolerance Met?	YES		

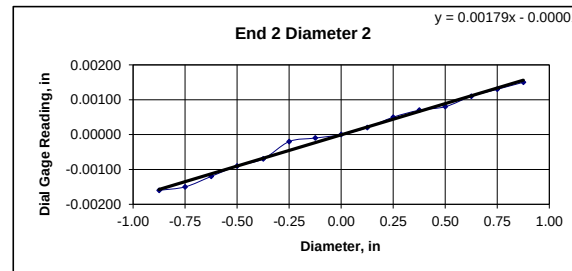
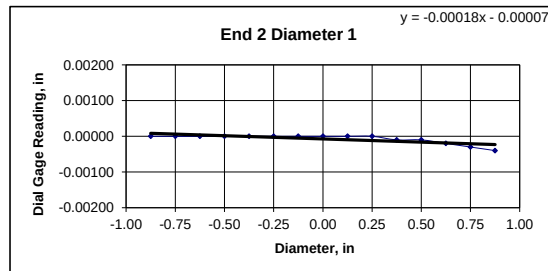
END FLATNESS AND PARALLELISM (Procedure FP1)													
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00020	-0.00030	-0.00040
Diameter 2, in (rotated 90°)	0.00130	0.00130	0.00110	0.00080	0.00070	0.00050	0.00030	0.00000	-0.00010	-0.00020	-0.00040	-0.00070	-0.00090
Difference between max and min readings, in:													
0° = 0.00050 90° = 0.00260													
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625
Diameter 1, in	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020
Diameter 2, in (rotated 90°)	-0.00160	-0.00150	-0.00120	-0.00090	-0.00070	-0.00020	-0.00010	0.00000	0.00020	0.00050	0.00070	0.00080	0.00110
Difference between max and min readings, in:													
0° = 0.0004 90° = 0.0031													
Maximum difference must be < 0.0020 in. Difference = ± 0.00155													
Flatness Tolerance Met? NO													



DIAMETER 1

End 1:	Slope of Best Fit Line	0.00030
	Angle of Best Fit Line:	0.01719
End 2:	Slope of Best Fit Line	0.00018
	Angle of Best Fit Line:	0.01031
Maximum Angular Difference:		0.00688

Parallelism Tolerance Met? NO
Spherically Seated



DIAMETER 2

End 1:	Slope of Best Fit Line	0.00152
	Angle of Best Fit Line:	0.08693
End 2:	Slope of Best Fit Line	0.00179
	Angle of Best Fit Line:	0.10264
Maximum Angular Difference:		0.01572

Parallelism Tolerance Met? NO
Spherically Seated

PERPENDICULARITY (Procedure P1)						(Calculated from End Flatness and Parallelism measurements above)	
END 1	Difference, Maximum and Minimum (in.)	Diameter (in.)	Slope	Angle°	Perpendicularity Tolerance Met?	Maximum angle of departure must be $\leq 0.25^\circ$	
Diameter 1, in	0.00050	1.970	0.00025	0.015	YES	Perpendicularity Tolerance Met?	
Diameter 2, in (rotated 90°)	0.00260	1.970	0.00132	0.076	YES	YES	
END 2							
Diameter 1, in	0.00040	1.970	0.00020	0.012	YES		
Diameter 2, in (rotated 90°)	0.00310	1.970	0.00157	0.090	YES		



Client:	Maine Department of Transportation	Test Date:	12/19/2024
Project Name:	Rice Bridge #2714	Tested By:	cml
Project Location:	Trescott Township, ME	Checked By:	smd
GTX #:	320290		
Boring ID:	BB-TRS-103	Reliable dial gauge measurements could not be performed on this rock type. Tolerance measurements were performed using a machinist straightedge and feeler gauges to ASTM specifications.	
Sample ID:	R3		
Depth (ft):	23.81-24.19		
Visual Description:	See photographs		

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

END FLATNESS

END 1

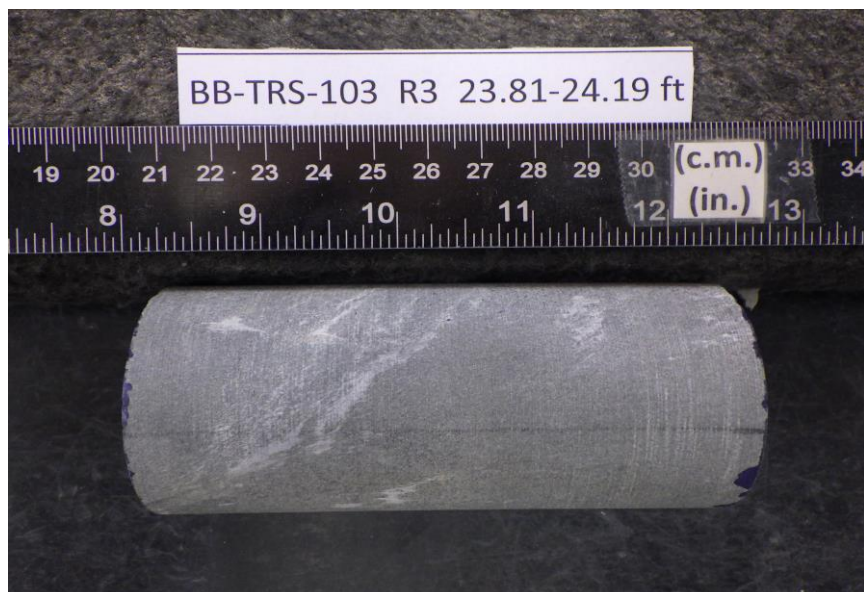
Diameter 1	Is the maximum gap $\leq \pm 0.001$ in.?	YES
Diameter 2 (rotated 90°)	Is the maximum gap $\leq \pm 0.001$ in.?	YES

END 2

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

End Flatness Tolerance Met? YES

Client:	Maine Department of Transportation
Project Name:	Rice Bridge #2714
Project Location:	Trescott Township, ME
GTX #:	320290
Test Date:	12/30/2024
Tested By:	gp
Checked By:	smd
Boring ID:	BB-TRS-103
Sample ID:	R3
Depth, ft:	23.81-24.19



After cutting and grinding



After break

Appendix D

Calculations

Earth Pressure

Earth Pressure

References

- 1) MaineDOT Bridge Design Guide (BDG), August 2003
- 2) AASHTO LRFD Bridge Design Specifications, 9th Edition, 2020

Backfill engineering strength parameters

Soil Type 4 Properties from BDG, Table 3-3 Material Classification

Unit weight	$\gamma := 125 \cdot \text{pcf}$
Internal friction angle	$\phi_f := 32 \cdot \text{deg}$
Cohesion	$c := 0 \cdot \text{psf}$

Backfill Angles

β = Angle of fill slope to the horizontal

North and South Stem Walls - Angle of fill slope is approximately level

$\beta_{\text{STEMWALL}} := 0 \text{deg}$	Stem Walls
---	------------

Flared Wingwalls - Backfill angles provided by design checker (MG). NPP verified the backfill angles in OpenRoads Designer.

$\beta_{\text{SEWW}} := 17.82 \text{deg}$	Southeast Wingwall
$\beta_{\text{SWWW}} := 19.46 \text{deg}$	Southwest Wingwall
$\beta_{\text{NEWW}} := 25.36 \text{deg}$	Northeast Wingwall
$\beta_{\text{NWWW}} := 16.56 \text{deg}$	Northwest Wingwall

Precast Frame Stem Walls and Headwalls Fixed to Frame

At Rest Earth Pressure - Rankine Theory

Formula for normally consolidated soils:

$$K_o := 1 - \sin(\phi_f) \quad \text{LRFD Eq. 3.11.5.2-1}$$

$$K_o = 0.47$$

Recommend at-rest earth pressure coefficient $K_o=0.47$ for stem walls and headwalls fixed to precast frame.

Flared Wingwalls

Note: LRFD C.3.11.5.3 states either Coulomb or Rankine wedge theory may be used for long heeled cantilever walls, and Coulomb wedge theory should be used for short heeled cantilever walls.

Active Earth Pressure - Rankine Theory

The earth pressure is applied to a plane extending vertically up from the heel of the wall base, and the weight of the soil on the inside of the vertical plane is considered as part of the wall weight. The failure sliding surface is not restricted by the top of the wall or back face of wall.

For cantilever walls with 2H:1V sloped backfill:

$$K_{aR}(\beta) := \cos(\beta) \frac{\cos(\beta) - \sqrt{\cos(\beta)^2 - \cos(\phi_f)^2}}{\cos(\beta) + \sqrt{\cos(\beta)^2 - \cos(\phi_f)^2}} \quad \text{BDG Section 3.6.5.2}$$

$$K_{aR}(\beta_{SEWW}) = 0.36 \quad \text{Southeast Wingwall - Long Heel}$$

$$K_{aR}(\beta_{SWWW}) = 0.37 \quad \text{Southwest Wingwall - Long Heel}$$

$$K_{aR}(\beta_{NEWW}) = 0.44 \quad \text{Northeast Wingwall - Long Heel}$$

$$K_{aR}(\beta_{NWWW}) = 0.35 \quad \text{Northwest Wingwall - Long Heel}$$

Note: Pa is oriented at an angle of β to the vertical plane per LRFD Fig. C3.11.5.3-1a.

Active Earth Pressure - Coulomb Theory

Angle of back face of wall to the horizontal, θ :

$$\theta := 90 \cdot \text{deg}$$

Friction angle between fill and wall:

$$\delta = 17 \text{ to } 22 \quad \text{LRFD Table 3.11.5.3-1 for Clean sand against concrete}$$

$$\text{Use } \delta := 19.5 \text{deg}$$

Check that friction angle is between recommended $\frac{\phi'_f}{3}$ and $\frac{2\phi'_f}{3}$ for Coulomb: LRFD Figure C3.11.5.3-1

$$\frac{\phi_f}{3} = 10.7 \cdot \text{deg} \quad \frac{2\phi_f}{3} = 21.3 \cdot \text{deg} \quad (\text{OK})$$

$$\Gamma(\beta) := \left(1 + \sqrt{\frac{\sin(\phi_f + \delta) \cdot \sin(\phi_f - \beta)}{\sin(\theta - \delta) \cdot \sin(\theta + \beta)}} \right)^2 \quad \text{AASHTO LRFD Eq. 3.11.5.3-2}$$

$$K_{aC}(\beta) := \frac{\sin(\theta + \phi_f)^2}{\Gamma(\beta) \cdot (\sin(\theta)^2 \cdot \sin(\theta - \delta))} \quad \text{AASHTO LRFD Eq. 3.11.5.3-1}$$

$$K_{aC}(\beta_{SEWW}) = 0.36$$

Southeast Wingwall - **Short or Long Heel**

$$K_{aC}(\beta_{SWWW}) = 0.37$$

Southwest Wingwall - **Short or Long Heel**

$$K_{aC}(\beta_{NEWW}) = 0.43$$

Northeast Wingwall - **Short or Long Heel**

$$K_{aC}(\beta_{NWWW}) = 0.35$$

Northwest Wingwall - **Short or Long Heel**

Note: P_a is oriented δ degrees up from a perpendicular line to the backface or 'pressure surface, as illustrated in LRFD Figure C3.11.5.3-1b.

Recommend the following active earth pressure coefficients:

$K_a = 0.36$	Southeast Wingwall - Short or Long Heel
$K_a = 0.37$	Southwest Wingwall - Short or Long Heel
$K_a = 0.44$	Northeast Wingwall - Short or Long Heel
$K_a = 0.35$	Northwest Wingwall - Short or Long Heel

3.4 Construction Loads

The construction live load to be used for constructibility checks is 50 psf applied over the entire deck area. Consideration should be given to slab placement sequence for calculation of maximum force effects.

3.5 Railroad Loads

Railroad bridges should be designed according to the latest American Railroad Engineering and Maintenance-of-Way Association specifications (AREMA, 2002), with the Cooper live loading as determined by the railroad company.

3.6 Earth Loads

3.6.1 General

Earth pressures considered for wall and substructure design must use the appropriate soil weight shown in Table 3-3.

Table 3-3 Material Classification

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

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

Figure 3-2 Calculating β with Broken Backfill Surface

Rankine theory, as described in Section 3.6.5.2, may also be used for the design of yielding walls, for a simplified analysis (at the Structural Designer's option). The use of Rankine theory will result in a slightly more conservative design.

3.6.5.2 Rankine Theory

Rankine theory should be used for long-heeled cantilever walls. Refer to AASHTO LRFD Figure C3.11.5.3-1 (a) for the definition of a long heeled cantilever wall. For simplicity (at the Structural Designer's option), Rankine theory may also be used to compute lateral earth pressures on any yielding wall listed in 3.6.5.1 Coulomb Theory, although its use will result in a slightly more conservative design.

For these cases, interface friction between the wall backface and the backfill is not considered. Rankine earth pressure is applied to a plane extending vertically from the heel of the wall base, as shown in Figure 3-3.

For a horizontal backfill surface where $\beta = 0^\circ$, the value of the coefficient of active earth pressure (Rankine), K_a , may be taken as:

$$K_a = \tan^2 \left(45^\circ - \frac{\phi}{2} \right)$$

where:

ϕ = angle of internal soil friction (degrees), taken from Table 3-3.

β = angle of backfill to the horizontal (degrees), as shown in Figure 3-3.

For a sloped backfill surface where $\beta > 0^\circ$, the coefficient of active earth pressure (Rankine), K_a , may be taken as:

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

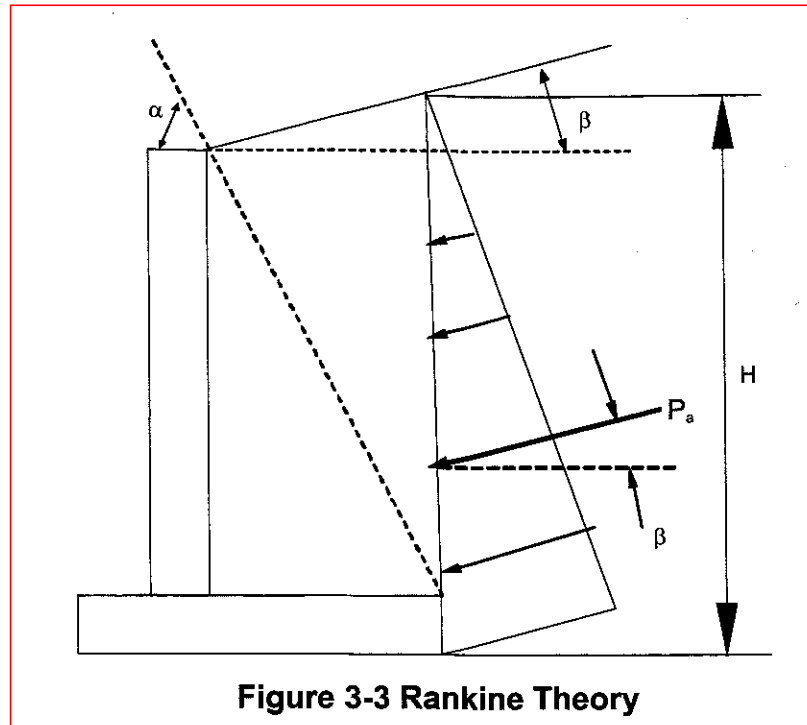


Figure 3-3 Rankine Theory

The resultant earth pressure force, P_a , is oriented at an angle, β , as shown in Figure 3-3. The resultant acts at a distance, $H/3$, from the base of the footing.

For situations with a broken backfill surface, the active earth pressure coefficient, K_a , may be determined using a β value adjusted per AASHTO LRFD Figures 3.11.5.8 -1 through 3, or substituted with β^* , as shown in Figure 3-2.

3.6.6 Coulomb Passive Lateral Earth Pressure Coefficient

Values of the coefficient of passive lateral earth pressure, K_p , may be taken from Figures 3.11.5.4-1 and 2 in AASHTO LRFD or using Coulomb theory, as shown below:

$$K_p = \frac{\sin(\alpha - \phi)^2}{\sin \alpha^2 \cdot \sin(\alpha + \delta) \cdot \left(1 - \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi + \beta)}{\sin(\alpha + \delta) \cdot \sin(\alpha + \beta)}} \right)^2}$$

where:

α = angle (degrees) of back of wall to the horizontal as shown in Figure 3-1.

ϕ = angle of internal soil friction (degrees), taken from Table 3-3.

Bearing Resistance

Conclusions and Recommendations

Strength Limit State

The recommended factored bearing resistance for the strength limit state is **20 ksf**, based on the computed bearing resistance for the North and South Stem Wall and Wingwall Footings.

20ksf

Strength Limit State

Extreme Limit State

The recommended factored bearing resistance for the extreme limit state is **36 ksf**, based on computed bearing resistance for the North and South Stem Wall and Wingwall Footings (Not applicable to foundations for buried structures including wingwalls).

36ksf

Extreme Limit State

Service Limit State

The recommended factored bearing resistance for the service limit state is **16 ksf**, based on the selected presumptive bearing resistance for the South Stem Wall and Wingwall Footings.

16ksf

Service Limit State

South Stem Wall and Wingwalls Spread Footings

Analysis

Calculation of nominal and factored bearing resistance of bedrock using Rock Mass Rating (RMR) based empirical correlation

Method

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

1. Estimation of Rock Mass Rating
2. Determine rock property constants s and m
3. Calculate nominal bearing resistance of bedrock, q_n , using RMR method in Wylie "Foundations on Rock"/AASHTO (2012) LRFD 10.4.6.4 - Rock Mass Strength

References

1. AASHTO LRFD Bridge Design Specifications, 6th Ed, 2012
2. AASHTO LRFD Bridge Design Specifications, 9th Ed, 2020
3. AASHTO Standard Specifications for Highway Bridges, 17th Ed. 2002
4. Wylie, Duncan C, "Foundations on Rock", Second Edition, 2009.
5. "The Hoek-Brown Failure Criterion - A 1988 Update", E. Hoek and E.T. Brown

A. Design Bedrock Properties

Model bedrock based on the rock encountered in borings BB-TRS-101 and BB-TRS-102A:

Bedrock Identification: Very fine to fine-grained, ARGILLITE, moderately hard, fresh. Very fine to fine-grained, SHALE and TUFF, moderately hard to hard, fresh was identified in lower core (R3) of BB-TRS-102A.

RQDs:

BB-TRS-101: 0-75%
BB-TRS-102A: 22-40%

Choose RQD = 25% for design.

Compressive Strength

Unconfined compressive strength (UCS) test results:

BB-TRS-101, R5 22.21-22.59' UCS = 15,289 psi $q := 15289 \text{ psi}$

Only one Argillite rock specimen tested, but failure mode was intact material and discontinuity failure. Use lab test UCS value for design:

$q := 15289 \text{ psi}$ $q = 2202 \cdot \text{ksf}$

Compressive strength is reasonable when compared with typical UCS of Argillite from Table 4.4.8.1.2B Typical Range of Uniaxial Compressive Strength as a Function of Rock Category and Rock Type, Ref. 3. Published values for UCS: 600-3,000 ksf (4200-21000 psi).

B. South Stem Wall and Wingwalls - Spread Footings

Determination of Rock Mass Rating (RMR) from LRFD (2012) Table 10.4.6.4-1 Geomechanics Classification of Rock Mass

Use RMR to supplement engineering judgment on rock competency according to LRFD 10.6.3.2.1. RMR is determined from the sum of five relative ratings listed in LRFD (2012) Table 10.4.6.4-1

1. Strength of intact rock

$q = 2202 \text{ ksf}$

From LRFD Table 10.4.6.4-1, Uniaxial compressive strength 2160 to 4320 ksf; **Relative Rating = 12**

2. Drill Core Quality

Design RQD = 25%; Reference section A above.

From LRFD Table 10.4.6.4-1, RQD 25% to 50%; **Relative Rating = 8**

3. Spacing of joints

The rock cores have joints that are typically very closely spaced (<2 in).

From LRFD Table 10.4.6.4-1; **Relative Rating = 5**

4. Condition of joints

Break surfaces are slightly rough and fresh. Joints are typically tight. Some rock flour observed on a fracture plane separating differing rock types in BB-TRS-102A, R3; **Relative Rating = 20**

5. Groundwater conditions

Water under moderate pressure; **Relative Rating = 4**

6. From LRFD Table 10.4.6.4-2 Geomechanics Rating Adjustment for Joint Orientations

Joints are typically steeply dipping (55-85 deg); **Relative Rating = -15**

ADJUSTED RMR

$$\text{RMR} := 12 + 8 + 5 + 20 + 4 - 15$$

$$\text{RMR} = 34$$

Determine Rock Type for LRFD Table 10.4.6.4-1

Metamorphic->Foliated->Slate (Closest rock type)

Geomechanics Rock Mass Class Determined from Total Rating

From AASHTO LRFD (2012) Table 10.4.6.4-3, RMR = 34 is Class No. IV and described as Poor rock.

C. Rock Property Constants s and m (Ref. 2 and Ref. 5)

$$\text{RMR} := 34$$

Direct calculation of m and s is required, Reference 5 (Hoek and Brown, 1988), Equations 18 and 19 and Table 1.

For a disturbed rock mass: $m/m_i = \exp((\text{RMR}-100)/14)$

$$s = \exp((\text{RMR}-100)/6)$$

$m_i = m$ for intact rock

For Argillite, $m_i = 7$ (LRFD 2020, Table 10.4.6.4-1):

$$m_i := 7$$

$$m := m_i \cdot \exp\left(\frac{\text{RMR} - 100}{14}\right) \quad \text{Equation 18, Ref. 5}$$

$$m = 0.063$$

$$s := \exp\left(\frac{\text{RMR} - 100}{6}\right) \quad \text{Equation 19, Ref. 5}$$

$$s = 0.0000167017$$

D. Nominal and Factored Bearing Resistance of Bedrock

Correction Factor for Foundation Shape, from Wyllie Table 5.4 Pg. 146 (Ref. 4)

$$C_{fl} := 1.0$$

Conservative selection of $C_{fl} = 1.0$ for $L/B > 6$

Nominal Bearing Resistance (Wyllie)

Reference 4: Wyllie "Foundations on Rock" Equation 5.4 Pg. 144

$$q_n := C_{fl} \cdot \sqrt{s} \cdot q \cdot \left[1 + \sqrt{m \cdot \left(\frac{-1}{s^2} \right) + 1} \right]$$

$$q_n = 45 \cdot \text{ksf}$$

Factored Bearing Resistance - Strength Limit State

Use a bearing resistance factor of 0.45 for Footings on Rock per LRFD Table 10.5.5.2.2-1

$$\phi_{b.strength} := 0.45$$

$$q_{r.strength} := q_n \cdot \phi_{b.strength}$$

$$q_{r.strength} = 20.4 \cdot \text{ksf}$$

Strength Limit State

Factored Bearing Resistance - Extreme Limit State

Use a bearing resistance factor of 0.80 LRFD 11.5.8 consistent with the design objective of no collapse.

$$\phi_{b.extreme} := 0.8$$

$$q_{r.extreme} := q_n \cdot \phi_{b.extreme}$$

$$q_{r.extreme} = 36 \cdot \text{ksf}$$

Extreme Limit State

Factored Bearing Resistance - Service Limit State

Reference LRFD (2020) Table C10.6.2.5.1-1 Presumptive Bearing Resistance for Spread Footings at the Service Limit State

Type of Bearing Material: Compaction shale or other highly argillaceous rock in sound condition.

Ordinary Range: 16-24 ksf

AASHTO Recommended Value of Use: 20 ksf

MaineDOT Recommended: 16 ksf

$$\phi_{b.service} := 1.0$$

$$q_{r.service} := 16 \text{ksf} \cdot \phi_{b.service}$$

$$q_{r.service} = 16 \cdot \text{ksf}$$

Service Limit State

Verify Nominal Bearing Resistance per Carter and Kulhawy (1988)

Reference : NCHRP, Report 651, LRFD Design and Construction of Shallow Foundations for Highway Bridge Structures, pg 40, Eq. 82b, and referred to in LRFD C.10.6.3.2.2. Same equation.

$$q_{n1} := q \cdot \left[\sqrt{s} + \sqrt{m \cdot (\sqrt{s}) + s} \right]$$

$$q_{n1} = 45 \cdot \text{ksf}$$

North Stem Wall and Wingwall Spread Footings

Analysis

Calculation of nominal and factored bearing resistance of bedrock using Rock Mass Rating (RMR) based empirical correlation

Method

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

1. Estimation of Rock Mass Rating
2. Determine rock property constants s and m
3. Calculate nominal bearing resistance of bedrock, q_n , using RMR method in Wylie "Foundations on Rock"/AASHTO (2012) LRFD 10.4.6.4 - Rock Mass Strength

References

1. AASHTO LRFD Bridge Design Specifications, 6th Ed, 2012
2. AASHTO LRFD Bridge Design Specifications, 9th Ed, 2020
3. AASHTO Standard Specifications for Highway Bridges, 17th Ed. 2002
4. Wylie, Duncan C, "Foundations on Rock", Second Edition, 2009.
5. "The Hoek-Brown Failure Criterion - A 1988 Update", E. Hoek and E.T. Brown

A. Design Bedrock Properties

Model bedrock based on the rock encountered in borings BB-TRS-103 and BB-TRS-104:

Bedrock Identification: Very fine to fine-grained, TUFF, moderately hard, fresh, competent.

RQDs:

BB-TRS-103: 0-90%

BB-TRS-104A: 78%

Choose RQD = 60% for design.

Compressive Strength

Unconfined compressive strength (UCS) test results:

BB-TRS-103, R3 23.81-24.19' UCS = 10,150 psi $q := 10150 \text{ psi}$

Only one Tuff rock specimen tested, and the failure mode was intact material failure. Conservatively reduce UCS for design:

$q := 8000 \text{ psi}$ $q = 1152 \cdot \text{ksf}$

LRFD Table 4.4.8.1.2B Typical Range of Uniaxial Compressive Strength as a Function of Rock Category and Rock Type, Ref. 3. Published values for UCS for Tuff - not listed.

B. North Stem Wall and Wingwalls - Spread Footings

Determination of Rock Mass Rating (RMR) from LRFD (2012) Table 10.4.6.4-1 Geomechanics Classification of Rock Mass

Use RMR to supplement engineering judgment on rock competency according to LRFD 10.6.3.2.1. RMR is determined from the sum of five relative ratings listed in LRFD (2012) Table 10.4.6.4-1

1. Strength of intact rock

$q = 1152 \text{ ksf}$

From LRFD Table 10.4.6.4-1, Uniaxial compressive strength 1080 to 2160 ksf; **Relative Rating = 7**

2. Drill Core Quality

Design RQD = 60%; Reference section A above.

From LRFD Table 10.4.6.4-1, RQD 50% to 75%; **Relative Rating = 13**

3. Spacing of joints

The rock cores have joints that are typically closely spaced (2-12 in).

From LRFD Table 10.4.6.4-1; **Relative Rating = 10**

4. Condition of joints

Break surfaces are slightly rough and fresh with no gouge. Joints are typically tight; **Relative Rating = 20**

5. Groundwater conditions

Water under moderate pressure; **Relative Rating = 4**

6. From LRFD Table 10.4.6.4-2 Geomechanics Rating Adjustment for Joint Orientations

Joints are moderately dipping (35-55 deg) to steeply dipping (55-85 deg); **Relative Rating = -15**

ADJUSTED RMR

$RMR := 7 + 13 + 10 + 20 + 4 - 15$

RMR = 39

Determine Rock Type for LRFD (2020) Table 10.4.6.4-1

Igneous->Volcanic->Pyroclastic->Tuff

Geomechanics Rock Mass Class Determined from Total Rating

From AASHTO LRFD (2012) Table 10.4.6.4-3, RMR = 47 is Class No. III and described as Poor rock.

C. Rock Property Constants s and m (Ref. 2 and Ref. 5)

$$\text{RMR} := 39$$

Direct calculation of m and s is required, Reference 5 (Hoek and Brown, 1988), Equations 18 and 19 and Table 1.

For a disturbed rock mass: $m/m_i = \exp((\text{RMR}-100)/14)$

$$s = \exp((\text{RMR}-100)/6)$$

$m_i = m$ for intact rock

For Tuff, $m_i = 13$ (LRFD 2020, Table 10.4.6.4-1):

$$m_i := 13$$

$$m := m_i \cdot \exp\left(\frac{\text{RMR} - 100}{14}\right) \quad \text{Equation 18, Ref. 3}$$

$$m = 0.167$$

$$s := \exp\left(\frac{\text{RMR} - 100}{6}\right) \quad \text{Equation 19, Ref. 3}$$

$$s = 0.0000384302$$

D. Nominal and Factored Bearing Resistance of Bedrock

Correction Factor for Foundation Shape, from Wyllie Table 5.4 Pg. 146 (Ref. 4)

$$C_{fl} := 1.0$$

Conservative selection of $C_{fl} = 1.0$ for $L/B > 6$

Nominal Bearing Resistance (Wyllie)

Reference 4: Wyllie "Foundations on Rock" Equation 5.4 Pg. 144

$$q_n := C_{fl} \cdot \sqrt{s} \cdot q \cdot \left[1 + \sqrt{m \cdot \left(\frac{-1}{s} \right) + 1} \right]$$

$$q_n = 45 \cdot \text{ksf}$$

Factored Bearing Resistance - Strength Limit State

Use a bearing resistance factor of 0.45 for Footings on Rock per LRFD Table 10.5.5.2.2-1

$$\phi_{b.\text{strength}} := 0.45$$

$$q_{r.\text{strength}} := q_n \cdot \phi_{b.\text{strength}}$$

$$q_{r.\text{strength}} = 20.2 \cdot \text{ksf}$$

Strength Limit State

Factored Bearing Resistance - Extreme Limit State

Use a bearing resistance factor of 0.80 LRFD 11.5.8 consistent with the design objective of no collapse.

$$\phi_{b.\text{extreme}} := 0.8$$

$$q_{r.\text{extreme}} := q_n \cdot \phi_{b.\text{extreme}}$$

$$q_{r.\text{extreme}} = 36 \cdot \text{ksf}$$

Extreme Limit State

Factored Bearing Resistance - Service Limit State

Reference LRFD (2020) Table C10.6.2.5.1-1 Presumptive Bearing Resistance for Spread Footings at the Service Limit State

Type of Bearing Material: Weathered or broken bedrock of any kind, except highly argillaceous rock.

Ordinary Range: 16-24 ksf

AASHTO Recommended Value of Use: 20 ksf

MaineDOT Recommended: 20 ksf

$$\phi_{b.\text{service}} := 1.0$$

$$q_{r.\text{service}} := 20 \text{ksf} \cdot \phi_{b.\text{service}}$$

$$q_{r.\text{service}} = 20 \cdot \text{ksf}$$

Service Limit State

Verify Nominal Bearing Resistance per Carter and Kulhawy (1988)

Reference : NCHRP, Report 651, LRFD Design and Construction of Shallow Foundations for Highway Bridge Structures, pg 40, Eq. 82b, and referred to in LRFD (2012) C.10.6.3.2.2. Same equation.

$$q_{n1} := q \cdot \left[\sqrt{s} + \sqrt{m \cdot (\sqrt{s}) + s} \right]$$

$$q_{n1} = 45 \cdot \text{ksf}$$

TABLE 4.4.8.1.2B Typical Range of Uniaxial Compressive Strength (C_o) as a Function of Rock Category and Rock Type

Rock Category	General Description	Rock Type	$C_o^{(1)}$	
			(ksf)	(psi)
A	Carbonate rocks with well-developed crystal cleavage	Dolostone	700- 6,500	4,800-45,000
		Limestone	500- 6,000	3,500-42,000
		Carbonatite	800- 1,500	5,500-10,000
		Marble	800- 5,000	5,500-35,000
		Tactite-Skarn	2,700- 7,000	19,000-49,000
B	Lithified argillaceous rock	Argillite	600- 3,000	4,200-21,000
		Claystone	30- 170	200- 1,200
		Marlstone	1,000- 4,000	7,600-28,000
		Phyllite	500- 5,000	3,500-35,000
		Siltstone	200- 2,500	1,400-17,000
		Shale ⁽²⁾	150- 740	1,000- 5,100
		Slate	3,000- 4,400	21,000-30,000
C	Arenaceous rocks with strong crystals and poor cleavage	Conglomerate	700- 4,600	4,800-32,000
		Sandstone	1,400- 3,600	9,700-25,000
		Quartzite	1,300- 8,000	9,000-55,000
D	Fine-grained igneous crystalline rock	Andesite	2,100- 3,800	14,000-26,000
		Diabase	450-12,000	3,100-83,000
E	Coarse-grained igneous and metamorphic crystalline rock	Amphibolite	2,500- 5,800	17,000-40,000
		Gabbro	2,600- 6,500	18,000-45,000
		Gneiss	500- 6,500	3,500-45,000
		Granite	300- 7,000	2,100-49,000
		Quartzdiorite	200- 2,100	1,400-14,000
		Quartzmonzonite	2,700- 3,300	19,000-23,000
		Schist	200- 3,000	1,400-21,000
		Syenite	3,800- 9,000	26,000-62,000

⁽¹⁾Range of Uniaxial Compressive Strength values reported by various investigations.⁽²⁾Not including oil shale.

$$\rho = q_o (1 - \nu^2) B I_p / E_m, \text{ with } I_p = (L/B)^{1/2} / \beta_z \quad (4.4.8.2.2-2)$$

Values of I_p may be computed using the β_z values presented in Table 4.4.7.2.2B from Article 4.4.7.2.2 for rigid footings. Values of Poisson's ratio (ν) for typical rock types are presented in Table 4.4.8.2.2A. Determination of the rock mass modulus (E_m) should be based on the results of in-situ and laboratory tests. Alternatively, values of E_m may be estimated by multiplying the intact rock modulus (E_o) obtained from uniaxial compression tests by a reduction factor (α_E) which accounts for frequency of discontinuities by the rock quality designation (RQD), using the following relationships (Gardner, 1987):

$$E_m = \alpha_E E_o \quad (4.4.8.2.2-3)$$

$$\alpha_E = 0.0231(RQD) - 1.32 \geq 0.15 \quad (4.4.8.2.2-4)$$

For preliminary design or when site-specific test data cannot be obtained, guidelines for estimating values of E_o (such as presented in Table 4.4.8.2.2B or Figure 4.4.8.2.2A) may be used. For preliminary analyses or for final design when in-situ test results are not available, a value of $\alpha_E = 0.15$ should be used to estimate E_m .

4.4.8.2.3 Tolerable Movement

Refer to Article 4.4.7.2.3.

4.4.9 Overall Stability

The overall stability of footings, slopes, and foundation soil or rock shall be evaluated for footings located on

Table 10.4.6.4-1—Geomechanics Classification of Rock Masses

Parameter			Ranges of Values						
1	Strength of intact rock material	Point load strength index	>175 ksf	85–175 ksf	45–85 ksf	20–45 ksf	For this low range, uniaxial compressive test is preferred		
		Uniaxial compressive strength	>4320 ksf	2160–4320 ksf	1080–2160 ksf	520–1080 ksf	215–520 ksf	70–215 ksf	20–70 ksf
	Relative Rating		15	12	7	4	2	1	0
2	Drill core quality RQD		90% to 100%	75% to 90%	50% to 75%	25% to 50%		<25%	
	Relative Rating		20	17	13	8		3	
3	Spacing of joints		>10 ft	3–10 ft	1–3 ft	2 in.–1 ft		<2 in.	
	Relative Rating		30	25	20	10		5	
4	Condition of joints		• Very rough surfaces • Not continuous • No separation • Hard joint wall rock	• Slightly rough surfaces • Separation <0.05 in. • Hard joint wall rock	• Slightly rough surfaces • Separation <0.05 in. • Soft joint wall rock	• Slicken-sided surfaces or • Gouge <0.2 in. thick or • Joints open 0.05–0.2 in. • Continuous joints	• Soft gouge >0.2 in. thick or • Joints open >0.2 in. • Continuous joints		
	Relative Rating		25	20	12	6		0	
5	Groundwater conditions (use one of the three evaluation criteria as appropriate to the method of exploration)	Inflow per 30 ft tunnel length	None	<400 gal./hr.	400–2000 gal./hr.		>2000 gal./hr.		
		Ratio = joint water pressure/ major principal stress	0	0.0–0.2	0.2–0.5		>0.5		
		General Conditions	Completely Dry	Moist only (interstitial water)	Water under moderate pressure		Severe water problems		
	Relative Rating		10	7	4		0		

Table 10.4.6.4-2—Geomechanics Rating Adjustment for Joint Orientations

Strike and Dip Orientations of Joints		Very Favorable	Favorable	Fair	Unfavorable	Very Unfavorable
Ratings	Tunnels	0	–2	–5	–10	–12
	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

The shear strength of fractured rock masses should be evaluated using the Hoek and Brown criteria, in which the shear strength is represented as a curved envelope that is a function of the uniaxial compressive strength of the intact rock, q_u , and two dimensionless constants m and s . The values of m and s as defined in Table 10.4.6.4-4 should be used.

The shear strength of the rock mass should be determined as:

$$\tau = (\cot \phi'_i - \cos \phi'_i) m \frac{q_u}{8} \quad (10.4.6.4-1)$$

in which:

$$\phi'_i = \tan^{-1} \left\{ 4h \cos^2 \left[30 + 0.33 \sin^{-1} \left(\frac{-3}{h^2} \right) \right] - 1 \right\}^{-\frac{1}{2}}$$

$$h = 1 + \frac{16(m\sigma'_n + sq_u)}{(3m^2q_u)}$$

where:

- τ = the shear strength of the rock mass (ksf)
- ϕ'_i = the instantaneous friction angle of the rock mass (degrees)
- q_u = average unconfined compressive strength of rock core (ksf)
- σ'_n = effective normal stress (ksf)
- m, s = constants from Table 10.4.6.4-4 (dim)

This method was developed by Hoek (1983) and Hoek and Brown (1988, 1997). Note that the instantaneous cohesion at a discrete value of normal stress can be taken as:

$$c_i = \tau - \sigma'_n \tan \phi'_i \quad (C10.4.6.4-1)$$

The instantaneous cohesion and instantaneous friction angle define a conventional linear Mohr envelope at the normal stress under consideration. For normal stresses significantly different than that used to compute the instantaneous values, the resulting shear strength will be unconservative. If there is considerable variation in the effective normal stress in the zone of concern, consideration should be given to subdividing the zone into areas where the normal stress is relative constant and assigning separate strength parameters to each zone. Alternatively, the methods of Hoek (1983) may be used to compute average values for the range of normal stresses expected.

Table 10.4.6.4-1—Geomechanics Classification of Rock Masses

Parameter			Ranges of Values						
1	Strength of intact rock material	Point load strength index	>175 ksf	85–175 ksf	45–85 ksf	20–45 ksf	For this low range, uniaxial compressive test is preferred		
		Uniaxial compressive strength	>4320 ksf	2160–4320 ksf	1080–2160 ksf	520–1080 ksf	215–520 ksf	70–215 ksf	20–70 ksf
	Relative Rating		15	12	7	4	2	1	0
2	Drill core quality RQD		90% to 100%	75% to 90%	50% to 75%	25% to 50%	<25%		
	Relative Rating		20	17	13	8	3		
3	Spacing of joints		>10 ft	3–10 ft	1–3 ft	2 in.–1 ft	<2 in.		
	Relative Rating		30	25	20	10	5		
4	Condition of joints		• Very rough surfaces • Not continuous • No separation • Hard joint wall rock	• Slightly rough surfaces • Separation <0.05 in. • Hard joint wall rock	• Slightly rough surfaces • Separation <0.05 in. • Soft joint wall rock	• Slicken-sided surfaces or • Gouge <0.2 in. thick or • Joints open 0.05–0.2 in. • Continuous joints	• Soft gouge >0.2 in. thick or • Joints open >0.2 in. • Continuous joints		
	Relative Rating		25	20	12	6	0		
5	Groundwater conditions (use one of the three evaluation criteria as appropriate to the method of exploration)	Inflow per 30 ft tunnel length	None	<400 gal./hr.	400–2000 gal./hr.	>2000 gal./hr.			
		Ratio = joint water pressure/ major principal stress	0	0.0–0.2	0.2–0.5	>0.5			
		General Conditions	Completely Dry	Moist only (interstitial water)	Water under moderate pressure	Severe water problems			
	Relative Rating		10	7	4	0			

Table 10.4.6.4-2—Geomechanics Rating Adjustment for Joint Orientations

Strike and Dip Orientations of Joints		Very Favorable	Favorable	Fair	Unfavorable	Very Unfavorable
Ratings	Tunnels	0	–2	–5	–10	–12
	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

The shear strength of fractured rock masses should be evaluated using the Hoek and Brown criteria, in which the shear strength is represented as a curved envelope that is a function of the uniaxial compressive strength of the intact rock, q_u , and two dimensionless constants m and s . The values of m and s as defined in Table 10.4.6.4-4 should be used.

The shear strength of the rock mass should be determined as:

$$\tau = (\cot \phi'_i - \cos \phi'_i) m \frac{q_u}{8} \quad (10.4.6.4-1)$$

in which:

$$\phi'_i = \tan^{-1} \left\{ 4h \cos^2 \left[30 + 0.33 \sin^{-1} \left(\frac{-3}{h^2} \right) \right] - 1 \right\}^{-\frac{1}{2}}$$

$$h = 1 + \frac{16(m\sigma'_n + sq_u)}{(3m^2q_u)}$$

where:

- τ = the shear strength of the rock mass (ksf)
- ϕ'_i = the instantaneous friction angle of the rock mass (degrees)
- q_u = average unconfined compressive strength of rock core (ksf)
- σ'_n = effective normal stress (ksf)
- m, s = constants from Table 10.4.6.4-4 (dim)

This method was developed by Hoek (1983) and Hoek and Brown (1988, 1997). Note that the instantaneous cohesion at a discrete value of normal stress can be taken as:

$$c_i = \tau - \sigma'_n \tan \phi'_i \quad (C10.4.6.4-1)$$

The instantaneous cohesion and instantaneous friction angle define a conventional linear Mohr envelope at the normal stress under consideration. For normal stresses significantly different than that used to compute the instantaneous values, the resulting shear strength will be unconservative. If there is considerable variation in the effective normal stress in the zone of concern, consideration should be given to subdividing the zone into areas where the normal stress is relative constant and assigning separate strength parameters to each zone. Alternatively, the methods of Hoek (1983) may be used to compute average values for the range of normal stresses expected.

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

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

Argillite

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

order to permit construction of the models. Consequently, our ability to predict the strength of jointed rock masses on the basis of direct tests or of model studies is severely limited.

In searching for a solution to this problem in order to provide a basis for the design of underground excavations in rock, Hoek and Brown (1980a) felt that some attempt had to be made to link the constants m and s of their criterion to measurements or observations which could be carried out by any competent geologist in the field. Recognizing that the characteristics of the rock mass which control its strength and deformation behaviour are similar to the characteristics which had been adopted by Bieniawski (1974) and by Barton, Lien and Lunde (1974) for their rock mass classifications, Hoek and Brown (1980a) proposed that these rock mass classifications could be used for estimating the material constants m and s .

Because of the lack of suitable methods for estimating the strength of rock masses, the first table relating rock mass classifications to material properties published by Hoek and Brown (1980a) was widely accepted by the geotechnical community and has been used on a large number of projects. Experience gained from these applications showed that the estimated rock mass strengths were reasonable when used for slope stability studies in which the rock mass is usually disturbed and loosened by relaxation due to excavation of the slope. However, the estimated rock mass strengths generally appeared to be too low in applications involving underground excavations where the confining stresses do not permit the same degree of loosening as would occur in a slope.

In order to incorporate the lessons learned from practical applications, Brown and Hoek (1988) proposed a revised set of relationships between the rock mass rating (RMR) from Bieniawski's (1974) rock mass classification and the constants m and s . Following Priest and Brown (1983), the relationships were presented in the form of the following equations:

Disturbed rock masses :

$$\frac{m}{m_i} = \exp \left(\frac{\text{RMR} - 100}{14} \right) \quad (18)$$

$$s = \exp \left(\frac{\text{RMR} - 100}{6} \right) \quad (19)$$

Undisturbed or interlocking rock masses:

$$\frac{m}{m_i} = \exp \left(\frac{\text{RMR} - 100}{28} \right) \quad (20)$$

$$s = \exp \left(\frac{\text{RMR} - 100}{9} \right) \quad (21)$$

where

m and s are the rock mass constants and m_i is the value of m for the *intact* rock.

Equations 18 to 21 have been used to construct Table 1 which shows the approximate relationship between rock mass quality and the Hoek-Brown material constants. Note that the value of the Tunnelling Quality Index Q from the NGI rock mass classification by Barton, Lien and Lunde (1974) has been calculated from the relationship proposed by Bieniawski (1976) :

$$\text{RMR} = 9 \log_e Q + 44 \quad (22)$$

Limitations on using failure criterion

Figure 1 illustrates a jointed rock mass in to which a tunnel has been mined. The circles adjacent to the right hand wall of the tunnel enclose different rock mass volumes and the comments on the right hand side of the drawing indicate situations to which the Hoek-Brown failure criterion can be applied.

When the volume of rock under consideration is small enough that it does not contain any structural discontinuities, equation 1 can be applied, using the m and s values for *intact* rock. This condition would apply to small scale specimens which has been extracted for laboratory testing or to the analysis of concentrated forces such as those which may be exerted by an individual pick on a tunnel boring machine cutter.

When the volume of rock being considered is such that only a few structural discontinuities are contained in this volume, the Hoek-Brown criterion should not be used. The behaviour of this rock is likely to be highly anisotropic and the Hoek-Brown failure criterion, which is only applicable to isotropic rock, will give erroneous results.

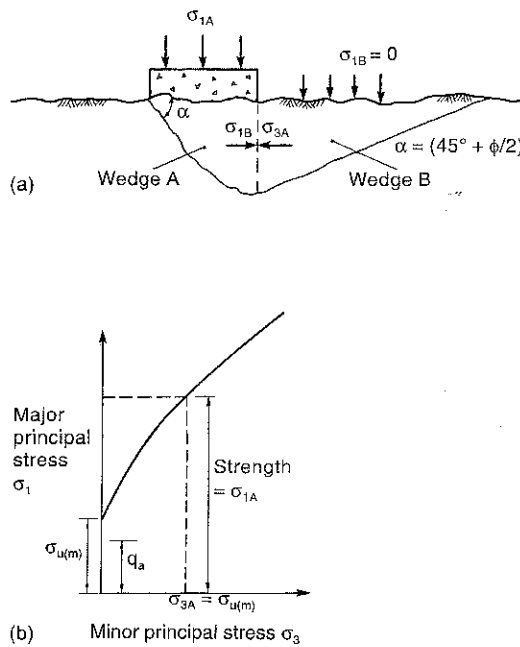


Figure 5.3 Analysis of bearing capacity of fractured rock: (a) active A and passive B wedges in foundation; and (b) curved rock mass strength envelope. Allowable bearing pressure = q_a , strength of bearing rock = σ_{1A} , factor of safety $FS = \sigma_{1A}/q_a$.

$$\sigma_1 = (m\sigma_{u(r)}(s\sigma_{u(r)}^2)^{1/2} + s\sigma_{u(r)}^2)^{1/2} + (s\sigma_{u(r)}^2)^{1/2} \\ = s^{1/2}\sigma_{u(r)}[1 + (ms^{-1/2} + 1)^{1/2}] \quad (5.3)$$

The plot in Fig. 5.3(b) shows the relationship between the strength σ_{1A} and the confining stresses provided by the surrounding rock σ_{3A} . This illustrates that a very significant increase in the bearing capacity is produced by a small increase in the confining pressure.

The allowable bearing pressure q_a is related to the rock mass strength by the factor of safety FS and the correction factor C_{f1} :

$$q_a = \frac{C_{f1}s^{1/2}\sigma_{u(r)}[1 + (ms^{-1/2} + 1)^{1/2}]}{FS} \quad (5.4)$$

The factor C_{f1} is applied to the calculated allowable bearing pressure to account for the shape of

the foundation and has the values given in Table 5.4 (Sowers, 1970).

A more comprehensive procedure for calculating the ultimate bearing capacity of fractured rock is described by Serrano and Olalla (1994) in which the rock mass strength is defined by the Hoek and Brown strength criteria as above. The method of analysis can accommodate recessed footings, inclined loads and foundations located on sloping ground surfaces.

For most loading conditions on sound rock the factor of safety will be in the range 2–3 for which there is little risk of settlement. A factor of safety of 3 is used for the dead load plus the maximum live load. If part of the live load is temporary such as wind and earthquake, then a factor of safety of 2 can be used (US Department of the Navy, 1982).

In the equations to calculate the allowable bearing capacity for a fractured rock mass with the strength defined by curved strength envelopes, it is important to distinguish between the compressive strength of the intact rock and that of the rock mass. The intact rock strength $\sigma_{u(r)}$ is determined from laboratory tests on rock cores, while for fractured rock the strength is defined by equation 5.1 with the degree of fracturing of the rock mass being accounted for by the constants m and s .

5.2.3 Recessed footings

In the case of a footing which is recessed into the rock surface, it is necessary to modify equation 5.4 to account for the increase in the stress σ_{1s} as a result of the confining stress q_s applied at the ground surface. That is, the minor principal stress

Table 5.4 Correction factors for foundation shapes (L = length, B = width)

Foundation shape	C_{f1}	C_{f2}
Strip ($L/B > 6$)	1.0	1.0
Rectangular		
$L/B = 2$	1.12	0.9
$L/B = 5$	1.05	0.95
Square	1.25	0.85
Circular	1.2	0.7

Table C10.6.2.5.1-1—Presumptive Bearing Resistance for Spread Footing Foundations at the Service Limit State Modified after U.S. Department of the Navy (1982)

Type of Bearing Material	Consistency in Place	Bearing Resistance (ksf)	
		Ordinary Range	Recommended Value of Use
Massive crystalline igneous and metamorphic rock: granite, diorite, basalt, gneiss, thoroughly cemented conglomerate (sound condition allows minor cracks)	Very hard, sound rock	120–200	160
Foliated metamorphic rock: slate, schist (sound condition allows minor cracks)	Hard sound rock	60–80	70
Sedimentary rock: hard cemented shales, siltstone, sandstone, limestone without cavities	Hard sound rock	30–50	40
Weathered or broken bedrock of any kind, except highly argillaceous rock (shale)	Medium hard rock	16–24	20
Compaction shale or other highly argillaceous rock in sound condition	Medium hard rock	16–24	20
Well-graded mixture of fine- and coarse-grained soil: glacial till, hardpan, boulder clay (GW-GC, GC, SC)	Very dense	16–24	20
Gravel, gravel-sand mixture, boulder-gravel mixtures (GW, GP, SW, SP)	Very dense	12–20	14
	Medium dense to dense	8–14	10
	Loose	4–12	6
Coarse to medium sand, and with little gravel (SW, SP)	Very dense	8–12	8
	Medium dense to dense	4–8	6
	Loose	2–6	3
Fine to medium sand, silty or clayey medium to coarse sand (SW, SM, SC)	Very dense	6–10	6
	Medium dense to dense	4–8	5
	Loose	2–4	3
Fine sand, silty or clayey medium to fine sand (SP, SM, SC)	Very dense	6–10	6
	Medium dense to dense	4–8	5
	Loose	2–4	3
Homogeneous inorganic clay, sandy or silty clay (CL, CH)	Very dense	6–12	8
	Medium dense to dense	2–6	4
	Loose	1–2	1
Inorganic silt, sandy or clayey silt, varved silt-clay-fine sand (ML, MH)	Very stiff to hard	4–8	6
	Medium stiff to stiff	2–6	3
	Soft	1–2	1

10.6.2.5.2—Semiempirical Procedures for Bearing Resistance

Bearing resistance on rock shall be determined using empirical correlation to the Geomechanic Rock Mass Rating System, RMR. Local experience should be considered in the use of these semi-empirical procedures.

If the recommended value of presumptive bearing resistance exceeds either the unconfined compressive strength of the rock or the nominal resistance of the concrete, the presumptive bearing resistance shall be taken as the lesser of the unconfined compressive strength of the rock or the nominal resistance of the concrete. The nominal resistance of concrete shall be taken as $0.3f'_c$.

Compressive Strength of Bedrock

Dowel Design - Compressive Strength of Bedrock

Analysis

Calculation of compressive strength of bedrock for dowel design using Rock Mass Rating (RMR) and Geological Strength Index (GSI)

References

1. AASHTO LRFD Bridge Design Specifications, 6th Ed, 2012
2. AASHTO LRFD Bridge Design Specifications, 9th Ed, 2020
3. "The Hoek-Brown Failure Criterion - A 1988 Update", E. Hoek and E.T. Brown
4. "Hoek-Brown Failure Criterion - 2002 Edition", E. Hoek, C. Carranza-Torres, B. Corkum

A. Design Bedrock Properties

Bedrock Identification:

South Stem Wall and Wingwalls Spread Footings: Very fine to fine-grained, ARGILLITE, moderately hard, fresh. Very fine to fine-grained SHALE and TUFF, moderately hard to hard, fresh was identified in lower core (R3) of BB-TRS-102A.

North Stem Wall and Wingwalls Spread Footings: Very fine to fine-grained, TUFF, moderately hard, fresh, competent.

The Argillite at the South Stem Wall and Wingwalls Spread Footings will be chosen for design purposes since it is the least competent bedrock at the site due to the spacing of joints.

Reference bearing resistance calculations. Design values have been reproduced below:

RQD = 25% Lowest design RQD based on bedrock at south stem wall and wingwalls spread footings

RMR := 34 Lowest RMR based on bedrock at south stem wall and wingwalls spread footings

$m_i := 7$ Lowest design intact rock constant based on bedrock at south stem wall and wingwall spread footings

$q := 15289 \text{ psi}$ $q = 2202 \cdot \text{ksf}$ Lab test UCS value - intact material and discontinuity failure

Geological Strength Index (GSI) and Disturbance Factor (D)

- Bedrock at the south stem wall and wingwalls spread footings will dictate.
- Bedrock surface condition is fair. Bedrock is fresh and smooth. Any weathered rock at the bearing surface will be removed.
- Bedrock structure is very blocky to blocky. Bedrock joint angles are steep to vertical, spaced close to very close. Loose bedrock at the bearing surface will be removed. Well interlocked, partially disturbed.
- Mechanical excavation will minimize disturbance

GSI := 50

D := 0

B. Hoek Brown 1988 UCS of Rock Mass (Ref. 3)

Disturbed Rock Mass

Rock Property Constants

Direct calculation of m and s is required, Reference 3 (Hoek and Brown, 1988), Equations 18 and 19

For a disturbed rock mass: $m/m_i = \exp((RMR-100)/14)$

$$s = \exp((RMR-100)/6)$$

$m_i = m$ for intact rock

$$m := m_i \cdot \exp\left(\frac{RMR - 100}{2}\right) \quad \text{Equation 18, Ref. 3}$$

$$m = 3.261 \times 10^{-14}$$

$$s := \exp\left(\frac{RMR - 100}{6}\right) \quad \text{Equation 19, Ref. 3}$$

$$s = 0.0000167017$$

Compressive Strength of Rock Mass

$$q_{\text{rockmass1}} := \sqrt{s} \cdot q \quad \text{Equation 2, Ref. 3}$$

$$q_{\text{rockmass1}} = 62 \cdot \text{psi}$$

Undisturbed Rock Mass

Rock Property Constants

Direct calculation of m and s is required, Reference 3 (Hoek and Brown, 1988), Equations 20 and 21

For an undisturbed rock mass: $m/m_i = \exp((RMR-100)/28)$

$$s = \exp((RMR-100)/9)$$

$m_i = m$ for intact rock

$$m := m_i \cdot \exp\left(\frac{RMR - 100}{28}\right) \quad \text{Equation 20, Ref. 3}$$

$$m = 0.663$$

$$s := \exp\left(\frac{\text{RMR} - 100}{9}\right)$$

Equation 21, Ref. 3

$$s = 0.000653392$$

Compressive Strength of Rock Mass

$$q_{\text{rockmass2}} := \sqrt{s} \cdot q$$

Equation 2, Ref. 3

$$q_{\text{rockmass2}} = 391 \cdot \text{psi}$$

C. Hoek Brown 2002 UCS of Rock Mass (Ref. 4)

Rock Property Constants

Direct calculation of s and a is required, Reference 4 (Hoek and Brown, 2002), Equations 4 and 5 and Table 1.

$$s := \exp\left(\frac{\text{GSI} - 100}{9 - 3D}\right)$$

Equation 4, Ref. 4

$$s = 0.004$$

$$a := \frac{1}{2} + \frac{1}{6} \left(\exp\left(\frac{-\text{GSI}}{15}\right) - \exp\left(\frac{-20}{3}\right) \right)$$

Equation 5, Ref. 4

$$a = 0.506$$

Compressive Strength of Rock Mass

$$q_{\text{rockmass3}} := q \cdot s^a$$

Equation 6, Ref. 4

$$q_{\text{rockmass3}} = 921 \cdot \text{psi}$$

Recommend compressive strength of rock mass $q=920$ psi

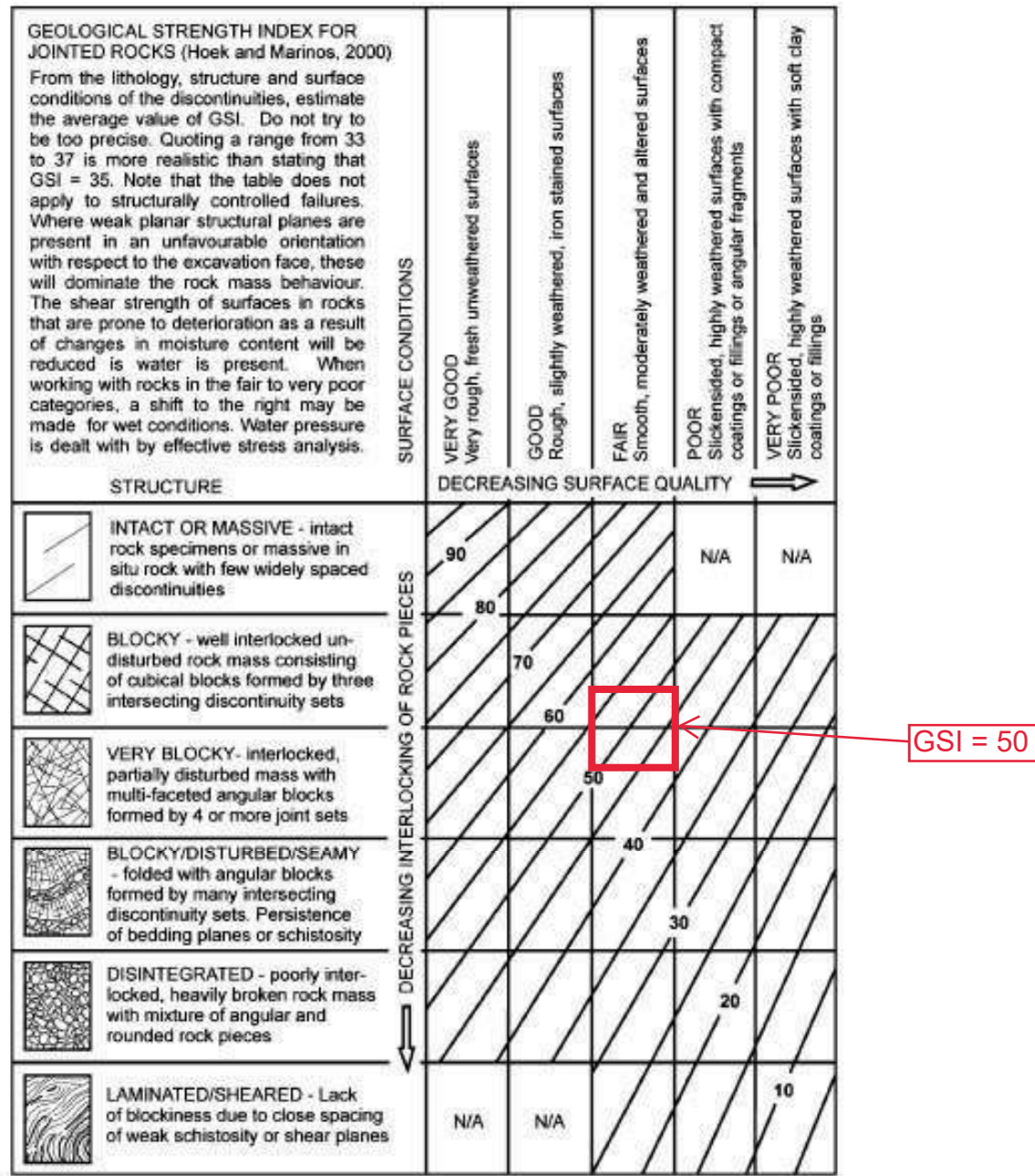


Figure 10.4.6.4-1—Determination of GSI for Jointed Rock Mass (Hoek and Marinos, 2000)

Table 1: Guidelines for estimating disturbance factor D

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

The Hoek-Brown Failure Criterion – a 1988 Update

E. HOEK

Department of Civil Engineering, University of Toronto, Toronto, Ontario

E.T. BROWN

Faculty of Engineering, University of Queensland, Brisbane, Australia

Abstract

The brittle failure criterion for rock, described by Hoek and Brown (1980 a,b) and Hoek (1983), is widely used for estimating the strength of jointed rock masses. Publications describing applications of the criterion and correspondence received by the authors suggests that there is confusion on some of the details of the criterion and upon its limitations. This paper gives a brief summary of the equations which define the failure criterion in terms of major and minor principal stresses and normal and shear stresses and then discusses approximate relationships between the constants m and s and the rock mass classification developed by Bieniawski (1974) for both disturbed and undisturbed rock masses. Limitations on the use of the criterion and guidance on the selection of the empirical constants are discussed in the final section of the paper.

Definition of failure criterion

The most detailed description of the Hoek-Brown failure criterion is contained in the Rankine lecture by Hoek (1983) and this will be taken as the reference upon which the up-dates presented in this paper are based.

The criterion was originally derived for applications in underground excavation design and it was therefore expressed in terms of the major and minor principal effective stresses acting upon an element of the rock mass. The basic equation defining the criterion is:

$$\sigma'_1 = \sigma'_3 + \sqrt{m\sigma_c\sigma'_3 + s\sigma_c^2} \quad (1)$$

where

σ'_1 is the major principal effective stress at failure

σ'_3 is the minor principal effective stress or confining pressure

m and s are material constants

σ_c is the uniaxial compressive strength of the intact rock.

Note that the uniaxial compressive strength of the intact rock refers to the strength which would be determined on a laboratory sized specimen (say a 50mm diameter by 100mm long core) which is free from discontinuities such as joints or bedding planes. This value is a measure of the contribution of the rock material to the overall strength of the rock mass. The uniaxial compressive strength of the rock mass is given by substituting $\sigma'_3 = 0$ into equation 1:

$$\sigma_{mass} = \sqrt{s} \sigma_c \quad (2)$$

Similarly, substituting $\sigma'_1 = 0$ into equation 1 and solving the resulting quadratic equation gives the uniaxial tensile strength of the rock or rock mass as:

$$\sigma_t = \frac{\sigma_c}{2} \left(m - \sqrt{m^2 + 4s} \right) \quad (3)$$

Although the original failure criterion was developed for use in underground excavation design, there has been considerable interest in applying it to the design of slopes in heavily jointed rock. This led to a number of attempts to derive a corresponding relationship between the normal and shear stresses at failure. A solution was obtained by Dr John Bray at Imperial College (reported by Hoek, 1983) and similar relationships were developed by Ucar (1986) and Londe (1988). While

order to permit construction of the models. Consequently, our ability to predict the strength of jointed rock masses on the basis of direct tests or of model studies is severely limited.

In searching for a solution to this problem in order to provide a basis for the design of underground excavations in rock, Hoek and Brown (1980a) felt that some attempt had to be made to link the constants m and s of their criterion to measurements or observations which could be carried out by any competent geologist in the field. Recognizing that the characteristics of the rock mass which control its strength and deformation behaviour are similar to the characteristics which had been adopted by Bieniawski (1974) and by Barton, Lien and Lunde (1974) for their rock mass classifications, Hoek and Brown (1980a) proposed that these rock mass classifications could be used for estimating the material constants m and s .

Because of the lack of suitable methods for estimating the strength of rock masses, the first table relating rock mass classifications to material properties published by Hoek and Brown (1980a) was widely accepted by the geotechnical community and has been used on a large number of projects. Experience gained from these applications showed that the estimated rock mass strengths were reasonable when used for slope stability studies in which the rock mass is usually disturbed and loosened by relaxation due to excavation of the slope. However, the estimated rock mass strengths generally appeared to be too low in applications involving underground excavations where the confining stresses do not permit the same degree of loosening as would occur in a slope.

In order to incorporate the lessons learned from practical applications, Brown and Hoek (1988) proposed a revised set of relationships between the rock mass rating (RMR) from Bieniawski's (1974) rock mass classification and the constants m and s . Following Priest and Brown (1983), the relationships were presented in the form of the following equations:

Disturbed rock masses :

$$\frac{m}{m_i} = \exp \left(\frac{\text{RMR} - 100}{14} \right) \quad (18)$$

$$s = \exp \left(\frac{\text{RMR} - 100}{6} \right) \quad (19)$$

Undisturbed or interlocking rock masses:

$$\frac{m}{m_i} = \exp \left(\frac{\text{RMR} - 100}{28} \right) \quad (20)$$

$$s = \exp \left(\frac{\text{RMR} - 100}{9} \right) \quad (21)$$

where

m and s are the rock mass constants and m_i is the value of m for the *intact* rock.

Equations 18 to 21 have been used to construct Table 1 which shows the approximate relationship between rock mass quality and the Hoek-Brown material constants. Note that the value of the Tunnelling Quality Index Q from the NGI rock mass classification by Barton, Lien and Lunde (1974) has been calculated from the relationship proposed by Bieniawski (1976) :

$$\text{RMR} = 9 \log_e Q + 44 \quad (22)$$

Limitations on using failure criterion

Figure 1 illustrates a jointed rock mass in to which a tunnel has been mined. The circles adjacent to the right hand wall of the tunnel enclose different rock mass volumes and the comments on the right hand side of the drawing indicate situations to which the Hoek-Brown failure criterion can be applied.

When the volume of rock under consideration is small enough that it does not contain any structural discontinuities, equation 1 can be applied, using the m and s values for *intact* rock. This condition would apply to small scale specimens which has been extracted for laboratory testing or to the analysis of concentrated forces such as those which may be exerted by an individual pick on a tunnel boring machine cutter.

When the volume of rock being considered is such that only a few structural discontinuities are contained in this volume, the Hoek-Brown criterion should not be used. The behaviour of this rock is likely to be highly anisotropic and the Hoek-Brown failure criterion, which is only applicable to isotropic rock, will give erroneous results.

Bray. Hoek [13] suggested that the cohesive strength determined by fitting a tangent to the curvilinear Mohr envelope is an upper bound value and may give optimistic results in stability calculations. Consequently, an average value, determined by fitting a linear Mohr-Coulomb relationship by least squares methods, may be more appropriate. In this paper Hoek also introduced the concept of the Generalized Hoek-Brown criterion in which the shape of the principal stress plot or the Mohr envelope could be adjusted by means of a variable coefficient a in place of the square root term in equation 1.

Hoek and Brown [14] attempted to consolidate all the previous enhancements into a comprehensive presentation of the failure criterion and they gave a number of worked examples to illustrate its practical application.

In addition to the changes in the equations, it was also recognised that the Rock Mass Rating of Bieniawski was no longer adequate as a vehicle for relating the failure criterion to geological observations in the field, particularly for very weak rock masses. This resulted in the introduction of the Geological Strength Index (GSI) by Hoek, Wood and Shah [7], Hoek [13] and Hoek, Kaiser and Bawden [15]. This index was subsequently extended for weak rock masses in a series of papers by Hoek, Marinos and Benissi [16], Hoek and Marinos [17, 18] and Marinos and Hoek [19].

The Geological Strength Index will not be discussed in the following text, which will concentrate on the sequence of calculations now proposed for the application of the Generalized Hoek Brown criterion to jointed rock masses.

2. GENERALIZED HOEK-BROWN CRITERION

This is expressed as

$$\sigma'_1 = \sigma'_3 + \sigma_{ci} \left(m_b \frac{\sigma'_3}{\sigma_{ci}} + s \right)^a \quad (2)$$

where m_b is a reduced value of the material constant m_i and is given by

$$m_b = m_i \exp \left(\frac{GSI - 100}{28 - 14D} \right) \quad (3)$$

s and a are constants for the rock mass given by the following relationships:

$$s = \exp \left(\frac{GSI - 100}{9 - 3D} \right) \quad (4)$$

$$a = \frac{1}{2} + \frac{1}{6} \left(e^{-GSI/15} - e^{-20/3} \right) \quad (5)$$

D is a factor which depends upon the degree of disturbance to which the rock mass has been subjected by blast damage and stress relaxation. It varies from 0 for undisturbed in situ rock masses to 1 for very disturbed rock masses. Guidelines for the selection of D are discussed in a later section.

The uniaxial compressive strength is obtained by setting $\sigma'_3 = 0$ in equation 2, giving:

$$\sigma_c = \sigma_{ci} \cdot s^a \quad (6)$$

and, the tensile strength is:

$$\sigma_t = -\frac{s \sigma_{ci}}{m_b} \quad (7)$$

Equation 7 is obtained by setting $\sigma'_1 = \sigma'_3 = \sigma_t$ in equation 2. This represents a condition of biaxial tension. Hoek [8] showed that, for brittle materials, the uniaxial tensile strength is equal to the biaxial tensile strength.

Note that the “switch” at $GSI = 25$ for the coefficients s and a (Hoek and Brown, [14]) has been eliminated in equations 4 and 5 which give smooth continuous transitions for the entire range of GSI values. The numerical values of a and s , given by these equations, are very close to those given by the previous equations and it is not necessary for readers to revisit and make corrections to old calculations.

Normal and shear stresses are related to principal stresses by the equations published by Balmer² [20].

$$\sigma'_n = \frac{\sigma'_1 + \sigma'_3}{2} - \frac{\sigma'_1 - \sigma'_3}{2} \cdot \frac{d\sigma'_1/d\sigma'_3 - 1}{d\sigma'_1/d\sigma'_3 + 1} \quad (8)$$

$$\tau = (\sigma'_1 - \sigma'_3) \frac{\sqrt{d\sigma'_1/d\sigma'_3}}{d\sigma'_1/d\sigma'_3 + 1} \quad (9)$$

where

$$d\sigma'_1/d\sigma'_3 = 1 + am_b \left(m_b \sigma'_3 / \sigma_{ci} + s \right)^{a-1} \quad (10)$$

3. MODULUS OF DEFORMATION

The rock mass modulus of deformation is given by:

² The original equations derived by Balmer contained errors that have been corrected in equations 8 and 9.

Frost Depth

Method 1 - MaineDOT Design Freezing Index (DFI) Map and Depth of Frost Penetration Table, BDG Section 5.2.1.

From Design Freezing Index Map: Trescott Township, Maine

DFI = 1100 degree-days.

Fine-Grained Fill w=25% (BB-TRS-101, 1D; BB-TRS-201, 4D; BB-TRS-202, 3D)

Coarse-Grained Fill w=10% (BB-TRS-102A, A1; BB-TRS-102A, 2D; BB-TRS-104, 3D; BB-TRS-202, 5D/A)

Fine-Grained Fill

For DFI = 1100, Fine-Grained Soil, w=20%

d=Depth of Frost Penetration

$$d_1 := 42.7\text{in} \quad w_1 := 20\%$$

For DFI = 1100, Fine-Grained Soil, w=30%

$$d_2 := 38.7\text{in} \quad w_2 := 30\%$$

Interpolate for DFI = 1100, Fine-Grained Soil, w=25%

$$w_3 := 25\%$$

$$d_{\text{fine}} := d_1 + (w_3 - w_1) \cdot \frac{(d_2 - d_1)}{(w_2 - w_1)}$$

$$d_{\text{fine}} = 40.7\text{in}$$

$$d_{\text{fine}} = 3.4\text{ft}$$

for Fine-Grained Fill

Coarse-Grained Fill

For DFI = 1100, Coarse-Grained Soil, w=10%

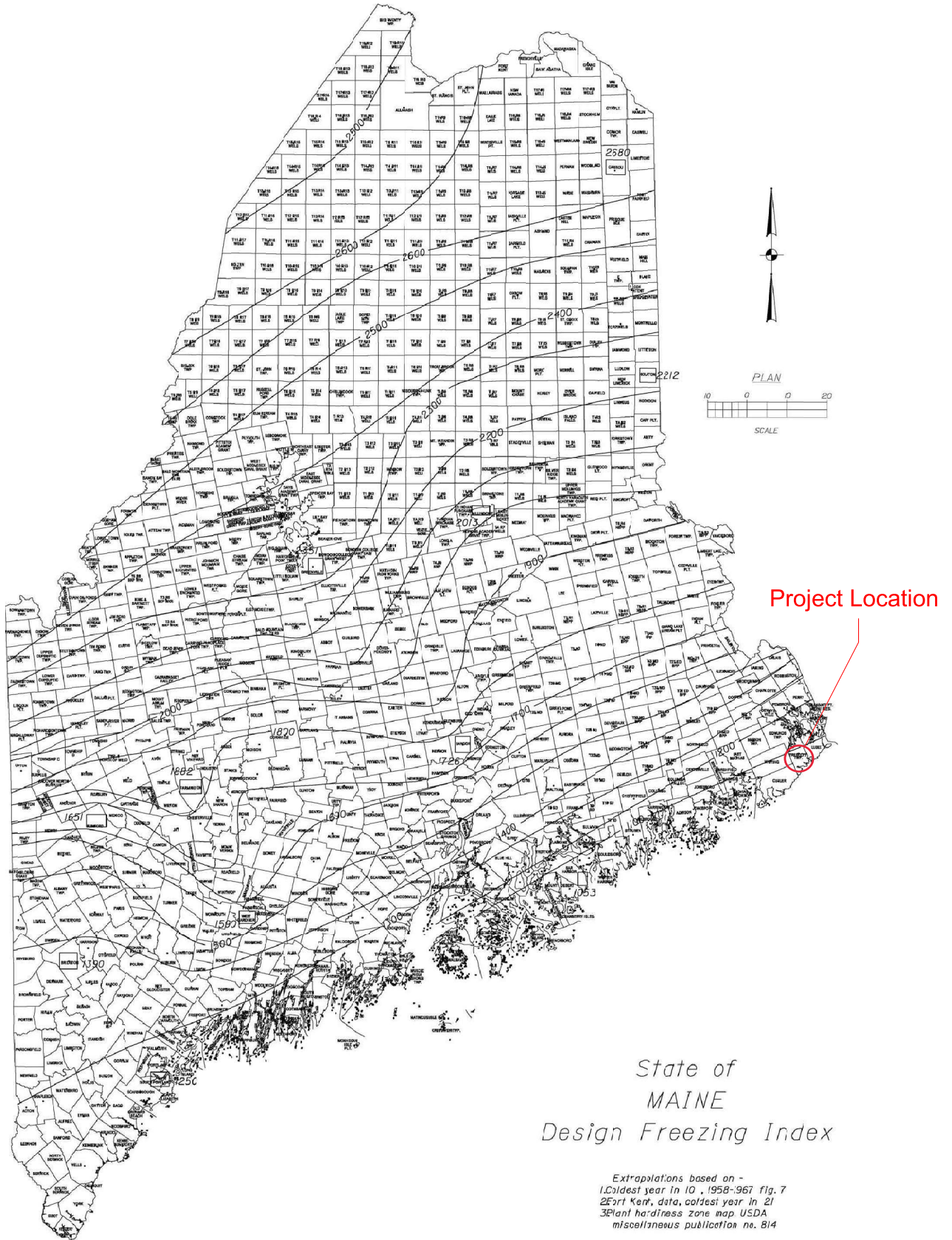
$$d_{\text{coarse}} := 69.8\text{in}$$

$$d_{\text{coarse}} = 5.8\text{ft}$$

for Coarse-Grained Fill

Recommend any foundation bearing on soils be embedded 5.8 feet for frost protection.

Figure 5-1 Maine Design Freezing Index Map



5.2 General

MaineDOT Bridge Design Guide

5.2.1 Frost

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

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

Table 5-1 Depth of Frost Penetration

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

Seismic Parameters

BB-TRS-101			
Depth	N ₆₀	di	di/N
5	79	9	0.11
10	8	5	0.63
14	100	86	0.86
SUM		100	1.60

di/di/N 62.54

BB-TRS-102A			
Depth	N ₆₀	di	di/N
5	18	7	0.39
7	34	2	0.06
9	10	3	0.30
12	100	88	0.88
SUM		100	1.63

di/di/N 61.44

BB-TRS-103			
Depth	N ₆₀	di	di/N
5	55	8	0.15
10	35	6	0.17
15	100	86	0.86
SUM		100	1.18

di/di/N 84.97

BB-TRS-104			
Depth	N ₆₀	di	di/N
1	87	3	0.03
5	29	4	0.14
7	35	5	0.14
12	100	88	0.88
SUM		100	1.20

di/di/N 83.66

BB-TRS-201			
Depth	N ₆₀	di	di/N
4	3	6	2.00
6	20	2	0.10
8	10	3	0.30
11	100	89	0.89
SUM		100	3.29

di/di/N 30.40

BB-TRS-202			
Depth	N ₆₀	di	di/N
2	22	4	0.18
4	43	2	0.05
6	6	2	0.33
8	24	2	0.08
10	100	90	0.90
SUM		100	1.54

di/di/N 64.73

SUM	Nav.	64.62
------------	-------------	--------------

Nav. > 50 bpf

Conclusion: Site Class C

Site Classification per LRFD Table C3.10.3.1-1 - Method B

Trescott Township, Rice Bridge #2714

WIN 26089.00

June 9, 2025

Abutment No. 1 and 2 Seismic Parameters

26089.00 Trescott Township - Rice Bridge #2714

Date and Time: 6/9/2025 11:15:34 AM

Conterminous 48 States

2007 AASHTO Bridge Design Guidelines

AASHTO Spectrum for 7% PE in 75 years

Latitude = 44.739722

Longitude = -067.123611

Site Class B

Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	
0.0	0.074	PGA - Site Class B
0.2	0.146	Ss - Site Class B
1.0	0.038	S1 - Site Class B

Conterminous 48 States

2007 AASHTO Bridge Design Guidelines

Spectral Response Accelerations SDs and SD1

Latitude = 44.739722

Longitude = -067.123611

As = FpgaPGA, SDs = FaSs, and SD1 = FvS1

Site Class C - Fpga = 1.20, Fa = 1.20, Fv = 1.70

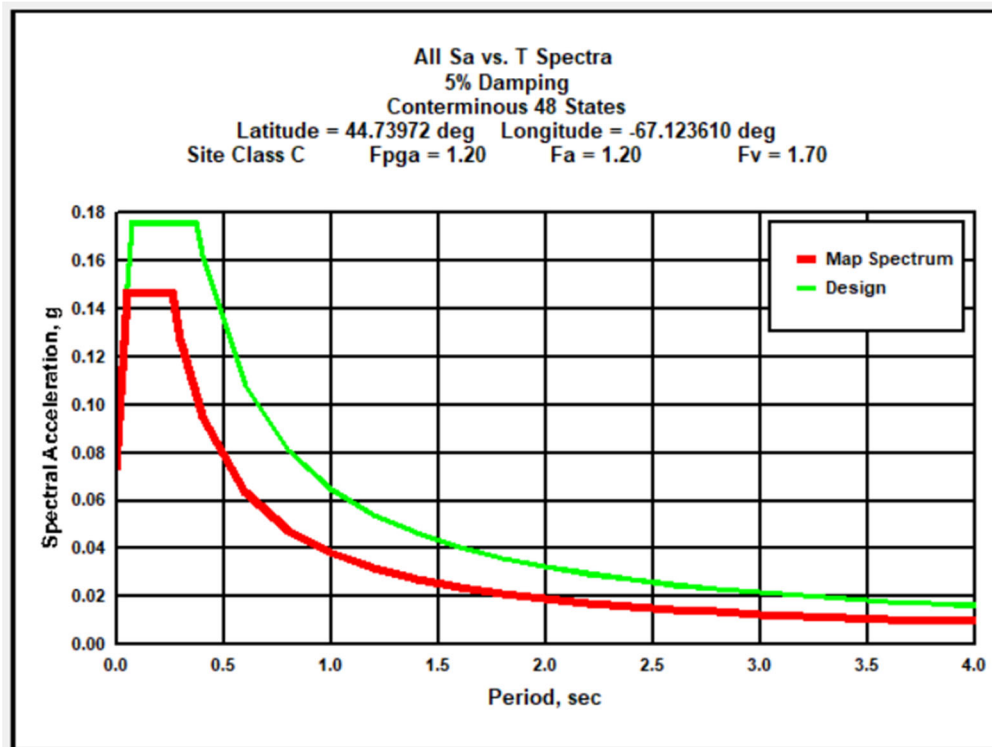
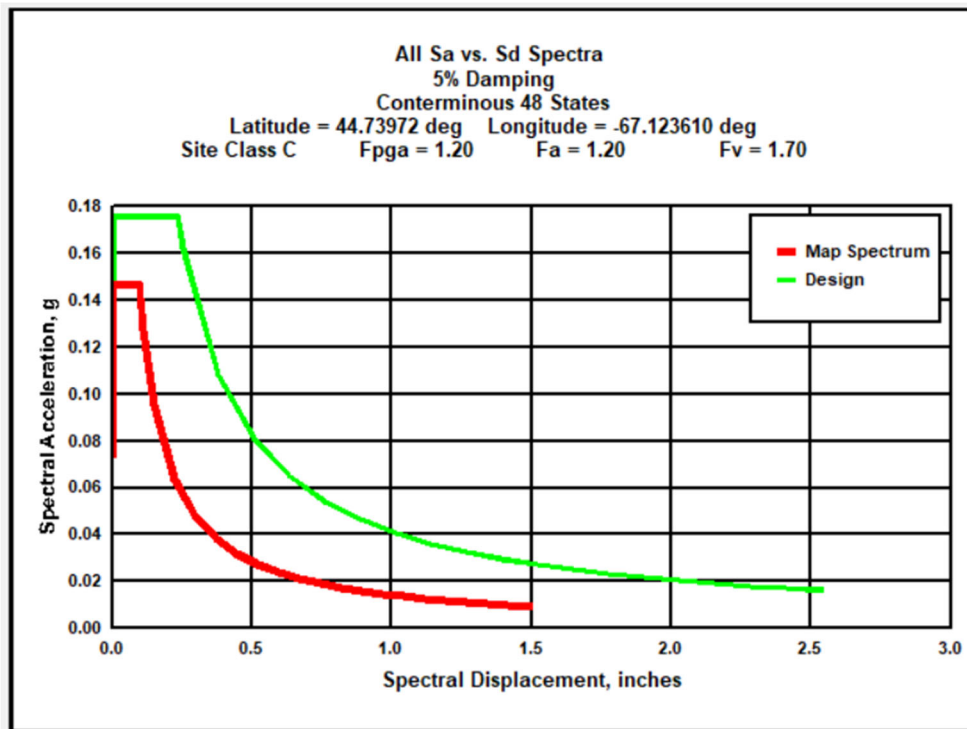
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	
0.0	0.089	As - Site Class C
0.2	0.176	SDs - Site Class C
1.0	0.065	SD1 - Site Class C

Trescott Township, Rice Bridge #2714

WIN 26089.00

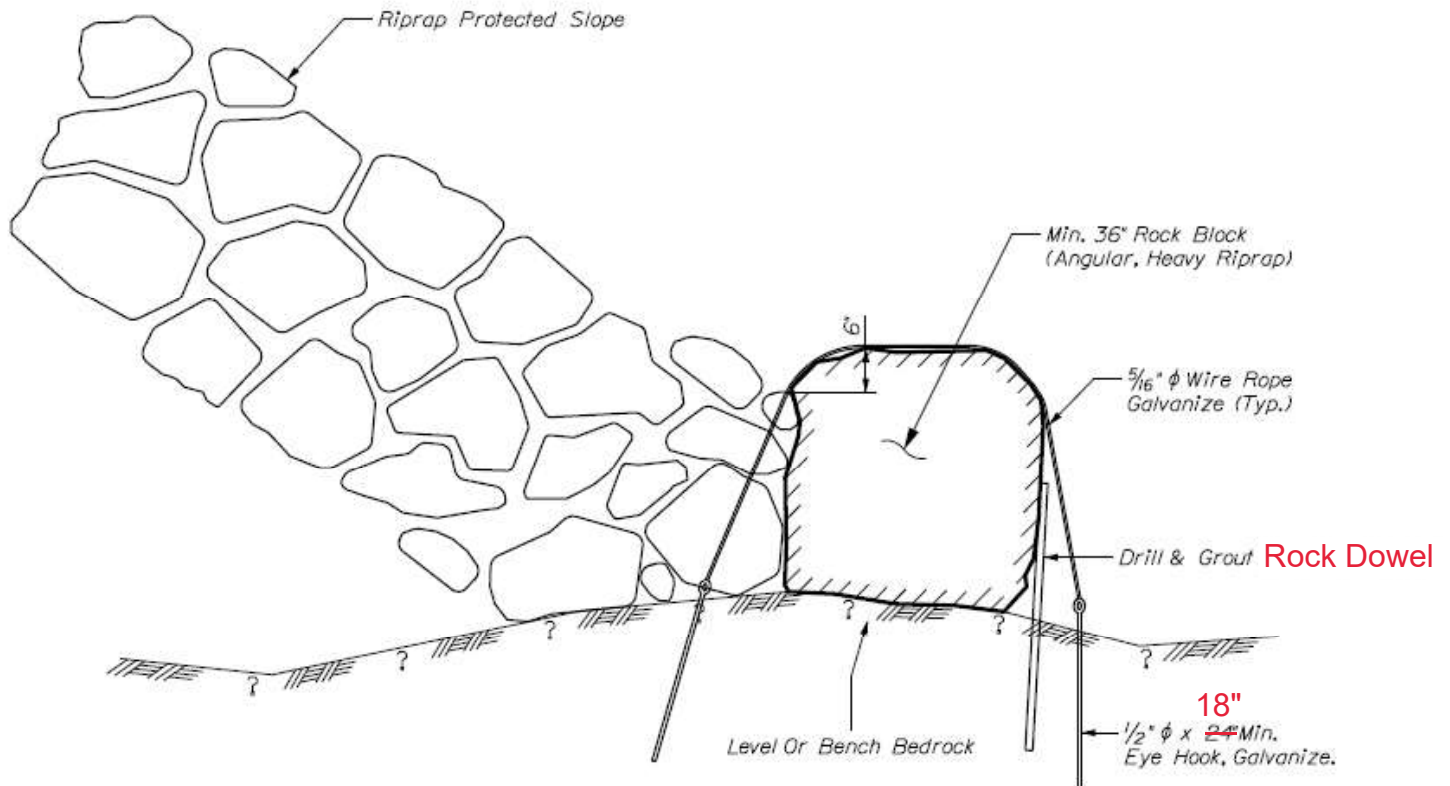
June 9, 2025



Appendix E

Rock Block Stabilization Detail and Special Provision

Rock Block Stabilization Detail



TOE BUTTRESS DETAIL

(To Be Constructed In Accordance With Special Provision 513)

SPECIAL PROVISION
SECTION 513
SLOPE PROTECTION

ROCK BLOCK STABILIZATION

513.01 DESCRIPTION. Add the following:

The work shall include furnishing and installing rock dowels, wire rope cable lashing and accessories at the locations shown on the Plans and in the Contract Documents, as directed by the Resident.

The purpose of the rock dowels and wire rope cable lashing are to stabilize the rock blocks installed as a buttress at the base of the riprap slopes that are designed to be steeper than 1.75 horizontal to 1 vertical (1.75H:1V) per the Contract Plans or if a toe trench cannot be installed according to the Standard Details.

513.02 MATERIALS. Add the following:

1. Rock Dowels - Rock dowels shall be made of ASTM A1035/ASTM A1035M, Type CS, Grade 100 low-carbon chromium steel, using #8 rebar. The rock dowels shall be a minimum of 3 feet in length.
2. Wire Rope Cable Lashing for Rock Block Stabilization - The wire rope cable lashing for rock block stabilization shall have a minimum rope diameter of 5/16 inches. The wire rope shall be 6x19 construction (or equivalent), IWRC and galvanized with a minimum breaking strength of 10,000 pounds. The rope shall be in accordance with Federal Specification RR-W-410, ASTM A1023/ A1023M including galvanizing.
3. Eye Hook Cable Anchors – Wire rope cable anchors shall consist of 1/2-inch diameter forged eye bolts, hot-dip galvanized according to ASTM A153/A153M. The anchor shall be capable of withstanding the same or greater breaking strength as the wire rope. The anchors shall be a minimum of 18 inches in length.
4. Miscellaneous Materials - All miscellaneous material associated with the wire rope cable lashing shall be hot dip galvanized and be supplied by the manufacturer. Wire rope clips shall be in accordance with Fed Spec FF-C-450, Type 1, Class 1 and hot-dip zinc galvanized according to ASTM A153/ A153M. Thimbles shall be in accordance with Fed Spec FF-T-276b and hot-dip zinc galvanized according to ASTM A153/ A153M.

Materials shall be suitably wrapped, packaged or covered at the factory or shop for protection against dirt, water, oil, grease, and rust contamination. Materials shall be protected against abrasion or damage during shipping and handling. Materials stored at or near the site shall be placed above ground on a well-supported, dry platform and covered with a water-resistant tarp or other covering.

513.03 EXECUTION. Add the following:

Wire Rope Cable Lashing - The wire rope cable lashing shall be installed over the center of each rock block installed as part of the riprap toe buttress. The wire rope is to be secured to the eye hook anchors installed on both sides of the rock block as shown in the Plans and in accordance with the manufacturer's recommendations and as directed by the Resident.

Eye Hook Cable Anchors – The eye hook cable anchors shall be installed to achieve a minimum 12-inch embedment into bedrock and 6-inch stickup. Epoxy or non-shrink grout may be used to install the anchors and shall be selected from MaineDOT Qualified Products Lists and installed according to manufacturer recommendations.

Rock Dowels – Rock dowels shall be installed in contact with the rock block as shown in the Plans. The rock dowels shall be installed to achieve a minimum 12-inch embedment and 24-inch stickup. Two rock dowels shall be installed at each rock block on either side of the cable lashing. The dowels shall be spaced to be centered between the cable lashing and the edge of the rock block. Epoxy or non-shrink grout may be used to install the rock dowels and shall be selected from MaineDOT Qualified Products Lists and installed according to manufacturer recommendations.

All damage to galvanized surfaces, threaded portions of all fittings and fasteners, and cut ends of wire rope, anchors, and fittings after assembly shall be repaired by thoroughly wire brushing the damaged area and painting it with two coats of zinc rich primer.

513.06 METHOD OF MEASUREMENT. Add the following:

Rock block stabilization will be measured as one lump sum, complete, in place, and accepted.

513.07 BASIS OF PAYMENT. Add the following:

Payment for rock block stabilization shall be made in accordance with Contract Pay Item 513.50 and shall include, but is not limited to, compensation for providing all rock blocks, materials, equipment, personnel, labor, tools, mobilization/demobilization

Trescott Township
Rice Bridge
WIN 026089.00
March 20, 2026

costs and incidental items necessary to complete the work.

PAY ITEMS

PAY UNIT

513.50	Rock Block Toe Buttress Stabilization	LS
--------	---------------------------------------	----