GEOTECHNICAL DESIGN REPORT

For the Replacement of:

VILLAGE BRIDGE
OVER KENDUSKEAG STREAM
KENDUSKEAG, MAINE

(LRFD Update of Soil Report No. 2005-19)

Prepared by:
Michael J. Moreau, P.E.
Geotechnical Design Engineer

Reviewed by:
Laura Krusinski, P.E.
Senior Geotechnical Engineer

Penobscot County
PIN 17576.00
Fed No. BR-1757(600)X
November 3, 2010
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOTECHNICAL DESIGN AND CONSTRUCTION SUMMARY</td>
<td>1</td>
</tr>
<tr>
<td>1.0 INTRODUCTION</td>
<td>4</td>
</tr>
<tr>
<td>2.0 GEOLOGIC SETTING</td>
<td>4</td>
</tr>
<tr>
<td>3.0 SUBSURFACE INVESTIGATION</td>
<td>5</td>
</tr>
<tr>
<td>4.0 LABORATORY TESTING</td>
<td>5</td>
</tr>
<tr>
<td>5.0 SUBSURFACE CONDITIONS</td>
<td>6</td>
</tr>
<tr>
<td>5.1 GRANULAR FILL</td>
<td>6</td>
</tr>
<tr>
<td>5.2 GLACIAL TILL</td>
<td>6</td>
</tr>
<tr>
<td>5.3 BEDROCK</td>
<td>7</td>
</tr>
<tr>
<td>5.4 GROUNDWATER</td>
<td>7</td>
</tr>
<tr>
<td>6.0 FOUNDATION ALTERNATIVES</td>
<td>7</td>
</tr>
<tr>
<td>7.0 EVALUATION AND RECOMMENDATIONS</td>
<td>8</td>
</tr>
<tr>
<td>7.1 SPREAD FOOTINGS ON BEDROCK</td>
<td>8</td>
</tr>
<tr>
<td>7.2 ABUTMENT AND WINGWALL DESIGN</td>
<td>8</td>
</tr>
<tr>
<td>7.3 FACTORED BEDROCK BEARING RESISTANCE</td>
<td>9</td>
</tr>
<tr>
<td>7.4 SETTLEMENT</td>
<td>10</td>
</tr>
<tr>
<td>7.5 FROST PROTECTION</td>
<td>10</td>
</tr>
<tr>
<td>7.6 SCOUR AND RIPRAP</td>
<td>10</td>
</tr>
<tr>
<td>7.7 SEISMIC DESIGN CONSIDERATIONS</td>
<td>11</td>
</tr>
<tr>
<td>7.8 CONSTRUCTION CONSIDERATIONS</td>
<td>11</td>
</tr>
<tr>
<td>7.8.1 Excavation</td>
<td>11</td>
</tr>
<tr>
<td>7.8.2 Blasting</td>
<td>12</td>
</tr>
<tr>
<td>7.8.3 Dewatering</td>
<td>12</td>
</tr>
<tr>
<td>7.8.4 Reuse of Excavated Soil and Bedrock</td>
<td>12</td>
</tr>
<tr>
<td>7.8.5 Embankment Areas Outside of Abutment/Wingwall Backfill Envelope</td>
<td>13</td>
</tr>
<tr>
<td>7.8.6 Erosion Control Recommendations</td>
<td>13</td>
</tr>
<tr>
<td>8.0 CLOSURE</td>
<td>13</td>
</tr>
</tbody>
</table>

References

Sheets
- Sheet 1 - Site Location Map
- Sheet 2 - Boring Location Plan and Interpretive Subsurface Profile
- Sheets 3 and 4 - Boring Log Sheets

Appendices
- Appendix A - Boring Logs
- Appendix B - Laboratory Test Data
- Appendix C - Calculations
GEOTECHNICAL DESIGN AND CONSTRUCTION SUMMARY

This report provides geotechnical recommendations for replacement of the Village Bridge over Kenduskeag Stream in Kenduskeag, Maine. The replacement structure will be a simply supported, single-span bridge with cantilever-type abutments on spread footings cast on bedrock or seals constructed on bedrock. The design and construction recommendations below are discussed in greater detail in Section 7.0 Evaluation and Recommendations.

This report is an update of Soil Report No. 2005-15 to address bridge design changes and AASHTO Load Resistance Factor Design requirements as referenced in AASHTO LRFD Bridge Design Specifications, 5th Edition, 2010, (herein referred to as LRFD). This report contains all of the subsurface information gathered for the original bridge design as well as additional subsurface information collected for the new bridge design.

Cantilever Abutments and Wingwalls – The abutments and wingwalls will be designed to resist all lateral earth loads, vehicular loads, superstructure loads, and any loads transferred through the superstructure. Abutments and wingwalls will be designed for all relevant strength, service and extreme limit states in accordance with LRFD.

The design of project abutments founded on spread footings at the strength limit state shall consider nominal bearing resistance, eccentricity (overturning), lateral sliding and structural failure. A sliding resistance factor, $\phi_s$, of 0.90 shall be applied to the nominal sliding resistance of abutments and wingwalls founded on spread footings on bedrock. A maximum frictional coefficient of 0.70 at the bedrock-concrete interface should be assumed. For footings on bedrock, the eccentricity of loading at the strength limit state, based on factored loads, shall not exceed three-eighths (3/8ths) of the footing dimensions, in either direction.

The bedrock at the site is highly fractured. Excavation of several feet of friable, weathered bedrock may be required and should be planned and accounted for on the estimated quantities sheet. The full extent of the rock excavation needed will not be known until the foundation excavation is made.

Earth loads shall be calculated using an active earth pressure coefficient, $K_a$, of 0.31 calculated using Rankine Theory for cantilever wingwalls. The designer may assume Soil Type 4 [Bridge Design Guide (BDG) Section 3.6.1] for backfill soil properties. The backfill properties are as follows: $\phi = 32$ degrees, $\gamma = 125$ pounds per cubic foot (pcf). Additional lateral earth pressure due to construction or live load surcharge is required for the abutments and wingwalls if an approach slab is not specified. If a structural approach slab is specified, some reduction of surcharge loads is permitted.

Factored Bedrock Bearing Resistance – The factored bearing resistance at the strength limit state for spread footings on bedrock should not exceed 15 kips per square foot (ksf). Based on presumptive bearing resistance values, a factored bearing resistance of 16 ksf may be used when analyzing the service limit state and for preliminary footing sizing, as allowed in LRFD C10.6.2.6.1. In no instance shall the service limit state bearing stress exceed the
nominal resistance of the footing concrete, which may be taken as $0.3f'_c$. The minimum footing size is 2 feet wide regardless of the applied bearing pressure or bearing material.

**Settlement** – Settlement of the bridge abutments due to elastic compression of the bedrock and any silt seams in the bedrock will be negligible and will occur during construction. Settlement of wall footings constructed on bedrock will be negligible. New approach fills and a grade rise of about 2½ feet are planned. Settlement beneath the new approaches will be negligible. Wall footings constructed on compacted fill soil may experience settlement on the order of ¼-inch or less. Differential settlements will also be on the order of ¼-inch or less. Most of the settlement will occur as the fill is placed and post-construction settlement will be negligible.

**Frost Protection** – Foundations placed on bedrock are not subject to heave by frost. Thus, there are no frost embedment requirements for project footings cast directly on sound bedrock. Retaining wall foundations placed on granular soils should be founded a minimum of 6.5 feet below finish exterior grade for frost protection. Riprap is not considered as contributing to the overall thickness of soils required for frost protection.

**Scour and Riprap** – Bridge approach slopes and slopes at wingwalls should be armored with 3 feet of riprap in accordance with the MaineDOT Bridge Design Guide (BDG) Section 2.3.11. The riprap section shall be underlain by Class A erosion control geotextile and a 1 foot thick layer of bedding material conforming to Standard Specification 703.19, Granular Borrow for Underwater Backfill, as shown in Standard Detail 610 (03) except where riprap is placed directly over exposed bedrock. Riprap shall meet the requirements of Section 703.26, Plain and Hand Laid Riprap. Riprap shall extend 1.5 feet horizontally in front of walls before sloping down at a maximum 1.75H:1V slope to the existing ground surface. The toe of riprap sections shall be constructed 1 foot below the streambed elevation.

**Seismic Design Considerations** – In accordance with LRFD 4.7.4.2, seismic analysis is not required for single-span bridges regardless of seismic zone. However, superstructure connections and bridge seat dimensions must satisfy LRFD Article 3.10.9 and 4.7.4.4, respectively.

**Construction Considerations** –

**Excavation**
- Construction of new abutment and retaining wall structures will require soil and loose/weathered bedrock excavation. Earth support systems may be required.
- Remove the old abutments in their entirety.
- Prepare bedrock subgrade for abutment footings by creating level benches or a completely level surface. Bedrock excavation may use conventional equipment, but may also require drilling and blasting methods. All loose bedrock fragments and soil debris should be removed from bearing surfaces and the surfaces washed with high pressure water and air before concrete or seal concrete is placed for the abutment foundations.

**Blasting**
- Where blasting is required, conduct pre and post-blast condition surveys, as well as, blast vibration monitoring at nearby residences and bridge structures in accordance with
MaineDOT Standard Specification 105.2.6, Use of Explosives and industry standards at the time of blast.

**Dewatering**
- Control groundwater and surface water infiltration to permit construction in-the-dry.
- Cofferdams, temporary ditches, pumping from sumps, granular drainage blankets, stone ditch protection, or hand-laid riprap with geotextile underlayment may be needed to divert surface water or groundwater if significant seepage is encountered during excavation.

**Reuse of Excavated Soil and Bedrock**
- Do not use excavated existing subbase aggregate for pavement structure construction or to re-base shoulders or for abutment and wall backfill soil. Excavated subbase sand and gravel may be used as fill below subgrade elevation in fill embankment areas.
- Do not use excavated existing fill or glacial till soils for fill anywhere beneath the pavement structure, dressing slopes, abutments or walls. Use these soils to dress slopes only below the bottom elevation of the shoulder subbase gravel.
- Glacial till or existing fill soils may be used as common borrow in accordance with MaineDOT Standard Specification Sections 203 and 703. It may be necessary to spread out and dry portions of these soils that are excessively moist.

**Embankment Fill Areas**
- Bench existing fill slope soils in accordance with MaineDOT Standard Specification 203.09, Preparation of Embankment Area, where new fill slope extensions are constructed over existing slopes.

**Erosion Control**
- Use MaineDOT Best Management Practices February 2008 to minimize erosion of fine-grained soils found on the project site.
1.0 INTRODUCTION

The Maine Department of Transportation (MaineDOT) plans to replace Village Bridge carrying Stetson Road over Kenduskeag Stream in the Town of Kenduskeag, Penobscot County, Maine. We show the project location on Sheet 1, Site Location Map, appended to this report. We conducted subsurface investigations at the bridge site to develop geotechnical recommendations for the structure replacement. This report summarizes our findings, discusses our evaluation of the subsurface conditions and presents our geotechnical recommendations for design and construction of the bridge foundations.

The existing bridge built in 1932 consists of a 110-foot long, single-span, steel truss with a 21-foot curb to curb width supported on concrete abutments. The east abutment is founded on a spread footing on gravel soil while the west abutment is founded on bedrock. Maintenance records indicate that the abutments were jacketed with concrete in 1991. At that time the remaining life of the abutments was expected to be approximately 15 years. Current plans call for the complete removal and replacement of the existing superstructure and substructure.

The bridge substructures have experienced severe deterioration and a substantial substructure concrete rehabilitation was constructed in 1991. At present, there has been some section loss in the substructure abutments and the deck has undergone significant cracking. The superstructure is narrow and has suffered collision damage from both truck traffic and high ice flows. As of the year 2010, the bridge sufficiency rating was 37.1.

Preliminary design studies by MaineDOT Bridge Program have identified cantilever-type abutments on spread footings to be the most practicable foundation type for this site. The spread footings will be founded directly on bedrock or seal concrete founded on bedrock. The proposed bridge will consist of a 114-foot, single span steel girder superstructure with a total width of 37 feet. The bridge will have 11-foot travel lanes, 5-foot shoulders, and a 5-foot wide sidewalk. The current bridge replacement plans include profile changes of up to approximately 3 feet higher than original grades at the center of the bridge and grading back down to original grade east and west of the bridge.

2.0 GEOLOGIC SETTING

The Village Bridge on Stetson Road in Kenduskeag crosses the Kenduskeag Stream approximately 2.5 miles east of the town line as shown on Sheet 1, Site Location Map, presented at the end of this report. Kenduskeag Stream flows in a southeasterly direction through Kenduskeag to Bangor and into the Penobscot River.

According to the “Surficial Geologic Map of Maine” published by the Maine Geological Survey (MGS) (1985), the surficial soils in the vicinity of the site consist of glaciomarine deposits. Glaciomarine deposits are generally comprised of silt, clay, sand and minor amounts of gravel. Sand is dominant in some areas, but may be underlain by finer-grained sediments. The unit contains small areas of till that are not completely covered by marine
sediiments. The unit is generally deposited in areas where the topography is gently sloping except where dissected by modern streams and commonly has a branching network of steep-walled stream gullies. These soils were generally deposited as glacial sediments that accumulated on the ocean floor during the late-glacial marine submergence of lowland areas in southern Maine.

According to the Bedrock Geologic Map of Maine, MGS, (1985), the bedrock at the Village Bridge site consists of Silurian-Ordovician age calcareous sandstone, interbedded sandstone and impure limestone of the Vassalboro Formation.

3.0 SUBSURFACE INVESTIGATION

MaineDOT investigated subsurface conditions at the site by drilling five test borings BB-KS-101, BB-KS-103, BB-KS-104, BB-KS-105, BB-KS-107, and two probes BP-KS-102 and BP-KS-106 in March 2005 and four test borings BB-KS-201 through BB-KS-204 in August 2010 to address the revised bridge design. The approximate boring locations are shown on Sheet 2, Boring Location Plan and Interpretive Subsurface Profile, found at the end of this report. All of the soil borings were terminated with bedrock cores and the probes were terminated on apparent bedrock. The only exception is boring BB-KS-107 which was drilled through existing Abutment No. 2 (east) in order to evaluate the condition of the abutment concrete. We present the details and sampling methods used, field data obtained, and soil and groundwater conditions encountered in the boring logs in Appendix A and on Sheet 3, Boring Logs, provided at the end of this report.

The MaineDOT geotechnical team member selected the boring locations and drilling methods, designated the type and depth of sampling techniques, and identified field and laboratory testing requirements. A MaineDOT Inspector certified under the Northeast Transportation Technician Certification Program logged the subsurface conditions encountered on the field logs in the March 2005 borings and a consultant inspector logged the August 2010 borings. The field crew tied down the boring locations by taping distances to adjacent site features. The boring locations were later picked up by MaineDOT survey.

The drill crew used solid stem auger and cased wash boring techniques to conduct the borings. Soil samples were obtained, where possible, at 5-foot intervals using Standard Penetration Test (SPT) methods. In the 200 series borings, the standard penetration resistances, or N-values, discussed in this report are corrected for average hammer energy transfer. We compute the corrected or, N_{60}-values, by applying an average hammer energy transfer factor of 0.84 to the raw field N-values obtained with the MaineDOT drill rig. Bedrock was cored using an NQ-2 core barrel producing a 2.0-inch diameter rock core.

4.0 LABORATORY TESTING

We conducted a laboratory soil testing program on selected samples recovered from the 100 series test borings to evaluate soil classification, material reuse, and subgrade soil properties. Laboratory testing consisted of 15 standard grain size analyses with natural water contents.
tests. We present results of laboratory testing in Appendix B, Laboratory Test Data. The AASHTO and Unified Soil Classification System (USCS) soil classifications and water content data are also presented on the boring logs in Appendix A.

5.0 SUBSURFACE CONDITIONS

The surficial geology map shows that the bridge site is located in an area of glaciomarine sediments which may include small units of glacial till. However, the bridge site is situated at the end of short fill extensions built across the Kenduskeag Stream flood plain. Consequently, the soil behind the abutments is predominantly granular fill and cobbles overlying a thin veneer of glacial till. Only at BB-KS-101 and BB-KS-203 did we observe a glacial till layer of significance which was approximately 4 and 3 feet thick, respectively. We found that the glacial till overlies bedrock. All of the boring locations are underlain by phyllite bedrock. We provide an interpretive subsurface profile depicting the site stratigraphy on Sheet 2, Boring Location Plan and Interpretive Subsurface Profile, found at the end of this report. A summary description of the subsurface conditions follows:

5.1 Granular Fill

We encountered granular fill to a depth ranging between approximately 10.8 and 16.7 feet below ground surface (bgs). The granular fill generally consists of fine to coarse sand, with some gravel to gravelly and trace to some silt. We observed one instance of fill consisting of organic silt with wood just above bedrock in BB-KS-204. Drill attitude also indicated the presence of cobbles and granite blocks at various levels in the fill. The SPT N60-values in the granular fill ranged from 4 to 80 blows per foot (bpf) indicating that the unit is very loose to very dense in consistency.

The granular fill samples subjected to laboratory testing had water contents ranging between approximately 5 and 9 percent. Grain size analyses conducted on selected samples of the fill soils indicate that the soils are classified as A-1-a, A-1-b, or A-2-4 by the AASHTO Classification System and SM or SW-SM under the Unified Soil Classification System.

5.2 Glacial Till

We generally encountered a layer of glacial till beneath the granular fill. The glacial till found in the borings generally comprised of gravelly fine to coarse sand with little to some silt, or fine to coarse sandy gravel with little silt. The thickness of this soil unit ranged between approximately 1.2 and 4.0 feet. SPT N60-values ranged from 22 to 67 bpf, indicating the till deposit is medium dense to very dense in consistency.

The glacial till samples selected for testing had water contents ranging between approximately 14 and 50 percent. Grain size analyses of the glacial till samples indicate that the soils are classified as A-1-a, A-1-b, or A-4 by the AASHTO Classification System and SM, ML, or GW-GM under the Unified Soil Classification System.
5.3 Bedrock

We encountered bedrock at approximate depths ranging from 1.8 to 18.0 feet bgs. Locally, the bedrock is mapped as Silurian-Ordovician age calcareous sandstone, interbedded sandstone and impure limestone of the Vassalboro Formation. Visual identification of rock cores indicates that the bedrock at all the cored boring locations is a green or greyish green, fine-grained, meta-sedimentary phyllite that is hard, severely weathered to fresh with very close to moderately close joints. The bedrock contains quartzite and calcite seams, fractures that are oriented horizontal to vertical along steeply dipping bedding planes and is iron-stained along the fractures. We determined that the rock quality designation (RQD) of the bedrock ranged from 0 to 50 percent which correlates to a very poor to poor rock mass quality. The table below summarizes the top of bedrock elevations at the boring locations:

<table>
<thead>
<tr>
<th>Substructure</th>
<th>Boring</th>
<th>Station</th>
<th>Depth to Bedrock (feet bgs)</th>
<th>Elevation of Bedrock Surface (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abutment No. 1</td>
<td>BB-KS-101</td>
<td>14+84.9, 6.1 RT</td>
<td>16.5</td>
<td>108.8</td>
</tr>
<tr>
<td></td>
<td>BP-KS-102</td>
<td>14+84.6, 3.9 LT</td>
<td>18.0</td>
<td>107.3</td>
</tr>
<tr>
<td></td>
<td>BB-KS-201</td>
<td>14+46.9, 11.2 LT</td>
<td>13.2</td>
<td>111.7</td>
</tr>
<tr>
<td></td>
<td>BB-KS-203</td>
<td>14+71.4, 8.0 RT</td>
<td>16.7</td>
<td>108.3</td>
</tr>
<tr>
<td>Mid-Stream Borings</td>
<td>BB-KS-103</td>
<td>15+35.7, 13.2 LT</td>
<td>2.7</td>
<td>106.6</td>
</tr>
<tr>
<td></td>
<td>BB-KS-104</td>
<td>15+51.8, 8.3 RT</td>
<td>1.8</td>
<td>107.8</td>
</tr>
<tr>
<td>Abutment No. 2</td>
<td>BB-KS-105</td>
<td>16+12.7, 5.6 LT</td>
<td>14.9</td>
<td>110.4</td>
</tr>
<tr>
<td></td>
<td>BB-KS-106</td>
<td>16+12.7, 7.5 RT</td>
<td>14.3</td>
<td>111.0</td>
</tr>
<tr>
<td></td>
<td>BB-KS-202</td>
<td>16+54.3, 9.7 LT</td>
<td>12.0</td>
<td>113.0</td>
</tr>
<tr>
<td></td>
<td>BB-KS-204</td>
<td>16+28.5, 6.4 RT</td>
<td>16.7</td>
<td>108.2</td>
</tr>
</tbody>
</table>

**Bedrock Depth and Elevation at the Boring Locations**

5.4 Groundwater

We observed the groundwater level at approximately the ground surface (streambed boring) to 12.5 feet bgs in the borings. However, the groundwater level will fluctuate with seasonal changes, runoff, and adjacent construction activities.

For a more detailed description of the subsurface conditions, please refer to Appendix A, Boring Logs attached to this report.

6.0 FOUNDATION ALTERNATIVES

Soil Report 2005-19 summarized the maintenance activities performed and assessments of the existing abutments when the project team considered reuse of the abutments in 2005. In the end, a significant body of data (including coring the entire height of abutment No. 2 concrete) demonstrated the need to replace the existing substructures in their entirety. The presence of shallow bedrock also indicates that full height cantilever abutments on spread
footings is the most practical and durable substructure alternative. Consequently, Section 7.0, Evaluation and Recommendations, of this report provides geotechnical design recommendations for full height cantilever abutments on spread footings founded on bedrock, or seal concrete founded on bedrock.

7.0 EVALUATION AND RECOMMENDATIONS

The design team has selected single-span, full height cast-in-place cantilever abutments on spread footings cast directly on bedrock or seal concrete on bedrock to replace the bridge at the Kenduskeag site. The design methodology used in the following evaluation is referenced from the AASHTO LRFD Bridge Design Specifications, 5th Edition, 2010.

7.1 Spread Footings on Bedrock

The borings encountered bedrock approximately 12 to 18 feet below the existing bridge approaches at the boring locations. It is therefore considered feasible that cofferdams, seals (if required) and spread footings could be practically and economically constructed to bear on bedrock. The boring logs indicate that the bedrock at the site is highly fractured. Thus, it will be necessary to excavate all dislodged, loose fractured or weathered bedrock before placing seal or spread footing concrete. The full extent of the weathered bedrock excavation needed will not be known until the foundation excavation is made.

7.2 Abutment and Wingwall Design

Abutments and wingwalls shall be proportioned for all applicable load combinations in LRFD Articles 3.4.1 and 11.5.5 and shall be designed for all relevant strength, service and extreme limit states. The design of project abutments and wingwalls founded on spread footings at the strength limit state shall consider nominal bearing resistance, eccentricity (overturning), lateral sliding and structural failure.

A sliding resistance factor, $\phi_s$, of 0.90 shall be applied to the nominal sliding resistance of cast-in-place, abutments and wingwalls founded on spread footings on bedrock. Sliding computations for resistance to lateral loads shall assume a maximum frictional coefficient of 0.70 at the bedrock-concrete interface.

For footings on bedrock, the eccentricity of loading at the strength limit state, based on factored loads, shall not exceed three-eighths ($3/8^{\text{ths}}$) of the footing dimensions, in either direction.

A resistance factor of 1.0 shall be used to assess spread footing design at the service limit state, including: settlement, excessive horizontal movement and overall stability. The overall stability of the foundation should be investigated at the Service I Load Combination and a resistance factor, $\varphi$, of 0.65.
Cantilever-type abutments and wingwalls shall be designed as unrestrained meaning that they are free to rotate at the top in an active state of earth pressure. Earth loads shall be calculated using an active earth pressure coefficient, $K_a = 0.31$, calculated using Rankine Theory for cantilever-type abutments and wingwalls. See Appendix C – Calculations, for supporting documentation. The designer may assume Soil Type 4 (BDG Section 3.6.1) for backfill material soil properties. The backfill properties are as follows: $\phi = 32$ degrees, $\gamma = 125$ pcf.

Additional lateral earth pressure due to construction surcharge or live load surcharge is required per Section 3.6.8 of the BDG for the abutments and wingwalls if an approach slab is not specified. In the case where a structural approach slab is specified, reduction of the surcharge loads is permitted per LRFD Article 3.11.6.5. The live load surcharge on walls may be estimated as a uniform horizontal earth pressure due to an equivalent height of soil ($h_{eq}$) of 2.0 feet, per LRFD Table 3.11.6.4-1. The live load surcharge on abutments may be estimated as a uniform earth pressure due to an equivalent height of soil ($h_{eq}$) taken from the table below:

<table>
<thead>
<tr>
<th>Abutment Height (feet)</th>
<th>$h_{eq}$ (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>4.0</td>
</tr>
<tr>
<td>10.0</td>
<td>3.0</td>
</tr>
<tr>
<td>$\geq 20.0$</td>
<td>2.0</td>
</tr>
</tbody>
</table>

All abutment and wingwall designs shall include a drainage system behind them to intercept any groundwater. Drainage behind the structure shall be in accordance with Section 5.4.1.4, Drainage, of the BDG.

Backfill within 10 feet of the abutments and wingwalls and side slope fill shall conform to MaineDOT Specification 709.19, Granular Borrow for Underwater Backfill. This gradation specifies 10 percent or less of material passing the No. 200 sieve. This material is specified in order to reduce the amount of fines and to minimize frost action behind the structure and below the approach slab.

Slopes in front of and sloping down to the wingwalls should be constructed with riprap and not exceed $1.75H:1V$.

### 7.3 Factored Bedrock Bearing Resistance

Substructure spread footings shall be proportioned to provide stability against bearing capacity failure. Application of permanent and transient loads are specified in LRFD Article 11.5.5. The stress distribution may be assumed to be a triangular or trapezoidal distribution over the effective base as shown in LRFD Figure 11.6.3.2-2. The factored bearing resistance for any structure founded on bedrock shall be investigated at the strength limit state using factored loads and a factored bearing resistance of 15 ksf. This assumes a bearing resistance factor, $\varphi_b$, for spread footings on bedrock of 0.45, based on bearing resistance evaluation using semi-empirical methods. A factored bearing resistance of 16 ksf may be used for
preliminary footing sizing and to control settlements when analyzing the service limit state load combination. See Appendix C, Calculations, for supporting documentation.

In no instance shall the factored service limit state bearing stress exceed the nominal compressive resistance of the footing concrete, which may be taken as 0.3 \( f'_c \). No footing shall be less than 2 feet wide regardless of the applied bearing pressure or bearing material.

7.4 Settlement

The current bridge replacement plans include profile changes of up to approximately 3 feet higher than original grades centered on the bridge. No compressible soils or peat occur beneath the existing approach embankments. Consequently, settlement beneath approach embankments resulting from new profile grades will be negligible.

We anticipate that all return walls behind the abutments will be founded on bedrock. If retaining walls or parts of retaining walls are founded on native or compacted fill soils, we estimate that settlements beneath the wall footings constructed on native soil or compacted granular fill will be on the order of \( \frac{1}{4} \) inch or less. Differential settlement will also be on the order of \( \frac{1}{4} \)-inch or less. We anticipate that all of these settlements will occur during construction and will have minimal effect on the completed structure.

We expect that any settlement of the bridge abutments will be due to the elastic compression of the bedrock and minor settlement due to silt seams in the bedrock. We estimate that this settlement will be on the order of 0.1 inch or less and will occur during construction.

7.5 Frost Protection

Abutment and return wing spread footings at the site will be founded on bedrock. Therefore, heave due to frost is not a design issue, and no requirements for minimum embedment depth are necessary.

We have evaluated the potential frost depth at the site. Based on State of Maine frost depth maps, BDG Figure 5-1, the site has a design-freezing index of approximately 1850 F-degree days. Considering an assumed water content of 10 percent, this correlates to a frost depth of 7.6 feet at this site. We also considered frost depth projections computed by Modberg software developed by the US Army Cold Regions Research and Engineering Laboratory. The results of the Modberg frost depth model indicate a potential frost depth of 6.0 feet. Consequently, we recommend that any foundations or leveling pads constructed at the site be founded a minimum of 6.5 feet below finished exterior grade. This minimum embedment applies only to foundations constructed on soil and not those founded on bedrock.

7.6 Scour and Riprap

We expect that abutment and return wing spread footings will be founded on bedrock. The bedrock at the site is not considered to be erodible. Therefore, no specific scour protection
recommendations are needed. However, if any abutment or wingwall footing is constructed on soil, they should be embedded for scour protection and armored with riprap.

The riprap layer shall be at least 3 feet thick. Stone riprap shall conform to MaineDOT Standard Specification 703.26, Plain and Hand Laid Riprap. For wingwalls and retaining walls, the riprap shall extend 1.5 feet horizontally in front of the walls before sloping at maximum 1.75H:1V slope to the existing ground surface. The toe of riprap sections shall be constructed 1 foot below the streambed elevation. The riprap section shall be underlain by Class A erosion control geotextile and a 1 foot thick layer of bedding material conforming to Standard Specification 703.19, Granular Borrow for Underwater Backfill, as shown in Standard Detail 610 (03).

### 7.7 Seismic Design Considerations

In conformance with LRFD Article 4.7.4.2, seismic analysis is not required for single-span bridges, regardless of seismic zone, however, superstructure connections and bridge seat dimensions shall be satisfied per LRFD 3.10.9 and 4.7.4.4, respectively. Furthermore, the bridge is not classified as a major structure since construction costs will be less than $10 million dollars, nor is it classified as functionally important. Consequently, seismic earth loads do not need to be considered in bridge substructure design.

The following parameters were determined for the site from the USGS Seismic Parameters CD provided with the LRFD Manual and LRFD Articles 3.10.3.1 and 3.10.6:

- Peak Ground Acceleration coefficient (PGA) = 0.070
- Design spectral acceleration coefficient at 0.2-second period, \( S_{DS} = 0.151 \)
- Design spectral acceleration coefficient at 1.0-second period, \( S_{D1} = 0.045 \)
- Site Class B (rock with an average shear wave velocity = 2,500ft/sec < \( v_s \) < 5,000ft/sec)
- Seismic Zone 1, based on an \( S_{D1} < 0.15g \)

### 7.8 Construction Considerations

#### 7.8.1 Excavation

Construction of the new abutment structures and any retaining walls will require soil and loose weathered rock excavation. Earth support systems may be required.

We anticipate that the existing abutments will be removed in their entirety. Cofferdams will be needed.

The abutment foundation subgrade should consist of sound bedrock. The bearing surface should be cleaned of all overburden soils, and loose, dislodged bedrock fragments should be removed by mechanical means. Mechanical means include expansive agents, use of hydraulic hoe ram, hydraulic splitters, or wedging and prying. We recommend final bedrock surface preparation by washing with a high pressure water jet.
The nature, slope, and degree of fracturing in the bedrock will not be evident until the foundation excavation is made. The bedrock surface shall be cleared of all loose fractured bedrock and loose decomposed bedrock and soil. Excavation of highly sloped and loose bedrock material may be done using conventional excavation methods, but may require drilling and blasting techniques. We recommend anchoring, doweling, benching or other means of improving sliding resistance if the prepared bedrock surface is steeper than 4:1 (H:V) in any direction. The final bearing surface shall then be washed with high pressure water and air prior to concrete being placed for the footing. The final bedrock surface shall be approved by the Resident prior to placing seal or footing concrete.

Surface water should be diverted from the foundation excavation throughout the period of construction. We recommend removing any groundwater encountered at the base of the foundation excavation by using a sump pump located in a corner of the excavation outside of the foundation footprint.

The native glacial till soil is susceptible to disturbance and rutting as a result of exposure to water or construction traffic. We recommend that the contractor protect the subgrade from exposure to water and any unnecessary construction traffic. If disturbance and rutting occur, we recommend that the contractor remove and replace the disturbed materials and replace with compacted gravel borrow.

7.8.2 Blasting

Bedrock excavation may be needed to achieve abutment and wingwall subgrade elevation. The contractor should conduct all blasting work for the project in accordance with MaineDOT Standard Specification 105.2.6, Use of Explosives. We also recommend that the contractor conduct pre and post-blast surveys, as well as, blast vibration monitoring at nearby residences and bridge structures in accordance with industry standards at the time of blast.

7.8.3 Dewatering

The contractor should control groundwater and surface water infiltration to permit construction in-the-dry. We recommend that the contractor use temporary ditches, sumps, granular drainage blankets, stone ditch protection, or hand-laid riprap with geotextile underlayment to divert surface water and groundwater if significant seepage is encountered during construction. We also recommend using French drains daylighted to nearby ditches if significant seepage is encountered in the subgrade along the construction areas.

7.8.4 Reuse of Excavated Soil and Bedrock

The project plans call for excavation of the existing approach areas to achieve planned grades. In the process, the contractor will excavate both the existing subbase gravel, and subgrade fill soils. We do not recommend using the excavated subbase aggregate to re-base the bridge approaches. Excavated subbase and any granular fill excavation may be used as
fill below subgrade elevation in fill embankment areas provided all other requirements of MaineDOT Standard Specification Sections 203 and 703 are met.

We do not recommend using excavated glacial till soils as fill directly beneath the pavement structure. The glacial till is typically susceptible to strength loss when wet or disturbed. The excavated till soils may be allowed as fill in accordance with the Standard Specification 203 as shown on Standard Detail 203 (01). This soil may also be used for dressing slopes, but only below the bottom elevation of the shoulder subbase gravel.

The native glacial till or existing fill soils may be used as common borrow in accordance with MaineDOT Standard Specification Sections 203 and 703. Contractors should expect that prior to placement and compaction it may be necessary to spread out and dry portions of these soils that are excessively moist.

7.8.5 Embankment Areas Outside of Abutment/Wingwall Backfill Envelope

Embankment approach slopes that are created or extended as part of the bridge construction effort should be designed as earth fill slopes no steeper than 2:1 (H:V). Slopes steeper than 2:1 (H:V) typically require reinforcement or rock fill surfacing.

We recommend that all new embankment fill be thoroughly and systematically compacted to the full limit of the slope. Where new fill slope extensions are constructed over existing slopes, we recommend benching the existing slope soils in accordance with MaineDOT Standard Specification 203.09, Preparation of Embankment Area, to prevent creation of a preferential slip plane under the new embankment fill.

The new embankment fill loads and densification of the fill materials during construction will result in ground surface settlement and consolidation of the underlying soils. We anticipate that most of this settlement will occur during and immediately after construction of the embankments. Post-construction settlement is expected to be minimal.

7.8.6 Erosion Control Recommendations

The fine-grained soils along the project are susceptible to erosion. We recommend using appropriate erosion control measures during construction as described in the MaineDOT Best Management Practices February 2008 guidelines to minimize erosion of the fine-grained soils at the site.

8.0 Closure

This report has been prepared for use by the MaineDOT Bridge Program for specific application to the replacement of the Village Bridge over the Kenduskeag Stream in Kenduskeag, Maine. We have prepared the report in accordance with generally accepted soil 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. Further, the analyses and recommendations are based in part upon limited soil explorations completed at discrete locations on the project 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.

We recommend that we be provided the opportunity for a general review of the final design drawings and specifications in order that we may verify that the earthwork and foundation recommendations have been properly interpreted and implemented in the design.
REFERENCES


MaineDOT, (2003), Bridge Design Guide, MaineDOT Bridge Program, Augusta, ME.
Sheets
Appendix A

Boring Logs
<table>
<thead>
<tr>
<th>MAJOR DIVISIONS</th>
<th>SYMBOLS</th>
<th>TYPICAL NAMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>COARSE-GRAINED SOILS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLEAN GRAVELS</td>
<td>GW</td>
<td>Well-graded gravels, gravel-sand mixtures, little or no fines</td>
</tr>
<tr>
<td>GP</td>
<td></td>
<td>Poorly-graded gravels, gravel-sand mixtures, little or no fines</td>
</tr>
<tr>
<td>GM</td>
<td></td>
<td>Silty gravels, gravel-sand-silt mixtures.</td>
</tr>
<tr>
<td>GC</td>
<td></td>
<td>Clayey gravels, gravel-sand-clay mixtures.</td>
</tr>
<tr>
<td>SANDS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CLEAN SANDS</td>
<td>SW</td>
<td>Well-graded sands, gravelly sands, little or no fines</td>
</tr>
<tr>
<td>SP</td>
<td></td>
<td>Poorly-graded sands, gravelly sand, little or no fines</td>
</tr>
<tr>
<td>SILTS AND CLAYS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ML</td>
<td></td>
<td>Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity.</td>
</tr>
<tr>
<td>CL</td>
<td></td>
<td>Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, clayly silts, lean clays.</td>
</tr>
<tr>
<td>OL</td>
<td></td>
<td>Organic silts and organic silty clays of low plasticity.</td>
</tr>
<tr>
<td>MH</td>
<td></td>
<td>Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.</td>
</tr>
<tr>
<td>CH</td>
<td></td>
<td>Inorganic clays of high plasticity, fat clays.</td>
</tr>
<tr>
<td>OH</td>
<td></td>
<td>Organic clays of medium to high plasticity, organic silts.</td>
</tr>
<tr>
<td>HIGHLY ORGANIC SOILS</td>
<td>PT</td>
<td>Peat and other highly organic soils.</td>
</tr>
</tbody>
</table>

**Unified Soil Classification Designation**

**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. Consistency is rated according to standard penetration resistance.

**Modified Burmister System**

<table>
<thead>
<tr>
<th>Descriptive Term</th>
<th>Portion of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>0% - 10%</td>
</tr>
<tr>
<td>Little</td>
<td>11% - 20%</td>
</tr>
<tr>
<td>Some</td>
<td>21% - 35%</td>
</tr>
<tr>
<td>Adjective (e.g. sandy, clayey)</td>
<td>36% - 50%</td>
</tr>
</tbody>
</table>

**Density of Cohesive Soils**

<table>
<thead>
<tr>
<th>Standard Penetration Resistance</th>
<th>N-Value (blows per foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very loose</td>
<td>0 - 4</td>
</tr>
<tr>
<td>Loose</td>
<td>5 - 10</td>
</tr>
<tr>
<td>Medium Dense</td>
<td>11 - 30</td>
</tr>
<tr>
<td>Dense</td>
<td>31 - 50</td>
</tr>
<tr>
<td>Very Dense</td>
<td>&gt; 50</td>
</tr>
</tbody>
</table>

Fine-grained soils: (more than half of material is smaller than No. 20 sieve): Includes (1) inorganic and organic silts and clays; (2) gravelly, sandy, or silty clays; and (3) clayey silts. Consistency is rated according to shear strength as indicated.

**Desired Rock Observations: (in this order)**

<table>
<thead>
<tr>
<th>Color (Munsell color chart)</th>
<th>Texture (aphanitic, fine-grained, etc.)</th>
<th>Lithology (igneous, sedimentary, metamorphic, etc.)</th>
<th>Hardness (very hard, hard, mod. hard, etc.)</th>
<th>Weathering (fresh, very slight, slight, moderate, severe, etc.)</th>
<th>Geologic discontinuities/jointing:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- spacing (very close - &lt;5 cm, close - 5-30 cm, mod. close 30-100 cm, wide - 1-3 m, very wide &gt;3 m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- tightness (tight, open or healed)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- infilling (grain size, color, etc.)</td>
</tr>
</tbody>
</table>

**Formation (Waterville, Ellsworth, Cape Elizabeth, etc.)**

<table>
<thead>
<tr>
<th>Rock Mass Quality (RQD)</th>
<th>Correlation of RQD to Rock Mass Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Poor</td>
<td>&lt;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>

**Sample Container Labeling Requirements:**

<table>
<thead>
<tr>
<th>PIN</th>
<th>Blow Counts</th>
<th>Sample Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sample Recovery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sample Recovery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sample Recovery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sample Recovery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sample Recovery</td>
</tr>
</tbody>
</table>

**Maine Department of Transportation**

**Geotechnical Section**

**Key to Soil and Rock Descriptions and Terms**

Field Identification Information

**Sample Container Labeling Requirements:**

<table>
<thead>
<tr>
<th>PIN</th>
<th>Blow Counts</th>
<th>Sample Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sample Recovery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sample Recovery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sample Recovery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sample Recovery</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sample Recovery</td>
</tr>
</tbody>
</table>

**January 2008**
## Maine Department of Transportation

**Soil/Rock Exploration Log**  
**US CUSTOMARY UNITS**

### Project: Village Bridge #2975 over Kenduskeag Stream  
**Location:** Stetson Road, Kenduskeag, Maine

**Boring No.:** BB-KS-101  
**PIN:** 17576.00

### Driller: MaineDOT  
**Elevation (ft.):** 125.3  
**Auger ID/OD:** 4½" SSA

### Operator: B. Wilder/G. Lidstone  
**Datum:** NAVD 88  
**Sampler:** Standard Split Spoon

### Logged By: M. Moreau  
**Rig Type:** CME 45C  
**Hammer Wt./Fall:** 140#/30"  
**Water Level:** 12.5' bgs

### Date Start/Finish: 3/21/05-3/21/05  
**Drilling Method:** Cased Wash Boring  
**Core Barrel:** NW

### Boring Location: 14+84.9, 6.1 Rt.  
**Casing ID/OD:** HW

### Hammer Efficiency Factor: 0.6  
**Hammer Type:** Automatic □ Hydraulic □ Rope & Cathead □

---

## Definitions:
- **R** = Rock Core Sample
- **S** = Split Spoon Sample
- **SSA** = Solid Stem Auger
- **MD** = Unsuccessful Split Spoon Sample attempt
- **U** = Thin Wall Tube Sample
- **MO** = Unsuccessful Thin Wall Tube Sample attempt
- **V** = In situ Vane Shear Test, PP = Pocket Penetrometer
- **MV** = Unsuccessful In situ Vane Shear Test attempt
- **T_v** = Pocket Penetrometer Shear Strength (psf)
- **WC** = water content, percent
- **LL** = Liquid Limit
- **PL** = Plastic Limit
- **PI** = Plasticity Index
- **G** = Grain Size Analysis
- **C** = Consolidation Test

## Laboratory Testing Results/ AASHTO and Unified Class.

### Visual Description and Remarks

<table>
<thead>
<tr>
<th>Sample Information</th>
<th>Depth (ft.)</th>
<th>Pen./Rec. (in.)</th>
<th>Sample Depth (ft.)</th>
<th>Blows (6 in.)</th>
<th>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></td>
<td>0</td>
<td>1D</td>
<td>24/24</td>
<td>1.00 - 3.00</td>
<td>23/43/37/38</td>
<td>80</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>2D</td>
<td>24/15</td>
<td>3.00 - 5.00</td>
<td>25/32/25/28</td>
<td>57</td>
<td>57</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>3D</td>
<td>12/12</td>
<td>5.00 - 6.00</td>
<td>16/55(6&quot;)</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>4D</td>
<td>24/8</td>
<td>7.50 - 9.50</td>
<td>7/5/6/5</td>
<td>11</td>
<td>11</td>
<td></td>
<td>117.80</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>5D</td>
<td>24/12</td>
<td>10.00 - 12.00</td>
<td>3/5/7/8</td>
<td>12</td>
<td>12</td>
<td>43</td>
<td>112.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6D</td>
<td>24/9</td>
<td>12.50 - 14.50</td>
<td>22/17/25/10</td>
<td>42</td>
<td>42</td>
<td>25/3</td>
<td>112.80</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>7D</td>
<td>24/16</td>
<td>15.00 - 17.00</td>
<td>7/4/18/30</td>
<td>22</td>
<td>22</td>
<td>45</td>
<td>108.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1</td>
<td>30/30</td>
<td>17.30 - 19.80</td>
<td>RQD = 0%</td>
<td>a0</td>
<td></td>
<td>150</td>
<td>108.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R2</td>
<td>37.2/37.2</td>
<td>19.80 - 22.90</td>
<td>RQD = 0%</td>
<td>102.40</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 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.

---

Boring No.: BB-KS-101
**Maine Department of Transportation**  
**Soil/Rock Exploration Log**  
**US CUSTOMARY UNITS**

<table>
<thead>
<tr>
<th>Depth (ft.)</th>
<th>Sample No.</th>
<th>Pen./Rec. (in.)</th>
<th>Sample Depth (ft.)</th>
<th>Blows (6 in.)</th>
<th>Shear Strength or RQD (%)</th>
<th>N-uncorrected</th>
<th>Casings</th>
<th>Blows</th>
<th>Elevation (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</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></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</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>
</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>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Visual Description and Remarks**:  
No descriptions taken.

**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.

---

**Maine DOT**  
**Elevation (ft.)**: 125.3  
**Auger ID/OD**: 4½"  
**Datum**: NAVD 88  
**Sampler**: Standard Split Spoon  
**Weathered ROCK.**  
**Bottom of Exploration at 19.10 feet below ground surface.**  
**REFUSAL.**
Maine Department of Transportation
Soil/Rock Exploration Log
US CUSTOMARY UNITS

Driller: MaineDOT  Elevation (ft.): 109.3  Auger ID/OD: 4½" SSA
Logged By: M. Moreau  Rig Type: CME 45C  Hammer Wt./Fall: 140#/30'
Date Start/Finish: 3/22/05-3/22/05  Drilling Method: Cased Wash Boring  Core Barrel: NW
Boring Location: 15+35.7, 13.2 Lt.  Casing ID/OD: HW  Water Level*: None Observed

Definitions:
- R = Rock Core Sample
- D = Split Spoon Sample
- MD = Unsuccessful Split Spoon Sample attempt
- U = Thin Wall Tube Sample
- MU = Unsuccessful Thin Wall Tube Sample attempt
- V = In situ Vane Shear Test, PP = Pocket Penetrometer
- MV = Unsuccessful In situ Vane Shear Test attempt
- SSA = Solid Stem Auger
- HSA = Hollow Stem Auger
- RC = Roller Cone
- WOR = weight of rods or casing
- WOH = weight of one person
- WOIP = Weight of one person
- T_v = Pocket Torvane Shear Strength (psf)
- WC = water content, percent
- WC_v = water content, percent
- LL = Liquid Limit
- PI = Plasticity Index
- PL = Plastic Limit
- MU = Unsuccessful Thin Wall Tube Sample attempt
- MU = Unsuccessful Thin Wall Tube Sample attempt
- MU = Unsuccessful Thin Wall Tube Sample attempt
- MU = Unsuccessful Thin Wall Tube Sample attempt
- MU = Unsuccessful Thin Wall Tube Sample attempt
- MU = Unsuccessful Thin Wall Tube Sample attempt

Bedrock: Green, fine-grained, PHYLLITE, severely weathered, occasional quartzite seams, with iron staining, (Vassalboro Formation).

Gravelly SAND, little silt in wash water.

Visual Description and Remarks

16.8' from middle of sidewalk to ground.
Sidewalk elevation taken from spot elevation from topo plans.

Remarks:

16.8' from middle of sidewalk to Ground.
Sidewalk elevation taken from spot elevation from topo plans.

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

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

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine
Boring No.: BB-KS-104
PIN: 17576.00

Driller: MaineDOT
Operator: G. Lidstone/B. Hyland

Logged By: B. Wilder
Datum: NAVD 88
Sampler: Standard Split Spoon

Date Start/Finish: 3/23/05-3/23/05
Drilling Method: Cased Wash Boring
Core Barrel: NW

Boring Location: 15+51.8, 8.3 Rt.
Casing ID/OD: HW
Water Level*: At Ground Surface

Hammer Efficiency Factor: 0.6
Hammer Type: Automatic

Definitions:
D = Split Spoon Sample
HSA = Hollow Stem Auger
U = Thin Wall Tube Sample
RC = Roller Cone
MD = Unsuccessful Split Spoon Sample attempt
HSA = Solid Stem Auger
MU = Unsuccessful Thin Wall Tube Sample attempt
WOR = weight of 140lb. hammer
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
WOR/C = weight of rods or casing
MV = Unsuccessful Insitu Vane Shear Test attempt
W = Thin Wall Tube Sample
M = Roller Cone Sample

Sample Information

Depth (ft.) | Sample No. | Pen./Rec. (in.) | Sample Depth (ft.) | Blows (/6 in.) | Shear Strength (psf) or RQD (%) | N-uncorrected | N60 | Casing Blows | Elevation (ft.) | Graphic Log | Laboratory Testing Results/ AASHTO and Unified Class.
---|---|---|---|---|---|---|---|---|---|---|---
0 | 1D | 21/13 | 0.00 - 1.75 | 7/11/14/50(3°) | 25 | 25 | 30 | 109.5 | | |
5 | R1 | 26.4/26.4 | 2.00 - 4.20 | RQD = 37% | | | | 109.5 | | |
| R2 | 16.8/16.8 | 4.20 - 5.60 | RQD = 23% | | | | 109.5 | | |
| R3 | 30/30 | 5.60 - 8.10 | RQD = 33% | | | | 109.5 | | |

Visual Description and Remarks
Grey, wet, medium dense, fine to coarse SAND, some gravel, little silt, (Till).

Rock fragments, weathered rock at 1.75' bgs.
Bedrock: Green, fine-grained, PHYLLITE, severely weathered, occasional quartzite seams, with iron staining, [Vassalboro Formation].
R1: Core Times (min:sec)
2.0-3.0' (7:30)
3.0-4.0' (11:00)
4.0-4.2' (8.00) 100% Recovery
R2: Core Times (min:sec)
4.2-5.2' (6:30)
5.2-5.6' (6:00) 100% Recovery
R3: Core Times (min:sec)
5.6-6.6' (8.00)
6.6-7.6' (7.00)
7.6-8.1 (6:00) 100% Recovery

Bottom of Exploration at 8.10 feet below ground surface.

Remarks:
16.0' from Bridge Deck to Ground. Bridge Deck 1.1' thick.
### Sample Information

<table>
<thead>
<tr>
<th>Depth (ft.)</th>
<th>Sample No.</th>
<th>Pen./Rec. (in.)</th>
<th>Sample Depth (ft.)</th>
<th>Blows (/6 in.)</th>
<th>Shear Strength (psf) or RQD (%)</th>
<th>N-uncorrected N60</th>
<th>Casing Blows</th>
<th>Elevation (ft.)</th>
<th>Graphic Log</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1D</td>
<td>24/13</td>
<td>1.00 - 3.00</td>
<td>9/13/10/15</td>
<td>23</td>
<td>23</td>
<td></td>
<td>125.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>124.30</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>2D</td>
<td>24/14</td>
<td>3.00 - 5.00</td>
<td>19/16/17/18</td>
<td>33</td>
<td>33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>3D</td>
<td>24/13</td>
<td>5.00 - 7.00</td>
<td>10/14/12/9</td>
<td>26</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5</td>
<td>4D</td>
<td>24/12</td>
<td>7.50 - 9.50</td>
<td>6/7/7/8</td>
<td>14</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.0</td>
<td>5D</td>
<td>24/9</td>
<td>10.00 - 12.00</td>
<td>5/7/8/13</td>
<td>15</td>
<td>15</td>
<td>22</td>
<td>113.30</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>112.60</td>
<td></td>
</tr>
<tr>
<td>13.0</td>
<td>6D/AB</td>
<td>24/8</td>
<td>13.00 - 15.00</td>
<td>35/3/9/47</td>
<td>12</td>
<td>12</td>
<td>47</td>
<td>111.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>110.40</td>
<td></td>
</tr>
<tr>
<td>15.0</td>
<td>R1</td>
<td>30/27</td>
<td>15.30 - 17.80</td>
<td>RQD = 33%</td>
<td>NQ</td>
<td>NQ</td>
<td></td>
<td>105.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R2</td>
<td>30/30</td>
<td>17.80 - 20.30</td>
<td>RQD = 50%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Visual Description and Remarks**

- **Pavement**: Brown, damp, medium dense, fine to coarse SAND, some gravel, little silt, (Fill).
- **Brown, moist, dense, fine to coarse SAND, some gravel, little silt, (Fill)**.
- Similar to above except medium dense.
- Similar to above.
- **Brown, wet, sandy GRAVEL, trace silt, (Fill)**.
- **Brown, wet, stiff, SILT, some sand, trace gravel**.
- **Brown, wet, GRAVEL, some sand, little silt**.
- **Weathered ROCK.** Washed ahead from 15.0-15.3' bgs.
- **Bedrock: Green, fine-grained, PHYLLITE, severely weathered, occasional quartzite seams, with iron staining, [Vassalboro Formation]**.

**Laboratory Testing Results/ AASHTO and Unified Class.**

- **G#181088 A-1-a, SW-SM**: WC=9.1%.
- **G#181089 A-1-b, SM**: WC=6.4%.
- **G#181090 A-1-b, SW-SM**: WC=6.2%.
- **G#181091 A-1-a, GP-GM**: WC=49.6%.
- **G#181092 A-1-b, SW-SM**: WC=6.8%.
- **G#181093 A-4, ML**: WC=49.6%.
- **G#181094 A-1-a, GP-GM**: WC=14.0%.

**Bottom of Exploration at 20.30 feet below ground surface.**
Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Boring No.: BP-KS-106
PIN: 17576.00

Driller: MaineDOT
Elevation (ft.): 125.3
Auger ID/OD: 4½"

Operator: G. Lidstone/B. Hyland
Datum: NAVD 88
Sampler: Standard Split Spoon

Logged By: B. Wilder
Rig Type: CME 45C
Hammer Wt./Fall: N/A

Date Start/Finish: 3/21/05-3/21/05
Drilling Method: Solid Stem Auger
Core Barrel: N/A

Boring Location: 16+12.7, 7.5 Rt.
Casing ID/OD: N/A
Water Level*: 12.5' bgs

Hammer Efficiency Factor: 1.0
Hammer Type: Automatic
Hydraulic
Rope & Cathead

Definitions:
D = Split Spoon Sample
U = Thin Wall Tube Sample
V = In situ Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful In situ Vane Shear Test attempt

Definitions:
R = Rock Core Sample
SSA = Solid Stem Auger

<table>
<thead>
<tr>
<th>Depth (ft.)</th>
<th>Sample No.</th>
<th>Pen./Rec. (in.)</th>
<th>Sample Depth (ft.)</th>
<th>Blows (/6 in.)</th>
<th>Shear Strength (psf) or RQD (%)</th>
<th>N-uncorrected</th>
<th>Casing Blows</th>
<th>Elevation (ft.)</th>
<th>Graphic Log</th>
<th>Visual Description and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</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></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</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></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>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Visual Description and Remarks

No descriptions taken.

Weathered ROCK.

Bottom of Exploration at 14.50 feet below ground surface.

REFUSAL

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.
**Maine Department of Transportation**  
**Soil/Rock Exploration Log**  
**US CUSTOMARY UNITS**

<table>
<thead>
<tr>
<th>Depth (ft.)</th>
<th>Sample No.</th>
<th>Pen./Rec. (in.)</th>
<th>Sample Depth (ft.)</th>
<th>Blows (/6 in.)</th>
<th>Shear Strength (psf) or RQD (%)</th>
<th>N-uncorrected</th>
<th>Casing Blows</th>
<th>Elevation (ft.)</th>
<th>Graphic Log</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>R1</td>
<td>50.4/50.4</td>
<td>0.00 - 4.20</td>
<td>NQ</td>
<td></td>
<td>NQ</td>
<td>NQ</td>
<td>125.3</td>
<td>Graphic Log</td>
</tr>
<tr>
<td>5</td>
<td>R2</td>
<td>60/60</td>
<td>4.20 - 9.20</td>
<td></td>
<td></td>
<td>NQ</td>
<td></td>
<td>111.30</td>
<td>Gravel</td>
</tr>
<tr>
<td>10</td>
<td>R3</td>
<td>60/60</td>
<td>9.20 - 14.20</td>
<td></td>
<td></td>
<td>NQ</td>
<td></td>
<td>111.30</td>
<td>Gravel</td>
</tr>
</tbody>
</table>

**Visual Description and Remarks**

- **Bottom of Exploration at 14.20 feet below ground surface.**

**Remarks:**

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

---

**Definitions:**

- **R** = Rock Core Sample
- **SSA** = Solid Stem Auger
- **HSA** = Hollow Stem Auger
- **RC** = Roller Cone
- **WOH** = weight of 140lb. hammer
- **WPCR** = weight of rods or casing
- **WOMP** = Weight of one person
- **WC** = Water content, percent
- **WC** = Water content, percent
- **PL** = Plastic Limit
- **G** = Grain Size Analysis
- **C** = Consolidation Test

---

**Laboratory Testing Results/AASHTO and Unified Class:**

- **CONCRETE**
  - R1: Core Times (min:sec)
  - 0.0-1.0' (4:08)
  - 1.0-2.0' (9:13)
  - 2.0-3.0' (4:57)
  - 3.0-4.0' (10:02)
  - 4.0-4.2' (3:00)
  - No loss of drilling water.

- R2: Core Times (min:sec)
  - 4.2-5.2' (2:50)
  - 5.2-6.2' (3:02)
  - 6.2-7.2' (2:58)
  - 7.2-8.2' (2:17)
  - 8.2-9.2' (2:15)
  - No loss of drilling water.

- R3: Core Times (min:sec)
  - 9.2-10.2' (1:45)
  - 10.2-11.2' (1:52)
  - 11.2-12.2' (2:05)
  - 12.2-13.2' (2:12)
  - 13.2-14.2' (2:15)
  - No loss of drilling water

---

* 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.
### Visual Description and Remarks

Brown, damp, medium dense, gravelly, fine to medium SAND, trace to little silt, trace coarse sand, (Fill).

Cored through Boulder from 5.2-6.1 ft bgs.

Failed sample attempt, likely missed sample and low blow counts due to disturbance from coring Boulder. No resample for same reason.

### Some Rock Core times were not logged where the symbol (---) is shown.

### Remarks:

Some Rock Core times were not logged where the symbol (---) is shown.

### Definitions:

- R = Rock Core Sample
- D = Split Spoon Sample
- MD = Unsuccessful Split Spoon Sample attempt
- U = Thin Wall Tube Sample
- MU = Unsuccessful Thin Wall Tube Sample attempt
- V = Insitu Vane Shear Test, PP = Pocket Penetrometer
- MV = Unsuccessful Insitu Vane Shear Test attempt

### Hammer Efficiency Factor

0.84

### Laboratory Testing Results/ AASHTO and Unified Class.

- Laboratory Testing Results
- AASHTO
- Unified Class.

### 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.
### Sample Information

<table>
<thead>
<tr>
<th>Depth (ft.)</th>
<th>Sample No.</th>
<th>Pen./Rec. (in.)</th>
<th>Sample Depth (ft.)</th>
<th>Boxes (6 in.)</th>
<th>Strength (psf)</th>
<th>RQD (%)</th>
<th>N-uncorrected N60</th>
<th>Casing Blows</th>
<th>Elevation (ft.)</th>
<th>Graphic Log</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>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</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>
</tr>
</tbody>
</table>

**Visual Description and Remarks:**

- **20.40 ft (3.15):** Brown sandy gravel [Vassalboro Formation]
  - **R3:** Bedrock: Same as R2 with more frequent, typically vertical breaks. Bottom of sample consists of angular gravel. [Vassalboro Formation]

- **22.00 ft (3.20):** Brown sandy gravel [Vassalboro Formation]
  - **R4:** Bedrock: Same as R2. Core sample consists of angular gravel. [Vassalboro Formation]

### Remarks:

Some Rock Core times were not logged where the symbol (---) is shown.

*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.*

### Definitions:

- **R** = Rock Core Sample
- **SSA** = Solid Stem Auger
- **RC** = Roller Cone
- **WOH** = weight of 140 lb. hammer
- **WOF** = weight of one person

### Soil/Rock Exploration Log

**Location:** Stetson Road, Kenduskeag, Maine

**Date Start/Finish:** 8/24/10; 07:30-10:40

**Driller:** MaineDOT

**Operator:** Giguere/Giles/Daggett

**Datum:** NAVD 88

**Auger ID/OD:** 5" SSA

**Elevation (ft.):** 124.9

**Sampler:** Standard Split Spoon

**Hammer Wt./Fall:** 140#/30"

**Rig Type:** CME 45C

**Core Barrel:** NQ-2"

**Depth (ft.):** 50

**Sample Information:**

- **Sample No.**
- **Pen./Rec. (in.).**
- **Sample Depth (ft.).**
- **Boxes (6 in.).**
- **Strength (psf) or RQD (%).**
- **N-uncorrected N60.**
- **Casing Blows.**
- **Elevation (ft.).**

**Visual Description and Remarks:**

- **18.4-19.4 ft (4:15):** 90% Recovery
- **19.4-20.4 ft (4:05):** 90% Recovery
- **R3:** Bedrock: Same as R2 with more frequent, typically vertical breaks. Bottom of sample consists of angular gravel. [Vassalboro Formation]

- **20.40 ft (3.15):** Brown sandy gravel [Vassalboro Formation]
  - **R3:** Bedrock: Same as R2 with more frequent, typically vertical breaks. Bottom of sample consists of angular gravel. [Vassalboro Formation]

- **22.00 ft (3.20):** Brown sandy gravel [Vassalboro Formation]
  - **R4:** Bedrock: Same as R2. Core sample consists of angular gravel. [Vassalboro Formation]

- **25.60 ft (3.25):** 75% Recovery
  - **R4:** Core times (min/sect)
    - 22.0-23.0 ft (-/-)
    - 23.0-24.0 ft (-/-
    - 24.0-25.0 ft (2:55)
    - 25.0-26.5 ft (-/-) 75% Recovery

**Bottom of Exploration at 25.60 feet below ground surface.**

### 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.
### Sample Information

<table>
<thead>
<tr>
<th>Depth (ft.)</th>
<th>Sample No.</th>
<th>Pen./Rec. (in.)</th>
<th>Sample Depth (ft.)</th>
<th>Blows (/6 in.)</th>
<th>Shear Strength (psf) or RQD (%)</th>
<th>N-uncorrected</th>
<th>Casing Blows</th>
<th>Elevation (ft.)</th>
<th>Graphic Log</th>
<th>Visual Description and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1D</td>
<td>24/18</td>
<td>1.00 - 3.00</td>
<td>12/25/12/14</td>
<td>37</td>
<td>52</td>
<td></td>
<td>124.45</td>
<td>SSA</td>
<td>PAVEMENT. Brown, damp, very dense, gravelly fine to coarse SAND, trace to little silt, (Fill).</td>
</tr>
<tr>
<td>5</td>
<td>2D</td>
<td>24/7</td>
<td>5.00 - 7.00</td>
<td>3/4/3/2</td>
<td>7</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>3D/AB</td>
<td>24/17</td>
<td>10.00 - 12.00</td>
<td>13/17/18/24</td>
<td>35</td>
<td>49</td>
<td>WASH AHEAD</td>
<td>114.20</td>
<td></td>
<td>3D/A (10.0-10.8 ft). Brown, wet, dense fine to medium SAND, trace to little silt, (Fill).</td>
</tr>
<tr>
<td></td>
<td>R1</td>
<td>50.4/48</td>
<td>12.50 - 16.70</td>
<td>RQD = 0%</td>
<td></td>
<td></td>
<td></td>
<td>113.00</td>
<td>WOR/C</td>
<td>3D/B (10.8-12.0 ft). Brown, dense, gravelly fine to coarse SAND, little to some silt. Bottom 12&quot; decomposed rock, (Till).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.00</td>
<td></td>
<td>Top of bedrock at Elev. 113.0 ft.</td>
</tr>
<tr>
<td></td>
<td>R2</td>
<td>9.6/9.6</td>
<td>16.70 - 17.50</td>
<td>RQD = 0%</td>
<td></td>
<td></td>
<td></td>
<td>12.50</td>
<td></td>
<td>R1: Bedrock: Greyish green, fine grained, hard, fresh to slightly weathered, calcareous muscovite PHYLLITE, with thin, steeply dipping to vertical bedding. Very close, high angle, stepped and undulating, rough to smooth, fresh to decomposed, open breaks along bedding. Much of core sample is angular gravel; broken along bedding.</td>
</tr>
<tr>
<td></td>
<td>R3</td>
<td>25.2/25.2</td>
<td>17.50 - 19.60</td>
<td>RQD = 0%</td>
<td></td>
<td></td>
<td></td>
<td>108.30</td>
<td></td>
<td>[Vassalboro Formation] R1: Core Times (min:sec) 12.5-13.5 ft (4:40) 13.5-14.5 ft (4:30) 14.5-15.5 ft (5:25) 15.5-16.5 ft (6:00) 16.5-16.7 ft (6:30) 95% Recovery</td>
</tr>
<tr>
<td></td>
<td>R4</td>
<td>34.8/32</td>
<td>19.60 - 22.50</td>
<td>RQD = 20%</td>
<td></td>
<td></td>
<td></td>
<td>105.40</td>
<td></td>
<td>R2: Bedrock: Same as R1. Core sample consists primarily of angular gravel; broken along vertical bedding. Evidence of decomposition of calcite-rich layers (mad). No complete 1 ft runs for core times. 100% Recovery</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>102.50</td>
<td></td>
<td>R3: Bedrock: Same as R1.</td>
</tr>
<tr>
<td></td>
<td>R3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R3: Core Times (min:sec) 17.5-18.5 ft (10:25) 18.5-19.5 ft (7:30) 19.5-19.6 ft (8:25) 100% Recovery</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>17.50</td>
</tr>
</tbody>
</table>

### Remarks:

Some Rock Core times were not logged where the symbol (--) is shown.

*Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.
Maine Department of Transportation
Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Village Bridge #2975 over Kenduskeag Stream
Location: Stetson Road, Kenduskeag, Maine

Auger ID/OD: 5" SSA
Sampler: Standard Split Spoon

Driller: MaineDOT
Elevation (ft.): 125.0

Operator: Giguere/Giles/Daggett
Datum: NAVD 88

Logged By: Be Schonewald
Rig Type: CME 45C

Date Start/Finish: 8/25/10; 9:35-12:35
Drilling Method: Cased Wash Boring

Boring Location: 16+54.3, 9.7 Lt.
Casing ID/OD: NW

Water Level*: 8.9 ft bgs.

Hammer Efficiency Factor: 0.84
Hammer Type: Automatic

Definitions:
- R = Rock Core Sample
- SSA = Solid Stem Auger
- HSA = Hollow Stem Auger
- RC = Roller Cone
- WOH = weight of 140 lb. hammer
- WOP = Weight of one person

- T v = Pocket Torvane Shear Strength (psf)
- WC = water content, percent
- LL = Liquid Limit
- PI = Plasticity Index
- G = Grain Size Analysis
- C = Consolidation Test

- N60 = (Hammer Efficiency Factor/60%)*N-uncorrected
- N 60 = SPT N-value corrected for hammer efficiency

- N-uncorrected = Raw field SPT N-value

- N 60 = SPT N-value corrected for hammer efficiency

- MU = Unsuccessful Thin Wall Tube Sample attempt
- MV = Unsuccessful Insitu Vane Shear Test attempt

- D = Split Spoon Sample
- MD = Unsuccessful Split Spoon Sample attempt
- U = Thin Wall Tube Sample
- V = Insitu Vane Shear Test

- PP = Pocket Penetrometer
- WP = Weight of rods or casing

- Blows (/6 in.)
- Shear Strength (psf) or RQD (%)
- Elevation (ft.)

- Visual Description and Remarks

<table>
<thead>
<tr>
<th>Depth (ft.)</th>
<th>Sample No.</th>
<th>Pen./Rec. (ft.)</th>
<th>Sample Depth (ft.)</th>
<th>Blows (/6 in.)</th>
<th>Shear Strength (psf) or RQD (%)</th>
<th>N-uncorrected</th>
<th>No.</th>
<th>Casing Blows</th>
<th>Elevation</th>
<th>Graphic Log</th>
<th>Visual Description and Remarks</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>R4: Bedrock: same as R1, except fresh, more intact.</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19.6-20.6 ft (-:--)</td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20.6-21.6 ft (7:00) 92% Recovery</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21.6-22.5 ft (6:20) 92% Recovery</td>
</tr>
<tr>
<td>45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22.50-</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>Bottom of Exploration at 22.50 feet below ground surface.</td>
</tr>
</tbody>
</table>

Remarks:

Some Rock Core times were not logged where the symbol (-:--) is shown.

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

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.
**Maine Department of Transportation**  
**Soil/Rock Exploration Log**  
**US CUSTOMARY UNITS**

**Project:** Village Bridge #2975 over Kenduskeag Stream  
**Location:** Stetson Road, Kenduskeag, Maine  
**Boring No.:** BB-KS-203  
**PIN:** 17576.00

**Driller:** MaineDOT  
**Elevation (ft.):** 125.0  
**Auger ID/OD:** 5" SSA

**Operator:** Giguere/Giles/Daggett  
**Datum:** NAVD 88

**Logged By:** Be Schonewald  
**Rig Type:** CME 45C  
**Hammer Wt./Fall:** 140#/30"  
**Sampler:** Standard Split Spoon

**Date Start/Finish:** 8/24/10; 10:50-14:05

**Boring Location:** 14+71.4, 8.0 Rt.

**Casing ID/OD:** HW & NW  
**Water Level:** None Observed

**Hammer Efficiency Factor:** 0.84  
**Hammer Type:** Automatic

**Definitions:**
- D = Split Spoon Sample
- MD = Unsuccessful Split Spoon Sample attempt
- U = Thin Wall Tube Sample
- MU = Unsuccessful Thin Wall Sample attempt
- V = Insitu Vane Shear Test
- PP = Pocket Penetrometer
- MV = Unsuccessful Vane Shear Test attempt

**Sample Information**

<table>
<thead>
<tr>
<th>Depth (ft.)</th>
<th>Sample No.</th>
<th>Pen./Rec. (in.)</th>
<th>Sample Depth (ft.)</th>
<th>Blows (/6 in.)</th>
<th>Shear Strength (psf) or RQD (%)</th>
<th>N-uncorrected</th>
<th>Casing Blows</th>
<th>Elevation (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1D</td>
<td>24/16</td>
<td>1.00 - 3.00</td>
<td>10/10/9/7</td>
<td>19</td>
<td>27</td>
<td></td>
<td>SSA</td>
</tr>
<tr>
<td>5</td>
<td>2D</td>
<td>24/10</td>
<td>5.00 - 7.00</td>
<td>3/4/5/5</td>
<td>9</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>3D</td>
<td>24/11</td>
<td>10.00 - 12.00</td>
<td>8/10/5/6</td>
<td>15</td>
<td>21</td>
<td>78</td>
<td>69</td>
</tr>
<tr>
<td>15</td>
<td>4D</td>
<td>24/11</td>
<td>15.00 - 17.00</td>
<td>4/10/38/33</td>
<td>48</td>
<td>67</td>
<td></td>
<td>235</td>
</tr>
<tr>
<td>20</td>
<td>R1</td>
<td>32.4/23</td>
<td>17.40 - 20.10</td>
<td>RQD = 0%</td>
<td></td>
<td></td>
<td>108.30</td>
<td>107.60</td>
</tr>
<tr>
<td></td>
<td>R2</td>
<td>27.6/26</td>
<td>20.10 - 22.40</td>
<td>RQD = 0%</td>
<td></td>
<td></td>
<td>104.90</td>
<td>102.60</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Visual Description and Remarks**

- Brown, dam, medium dense, fine to coarse sandy GRAVEL, trace to little silt, (Fill).
- Greenish grey, very dense, fine to coarse sandy GRAVEL, little silt, (Till). Bottom 4" of sample consists primarily of crushed rock.
- Roller Bit through 0.8 ft thick timber at approximately 13.0 ft bgs.

**Remarks:**

Some Rock Core times were not logged where the symbol (--) is shown.

---

* 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-KS-203
Maine Department of Transportation

Driller: MaineDOT
Operator: Giguere/Giles/Daggett
Logged By: Be Schonewald
Date Start/Finish: 8/24/10; 10:50-14:05
Boring Location: 14+71.4, 8.0 Rt.
Soil/Rock Exploration Log

PIN: 17576.00
Location: Stetson Road, Kenduskeag, Maine

US CUSTOMARY UNITS

Elevation (ft.): 125.0
Datum: NAVD 88
Hammer Type: Automatic

Auger ID/OD: 5" SSA
Sampler: Standard Split Spoon
Hammer Wt./Fall: 140#/30"

Definitions:

R = Rock Core Sample
SSA = Solid Stem Auger

HSA = Hollow Stem Auger
RC = Roller Cone

RC = Roller Cone

N-uncorrected = Raw field SPT N-value

WC = water content, percent

LL = Liquid Limit

PL = Plastic Limit

G = Grain Size Analysis

Hammer Efficiency Factor = annual calibration value

PI = Plasticity Index

C = Consolidation Test

WOR/C = weight of rods or casing

WG1P = Weight of one person

Remarks:

Some rock core times were not logged where the symbol (-:--) is shown.

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.

22.1-22.4 ft (3.35) 94% Recovery

Bottom of Exploration at 22.40 feet below ground surface.
### Sample Information

<table>
<thead>
<tr>
<th>Depth (ft.)</th>
<th>Sample No.</th>
<th>Pen./Rec. (in.)</th>
<th>Sample Depth (ft.)</th>
<th>Blows (/6 in.)</th>
<th>Shear Strength (psf) or RQD (%)</th>
<th>N-uncorrected</th>
<th>Caseing Blows</th>
<th>Elevation (ft.)</th>
<th>Graphic Log</th>
<th>Visual Description and Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1D</td>
<td>24/15</td>
<td>1.00 - 3.00</td>
<td>12/10/7/8</td>
<td>17</td>
<td>24</td>
<td></td>
<td>124.9</td>
<td>SSA</td>
<td>Brown, damp, medium dense, fine to coarse SAND, some gravel, trace to little silt, (Fill).</td>
</tr>
<tr>
<td>5</td>
<td>2D</td>
<td>24/15</td>
<td>5.00 - 7.00</td>
<td>5/4/7/5</td>
<td>11</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td>Brown, dry, medium dense, gravelly, fine to coarse SAND, trace to little silt, (Fill).</td>
</tr>
<tr>
<td>10</td>
<td>3D</td>
<td>4.8/3</td>
<td>10.00 - 10.40</td>
<td>50(4.8&quot;)</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td>Brown, moist, fine to coarse SAND, some gravel, little silt, rock in tip of spoon, (Fill). Probable Boulder at 10.4 ft bgs.</td>
</tr>
<tr>
<td>15</td>
<td>4D/AB</td>
<td>24/9</td>
<td>15.00 - 17.00</td>
<td>1/2/2/13</td>
<td>4</td>
<td>6</td>
<td></td>
<td>108.20</td>
<td></td>
<td>4D/A (15.0-16.7 ft). Brown, loose, very fine sandy ORGANIC SILT with wood layers bottom and top, (Fill).</td>
</tr>
<tr>
<td></td>
<td>R1</td>
<td>32/4/26</td>
<td>17.00 - 19.70</td>
<td>RQD = 0%</td>
<td>NO-2</td>
<td></td>
<td></td>
<td>107.90</td>
<td></td>
<td>4D/B (16.7-17.0 ft). Greyish green crushed ROCK. Top of Bedrock at Elev. 108.2 ft.</td>
</tr>
<tr>
<td></td>
<td>R2</td>
<td>18/18</td>
<td>19.70 - 21.20</td>
<td>RQD = 0%</td>
<td></td>
<td></td>
<td></td>
<td>105.20</td>
<td></td>
<td>R1-Core Times (min:sec): 17.0-18.0 ft (3:45) 18.0-19.0 ft (3:00) 19.0-19.7 ft (--:--) 80% Recovery</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>103.70</td>
<td></td>
<td>R2-Core Times (min:sec): 19.7-20.0 ft (--:--)</td>
</tr>
</tbody>
</table>

### Visual Description and Remarks

- **PAVEMENT.**
  - Brown, damp, medium dense, fine to coarse SAND, some gravel, trace to little silt, (Fill).
- **Bedrock.**
  - Brown, dry, medium dense, gravelly, fine to coarse SAND, trace to little silt, (Fill).
  - Brown, moist, fine to coarse SAND, some gravel, little silt, rock in tip of spoon, (Fill). Probable Boulder at 10.4 ft bgs.
  - HW Casing break at 12.5 ft . Moved ahead approximately 3 ft and continued boring with NW Casing.
  - 4D/A (15.0-16.7 ft). Brown, loose, very fine sandy ORGANIC SILT with wood layers bottom and top, (Fill).
  - 4D/B (16.7-17.0 ft). Greyish green crushed ROCK. Top of Bedrock at Elev. 108.2 ft.

### Remarks:

Some Rock Core times were not logged where the symbol (---) is shown.

---

*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.*
### Definitions:
- **R** = Rock Core Sample
- **SSA** = Solid Stem Auger
- **HSA** = Hollow Stem Auger
- **RC** = Roller Cone
- **WOH** = weight of 140lb. hammer
- **WOP** = Weight of one person
- **WC** = water content, percent
- **LL** = Liquid Limit
- **PL** = Plastic Limit
- **G** = Grain Size Analysis
- **C** = Consolidation Test

### Laboratory Testing Results/AASHTO and Unified Class.

### Visual Description and Remarks

Bottom of Exploration at 21 feet below ground surface.

### Remarks:
Some Rock Core times were not logged where the symbol (-:--) is shown.

<table>
<thead>
<tr>
<th>Depth</th>
<th>Sample No.</th>
<th>Pen./Rec. (ft.)</th>
<th>Sample Depth (ft.)</th>
<th>Blows (/6 in.)</th>
<th>Box Shear Strength (psi) or RQD (%)</th>
<th>N-uncorrected</th>
<th>Casing Blows</th>
<th>Elevation (ft.)</th>
<th>Graphic Log</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>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</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>
</tr>
</tbody>
</table>
Appendix B

Laboratory Test Data
<table>
<thead>
<tr>
<th>Boring &amp; Sample Identification Number</th>
<th>Station (Feet)</th>
<th>Offset (Feet)</th>
<th>Depth (Feet)</th>
<th>Reference Number</th>
<th>G.S.D.C. Number</th>
<th>W.C.</th>
<th>L.L.</th>
<th>P.I.</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB-KS-101, 1D</td>
<td>14+84.9</td>
<td>6.1 Rt.</td>
<td>1.0-3.0</td>
<td>181080</td>
<td>1</td>
<td>6.2</td>
<td></td>
<td></td>
<td>SM A-1-b II</td>
</tr>
<tr>
<td>BB-KS-101, 2D</td>
<td>14+84.9</td>
<td>6.1 Rt.</td>
<td>3.0-5.0</td>
<td>181081</td>
<td>1</td>
<td>7.0</td>
<td></td>
<td></td>
<td>SM A-1-b II</td>
</tr>
<tr>
<td>BB-KS-101, 3D</td>
<td>14+84.9</td>
<td>6.1 Rt.</td>
<td>5.0-6.0</td>
<td>181082</td>
<td>1</td>
<td>6.7</td>
<td></td>
<td></td>
<td>SM A-2-4 II</td>
</tr>
<tr>
<td>BB-KS-101, 4D</td>
<td>14+84.9</td>
<td>6.1 Rt.</td>
<td>7.5-9.5</td>
<td>181083</td>
<td>1</td>
<td>6.0</td>
<td></td>
<td></td>
<td>SM A-1-a II</td>
</tr>
<tr>
<td>BB-KS-101, 5D</td>
<td>14+84.9</td>
<td>6.1 Rt.</td>
<td>10.0-12.0</td>
<td>181084</td>
<td>1</td>
<td>7.0</td>
<td></td>
<td></td>
<td>SM A-1-b II</td>
</tr>
<tr>
<td>BB-KS-101, 6D</td>
<td>14+84.9</td>
<td>6.1 Rt.</td>
<td>12.5-14.5</td>
<td>181086</td>
<td>2</td>
<td>24.8</td>
<td></td>
<td></td>
<td>SM A-1-b II</td>
</tr>
<tr>
<td>BB-KS-101, 7D</td>
<td>14+84.9</td>
<td>6.1 Rt.</td>
<td>15.0-17.0</td>
<td>181087</td>
<td>2</td>
<td>28.6</td>
<td></td>
<td></td>
<td>SM A-1-b II</td>
</tr>
<tr>
<td>BB-KS-104, 1D</td>
<td>15+51.8</td>
<td>8.3 Rt.</td>
<td>0.0-1.75</td>
<td>181088</td>
<td>2</td>
<td>11.1</td>
<td></td>
<td></td>
<td>SM A-1-b II</td>
</tr>
<tr>
<td>BB-KS-105, 1D</td>
<td>16+12.7</td>
<td>5.6 Lt.</td>
<td>1.0-3.0</td>
<td>181089</td>
<td>2</td>
<td>9.1</td>
<td></td>
<td></td>
<td>SW-SM A-1-a 0</td>
</tr>
<tr>
<td>BB-KS-105, 2D</td>
<td>16+12.7</td>
<td>5.6 Lt.</td>
<td>3.0-5.0</td>
<td>181090</td>
<td>3</td>
<td>6.2</td>
<td></td>
<td></td>
<td>SW-SM A-1-b 0</td>
</tr>
<tr>
<td>BB-KS-105, 3D</td>
<td>16+12.7</td>
<td>5.6 Lt.</td>
<td>5.0-7.0</td>
<td>181091</td>
<td>3</td>
<td>5.3</td>
<td></td>
<td></td>
<td>SM A-1-b II</td>
</tr>
<tr>
<td>BB-KS-105, 5D</td>
<td>16+12.7</td>
<td>5.6 Lt.</td>
<td>7.5-9.5</td>
<td>181092</td>
<td>3</td>
<td>6.8</td>
<td></td>
<td></td>
<td>SW-SM A-1-b 0</td>
</tr>
<tr>
<td>BB-KS-105, 6D/A</td>
<td>16+12.7</td>
<td>5.6 Lt.</td>
<td>10.0-12.0</td>
<td>181093</td>
<td>3</td>
<td>49.6</td>
<td></td>
<td></td>
<td>ML A-4 IV</td>
</tr>
<tr>
<td>BB-KS-105, 6D/B</td>
<td>16+12.7</td>
<td>5.6 Lt.</td>
<td>14.2-14.9</td>
<td>181094</td>
<td>3</td>
<td>14.0</td>
<td></td>
<td></td>
<td>GP-GM A-1-a 0</td>
</tr>
</tbody>
</table>

Classification of these soil samples is in accordance with AASHTO Classification System M-145-40. This classification is followed by the "Frost Susceptibility Rating" from zero (non-frost susceptible) to Class IV (highly frost susceptible).

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

GSDC = Grain Size Distribution Curve as determined by AASHTO T 88-93 (1996) and/or ASTM D 422-63 (Reapproved 1998)
WC = water content as determined by AASHTO T 265-93 and/or ASTM D 2216-98
LL = Liquid limit as determined by AASHTO T 89-96 and/or ASTM D 4318-98
PI = Plasticity Index as determined by AASHTO 90-96 and/or ASTM D4318-98
## UNIFIED CLASSIFICATION

<table>
<thead>
<tr>
<th>Boring/Sample No.</th>
<th>Depth, ft</th>
<th>Description</th>
<th>W, %</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB-KS-101/1D</td>
<td>1.0-3.0</td>
<td>SAND, some gravel, little silt.</td>
<td>6.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BB-KS-101/2D</td>
<td>3.0-5.0</td>
<td>SAND, some gravel, some silt.</td>
<td>7.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BB-KS-101/3D</td>
<td>5.0-6.0</td>
<td>SAND, some silt, some gravel.</td>
<td>6.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BB-KS-101/4D</td>
<td>7.5-9.5</td>
<td>Gravelly SAND, little silt.</td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BB-KS-101/5D</td>
<td>10.0-12.0</td>
<td>SAND, some gravel, some silt.</td>
<td>7.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**State of Maine Department of Transportation**

### GRAIN SIZE DISTRIBUTION CURVE

**SIEVE ANALYSIS**

US Standard Sieve Numbers

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>#4</th>
<th>#8</th>
<th>#10</th>
<th>#16</th>
<th>#20</th>
<th>#40</th>
<th>#60</th>
<th>#100</th>
<th>#200</th>
<th>0.05</th>
<th>0.03</th>
<th>0.010</th>
<th>0.005</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot;</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>
<td></td>
</tr>
<tr>
<td>2&quot;</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>
<td></td>
</tr>
<tr>
<td>1-1/2&quot;</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>
<td></td>
</tr>
<tr>
<td>1&quot;</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>
<td></td>
</tr>
<tr>
<td>3/4&quot;</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>
<td></td>
</tr>
<tr>
<td>1/2&quot;</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>
<td></td>
</tr>
<tr>
<td>3/8&quot;</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>
<td></td>
</tr>
<tr>
<td>1/4&quot;</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>
<td></td>
</tr>
</tbody>
</table>

**HYDROMETER ANALYSIS**

Grain Diameter, mm

<table>
<thead>
<tr>
<th>Diameter (mm)</th>
<th>0.05</th>
<th>0.03</th>
<th>0.010</th>
<th>0.005</th>
</tr>
</thead>
<tbody>
<tr>
<td>76.2</td>
<td>50.8</td>
<td>38.1</td>
<td>25.4</td>
<td>19.05</td>
</tr>
<tr>
<td>12.7</td>
<td>9.53</td>
<td>6.35</td>
<td>4.75</td>
<td>2.36</td>
</tr>
<tr>
<td>2.00</td>
<td>1.18</td>
<td>0.85</td>
<td>0.426</td>
<td>0.25</td>
</tr>
<tr>
<td>0.85</td>
<td>0.426</td>
<td>0.25</td>
<td>0.15</td>
<td>0.075</td>
</tr>
<tr>
<td>0.075</td>
<td>0.075</td>
<td>0.05</td>
<td>0.03</td>
<td>0.005</td>
</tr>
</tbody>
</table>

**GRAVEL**

**SAND**

**SILT**

**CLAY**

---

**PIN:** 017576.00

**Town:** Kenduskeag

**Reported by:** WHITE, TERRY A

**Date:** 5/19/2005
**State of Maine Department of Transportation**

**GRAIN SIZE DISTRIBUTION CURVE**

**SIEVE ANALYSIS**
US Standard Sieve Numbers

**HYDROMETER ANALYSIS**
Grain Diameter, mm

---

**UNIFIED CLASSIFICATION**

<table>
<thead>
<tr>
<th>Boring/Sample No.</th>
<th>Depth, ft</th>
<th>Description</th>
<th>W, %</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB-KS-105/3D</td>
<td>5.0-7.0</td>
<td>SAND, some gravel, little silt.</td>
<td>6.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BB-KS-105/4D</td>
<td>7.5-9.5</td>
<td>SAND, some gravel, little silt.</td>
<td>5.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BB-KS-105/5D</td>
<td>10.0-12.0</td>
<td>SAND, some gravel, little silt.</td>
<td>6.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BB-KS-105/6D(A)</td>
<td>13.4-14.2</td>
<td>SILT, some sand, trace gravel.</td>
<td>49.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BB-KS-105/6D(B)</td>
<td>14.2-14.9</td>
<td>GRAVEL, some sand, little silt.</td>
<td>14.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**BB-KS-105/6D(B)**

**PIN:** 017576.00
**Town:** Kenduskeag
**Reported by:** WHITE, TERRY A
**Date:** 5/19/2005
ABUTMENT AND WINGWALL PASSIVE AND ACTIVE EARTH PRESSURES:

**Rankine Theory - Active Earth Pressure** from MaineDOT Bridge Design Guide Section 3.6.5.2, pg. 3-7

Either Rankine or Coulomb may be used for long-heeled cantilever walls where the failure surface is uninterrupted by the top of the wall stem. In general, use Rankine though.

Soil angle of internal friction: $\phi := 32\text{deg}$

Slope angle of backfill soil from horizontal: $\beta := 0\text{deg}$

$$K_a := \tan \left[ 45\text{deg} - \left( \frac{\phi}{2} \right)^2 \right]$$

$K_a = 0.31$

**Rankine Theory - Passive Earth Pressure** from Bowles 5th Edition Section 11-5, pg 602

Soil angle of internal friction: $\phi := 32\text{deg}$

Slope angle of backfill soil from horizontal: $\beta := 0\text{deg}$

$$K_{p,\text{rank}} := \frac{\cos(\beta) + \sqrt{\cos(\beta)^2 - \cos(\phi)^2}}{\cos(\beta) - \sqrt{\cos(\beta)^2 - \cos(\phi)^2}}$$

$K_{p,\text{rank}} = 3.25$
Coulomb Theory - Active Earth Pressure from MaineDOT Bridge Design Guide
Section 3.6.5.2, pg. 3-7

For gravity walls, semi-gravity walls, prefabricated modular walls, and cantilever walls and abutments with short heels where wall and backfill interface friction is considered, use Coulomb Theory

\[
\begin{align*}
\text{Angle of back face of wall:} & \quad \alpha := 90 \text{deg} \\
\text{Soil angle of internal friction:} & \quad \phi := 32 \text{deg} \\
\text{Slope angle of backfill soil from horizontal:} & \quad \beta := 0 \text{deg} \\
\delta &= \frac{\sin(\alpha + \phi)}{\sin(\alpha)} \\
\therefore & \quad \delta = \beta
\end{align*}
\]

\[
K_a := \frac{\sin(\alpha + \phi)^2}{\sin(\alpha)^2 \cdot \sin(\alpha - \delta) \cdot \left(1 + \frac{\sin(\phi + \delta) \cdot \sin(\phi - \beta)}{\sin(\alpha - \delta) \cdot \sin(\beta + \alpha)}\right)^2} = K_a = 0.31
\]

Coulomb Theory - Passive Earth Pressure from MaineDOT Bridge Design Guide
Section 3.6.6, pg. 3-8

\[
\begin{align*}
\text{Angle of back face of wall:} & \quad \alpha := 90 \text{deg} \\
\text{Soil angle of internal friction:} & \quad \phi := 32 \text{deg} \\
\text{Friction angle between fill and wall:} & \quad \delta := 20 \text{deg} \\
\text{From LRFD Table 3.11.5.3-1, pg. 3-74, \delta ranges from 17 to 22} \\
\text{Angle of backfill from horizontal:} & \quad \beta := 0 \text{deg} \\
K_p := \frac{\sin(\alpha - \phi)^2}{\sin(\alpha)^2 \cdot \sin(\alpha + \delta) \cdot \left(1 - \frac{\sin(\phi + \delta) \cdot \sin(\phi - \beta)}{\sin(\alpha - \delta) \cdot \sin(\beta + \alpha)}\right)^2} = K_p = 6.89
\end{align*}
\]
Frost Protection:
Method 1

From the Maine Design Freezing Index Map:

DFI = 1850 degree-days

Site has Granular Soils With Wn = 10% or less

From the 2003 Bridge Design Guide Table 5-1:

Frost_depth := [0.5 \cdot (92.6in − 90.1in) + 90.1in]

Frost_depth = 91.35 in

Frost_depth = 7.61 ft

Method 2

--- Moberg Results ---

<table>
<thead>
<tr>
<th>Layer</th>
<th>#</th>
<th>Type</th>
<th>t</th>
<th>w%</th>
<th>d</th>
<th>Cf</th>
<th>Cu</th>
<th>Kf</th>
<th>Ku</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>Asphalt</td>
<td>6.0</td>
<td>110</td>
<td>0</td>
<td>28</td>
<td>28</td>
<td>0.9</td>
<td>1.3</td>
<td>403</td>
</tr>
<tr>
<td>2</td>
<td>C</td>
<td>Coarse</td>
<td>65.9</td>
<td>2.0</td>
<td>140</td>
<td>25</td>
<td>27</td>
<td>1.0</td>
<td>1.3</td>
<td>403</td>
</tr>
</tbody>
</table>

| t | Layer thickness, in inches. |
| w% | Moisture content, in percentage of dry density. |
| d | Dry density, in lbs/cubic ft. |
| Cf | Heat capacity of frozen phase, in BTU/(cubic ft degree F). |
| Cu | Heat Capacity of thawed phase, in BTU/(cubic ft degree F). |
| Kf | Thermal conductivity in frozen phase, in BTU/(ft hr degree F). |
| Ku | Thermal conductivity in thawed phase, in BTU/(ft hr degree F). |
| L | Latent heat of fusion, in BTU / cubic ft. |

Ok Use 6.5 feet

Total depth of Frost Penetration = 5.99 ft = 71.9 in.
BEARING RESISTANCE - FOOTINGS ON COMPACTED FILL SOILS:
Consider this for use with PCMG and Wingwalls; however it's likely that all footings will bear on bedrock.

SERVICE LIMIT STATE:

Based on LRFD Table C10.6.2.6.1-1 - "Presumptive Bearing Resistances for Spread Footing Foundations at the Service Limit State."

<table>
<thead>
<tr>
<th>Bearing Material</th>
<th>Consistency in Place</th>
<th>Allowable Bearing Pressure (tons per sq. foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse to Medium sand, little gravel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very compact</td>
<td>4 to 6</td>
<td>4 tsf (8 ksf)</td>
</tr>
<tr>
<td>Medium to compact</td>
<td>2 to 4</td>
<td>3 tsf (6 ksf)</td>
</tr>
<tr>
<td>Loose</td>
<td>1 to 3</td>
<td>1.5 tsf (3 ksf)</td>
</tr>
</tbody>
</table>

Recommend 6.0 ksf to control settlements for Service Limit State analyses and for preliminary footing sizing.

STRENGTH LIMIT STATE:

Nominal and Factored Bearing Resistance for spread footings on fill soils At the Strength Limit State:
This may considered for PCMG or Cast-In-Place Wall Bases.

Assumptions:

1. Footings will be embedded 6.5 feet for frost protection. \( D_f := 6.5 \text{ft} \)
2. Assumed parameters for soils: Assume granular fill
   - Moist unit weight: \( \gamma_m := 125 \text{pcf} \)
   - Saturated unit weight: \( \gamma_{sat} := 130 \text{pcf} \)
   - Soil angle of internal friction: \( \phi_{ns} := 32 \)
   - Undrained shear strength (cohesion): \( c_{ns} := 0 \text{psf} \)
3. Use Terzaghi strip equations as \( L > B \)

Depth to Groundwater table based on boring data: \( D_w := 0 \text{-ft} \)
Unit weight of water: $\gamma_w = 62.4 \text{pcf}$

Effective Stress at the footing bearing level:

$$q_{\text{eff, str}} := D_w \gamma_m + (\gamma_f - D_w) (\gamma_{\text{sat}} - \gamma_w)$$

$$q_{\text{eff, str}} = 0.44 \text{ ksf}$$

Look at several wall base widths:

$$B := \begin{pmatrix} 4 \\ 6 \\ 8 \end{pmatrix} \text{ ft}$$

Terzaghi Shape Factors from Table 4-1, p. 220

For strip footing:

$$s_c := 1.0$$

$$s_\gamma := 1.0$$

Meyerhof Bearing Capacity Factors For $\phi = 32$ deg

Bowles 5th Ed. Table 4-4 pg. 223

$$N_c := 35.47$$

$$N_q := 23.2$$

$$N_{\gamma} := 22.0$$

Nominal Bearing Resistance per Terzaghi equation

Bowles 5th Ed. Table 4-1 pg. 220

$$q_{\text{nom}} := c_n s_n N_c s_c + q_{\text{eff, str}} N_q + 0.5 (\gamma_{\text{sat}} - \gamma_w) B \gamma_1 s_\gamma$$

$$q_{\text{nom}} = \begin{pmatrix} 13.2 \\ 14.7 \\ 16.1 \end{pmatrix} \text{ ksf}$$

Resistance Factor from LRFD Table 10.5.2.2-1 pg. 10-32:

$$\phi_b := 0.45$$

$$q_{\text{fac}} := q_{\text{nom}} \phi_b$$

$$q_{\text{fac}} = \begin{pmatrix} 5.9 \\ 6.6 \\ 7.3 \end{pmatrix} \text{ ksf}$$

Recommend **6.0 ksf** for **Strength Limit State** Factored Bearing Resistance for wall bases 8 feet or less wide.
BEARING RESISTANCE - FOOTINGS ON BEDROCK:

SERVICE LIMIT STATE:

Method 1

Method: Based on LRFD Table C10.6.2.6.1-1 (Based on NAVFAC DM 7.2, May 1982) - "Presumptive Bearing Resistances for Spread Footing Foundations at the Service Limit State."

Description of Bedrock Materials:

Highly fractured PHYLLITE, RQD 0%

Bearing Material: Weathered bedrock, RQD less than 25%
Consistency in Place: Medium hard rock
Bearing Resistance: Range 16 - 24 ksf
Recommended Value: 16 ksf

Method 2


Section 4.4.8.1.1 - Competent Rock
Figure 4.4.8.1.1A - for footings supported on competent rock
Average RQD of site bedrock is 0%

Allowable contact stress: 10 tsf (20 ksf)

Use a Factored Bearing Resistance of 16 ksf for Service Limit State analysis and preliminary sizing of the footings.
STRENGTH LIMIT STATE:

Method 3


Section 4.4.8.1.2 - Footings on Broken or Jointed Rock, Pg. 62
Table 4.4.8.1.2A - for footings supported on Broken or Jointed Rock, Pg. 63

a. estimated Rock Mass Rating Very Poor (RQD ~0)
b. Rock Category per 4.4.8.1.2B B, Phylite
c. Unconfined compressive strength, Co 3500 psi
d. Nms, per Table 4.4.8.1.2A Use qult of equivalent soil mass
e. Qult = Qnom qult of equivalent soil mass

Nominal Bearing Resistance for Spread Footings on Fractured Bedrock Using Equivalent Soil Mass:

Use Terzaghi Strip Footing Equation to Calculate Qnom.

Assumptions:

1. Footings only embedded by riprap layer 3.0 feet.
   \[ D_f := 3.0 \text{ft} \]

2. Assumed parameters for soils:
   Assume granular fill
   Moist unit weight: \[ \gamma_m := 145 \text{pcf} \]
   Saturated unit weight: \[ \gamma_{sat} := 150 \text{pcf} \]
   Soil angle of internal friction: \[ \phi_{ns} := 36 \]
   Assume similar to dense till
   Undrained shear strength (cohesion): \[ c_{ns} := 0 \text{psf} \]

3. Use Terzaghi strip equations as L > B
   Depth to Groundwater table based on boring data: \[ D_w := 0 \text{-ft} \]
   Unit weight of water: \[ \gamma_w := 62.4 \text{pcf} \]
   Effective Stress at the footing bearing level: \[ q_{\text{eff, str}} := D_w \gamma_m + (D_f - D_w)(\gamma_{sat} - \gamma_w) \]
   \[ q_{\text{eff, str}} = 0.26 \cdot \text{ksf} \]
Look at several typical footing widths:

\[
B := \begin{bmatrix}
12 \\
14 \\
16 \\
\end{bmatrix} \text{ ft}
\]

Terzaghi Shape Factors from Bowles 5th Ed., Table 4-1, p. 220, for strip footing:

\[
s_c := 1.0 \\
s_γ := 1.0
\]

Meyerhof Bearing Capacity Factors For $\phi = 36$ deg Bowles 5th Ed. Table 4-4 pg. 223

\[
N_c := 50.55 \\
N_q := 37.7 \\
N_γ := 44.4
\]

Nominal Bearing Resistance per Terzaghi equation Bowles 5th Ed. Table 4-1 pg. 220

\[
Q_{\text{nom}} := c_{ns} \cdot N_c \cdot s_c + q_{\text{eff_str}} \cdot N_q + 0.5(\gamma_{\text{sat}} - \gamma_w) \cdot B \cdot N_γ \cdot s_γ
\]

\[
Q_{\text{nom}} = \begin{bmatrix} 33.2 \\ 37.1 \\ 41 \end{bmatrix} \text{ ksf}
\]

Resistance Factor from LRFD Table 10.5.2.2-1 pg. 10-39: $\phi_b := 0.45$

\[
q_{\text{fac}} := Q_{\text{nom}} \cdot \phi_b
\]

Factored Bearing Resistance

\[
q_{\text{fac}} = \begin{bmatrix} 15 \\ 16.7 \\ 18.5 \end{bmatrix} \text{ ksf}
\]

Use a Strength Limit State Factored Bearing Resistance of 15 ksf.
SETTLEMENT ANALYSIS:

Estimate Settlement for PCMG or Cast-In-Place Wall Footing on Soil Using Hough Method:
Ref. LRFD Section 10.6.2.4.2, pg. 10-56

Assumptions:
B = 8 ft
Maximum grade rise is 2.5 feet
Soil thickness below footing is 4 feet (Assumed)
Use N1 of 40 (assumed corrected N60 value for very dense till or compacted fill)
I Influence factors from LRFD Figure 10.6.2.4.1-1, pg. 10-56
Bearing Capacity Indices (C’) from LRFD Figure 10.6.2.4.2-1, pg. 10-59

\[ N1 := 40 \quad l := 0.9 \quad C’ := 135 \]

\[ \sigma_o := (120 \text{pcf} - 62.4 \text{pcf}) \cdot 6.5 \text{ft} \]

\[ \Delta \sigma_v := 2.5 \text{ft} \cdot 125 \text{pcf} \cdot l \quad \Delta \sigma_v = 0.28 \text{ksf} \]

\[ \Delta H := 4 \text{ft} \cdot \left(\frac{1}{C’}\right) \cdot \log\left(\frac{\sigma_o + \Delta \sigma_v}{\sigma_o}\right) \]

\[ \Delta H = 0.09 \text{in} \]

OK, Say 1/4 inch or less settlement below PCMG or Cast-In-Place wall footing on soil.

Settlement of Footings on Rock, LRFD Section 10.6.2.4.4

Assumptions:
Borings show evidence of silt seams, Assume 3 in thick
\[ e_o := 1.0 \]
\[ C_r := 0.05 \]
Depth of seam approximately 7 feet below top of rock
Footing Width B = 15 feet, So depth of Influence is 0.5B
LRFD Figure 10.6.2.4.1-1 Boussinesq Stress Contours: Stress is approximately 0.8q_o
\[ q_o := 16 \text{ksf} \]
\[ \Delta \sigma_v := 0.8 \cdot q_o + 2 \cdot (125 \text{pcf}) \quad \Delta \sigma_v = 13.05 \text{ksf} \]
\[ \gamma_{fill} := 120 \text{pcf} \]
\[ \gamma_{\text{rock}} := 150 \text{pcf} \]
\[ \gamma_{\text{fill}} := 135 \text{pcf} \]
\[ \sigma_v := \gamma_{\text{fill}} \cdot 12 \text{ft} + (\gamma_{\text{fill}} - 62.4 \text{pcf}) \cdot 3 \text{ft} + (\gamma_{\text{rock}} - 62.4 \text{pcf}) \cdot 7 \text{ft} \]
\[ \sigma_v = 2.27 \text{ ksf} \]

Calculate Settlement:

\[ \Delta H := 3 \ln \left( \frac{C_r}{1 + e_o} \right) \cdot \log \left[ \frac{(\sigma_v + \Delta \sigma_v)}{\sigma_v} \right] \]
\[ \Delta H = 0.06 \text{ in} \]

OK Say up to 0.1 inch of settlement possible due to consolidation of silt seam in bedrock.

**SEISMIC DESIGN PARAMETERS:**

<table>
<thead>
<tr>
<th>Period (sec)</th>
<th>Sa (g)</th>
<th>As (g)</th>
<th>SDs (g)</th>
<th>SD1 (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.070</td>
<td>0.18</td>
<td>0.161</td>
<td>0.045</td>
</tr>
<tr>
<td>1.0</td>
<td>0.045</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Conterminous 48 States**
2007 AASHTO Bridge Design Guidelines
AASHTO Spectrum for 7% PE in 75 years
State - Maine
Zip Code - 04456
Zip Code Latitude = 44.888300
Zip Code Longitude = -68.988300
Site Class B
Data are based on a 0.05 deg grid spacing.

<table>
<thead>
<tr>
<th>Period (sec)</th>
<th>Sa (g)</th>
<th>As (g)</th>
<th>SDs (g)</th>
<th>SD1 (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.070</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td>0.161</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>0.045</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>