# STATE OF MAINE
## MAINE DEPARTMENT OF TRANSPORTATION
Letter of Transmittal

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Project Resident, Highway Program (Unknown as of 7/14/2014)

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**Subject:** Geotechnical Design Report, River Road Bridge, Clinton, Maine

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**Soils Report No.:** 2014-133

**Bridge #:** 6485

**Route:** N/A

**PIN:** 020337.00

**Town:** Clinton

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Attached is one (1) copy of 100 Series Soils Report No. 2014-133, dated: June 2014.

This report is available in TEDOCS as Document #1380028.

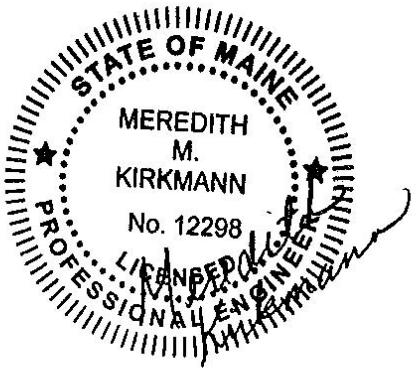
att: 1 of 2014-133

**Maine Department of Transportation**
**Highway/Bridge Program**
**Geotechnical Section**
**Augusta, Maine**

# Geotechnical Design Report

*For the Replacement of:*

**River Road Bridge**
**Jackins Brook**
**Clinton, Maine**

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Kennebec County

Soils Report No. 2014-133
Bridge No. 6485

WIN 20337.00
June 2014

# Table of Contents

GEOTECHNICAL DESIGN SUMMARY ..... 3
INTRODUCTION ..... 5
GEOLOGIC SETTING ..... 5
SUBSURFACE INVESTIGATION ..... 6
LABORATORY TESTING ..... 6
SUBSURFACE CONDITIONS ..... 6
Fill ..... 7
Native Soils ..... 7
Bedrock ..... 7
Groundwater ..... 7
Existing Pavement Structure ..... 8
GEOTECHNICAL DESIGN RECOMMENDATIONS ..... 8
Bearing Resistance ..... 8
Scour, Riprap and Collar ..... 8
Seismic Design Considerations ..... 9
Pavement Design ..... 9
Construction Considerations ..... 9
CLOSURE ..... 9
SHEETS ..... 11
Location Map ..... 12
GeoPlan and Profile ..... 13
Boring Log Sheet ..... 14
ATTACHMENTS ..... 15
Boring Logs ..... 16
Rock Core Photos ..... 19
Laboratory Data ..... 26
Calculations ..... 36

## GEOTECHNICAL DESIGN SUMMARY

The purpose of this report is to present the subsurface information and make geotechnical recommendations for the replacement of the twin 6-foot corrugated metal pipes that carry Jackins Brook under River Road in Clinton, located 1.0 miles north of the Clinton/Benton town line. River Road is a Priority 5 Highway Corridor. The proposed replacement will be a precast concrete box culvert with a 10-foot span by 6-foot rise, defined as a minor span bridge by MaineDOT. The following design and construction sections should be considered, and are discussed in full detail in the attached report.

**Box Culvert -** The current culvert will be replaced by a 10-foot span by 6-foot rise precast concrete box culvert. The culvert will be lengthened to 80 feet. The inlet and outlet will be riprapped to protect against erosion at slopes of 2:1.

**Roadway and Pavement -** The roadway will have 11-foot travel lanes and 5-foot paved shoulders with a 1-foot paved offset to guard rail, pavement shall extend 3-feet past the face of guard rail. The pavement structural section should include a minimum section of 4-inches of Hot Mix Asphalt (HMA) and 18-inches of gravel meeting requirements of MaineDOT Standard Specification 703.06 in the travel lanes, paved 12' wide. There should be a minimum of 2-inches of HMA placed on the shoulder and guard rail with 18-inches of gravel as specified above.

**Culvert Construction –** A 10-foot span by 6-foot rise precast concrete box culvert meeting the requirements of Special Provision 534 will be installed to replace the existing twin 6-foot diameter culverts. The culvert invert will be embedded 1-foot below existing streambed, with retention sills installed into the culvert, and special fill placed. On both the inlet and outlet ends of the culvert 1'x1' concrete headwalls are recommended to retain soil on top of the box. At the inlet, a collar or toe wall is recommended to prevent the stream water from flowing underneath the box and along the bedrock. The road will be closed during construction, and traffic will be detoured.

**Culvert Bearing Resistance –** Bearing capacity calculations have been completed for both the native soils above bedrock and for the bedrock. As the exact extents of bedrock are unknown, the box may partly or wholly rest on native soils. A value of 5 ksf should be used as the Service Limit State for bearing resistance if the box is constructed over native soils. A value of 15.7 ksf should be used as the Strength Limit State for bearing resistance if the box is constructed over native soils. These calculations are attached to this report.

If the culvert is placed upon bedrock, a value of 20 ksf should be used as the Service Limit State for bearing resistance, and a value of 5.5 ksf should be used as the Strength Limit State for bearing resistance. Bearing capacity for the rock has been calculated using the RMR method, calculations are attached to this report.

**Scour, Riprap and Collar –** Both the inlet and outlet of the precast concrete box culvert should be protected against scour with riprap. The toe of the riprap section shall be constructed 1 foot below the streambed elevation. The riprap section shall be underlain by a geotextile material conforming to item number 722.03 of the Standard Specification and Class "1" Erosion Control Geotextile with a permittivity on the order of 0.1/sec to prevent clogging of the geotextile by fines.

In addition to riprap protection, a collar should be installed at the inlet of the culvert in order to prevent water from flowing under the culvert on the bedrock. This collar can be constructed from flowable fill, impermeable soils such as a clay silt, or an alternative collar method.

**Seismic Design Considerations** – Seismic analysis is not required for single span bridges regardless of seismic zone. However, superstructure connections and minimum support lengths should be designed in accordance with LRFD requirements.

**Construction Considerations –** Soils encountered in borings at this pipe location include sandy gravels and sands. Some silts and organic materials were found. Any organic materials removed during construction should be replaced with granular borrow.

Borings indicate that bedrock exists just below the invert of the precast concrete box culvert. Excavation of bedrock is likely necessary for installation of the culvert. The bedrock surface is likely to be rough and fractured. If the culvert is placed upon bedrock, the bedrock surface shall be cleared of all loose fractured bedrock, loose decomposed bedrock, and soil. The cleanliness and condition of the bedrock surface shall be confirmed by the Resident prior to placing culvert bedding material.

## INTRODUCTION

The purpose of this Geotechnical Design Report is to present geotechnical recommendations for the proposed replacement of an existing box culvert which carries Jackins Brook under River Road in the Town of Clinton. River Road is a Priority 5 Highway Corridor. A subsurface investigation has been completed for this site. This report presents the soils and bedrock information obtained at the site and geotechnical design recommendations.

The existing twin 6-foot pipes are deteriorated and deformed. Slopes at the outlet of the culverts have begun eroding, and soils appear to be draining into the culvert joints.

Existing roadway lanes are 11 feet wide with gravel shoulders, and there is no guardrail at the Jackins Brook crossing. The existing vertical and horizontal highway alignments will be maintained in the replacement.

The proposed replacement structure will be a precast concrete box culvert with a span of 10-feet, a rise of 6-feet, and a length of 80-feet. The proposed roadway will have 11-foot lanes with 5-foot shoulders, guardrail, and 3-feet of pavement beyond the face of guardrail. River Road in Clinton has an Annual Average Daily Traffic (AADT) of 1406 vehicles.

Bedrock underneath the existing structure was found at elevations just below the proposed culvert inverts. Construction will likely require removal of bedrock, and the structure may be placed in part, or completely, on bedrock.

## GEOLOGIC SETTING

The existing culvert carries Jackins Brook under the River Road near its outlet into the Kennebec River, as shown in the location map found attached to this report.

Mapping by the Natural Resources Conservation Service (NRCS) indicates that soils in the site vicinity are Suffield silt loam, 15 to 25 percent slopes, eroded (SuD2).

According to the Surficial Geology map of the of the Waterville Quadrangle, Maine published by the Maine Geologic Survey, the surficial soils in the vicinity of the site consist of Glacial-marine deposits (Presumpscot Formation), mostly silt and clay, having low permeability, and poor drainage.

According to the Bedrock Geologic Map of Maine 1:500,000 (1984) published by the Maine Geological Survey, the bedrock in the vicinity of the site in consists of "Interbedded pelite and limestone and/or dolomite" of the Sangerville Formation (Ss).

## SUBSURFACE INVESTIGATION

Subsurface conditions at the site were explored by drilling two test borings on April 17, 2014 by MaineDOT. The borings were drilled using a 5-inch solid-stem auger. Soil samples were obtained using Standard Penetration Test (SPT) test methods with a 40 lb. hammer dropped 30". The standard penetration resistances (N-values) discussed in this report have been corrected for average energy transfer to $N_{60}$ values. A five-foot rock core was obtained for each boring using an NQ-2" core barrel.

Test boring SB-CLIN-101 was drilled at the southwest corner of the existing culvert in the gravel shoulder. Boring SB-CLIN-102 was drilled in the northeastern corner of the project, in the lane. Boring locations are shown on the Boring Location Plan and Profile attached to this report.

Rock cores were taken from both borings and found to be Sangerville Formation (Ss), composed of a moderately soft phyllite layer and a relatively hard siltstone layer. The cores have a low Rock Quality Designation (RQD) of 6 and 17%, and are significantly fractured.

Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are presented in the boring logs provided as an attachment to this report. Rock core
results of these laboratory tests are provided attached to this report. Moisture content photographs are provided as an attachment to this report.

The culvert invert will be installed at elevation 109.54 and the outlet invert at elevation 108.56, just above encountered bedrock. Excavation of bedrock is likely necessary to allow for precast or cast-in-place concrete toe walls and crushed stone bedding. Because bedrock location information is limited to two boring locations, the actual extents of the bedrock are unknown. The culvert may rest directly on bedrock, or may be placed in the soil layer above the bedrock.

## LABORATORY TESTING

Laboratory testing for samples obtained from the two borings consisted of five (5) standard grain size analysis with natural water content of the samples, as well as organic content testing for on applicable soil samples. The information and other soil test results are included on the Boring Logs found attached to this report.

## SUBSURFACE CONDITIONS

Subsurface conditions encountered at the borings were generally fill soils, fine to coarse sands and gravels with a thin layer of native till directly over the bedrock. An interpretive subsurface profile depicting the site stratigraphy is shown on the GeoPlan

and Interpretive Subsurface Profile attached to this report. The following paragraphs discuss the subsurface conditions encountered at the site in detail:

## Fill

Test Boring SB-CLIN-101 was drilled at the southwest corner of the existing culvert in the gravel shoulder. The boring found 9.5-feet of sandy GRAVEL, little silt. This was underlain by loose SAND, some gravel, some silt from 9.5-feet to 13-feet below ground surface. This layer was underlain by dense SAND, some gravel, little silt, a native till extending to bedrock at 16.9-feet below surface, at elevation 105.30.

Test boring SB-CLIN-102 was drilled in the northeastern corner of the project, in the lane. The boring encountered 4-inches of Hot Mix Asphalt pavement. Subbase material is approximately 5-feet of GRAVEL, some sand, some silt, trace clay. The gravel layer is underlain by approximately 1.5-feet of SILT, some clay, some sand from 5.5- to 7-feet below surface. From 7- to 14.7-feet below surface material consists of GRAVEL, some sand, some silt, a fill material with traces of brick and wood. Bedrock was encountered at 14.7-feet below surface, at elevation 108.50.

## Native Soils

A layer of native soils was encountered beneath the fill on test boring SB-CLIN-101 from elevation 109.2 to elevation 105.3. This dense SAND, with some gravel and little silt is a native till. Standard Penetration Testing (SPT) on this layer found strong materials, though $N_{60}$ values are not reliable as the values were likely influenced by the layer's proximity to bedrock. An approximate $N_{60}$ value of 16 has been used for bearing capacity calculations for this native material.

## Bedrock

Both borings encountered bedrock and were extended to include a 5-foot bedrock core. Bedrock is of the Sangerville Formation (Ss), and consist of highly fractured phyllite and stronger siltstone.

Boring SB-CLIN-101 encountered bedrock at an elevation of 105.30 and was cored to elevation 100.30, a depth of 21.9 feet below ground surface. Bedrock in this core was identified as highly fractured phyllite at the top of the core, with stronger siltstone at the bottom of the core. The Rock Quality Designation (RQD) is 6%, indicating that only 6% of the length of the core was in pieces of 4 inches or more.

Boring SB-CLIN-102 encountered bedrock at an elevation of 108.5 and was cored to elevation 103.70, a depth of 19.5 feet below ground surface. Bedrock in this core was identified as stronger siltstone at the top of the core, and highly fractured phyllite at the bottom of the care. An RQD of 17% was found for the core.

## Groundwater

Groundwater was observed at 9.0 feet below ground surface, and is expected to fluctuate seasonally depending upon local precipitation magnitude. The stream is at

### Existing Pavement Structure

The existing pavement structure observed at the boring location SB-CLIN-102 was found to have 4 inches of Hot Mix Asphalt (HMA). It was not possible to determine a change in soils that would indicate the thickness of the existing pavement structural section.

## GEOTECHNICAL DESIGN RECOMMENDATIONS

The following section discusses geotechnical design recommendations for a precast concrete box culvert.

### Bearing Resistance

The culvert will be constructed over either native tills or fractured bedrock.

In sections where the culvert is resting on native till soils a value of 15.7 ksf should be used for the Strength Limit State for bearing resistance, and a value of 5 ksf should be used as the Service Limit State for bearing resistance. Calculations for these values are attached to this report.

In sections where the culvert is resting on bedrock a value of 5.5 ksf should be used as the Strength Limit State for bearing resistance, and a value of 20 ksf should be used as the Service Limit State for bearing resistance. Bearing capacity for the rock has been calculated using the RMR method. Calculations for these values are attached to this report.

As it is not possible to know ahead of time whether the culvert will rest on bedrock or native till, a conservative value of 5.5 ksf should be used for the Strength Limit State for bearing resistance to prevent settlement, and a conservative value of 5 ksf should be used for the Service Limit State.

### Scour, Riprap and Collar

For scour protection and protection of the structure both the inlet and the outlet of the precast concrete box culvert should be protected with riprap. Refer to MaineDOT Bridge Design Guide (BDG) Section 2.3.11 for information regarding scour design.

Stone riprap shall conform to item number 703.26 of the MaineDOT Standard Specifications, and shall be placed at a maximum slope of 1.75H:1V. The riprap section shall be underlain by a geotextile material conforming to item number 722.03 of the Standard Specification and Class “1” Erosion Control Geotextile with a permittivity on the order of 0.1/sec to prevent clogging of the geotextile by fines.

In addition to riprap protection, a collar or toewall should be installed at the inlet of the culvert in order to prevent water from flowing under the culvert through the fractured bedrock and stone bedding. This collar can be constructed from flowable fill, impermeable soils such as clay silt, or an alternative collar method.

### 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. This culvert is not part of the National Highway System (NHS). While this culvert, at a 10-foot span, qualifies as a bridge to the MaineDOT, this bridge is not classified as a major structure. These criteria eliminate the MaineDOT BDG requirement to design the foundations for seismic earth loads. However, superstructure connections and minimum support length requirements shall be satisfied per LRFD Articles 3.10.9 and 4.7.4.4, respectively.

### Pavement Design

A minimum pavement thickness of 4 inches of Hot Mix Asphalt (HMA) should be placed in the traveled way in order to match existing pavement depths. A minimum of 18 inches of ASC-Gravel should be placed for the pavement structural section.

### Construction Considerations

Soils encountered in borings at this pipe location include sandy gravels and sands. Some silts, and brick and wood fill, and organic materials were found. Any organic materials removed during construction should be replaced with granular borrow. Excavated soils may be used as common borrow in accordance with MaineDOT Standard Specifications 203 and 703, but these soils may not be used as gravel in the new roadway construction. If substantial amounts of brick, wood or other fill materials are found, excavated soils may not be appropriate for use as common borrow.

Borings indicate that bedrock exists just below the invert of the precast concrete box culvert. Excavation of bedrock is likely necessary for installation of the culvert. The bedrock surface is likely to be rough and fractured. If the culvert is placed upon bedrock, the bedrock surface shall be cleared of all loose fractured bedrock, loose decomposed bedrock, and soil. The cleanliness and condition of the bedrock surface shall be confirmed by the Resident prior to placing culvert bedding material.

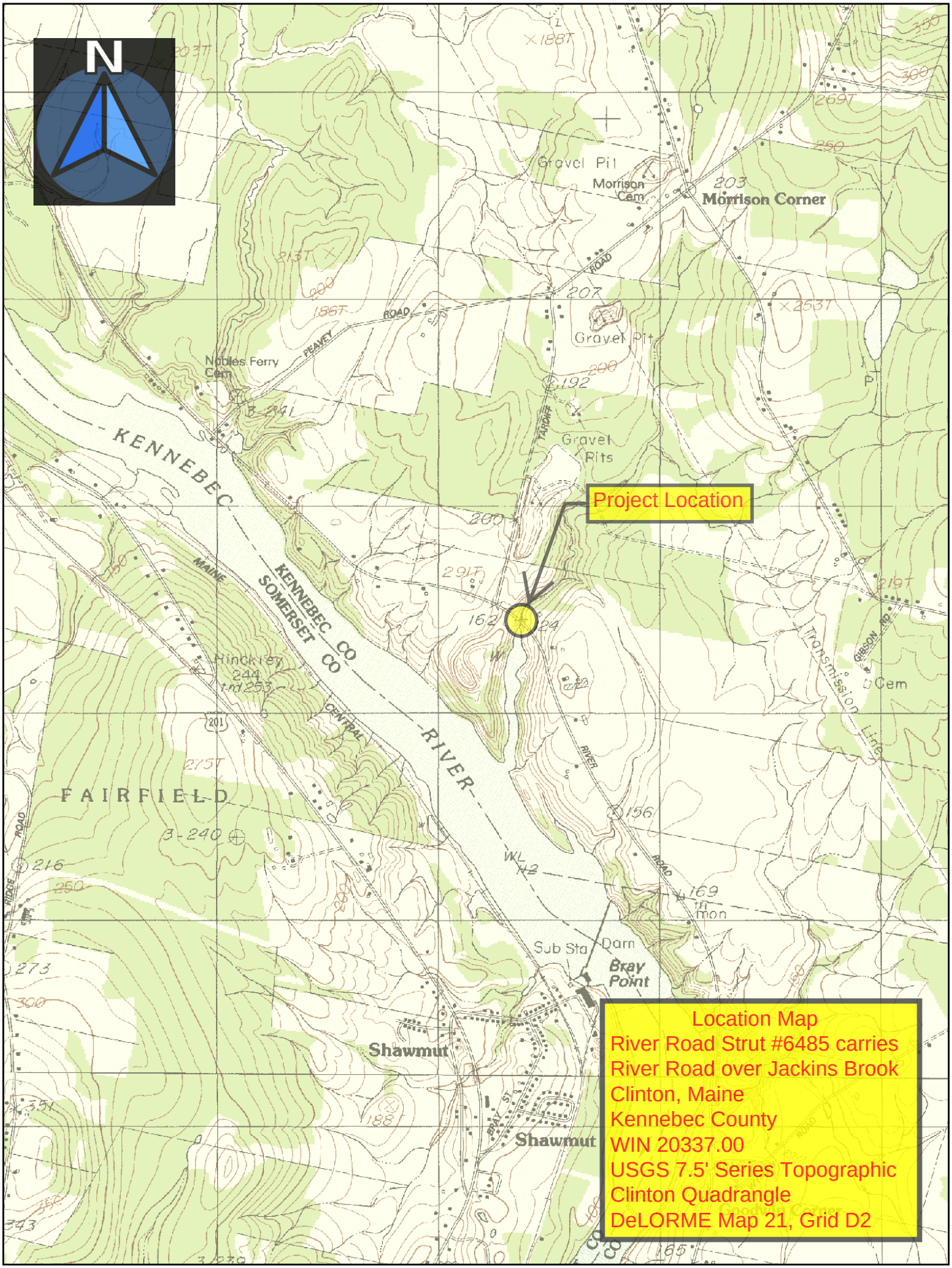
It is anticipated that there will be seepage of water from fractures and joints exposed in the bedrock surface. If areas of groundwater seepage are encountered during construction it may become necessary to control groundwater.

## CLOSURE

This report has been prepared for the use of the MaineDOT Highway Program for specific application to the proposed construction of the Jackins Brook culvert on River Road in Clinton. No other intended use of warranty is 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 at discrete locations at the site. If variations from the conditions encountered during the investigation appear evident during construction, it may also become necessary to re-evaluate the recommendations made in this report.

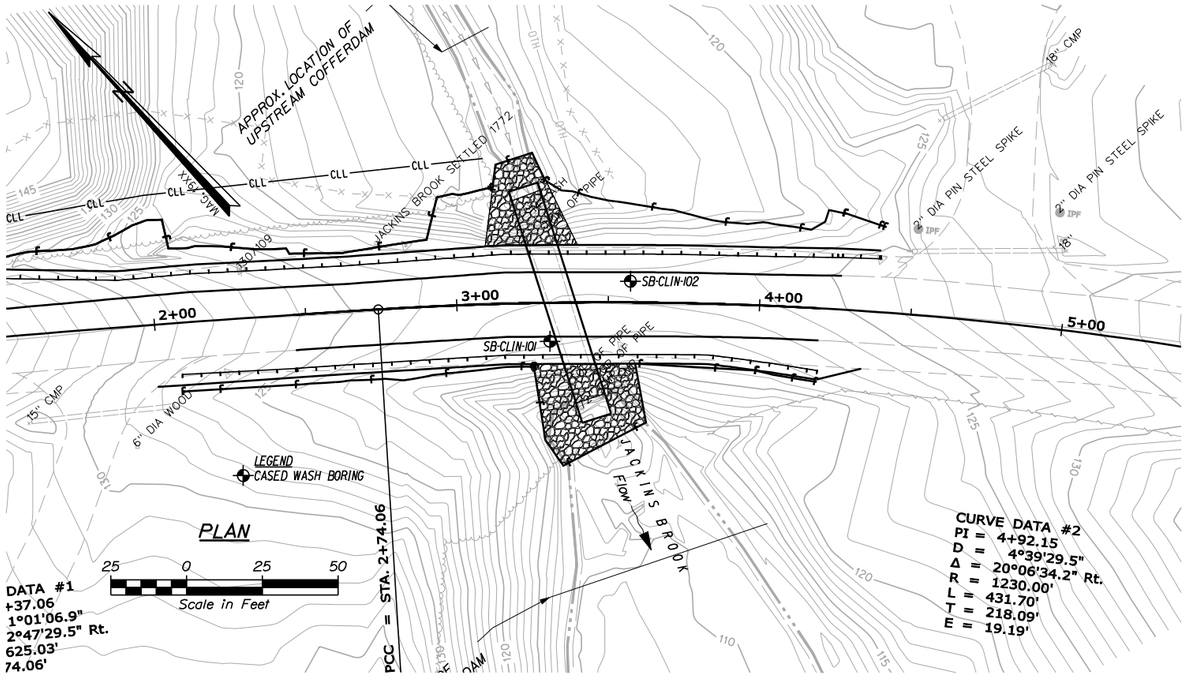
We also recommend that we be provided the opportunity for a general review of the final design plans and specifications in order to verify that the earthwork and foundation recommendations have been properly interpreted and implemented in the design.

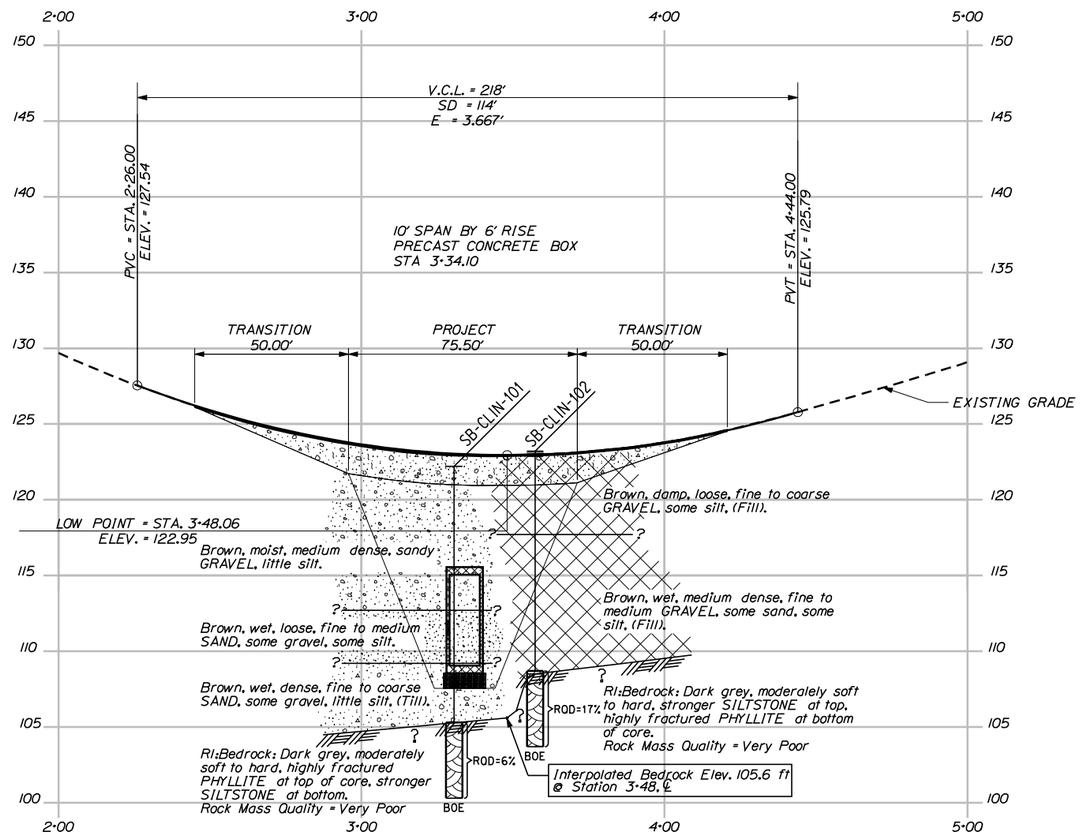
# SHEETS

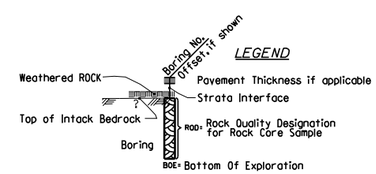


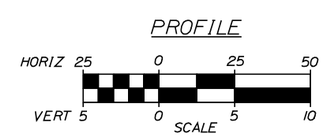

***Map Scale 1:24000***

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




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

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

WIN 20337.00

BRIDGE NO. 6485

HIGHWAY PLANS

| | | BY | DATE |
|---|---|---|---|
| PROJ. MANAGER | SHAWN SMITH | | |
| DESIGN-DETAILED | N HARTLEY | | |
| CHECKED-REVIEWED | | | |
| DESIGN2-DETAILED2 | M.KIRKMANN | T.WHITE | MAY 2014 |
| DESIGN3-DETAILED3 | | | |
| REVISIONS 1 | | | |
| REVISIONS 2 | | | |
| REVISIONS 3 | | | |
| REVISIONS 4 | | | |
| FIELD CHANGES | | | |

SIGNATURE

P.E. NUMBER

DATE

CLINTON
RIVER ROAD

GEOPLAN & INTERPRETIVE
SUBSURFACE PROFILE

SHEET NUMBER
2
OF 3

Filename: ...\GEOTECH\MSTA\001_GP&ISP1.dgn Division: GEOTECH Username: terry.white Date:6/18/2014

Filename: ...\MSTA\002_BORING LOGS1.dgn Division: GEOTECH Username: terry.white Date:6/18/2014

# Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: River Road Strut Replacement
Location: Clinton, Maine

Boring No.: SB-CLIN-101
WIN: 20337.00

| | | | | | |
|---|---|---|---|---|---|
| Driller: | MaineDOT | Elevation (ft.) | 122.2 | Auger ID/OD: | 5" Solid Stem |
| Operator: | Giles/Daggett | Datum: | NAVD88 | Sampler: | Standard Split Spoon |
| Logged By: | B. Wilder | Rig Type: | CME 45C | Hammer Wt./Fall: | 140#/30" |
| Date Start/Finish: | 4/17/2014; 08:00-11:30 | Drilling Method: | Cased wash Boring | Core Barrel: | NQ-2" |
| Boring Location: | 3+30.6, 12.7 ft Rt. | Casing ID/OD: | NW | Water Level*: | 9.0 ft bgs. |
| Hammer Efficiency Factor: 0.867 | | Hammer Type: | Automatic ☒ Hydraulic ☐ Rope & Cathead ☐ | | |

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
$S_u$ = Insitu Field Vane Shear Strength (psf)
$T_v$ = Pocket Torvane Shear Strength (psf)
$q_p$ = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
$N_{60}$ = SPT N-uncorrected corrected for hammer efficiency
$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

| Depth (ft.) | Sample No. | Pen./Rec. (in.) | Sample Depth (ft.) | Blows /6 in. Shear Strength (psf) or RQD (%) | N-uncorrected | $N_{60}$ | Casing Blows | Elevation (ft.) | Visual Description and Remarks | Laboratory Testing Results/ AASHTO and Unified Class |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | SSA | | | |
| 5 | 1D | 24/15 | 5.00 - 7.00 | 28/11/12/11 | 23 | 33 | 48 | | Brown, moist, medium dense, sandy GRAVEL, little silt. | G#243126 A-1-a, GM WC=4.5% |
| | | | | | | | 34 | | | |
| | | | | | | | 22 | | | |
| | | | | | | | 20 | | | |
| | | | | | | | 12 | 112.70 | 9.50 | |
| 10 | 2D | 24/19 | 10.00 - 12.00 | 2/3/2/2 | 5 | 7 | 11 | | Grey, wet, loose, fine to medium SAND, some gravel, some silt, trace clay, trace organics with wood. | G#243127 A-2-4, SC-SM WC=29.8% |
| | | | | | | | 13 | | | |
| | | | | | | | 52 | | | |
| | | | | | | | 265 | 109.20 | 13.00 | |
| | | | | | | | 90 | | | |
| 15 | 3D | 21.6/18 | 15.00 - 16.80 | 14/12/28/50(3.6) | 40 | 58 | 20 | | Brown, wet, dense, fine to coarse SAND, some gravel, little silt (Till). Weathered Rock in spoon tip. | G#243128 A-1-b, SM WC=11.0% |
| | R1 | 60/60 | 16.90 - 21.90 | RQD = 6% | | | @50 NQ-2 | 105.30 | @50 blows for 0.8 ft. Roller Coned ahead to 16.9 ft bgs. 16.90 | |
| | | | | | | | | | Top of Bedrock at Elev. 105.3 ft. R1:Bedrock: Dark gray, white quartz veins. Moderately soft to hard, minor rusty staining at top of core. Highly fractured phyllite at top of core, stronger siltstone at bottom of core. RQD 6% R1:Core Times (min:sec) 16.9-17.9 ft (2:55) 17.9-18.9 ft (7:00) 18.9-19.9 ft (9:20) 19.9-20.9 ft (7:50) 20.9-21.9 ft (8:30) 100% Recovery | | |
| 20 | | | | | | | | 100.30 | 21.90 | |
| | | | | | | | | | Bottom of Exploration at 21.90 feet below ground surface. | |
| 25 | | | | | | | | | | |

Remarks:
400# down pressure on Core Barrel.

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

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

Page 1 of 1
Boring No.: SB-CLIN-101

# Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: River Road Strut Replacement
Location: Clinton, Maine

Boring No.: SB-CLIN-102
WIN: 20337.00

| | | | | | |
|---|---|---|---|---|---|
| Driller: | MaineDOT | Elevation (ft.) | 123.2 | Auger ID/OD: | 5" Solid Stem |
| Operator: | Giles/Daggett | Datum: | NAVD88 | Sampler: | Standard Split Spoon |
| Logged By: | B. Wilder | Rig Type: | CME 45C | Hammer Wt./Fall: | 140#/30" |
| Date Start/Finish: | 4/17/2014; 11:30-14:00 | Drilling Method: | Cased wash Boring | Core Barrel: | NQ-2" |
| Boring Location: | 3+57.3, 7.0 ft Lt. | Casing ID/OD: | NW | Water Level*: | 9.0 ft bgs. |
| Hammer Efficiency Factor: 0.867 | | Hammer Type: | Automatic ☒ Hydraulic ☐ Rope & Cathead ☐ | | |

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
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HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
$S_u$ = Insitu Field Vane Shear Strength (psf)
$T_v$ = Pocket Torvane Shear Strength (psf)
$q_p$ = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
$N_{60}$ = SPT N-uncorrected corrected for hammer efficiency
$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

| Depth (ft.) | Sample No. | Pen./Rec. (in.) | Sample Depth (ft.) | Blows /6 in. Shear Strength (psf) or RQD (%) | N-uncorrected | $N_{60}$ | Casing Blows | Elevation (ft.) | Visual Description and Remarks | Laboratory Testing Results/ AASHTO and Unified Class |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | SSA | 122.87 | 4" PAVEMENT. 0.33 | |
| 5 | 1D 1D/A | 24/13 | 5.00 - 7.00 | 6/5/5/5 | 10 | 14 | | 117.70 | 1D (5.0-5.5 ft) Brown, damp, loose, fine to coarse GRAVEL, some sand, some silt, trace clay, occasional cobbles. (Fill). 5.50 1D/A (5.5-7.0 ft) Brown, wet, loose, SILT, some clay, some sand, trace gravel (Fill). | G#243129 A-1-b, GC-GM WC=6.4% G#243130 A-4, CL-ML WC=22.9% |
| 10 | 2D | 24/16 | 10.00 - 12.00 | 3/12/13/32 | 25 | 36 | 22 | | Brown, wet, medium dense, fine to medium GRAVEL, some sand, some silt, trace clay, with brick pieces (Fill). | G#243131 A-4, GC-GM WC=15.9% |
| | | | | | | | 67 | | | |
| | | | | | | | 89 | | | |
| | | | | | | | 132 | | | |
| 15 | R1 | 60/48 | 14.50 - 19.50 | RQD = 17% | | | @175 NQ-2 | 108.50 | @175 blows for 0.5 ft. Cobble from 14.5-14.7 ft bgs. R1:Core Times (min:sec) 14.5-15.5 ft (4:09) 14.70 | |
| | | | | | | | | | Top of Bedrock at Elev. 108.5 ft. R1:Bedrock:Dark gray, white quartz veins. Moderately soft to hard. No significant staining. Stronger siltstone at top of core, highly fractured phyllite at bottom of core. RQD 17%. R1:Core Times cont. (min:sec) 15.5-16.5 ft (4:30) 16.5-17.5 ft (3:45) 17.5-18.5 ft (5:00) 18.5-19.5 ft (5:05) 80% Recovery No Water Return. Left 0.4 ft of core in hole. 19.50 | | |
| 20 | | | | | | | | 103.70 | | |
| | | | | | | | | | Bottom of Exploration at 19.50 feet below ground surface. | |
| 25 | | | | | | | | | | |

Remarks:
400# down pressure on Core Barrel.

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

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

Page 1 of 1
Boring No.: SB-CLIN-102

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

HIGHWAY PLANS

WIN 20337.00

BRIDGE NO. 6485

| PROJ. MANAGER | SHAWN SMITH | BY | DATE |
|---|---|---|---|
| DESIGN-DETAILED | N HARTLEY | ----- | ----- |
| CHECKED-REVIEWED | ----- | ----- | ----- |
| DESIGN2-DETAILED2 | M.KIRKMANN | T.WHITE | MAY 2014 |
| DESIGN3-DETAILED3 | ----- | ----- | ----- |
| REVISIONS 1 | ----- | ----- | ----- |
| REVISIONS 2 | ----- | ----- | ----- |
| REVISIONS 3 | ----- | ----- | ----- |
| REVISIONS 4 | ----- | ----- | ----- |
| FIELD CHANGES | ----- | ----- | ----- |

SIGNATURE
P.E. NUMBER
DATE

CLINTON
RIVER ROAD

BORING LOGS

SHEET NUMBER
3
OF 3

# ATTACHMENTS

# Boring Logs

# Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

**Project:** River Road Strut Replacement
**Location:** Clinton, Maine

**Boring No.:** SB-CLIN-101
**WIN:** 20337.00

| | | | | | |
|---|---|---|---|---|---|
| **Driller:** | MaineDOT | **Elevation (ft.)** | 122.2 | **Auger ID/OD:** | 5" Solid Stem |
| **Operator:** | Giles/Daggett | **Datum:** | NAVD88 | **Sampler:** | Standard Split Spoon |
| **Logged By:** | B. Wilder | **Rig Type:** | CME 45C | **Hammer Wt./Fall:** | 140#/30" |
| **Date Start/Finish:** | 4/17/2014; 08:00-11:30 | **Drilling Method:** | Cased wash Boring | **Core Barrel:** | NQ-2" |
| **Boring Location:** | 3+30.6, 12.7 ft Rt. | **Casing ID/OD:** | NW | **Water Level*:** | 9.0 ft bgs. |
| **Hammer Efficiency Factor:** | 0.867 | **Hammer Type:** | Automatic ☒ Hydraulic ☐ Rope & Cathead ☐ | | |

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
$S_u$ = Insitu Field Vane Shear Strength (psf)
$T_v$ = Pocket Torvane Shear Strength (psf)
$q_p$ = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
$N_{60}$ = SPT N-uncorrected corrected for hammer efficiency
$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

| Depth (ft.) | Sample No. | Pen./Rec. (in.) | Sample Depth (ft.) | Blows (/6 in.) Shear Strength (psf) or RQD (%) | N-uncorrected | $N_{60}$ | Casing Blows | Elevation (ft.) | Visual Description and Remarks | Laboratory Testing Results/ AASHTO and Unified Class. |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | SSA | | | |
| 5 | 1D | 24/15 | 5.00 - 7.00 | 28/11/12/11 | 23 | 33 | 48 | | Brown, moist, medium dense, sandy GRAVEL, little silt. | G#243126 A-1-a, GM WC=4.5% |
| | | | | | | | 34 | | | |
| | | | | | | | 22 | | | |
| | | | | | | | 20 | | | |
| | | | | | | | 12 | 112.70 | 9.50 | |
| 10 | 2D | 24/19 | 10.00 - 12.00 | 2/3/2/2 | 5 | 7 | 11 | | Grey, wet, loose, fine to medium SAND, some gravel, some silt, trace clay, trace organics with wood. | G#243127 A-2-4, SC-SM WC=29.8% |
| | | | | | | | 13 | | | |
| | | | | | | | 52 | | | |
| | | | | | | | 265 | 109.20 | 13.00 | |
| | | | | | | | 90 | | | |
| 15 | 3D | 21.6/18 | 15.00 - 16.80 | 14/12/28/50(3.6) | 40 | 58 | 20 | | Brown, wet, dense, fine to coarse SAND, some gravel, little silt (Till). Weathered Rock in spoon tip. [a]50 blows for 0.8 ft. Roller Coned ahead to 16.9 ft bgs. | G#243128 A-1-b, SM WC=11.0% |
| | R1 | 60/60 | 16.90 - 21.90 | RQD = 6% | | | [a]50 NQ-2 | 105.30 | 16.90 | |
| 20 | | | | | | | | 100.30 | Top of Bedrock at Elev. 105.3 ft. R1:Bedrock: Dark gray, white quartz veins. Moderately soft to hard, minor rusty staining at top of core. Highly fractured phyllite at top of core, stronger siltstone at bottom of core. RQD 6% R1:Core Times (min:sec) 16.9-17.9 ft (2:55) 17.9-18.9 ft (7:00) 18.9-19.9 ft (9:20) 19.9-20.9 ft (7:50) 20.9-21.9 ft (8:30) 100% Recovery | |
| 25 | | | | | | | | | 21.90 **Bottom of Exploration at 21.90 feet below ground surface.** | |

**Remarks:**

400# down pressure on Core Barrel.

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.:** SB-CLIN-101

# Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

**Project:** River Road Strut Replacement
**Location:** Clinton, Maine

**Boring No.:** SB-CLIN-102
**WIN:** 20337.00

| | | | | | |
|---|---|---|---|---|---|
| **Driller:** | MaineDOT | **Elevation (ft.)** | 123.2 | **Auger ID/OD:** | 5" Solid Stem |
| **Operator:** | Giles/Daggett | **Datum:** | NAVD88 | **Sampler:** | Standard Split Spoon |
| **Logged By:** | B. Wilder | **Rig Type:** | CME 45C | **Hammer Wt./Fall:** | 140#/30" |
| **Date Start/Finish:** | 4/17/2014; 11:30-14:00 | **Drilling Method:** | Cased wash Boring | **Core Barrel:** | NQ-2" |
| **Boring Location:** | 3+57.3, 7.0 ft Lt. | **Casing ID/OD:** | NW | **Water Level*:** | 9.0 ft bgs. |
| **Hammer Efficiency Factor:** | 0.867 | **Hammer Type:** | Automatic ☒ Hydraulic ☐ Rope & Cathead ☐ | | |

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample attempt
V = Insitu Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Insitu Vane Shear Test attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = weight of 140lb. hammer
WOR/C = weight of rods or casing
WO1P = Weight of one person
$S_u$ = Insitu Field Vane Shear Strength (psf)
$T_v$ = Pocket Torvane Shear Strength (psf)
$q_p$ = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw field SPT N-value
Hammer Efficiency Factor = Annual Calibration Value
$N_{60}$ = SPT N-uncorrected corrected for hammer efficiency
$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$S_{u(lab)}$ = Lab Vane Shear Strength (psf)
WC = water content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Analysis
C = Consolidation Test

**Sample Information**

| Depth (ft.) | Sample No. | Pen./Rec. (in.) | Sample Depth (ft.) | Blows (/6 in.) Shear Strength (psf) or RQD (%) | N-uncorrected | $N_{60}$ | Casing Blows | Elevation (ft.) | Visual Description and Remarks | Laboratory Testing Results/ AASHTO and Unified Class. |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | SSA | 122.87 | 4" PAVEMENT. 0.33 | |
| 5 | 1D | 24/13 | 5.00 - 7.00 | 6/5/5/5 | 10 | 14 | | 117.70 | 1D (5.0-5.5 ft) Brown, damp, loose, fine to coarse GRAVEL, some sand, some silt, trace clay, occasional cobbles, (Fill). 5.50 | G#243129 A-1-b, GC-GM WC=6.4% |
| | 1D/A | | | | | | | | 1D/A (5.5-7.0 ft) Brown, wet, loose, SILT, some clay, some sand, trace gravel (Fill). | G#243130 A-4, CL-ML WC=22.9% |
| 10 | 2D | 24/16 | 10.00 - 12.00 | 3/12/13/32 | 25 | 36 | 22 | | Brown, wet, medium dense, fine to medium GRAVEL, some sand, some silt, trace clay, with brick pieces (Fill). | G#243131 A-4, GC-GM WC=15.9% |
| | | | | | | | 67 | | | |
| | | | | | | | 89 | | | |
| | | | | | | | 132 | | | |
| 15 | R1 | 60/48 | 14.50 - 19.50 | RQD = 17% | | | a175 NQ-2 | 108.50 | a175 blows for 0.5 ft. Cobble from 14.5-14.7 ft bgs. R1:Core Times (min:sec) 14.5-15.5 ft (4:09) 14.70 | |
| 20 | | | | | | | | 103.70 | Top of Bedrock at Elev. 108.5 ft. R1:Bedrock:Dark gray, white quartz veins. Moderately soft to hard. No significant staining. Stronger siltstone at top of core, highly fractured phyllite at bottom of core. RQD 15%. R1:Core Times cont. (min:sec) 15.5-16.5 ft (4:30) 16.5-17.5 ft (3:45) 17.5-18.5 ft (5:00) 18.5-19.5 ft (5:05) 80% Recovery No Water Return. Left 0.4 ft of core in hole. 19.50 | |
| 25 | | | | | | | | | **Bottom of Exploration at 19.50 feet below ground surface.** | |

**Remarks:**

400# down pressure on Core Barrel.

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.:** SB-CLIN-102

# Rock Core Photos

CLINTON 2033700

| | | |
|---|---|---|
| SB-CLIN-101<br>RI- 16.9-21.9 | Recovery<br>100% | RQD<br>4"/60" = 6% |
| SB-CLIN-102<br>RI- 14.5-19.5 | Recovery<br>48"/60" = 80% | RQD<br>10"/60" = 17% |

# Laboratory Data

State of Maine - Department of Transportation

## Laboratory Testing Summary Sheet

# Town(s): Clinton Work Number: 20337.00

| Boring & Sample Identification Number | Station (Feet) | Offset (Feet) | Depth (Feet) | Reference Number | G.S.D.C. Sheet | W.C. % | L.L. | P.I. | Classification | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Unified | AASHTO | Frost |
| SB-CLIN-101, 1D | 3+30.6 | 12.7 Rt. | 5.0-7.0 | 243126 | 1 | 4.5 | | | GM | A-1-a | I |
| SB-CLIN-101, 2D | 3+30.6 | 12.7 Rt. | 10.0-12.0 | 243127 | 1 | 29.8 | | | SC-SM | A-2-4 | II |
| SB-CLIN-101, 3D | 3+30.6 | 12.7 Rt. | 15.0-16.8 | 243128 | 1 | 11.0 | | | SM | A-1-b | II |
| SB-CLIN-102, 1D | 3+57.3 | 7.0 Lt. | 5.0-5.5 | 243129 | 2 | 6.4 | | | GC-GM | A-1-b | II |
| SB-CLIN-102, 1D/A | 3+57.3 | 7.0 Lt. | 5.5-7.0 | 243130 | 2 | 22.9 | | | CL-ML | A-4 | IV |
| SB-CLIN-102, 2D | 3+57.3 | 7.0 Lt. | 10.0-12.0 | 243131 | 2 | 15.9 | | | GC-GM | A-4 | III |
| | | | | | | | | | | | |
| SB-CLIN-101, 2D | Loss on Ignition (T 267) Loss 5.7% H2O 29.5% | | | | | | | | | | |

**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 MaineDOT and Corps of Engineers Classification Systems.**

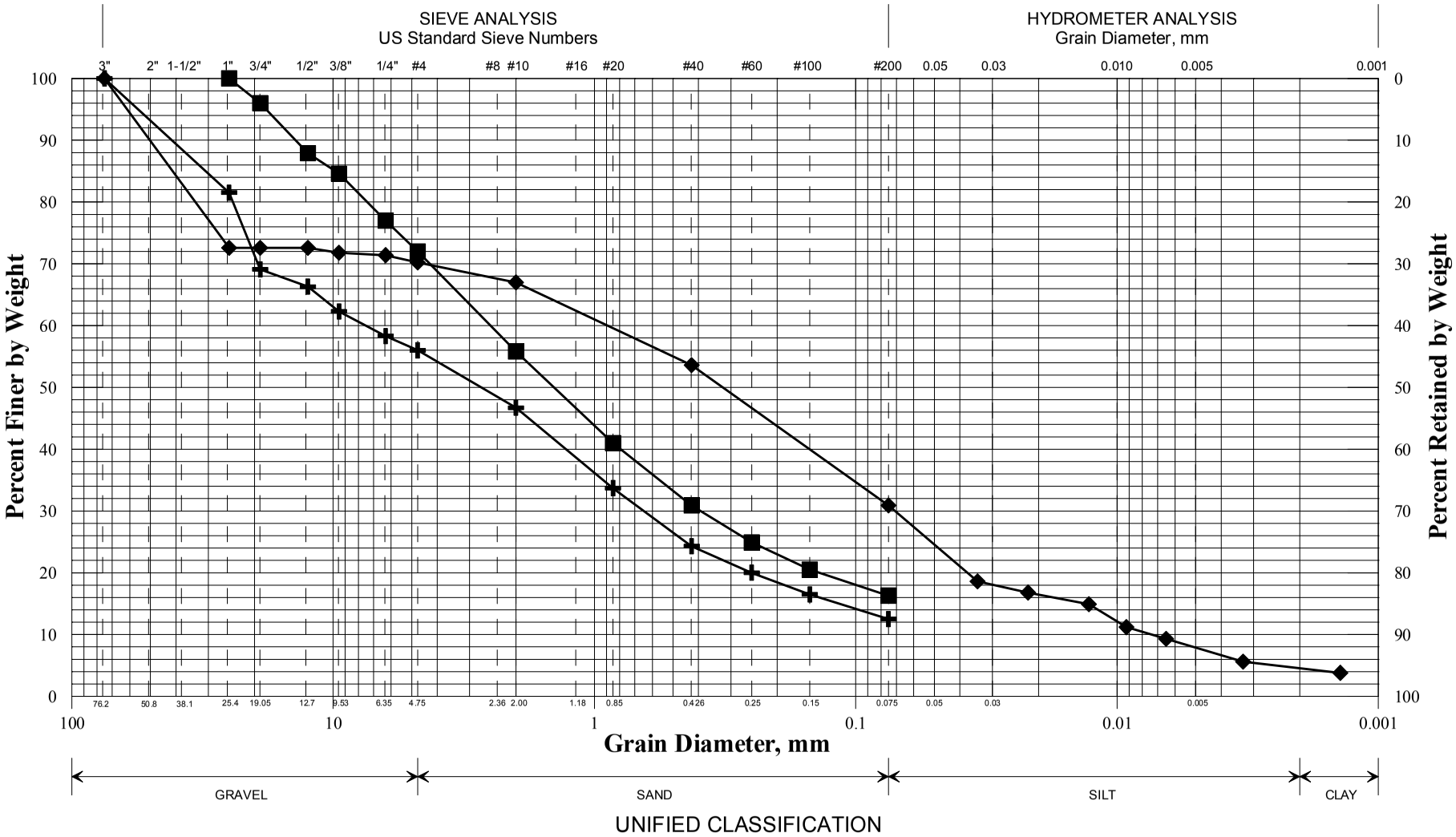
GSDC = Grain Size Distribution Curve as determined by AASHTO T 88-93 (1996) and/or ASTM D 422-63 (Reapproved 1998)

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 NP = Non Plastic

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

## *State of Maine Department of Transportation*
## GRAIN SIZE DISTRIBUTION CURVE

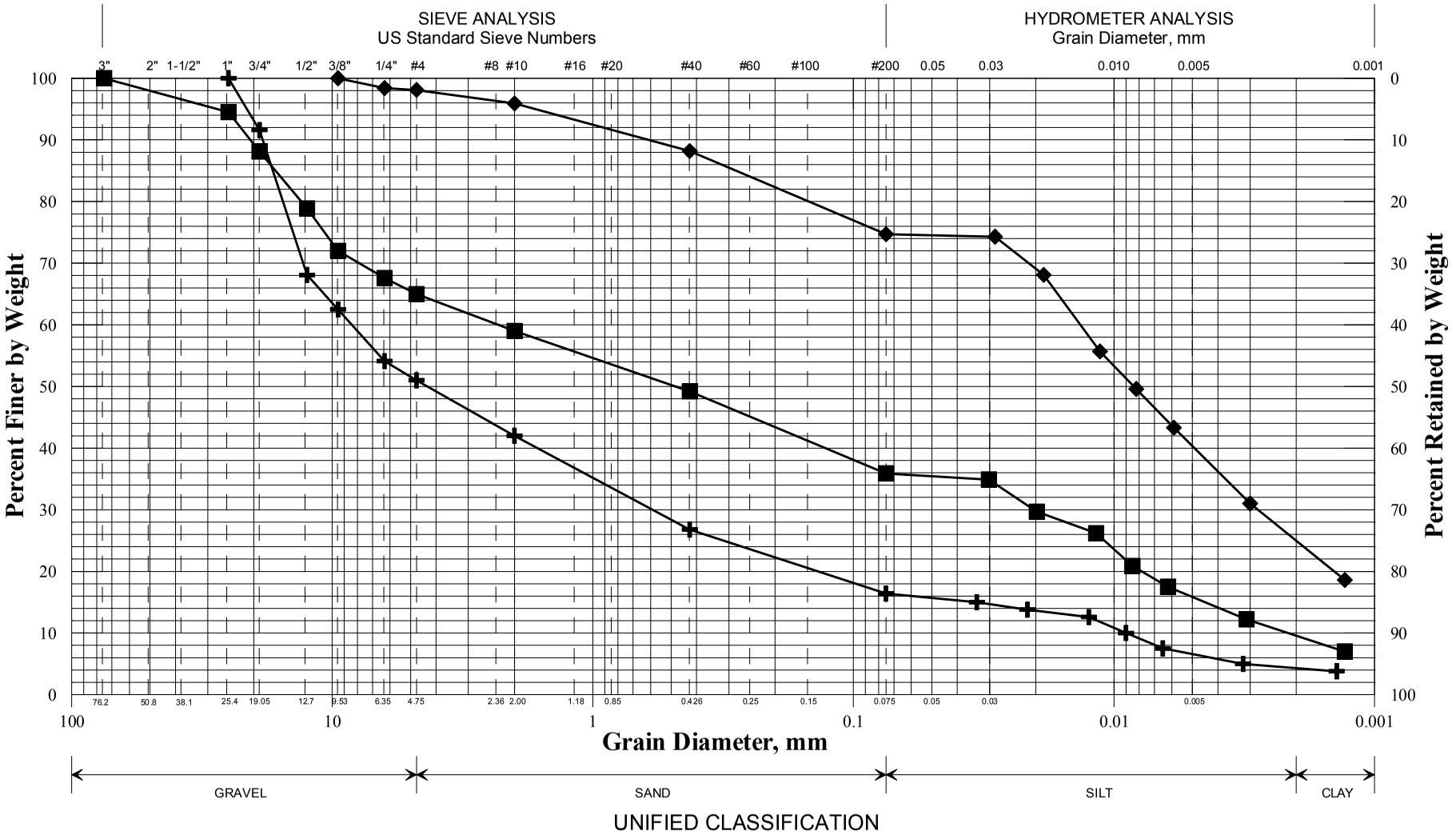



UNIFIED CLASSIFICATION

| | Boring/Sample No. | Station | Offset, ft | Depth, ft | Description | W, % | LL | PL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ✚ | SB-CLIN-101/1D | 3+30.6 | 12.7 RT | 5.0-7.0 | Sandy GRAVEL, little silt. | 4.5 | | | |
| ◆ | SB-CLIN-101/2D | 3+30.6 | 12.7 RT | 10.0-12.0 | SAND, some gravel, some silt, trace clay. | 29.8 | | | |
| ■ | SB-CLIN-101/3D | 3+30.6 | 12.7 RT | 15.0-16.8 | SAND, some gravel, little silt. | 11.0 | | | |
| ● | | | | | | | | | |
| ▲ | | | | | | | | | |
| ✕ | | | | | | | | | |

| WIN |
|---|
| 020337.00 |
| Town |
| Clinton |
| Reported by/Date |
| WHITE, TERRY A 4/29/2014 |

## *State of Maine Department of Transportation*
## GRAIN SIZE DISTRIBUTION CURVE




UNIFIED CLASSIFICATION

| | Boring/Sample No. | Station | Offset, ft | Depth, ft | Description | W, % | LL | PL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ✚ | SB-CLIN-102/1D | 3+57.3 | 7.0 LT | 5.0-5.5 | GRAVEL, some sand, little silt, trace clay. | 6.4 | | | |
| ◆ | SB-CLIN-102/1DA | 3+57.3 | 7.0 LT | 5.5-7.0 | SILT, some clay, some sand, trace gravel. | 22.9 | | | |
| ■ | SB-CLIN-102/2D | 3+57.3 | 7.0 LT | 10.0-12.0 | GRAVEL, some sand, some silt, trace clay. | 15.9 | | | |
| ● | | | | | | | | | |
| ▲ | | | | | | | | | |
| ✕ | | | | | | | | | |

| WIN |
|---|
| 020337.00 |
| Town |
| Clinton |
| Reported by/Date |
| WHITE, TERRY A 4/29/2014 |

MaineDOT

# GEOTECHNICAL TEST REPORT
## Central Laboratory

## SAMPLE INFORMATION

| Reference No. | Boring No./Sample No. | Sample Description | Sampled | Received |
|---|---|---|---|---|
| 243126 | SB-CLIN-101/1D | GEOTECHNICAL (DISTURBED) | 4/17/2014 | 4/22/2014 |

Sample Type: **GEOTECHNICAL** Location: **OTHER** Station: **3+30.6** Offset, ft: **12.7 RT** Dbfg, ft: **5.0-7.0**

WIN/Town **020337.00 - CLINTON** Sampler: **WILDER, BRUCE H**

## TEST RESULTS

**Sieve Analysis (T 27, T 11)**

Wash Method

Procedure A

| SIEVE SIZE U.S. [SI] | % Passing |
|---|---|
| 3 in. [75.0 mm] | 100.0 |
| 1 in. [25.0 mm] | 81.5 |
| ¾ in. [19.0 mm] | 69.1 |
| ½ in. [12.5 mm] | 66.3 |
| ⅜ in. [9.5 mm] | 62.3 |
| ¼ in. [6.3 mm] | 58.3 |
| No. 4 [4.75 mm] | 56.0 |
| No. 10 [2.00 mm] | 46.7 |
| No. 20 [0.850 mm] | 33.7 |
| No. 40 [0.425 mm] | 24.3 |
| No. 60 [0.250 mm] | 20.0 |
| No. 100 [0.150 mm] | 16.5 |
| No. 200 [0.075 mm] | 12.5 |

**Miscellaneous Tests**

| | |
|---|---|
| Liquid Limit @ 25 blows (T 89), % | |
| Plastic Limit (T 90), % | |
| Plasticity Index (T 90), % | |
| Specific Gravity, Corrected to 20°C (T 100) | |
| Loss on Ignition (T 267) | |
| Loss, % | |
| H2O, % | |
| Water Content (T 265), % | 4.5 |

**Consolidation (T 216)**

| Trimmings, Water Content, % | |
|---|---|

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

**Vane Shear Test on Shelby Tubes (Maine DOT)**

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

Comments:

## AUTHORIZATION AND DISTRIBUTION

Reported by: **FOGG, BRIAN** Date Reported: **4/24/2014**

*Paper Copy: Lab File; Project File; Geotech File*

MaineDOT

# GEOTECHNICAL TEST REPORT
## Central Laboratory

## SAMPLE INFORMATION

| Reference No. | Boring No./Sample No. | Sample Description | Sampled | Received |
|---|---|---|---|---|
| 243127 | SB-CLIN-101/2D | GEOTECHNICAL (DISTURBED) | 4/17/2014 | 4/22/2014 |

Sample Type: **GEOTECHNICAL** Location: **OTHER** Station: **3+30.6** Offset, ft: **12.7 RT** Dbfg, ft: **10.0-12.0**

WIN/Town **020337.00 - CLINTON** Sampler: **WILDER, BRUCE H**

## TEST RESULTS

### Sieve Analysis (T 88)

Wash Method

| SIEVE SIZE U.S. [SI] | % Passing |
|---|---|
| 3 in. [75.0 mm] | 100.0 |
| 1 in. [25.0 mm] | 72.6 |
| ¾ in. [19.0 mm] | 72.6 |
| ½ in. [12.5 mm] | 72.6 |
| ⅜ in. [9.5 mm] | 71.8 |
| ¼ in. [6.3 mm] | 71.4 |
| No. 4 [4.75 mm] | 70.2 |
| No. 10 [2.00 mm] | 67.0 |
| No. 20 [0.850 mm] | |
| No. 40 [0.425 mm] | 53.6 |
| No. 60 [0.250 mm] | |
| No. 100 [0.150 mm] | |
| No. 200 [0.075 mm] | 30.9 |
| [0.0342 mm] | 18.6 |
| [0.0219 mm] | 16.8 |
| [0.0128 mm] | 14.9 |
| [0.0092 mm] | 11.2 |
| [0.0065 mm] | 9.3 |
| [0.0033 mm] | 5.6 |
| [0.0014 mm] | 3.8 |

### Miscellaneous Tests

| | |
|---|---|
| Liquid Limit @ 25 blows (T 89), % | |
| Plastic Limit (T 90), % | |
| Plasticity Index (T 90), % | |
| Specific Gravity, Corrected to 20°C (T 100) | 2.59 |
| Loss on Ignition (T 267) | |
| Loss, % | 5.7 |
| H2O, % | 29.5 |
| Water Content (T 265), % | 29.8 |

### Consolidation (T 216)

| Trimmings, Water Content, % | |
|---|---|

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

### Vane Shear Test on Shelby Tubes (Maine DOT)

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

Comments:

## AUTHORIZATION AND DISTRIBUTION

Reported by: **FOGG, BRIAN** Date Reported: **4/25/2014**

*Paper Copy: Lab File; Project File; Geotech File*

MaineDOT

# GEOTECHNICAL TEST REPORT
## Central Laboratory

## SAMPLE INFORMATION

| Reference No. | Boring No./Sample No. | Sample Description | Sampled | Received |
|---|---|---|---|---|
| 243128 | SB-CLIN-101/3D | GEOTECHNICAL (DISTURBED) | 4/17/2014 | 4/22/2014 |

Sample Type: **GEOTECHNICAL** Location: **OTHER** Station: **3+30.6** Offset, ft: **12.7 RT** Dbfg, ft: **15.0-16.8**

WIN/Town **020337.00 - CLINTON** Sampler: **WILDER, BRUCE H**

## TEST RESULTS

### Sieve Analysis (T 27, T 11)

Wash Method

Procedure A

| SIEVE SIZE U.S. [SI] | % Passing |
|---|---|
| 3 in. [75.0 mm] | |
| 1 in. [25.0 mm] | 100.0 |
| ¾ in. [19.0 mm] | 96.0 |
| ½ in. [12.5 mm] | 87.9 |
| ⅜ in. [9.5 mm] | 84.6 |
| ¼ in. [6.3 mm] | 77.0 |
| No. 4 [4.75 mm] | 72.0 |
| No. 10 [2.00 mm] | 55.8 |
| No. 20 [0.850 mm] | 41.0 |
| No. 40 [0.425 mm] | 30.9 |
| No. 60 [0.250 mm] | 24.9 |
| No. 100 [0.150 mm] | 20.5 |
| No. 200 [0.075 mm] | 16.3 |

### Miscellaneous Tests

| | |
|---|---|
| Liquid Limit @ 25 blows (T 89), % | |
| Plastic Limit (T 90), % | |
| Plasticity Index (T 90), % | |
| Specific Gravity, Corrected to 20°C (T 100) | |
| Loss on Ignition (T 267) | |
| Loss, % | |
| H2O, % | |
| Water Content (T 265), % | 11.0 |

### Consolidation (T 216)

| Trimmings, Water Content, % | |
|---|---|

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

### Vane Shear Test on Shelby Tubes (Maine DOT)

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

Comments:

## AUTHORIZATION AND DISTRIBUTION

Reported by: **FOGG, BRIAN** Date Reported: **4/24/2014**

*Paper Copy: Lab File; Project File; Geotech File*

MaineDOT

# GEOTECHNICAL TEST REPORT
## Central Laboratory

## SAMPLE INFORMATION

| Reference No. | Boring No./Sample No. | Sample Description | Sampled | Received |
|---|---|---|---|---|
| 243129 | SB-CLIN-102/1D | GEOTECHNICAL (DISTURBED) | 4/17/2014 | 4/22/2014 |

Sample Type: **GEOTECHNICAL** Location: **OTHER** Station: **3+57.3** Offset, ft: **7.0** **LT** Dbfg, ft: **5.0-5.5**

WIN/Town **020337.00 - CLINTON** Sampler: **WILDER, BRUCE H**

## TEST RESULTS

### Sieve Analysis (T 88)

Wash Method

| SIEVE SIZE U.S. [SI] | % Passing |
|---|---|
| 3 in. [75.0 mm] | |
| 1 in. [25.0 mm] | 100.0 |
| ¾ in. [19.0 mm] | 91.6 |
| ½ in. [12.5 mm] | 68.1 |
| ⅜ in. [9.5 mm] | 62.5 |
| ¼ in. [6.3 mm] | 54.1 |
| No. 4 [4.75 mm] | 51.0 |
| No. 10 [2.00 mm] | 42.0 |
| No. 20 [0.850 mm] | |
| No. 40 [0.425 mm] | 26.8 |
| No. 60 [0.250 mm] | |
| No. 100 [0.150 mm] | |
| No. 200 [0.075 mm] | 16.4 |
| [0.0336 mm] | 15.0 |
| [0.0215 mm] | 13.8 |
| [0.0125 mm] | 12.6 |
| [0.0090 mm] | 10.0 |
| [0.0065 mm] | 7.5 |
| [0.0032 mm] | 5.0 |
| [0.0014 mm] | 3.8 |

### Miscellaneous Tests

| | |
|---|---|
| Liquid Limit @ 25 blows (T 89), % | |
| Plastic Limit (T 90), % | |
| Plasticity Index (T 90), % | |
| Specific Gravity, Corrected to 20°C (T 100) | 2.60 |
| Loss on Ignition (T 267) | |
| Loss, % | |
| H2O, % | |
| Water Content (T 265), % | 6.4 |

### Consolidation (T 216)

| Trimmings, Water Content, % | |
|---|---|

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

### Vane Shear Test on Shelby Tubes (Maine DOT)

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

Comments:

## AUTHORIZATION AND DISTRIBUTION

Reported by: **FOGG, BRIAN** Date Reported: **4/25/2014**

*Paper Copy: Lab File; Project File; Geotech File*

MaineDOT

# GEOTECHNICAL TEST REPORT
## Central Laboratory

## SAMPLE INFORMATION

| Reference No. | Boring No./Sample No. | Sample Description | Sampled | Received |
|---|---|---|---|---|
| 243130 | SB-CLIN-102/1DA | GEOTECHNICAL (DISTURBED) | 4/17/2014 | 4/22/2014 |

Sample Type: **GEOTECHNICAL** Location: **OTHER** Station: **3+57.3** Offset, ft: **7.0** **LT** Dbfg, ft: **5.5-7.0**

WIN/Town **020337.00 - CLINTON** Sampler: **WILDER, BRUCE H**

## TEST RESULTS

### Sieve Analysis (T 88)

Wash Method

| SIEVE SIZE U.S. [SI] | % Passing |
|---|---|
| 3 in. [75.0 mm] | |
| 1 in. [25.0 mm] | |
| ¾ in. [19.0 mm] | |
| ½ in. [12.5 mm] | |
| ⅜ in. [9.5 mm] | **100.0** |
| ¼ in. [6.3 mm] | **98.4** |
| No. 4 [4.75 mm] | **98.1** |
| No. 10 [2.00 mm] | **95.9** |
| No. 20 [0.850 mm] | |
| No. 40 [0.425 mm] | **88.2** |
| No. 60 [0.250 mm] | |
| No. 100 [0.150 mm] | |
| No. 200 [0.075 mm] | **74.7** |
| [0.0286 mm] | **74.3** |
| [0.0186 mm] | **68.1** |
| [0.0113 mm] | **55.7** |
| [0.0082 mm] | **49.6** |
| [0.0059 mm] | **43.3** |
| [0.0030 mm] | **31.0** |
| [0.0013 mm] | **18.6** |

### Miscellaneous Tests

| | |
|---|---|
| Liquid Limit @ 25 blows (T 89), % | |
| Plastic Limit (T 90), % | |
| Plasticity Index (T 90), % | |
| Specific Gravity, Corrected to 20°C (T 100) | **2.67** |
| Loss on Ignition (T 267) | |
| Loss, % | |
| H2O, % | |
| Water Content (T 265), % | **22.9** |

### Consolidation (T 216)

| Trimmings, Water Content, % | |
|---|---|

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

### Vane Shear Test on Shelby Tubes (Maine DOT)

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

Comments:

## AUTHORIZATION AND DISTRIBUTION

Reported by: **FOGG, BRIAN** Date Reported: **4/25/2014**

*Paper Copy: Lab File; Project File; Geotech File*

MaineDOT

# GEOTECHNICAL TEST REPORT
## Central Laboratory

## SAMPLE INFORMATION

| Reference No. | Boring No./Sample No. | Sample Description | Sampled | Received |
|---|---|---|---|---|
| 243131 | SB-CLIN-102/2D | GEOTECHNICAL (DISTURBED) | 4/17/2014 | 4/22/2014 |

Sample Type: **GEOTECHNICAL** Location: **OTHER** Station: **3+57.3** Offset, ft: **7.0** **LT** Dbfg, ft: **10.0-12.0**

WIN/Town **020337.00 - CLINTON** Sampler: **WILDER, BRUCE H**

## TEST RESULTS

### Sieve Analysis (T 88)

Wash Method

| SIEVE SIZE U.S. [SI] | % Passing |
|---|---|
| 3 in. [75.0 mm] | 100.0 |
| 1 in. [25.0 mm] | 94.5 |
| ¾ in. [19.0 mm] | 88.1 |
| ½ in. [12.5 mm] | 78.9 |
| ⅜ in. [9.5 mm] | 72.0 |
| ¼ in. [6.3 mm] | 67.6 |
| No. 4 [4.75 mm] | 65.0 |
| No. 10 [2.00 mm] | 59.0 |
| No. 20 [0.850 mm] | |
| No. 40 [0.425 mm] | 49.2 |
| No. 60 [0.250 mm] | |
| No. 100 [0.150 mm] | |
| No. 200 [0.075 mm] | 35.9 |
| [0.0302 mm] | 34.9 |
| [0.0198 mm] | 29.7 |
| [0.0117 mm] | 26.2 |
| [0.0085 mm] | 20.9 |
| [0.0062 mm] | 17.5 |
| [0.0031 mm] | 12.2 |
| [0.0013 mm] | 7.0 |

### Miscellaneous Tests

| | |
|---|---|
| Liquid Limit @ 25 blows (T 89), % | |
| Plastic Limit (T 90), % | |
| Plasticity Index (T 90), % | |
| Specific Gravity, Corrected to 20°C (T 100) | 2.65 |
| Loss on Ignition (T 267) | |
| Loss, % | |
| H2O, % | |
| Water Content (T 265), % | 15.9 |

### Consolidation (T 216)

| Trimmings, Water Content, % | |
|---|---|

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

### Vane Shear Test on Shelby Tubes (Maine DOT)

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

Comments:

## AUTHORIZATION AND DISTRIBUTION

Reported by: **FOGG, BRIAN** Date Reported: **4/25/2014**

*Paper Copy: Lab File; Project File; Geotech File*

# Calculations

## At-Rest Earth Pressures

$\beta := 0\ deg$ Slope angle of backfill soils from horizontal

$\phi := 32\ deg$ Assumed effective friction angle for granular borow (BDG Table 3-3)

$K_o := 1 - \sin(\phi)$

$K_o = 0.47$

## Service Limit State Bearing Resistance

Nominal and factored Bearing Resistance

Presumptive Bearing Resistance for Service Limit State ONLY

Reference : AASHTO LRFD Bridge Design Specification 6th Edition
Table C10.6.2.6.1-1 Presumptive Bearing Resistances for Sprad Footings at
the Service Limit State Modified after US Department of Navy (1982)

Type of Bearing Material: Weathered or broken bedrock of any kind except shale.
Consistency in Place: Heavily fractured - RQD = 6 to 15%.
Bearing Resistance: Ordinary Range (ksf) 16-24.
Recommended Value of Use: 20 ksf.

### Recommended Value: 20 ksf = 10 tsf

Note: This bearing resistance is settlement limited (1 inch) and applies only to the service limit state.

## Strength Limit State Bearing Resistance

**Determine Bearing Resistance of pre-cast concrete culvert on bedrock using RMR method from AASHTO LRFD Section 10.4.6.4 Rock Mass Strength**

References
1. AASHTO LRFD Bridge Design Specifications, 6th Edition, 2012
2. Wylie, Duncan C., "Foundations on Rock", Second Edition 2009
3. Hoek, E. and Brown, E.T., "The Hoek-Brown Failure Criterion - A 1988 Update", 1988

Rock is Sangerville Formation (Ss), Interbedded pelite and limestone, and/or dolomite.

RQD of samples were 6% and 15%.

Determine RMR form Table 10.4.9.4-1: Geomethanics Classification of Rock Mass.

1. Strength of intact rock material - see TABLE 4.4.8.1.2B Standard Specification 17th Ed., 2002. Typical Range of Uniaxial Compressive Stregth (Co) as a Function of Rock Category and Rock Type.
   Type B - Lithified argillaceous rock
   Phyllite qu = 500 - 5,000 ksf or 3,500 - 35,000 psi
   Siltstone qu = 200 - 2,500 ksf or 1,400 - 17,000 psi
   Values to Use - qu = 1,250 ksf or 8,680 psi

   From LRFD Table 10.4.6.4-1, 1080-2160 ksf, Relative Rating = 7

2. Drill core quality RQD - from Table 10.4.6.4-1, <25%, Relative Rating = 3

3. Spacing of Joints - from Table 10.4.6.4-1, <2 inc., Relative Rating = 5

4. Condition of Joints - from Table 10.4.6.4-1, joints open .05-0.2 inc., continuous joints, Relative Rating = 6

5. Groundwater conditions - from Table 10.4.6.4-1, moist only, Relative Rating = 7

RMR = Sum of 5 Relative Ratings = 28.

From Table 10.4.6.4-2 Geomechanics Rating Adjustment for Joint Orientations, Fair = -7.

Adjusted RMR = 21

Table 10.4.6.4-3 Geomechanics Rock Mass Classes Determined from Total Ratings, RMR 40-21, Class No. IV, Poor Rock.

**Determine Rock Type from TABLE 10.4.6.4-4:**

Rock Type B - Lithified argillaceous rocks.

**Determine Rock Property Constants m and s:**

Reference: "The Hoek-Brown Failure Criterion - a 1988 Update", Hoek, E. and Brown, E.T.

for intact rock, from Table 10.4.6.4-4, Type B $m_i := 10.00$

for a disturbed rock mass

$$RMR := 21$$

$$m := m_i \cdot \exp\left(\frac{RMR - 100}{14}\right) \qquad m = 0.035$$

$$s := \exp\left(\frac{RMR - 100}{6}\right) \qquad s = 1.913 \cdot 10^{-6}$$

**Determine Nominal and Factored Bearing Resistance of Bedrock:**

$C_{f1} := 1.0$ from Willie, Table 5.4, pg. 138 for Strip Foundation

$q_{uc} := \begin{bmatrix} 5000 \\ 10000 \end{bmatrix} psi$ AASHTO Table 4.4.8.1.2B, low end for phyllite and siltstone

Nominal Bearing Resistance

$$q_{nom} := C_{f1} \cdot \sqrt{s} \cdot q_{uc} \cdot \left(1 + \sqrt{m \cdot s^{-.5} + 1}\right)$$

$q_{nom} = \begin{bmatrix} 6.134 \\ 12.267 \end{bmatrix} ksf$ from Willie Equation 5.4, pg. 138

**Factored Bearing Resistance - Strength Limit State:**

Use resistance factor of 0.45 for footings on rock, LRFD Table 10.5.5.2.2-1

$\phi_{bc} := 0.45 \qquad q_f := q_{nom} \cdot \phi_{bc}$

$$q_f = \begin{bmatrix} 2.76 \\ 5.52 \end{bmatrix} ksf$$

Use 5.5 ksf for Strength Limit State

## Service Limit State Bearing Resistance - Native Sand Soils

Nominal and factored Bearing Resistance

Presumptive Bearing Resistance for Service Limit State ONLY

Reference: AASHTO LRFD Bridge Design Specifications 2012 Edition
Table C10.6.2.6.1-1 Presumptive Bearing Resistances for Spread Footings at the Service Limit State Modified after US Department of Navy (1982)

Type of Bearing Material: Brown, wet, dense, fine to coarse SAND, some gravel, little silt (Till).

Consistency In Place: Moderately Dense, N60 = 16.

Bearing Resistance: Ordinary Range (ksf) 4-8 medium dense to dense (based on SM).

Recomended Value of Use: 5 ksf

**RECOMMENDED VALUE: 5 ksf**

*Note: This bearing resistance is settlement limited (1 inch) and applies only to the service limit state.*

## Characteristics of Native Soils at Foundation Level

Brown, wet, dense, fine to coarse SAND, some gravel, little silt (Till).

| | |
|---|---|
| $wc := 0.11$ | average water content |
| $e := 0.7$ | estimated void ratio |
| $\gamma_w := 62.4\ pcf$ | unit weight of water |
| $sp := 2.67$ | estimated specific gravity |

saturation $\quad sat := \frac{(wc \cdot sp)}{e} \quad sat = 0.42$

total unit weight $\quad \gamma_t := \frac{(sp + sat \cdot e) \cdot \gamma_w}{(1+e)} \quad \gamma_t = 108.8\ pcf$

saturated unit weight $\quad \gamma_{sat} := \frac{(sp + e) \cdot \gamma_w}{(1+e)} \quad \gamma_{sat} = 123.7\ pcf$

## Strength Limit State Bearing Resistance - Native Silt-Clay Soils

Nominal and factored Bearing Resistance for culverts

Assumptions:

1. 6 foot rise by 10 foot span precast concrete culvert. Length of 80'. Depth of the culvert is 14 feet. $D_f := 14\ ft$

2. Assumed soil parameters are:

| | |
|---|---|
| moist unit weight | $\gamma_t = 108.8\ pcf$ |
| saturated unit weight | $\gamma_{sat} = 123.7\ pcf$ |
| angle of internal friction | $\phi := 30\ °$ |
| cohesion | $c := 0\ ksf$ |
| depth to groundwater | $D_w := 9\ ft$ |

3. L>B, so use Terzaghi strip foundation equations

Terzaghi shape factors

$B := 10\ ft$

$s_c := 1.0$

$s_\gamma := 1.0$

Bearing capacity factors
Table 10.6.3.1.2a-1 LRFD

$N_c := 30.1$

$N_q := 18.4$

$N_\gamma := 22.4$

Effective stress at footing level

$q_{eff} := \gamma_t \cdot D_f$

$q_{eff} = 1523\ psf$

Nominal Bearing Resistance

$q_{nom} := c \cdot N_c \cdot s_c + q_{eff} \cdot N_q + 0.5 \cdot (\gamma_{sat} - \gamma_w) \cdot B \cdot N_\gamma \cdot s_\gamma$

$q_{nom} = 34888.5\ psf$

Resistance Factor from LRFD
Table 10.5.5.2.2-1, pg 10-39

$\Phi_b := 0.45$

$q_{factored} := q_{nom} \cdot \Phi_b$ $\qquad$ $q_{factored} = 15.7\ ksf$

**For this project the Service Limit State Bearing Resistance Controls. The bearing resistance of 6 ksf should be used.**