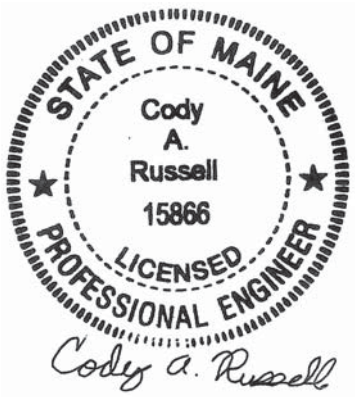
**MAINE DEPARTMENT OF TRANSPORTATION**
**HIGHWAY PROGRAM**
**GEOTECHNICAL SECTION**
**AUGUSTA, MAINE**

# GEOTECHNICAL DESIGN REPORT

*For the Replacement of:*

**CROSS CULVERT #XC-180749**
**SLY BROOK ROAD**
**EAGLE LAKE, MAINE**

*Prepared by:*
Cody Russell, P.E.
Geotechnical Engineer




*Reviewed by:*
Kathleen Maguire, P.E.
Senior Geotechnical Engineer

Aroostook County
WIN 22853.00

Soils Report 2020-21
June 22, 2020

## PROJECT DETAILS

The purpose of this Geotechnical Design Report is to present subsurface information and make geotechnical design and construction recommendations for the replacement of an existing approximately 40-foot long, 36-inch diameter corrugated metal pipe (CMP) cross culvert (#XC-180749) on Sly Brook Road in Eagle Lake. The existing culvert is collapsing. The culvert is located approximately 1.65 miles south of the Wallagrass town line as shown in the attached Location Map. Sly Brook Road is a Highway Corridor Priority 4 road.

The proposed replacement structure will be a 103-inch span by 71-inch rise, 62-foot long polymer-coated steel structural pipe arch culvert. The invert of the proposed culvert is approximately 9 feet below the existing road grade at the roadway centerline. The roadway embankment slopes at the proposed culvert inlet and outlet shall be no steeper than 2H:1V on the inlet outlet to protect against erosion.

## SUBSURFACE INVESTIGATION

One (1) probe (HB-EALA-101) and one (1) boring (HB-EALA-102) were drilled for this project on May 17, 2016 by the MaineDOT drill crew using a trailer-mounted drill rig. Exploration locations are shown on the attached Boring Location Plan & Interpretive Subsurface Profile with Boring Logs sheet. Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are shown on the attached boring logs.

Probe HB-EALA-101 was drilling using solid stem auger techniques. No soil samples were obtained in the probe. Boring HB-EALA-102 was drilled using solid stem auger and cased washed boring techniques. Soil samples were obtained in boring HB-EALA-102 at 5-foot intervals using Standard Penetration Test (SPT) methods at depths of approximately 1.0 feet and 5.0 feet below ground surface (bgs). The MaineDOT drill rig is equipped with an automatic hammer to drive the split spoon. The MaineDOT calibrated automatic hammer delivers approximately 51 percent more energy during driving than the standard rope and cathead system. All N-values discussed in this report are corrected values ($N_{60}$) computed by applying an average energy transfer factor of 0.908 to the raw field N-values. The autohammer broke at a depth of approximately 9.0 feet bgs, preventing additional SPT sampling as the boring advanced.

The MaineDOT Geotechnical Team member selected the boring and probe locations, drilling methods, designated type and depth of sampling, reviewed field logs for accuracy and identified field and laboratory testing requirements. A NorthEast Transportation Training and Certification (NETTCP) certified Subsurface Investigator logged the subsurface conditions encountered. The boring and probe were located in the field by taping to surveyed site features after completion of the drilling program.

## LABORATORY TESTING

A laboratory testing program was conducted to assist in soil classification, evaluation of engineering properties of the soils and geologic assessment of the project site. Laboratory testing consisted of one (1) standard grain size analysis with natural water content and one (1) grain size

analysis with hydrometer and natural water content. The results of the laboratory testing program are discussed in the following section and are shown on the attached boring logs, Laboratory Testing Summary Sheet, and Grain Size Distribution Curve sheet.

## SUBSURFACE CONDITIONS

Subsurface conditions encountered at the test boring generally consisted of fill underlain by native sandy silt underlain by glacial till. An interpretive subsurface profile depicting the generalized soil stratigraphy at the boring location is shown on the attached Boring Location Plan & Interpretive Subsurface Profile with Boring Logs sheet.

Probe HB-EALA-101 was drilled to a depth of approximately 15.0 feet below ground surface (bgs) and did not encounter a refusal surface. Boring HB-EALA-102 was drilled to a depth of approximately 20.0 feet bgs and did not encounter a refusal surface.

The table below summarizes the field and laboratory information obtained in boring HB-EALA-102:

| Approx. Depth BGS[1] (feet) | Soil Description | AASHTO[2] Classification | USCS[3] | WC%[4] |
|---|---|---|---|---|
| 0.0 – 4.5 | Fill:<br>Brown, damp, fine to coarse sand, some gravel, little silt. | A-1-b | SM | 7.1 |
| 4.5 – 6.8 | Dark brown, wet, fine to coarse sandy silt, trace gravel, trace clay, some organics. | A-4 | CL | 21.4 |
| 6.8 – 9.0 | Cobbles. | -- | -- | -- |
| 9.0 – 20.0 | Gravelly Glacial Till, occasional cobbles. | -- | -- | -- |

[1]BGS = below ground surface
[2]AASHTO = American Association of State Highway and Transportation Officials
[3]USCS = Unified Soil Classification System
[4]WC% = Water content in percent

One (1) corrected N-value obtained in the fill was 24 indicating that the fill is medium dense in consistency. One (1) corrected N-value obtained in the sandy silt was 41 bpf indicating that the sandy silt is hard in consistency. No corrected N-values were obtained in the glacial till.

Groundwater was not observed in the boring or probe. Groundwater levels can be expected to fluctuate subject to seasonal variations, local soil conditions, topography, precipitation, and construction activity.

## GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS

**Polymer Coated Steel Structural Pipe Arch Culvert Construction** – The proposed replacement structure will be a 103-inch span by 71-inch rise, 62-foot long polymer coated steel structural pipe

arch culvert. The proposed polymer coated steel structural pipe arch culvert shall be furnished and installed in accordance with MaineDOT Standard Specification 603.

The invert of the proposed polymer coated steel structural pipe arch culvert ranges from approximately 583.6 feet at the inlet end to approximately 580.1 feet at the outlet end with a 5.65% slope.

The full nature of the proposed culvert bearing surface will not become evident until the culvert excavation is made. Any cobbles or boulders encountered in excess of 6 inches shall be removed and replaced with compacted Granular Borrow Material for Underwater Backfill or Crushed Stone ¾-Inch. The prepared subgrade shall be proof-rolled using a static roller to visually confirm the prepared subgrade is firm and stable. The exposed subgrade shall be free of ponded water so that bedding material placement and compaction can be completed in the dry.

The proposed structure shall be bedded on a 1-foot thick layer of Granular Borrow, Material for Underwater Backfill meeting the requirements of MaineDOT Standard Specification 703.19. The soil envelope and backfill shall consist of Standard Specification 703.19 - Granular Borrow with a maximum particle size of 4 inches. The granular borrow bedding and backfill material shall be placed in lifts of 6 to 8 inches loose measure and compacted to the manufacturer's specifications or, in the absence of manufacturer's specifications. The bedding and backfill soil shall be compacted to at least 92 percent of the AASHTO T-180 maximum dry density. All subgrade surfaces should be protected from construction traffic in order to limit disturbance.

**Settlement –** No settlement issues are anticipated at the site. No changes to the existing vertical or horizontal alignment are currently planned for this project. The proposed polymer coated steel structural pipe arch culvert is larger than the existing culvert and will result in a net unloading of the site soils at the proposed structure location. Placement of fill soils at the location of the existing structure is not anticipated to exceed the past loading condition of the site soils. Any settlement due to elastic compression of the bedding material will be immediate and negligible.

**Scour and Riprap –** Both the inlet and outlet of the polymer coated steel structural pipe arch culvert shall be protected against scour with riprap conforming to MaineDOT Standard Specification Section 703.26 Plain and Hand Laid Riprap. The roadway embankment slopes at the proposed culvert inlet and outlet shall be no steeper than 2H:1V. No specific scour protection recommendations are needed other than armoring with riprap. The riprap on the slopes shall be underlain by a non-woven, Class 1 Erosion Control Geotextile meeting the requirements of MaineDOT Standard Specification 722.03 that is underlain by a 1-foot layer of protective aggregate cushion consisting of Granular Borrow Material for Underwater Backfill (703.19). The toe of the riprap sections shall be keyed into the existing soils 1 foot below the streambed elevation.

**Construction Considerations** – Construction activities will include construction of cofferdams and earth support systems to control stream flow during construction. Construction activities will also include common earth excavation. Construction of the polymer coated steel structural pipe arch culvert will require soil excavation. Earth support systems shall be implemented if laying back slopes is not feasible. It is likely that the use of complex (four-sided) braced excavations with dewatering will be necessary due to the depth of the excavation. If this is the case, adequate

embedment into the native soils will be necessary to allow for the excavation and maintenance of a stable excavation bottom. All earth support systems shall be designed by a Professional Engineer licensed in the State of Maine. Regardless of the method of excavation, all excavations and earth support systems shall meet all applicable OSHA regulations.

Any cobbles or boulders encountered in excess of 6 inches shall be removed and replaced with compacted Granular Borrow Material for Underwater Backfill (MaineDOT 703.19) or Crushed Stone ¾-Inch (MaineDOT 703.13). All subgrade surfaces shall be proof-rolled using a static roller to provide a firm and stable surface and protected from any unnecessary construction equipment or traffic. If disturbance and rutting occur, the Contractor shall remove and replace disturbed areas with compacted Granular Borrow for Underwater Backfill (703.19) or Crushed Stone ¾-Inch (703.13).

The Contractor shall control groundwater and surface water infiltration using temporary ditches, sumps, granular drainage blankets, stone ditch protection or hand-laid riprap with geotextile underlayment to divert groundwater and surface water as needed to maintain a stable excavation and allow work in the dry.

Using the excavated native soils as backfill around the culvert shall not be permitted. The native soils may only be used as Common Borrow in accordance with MaineDOT Standard Specifications 203 and 703.

The Contractor will have to excavate the existing subbase and subgrade fill soils in the vicinity of the culvert. These materials should not be used to re-base the roadway. Excavated subbase sand and gravel may be used as fill below roadway subgrade level in fill areas provided all other requirements of MaineDOT Standard Specifications 203 and 703 are met.

## CLOSURE

This report has been prepared for the use of the MaineDOT Highway Program and their project design consultant for specific application to the proposed replacement of a cross culvert (#XC-180749) under Sly Brook Road in Eagle Lake, Maine in accordance with generally accepted geotechnical and foundation engineering practices. No other intended use or warranty is expressed or implied.

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

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

**Attachments:**

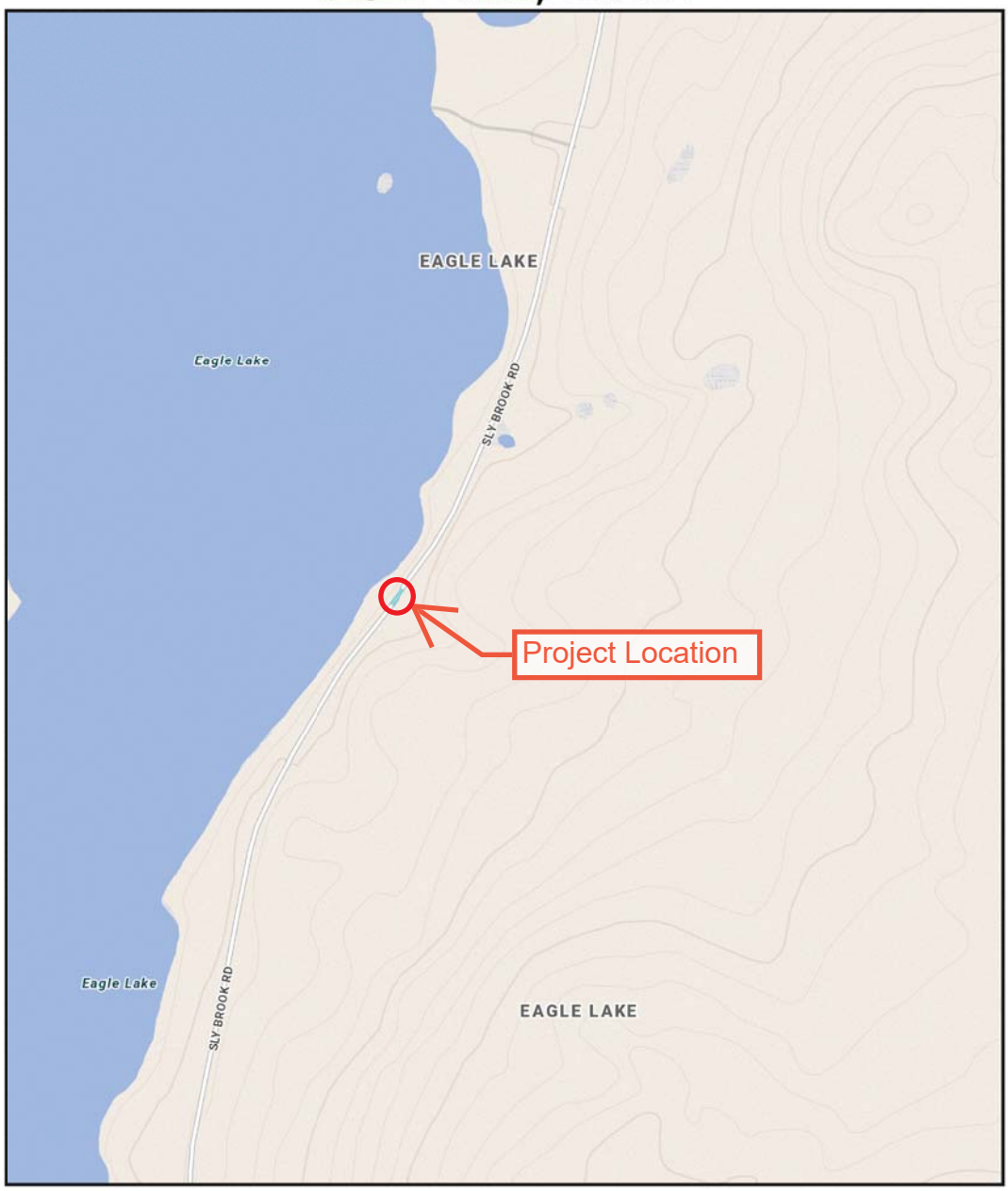
Location Map
Boring Location Plan & Interpretive Subsurface Profile with Boring Logs
Key to Soil and Rock Descriptions and Terms
Boring Logs
Laboratory Testing Summary Sheet
Grain Size Distribution Curves

Date:6/8/2020

Division: GEOTECH

Username: Terry.White

# EAGLE LAKE, MAINE



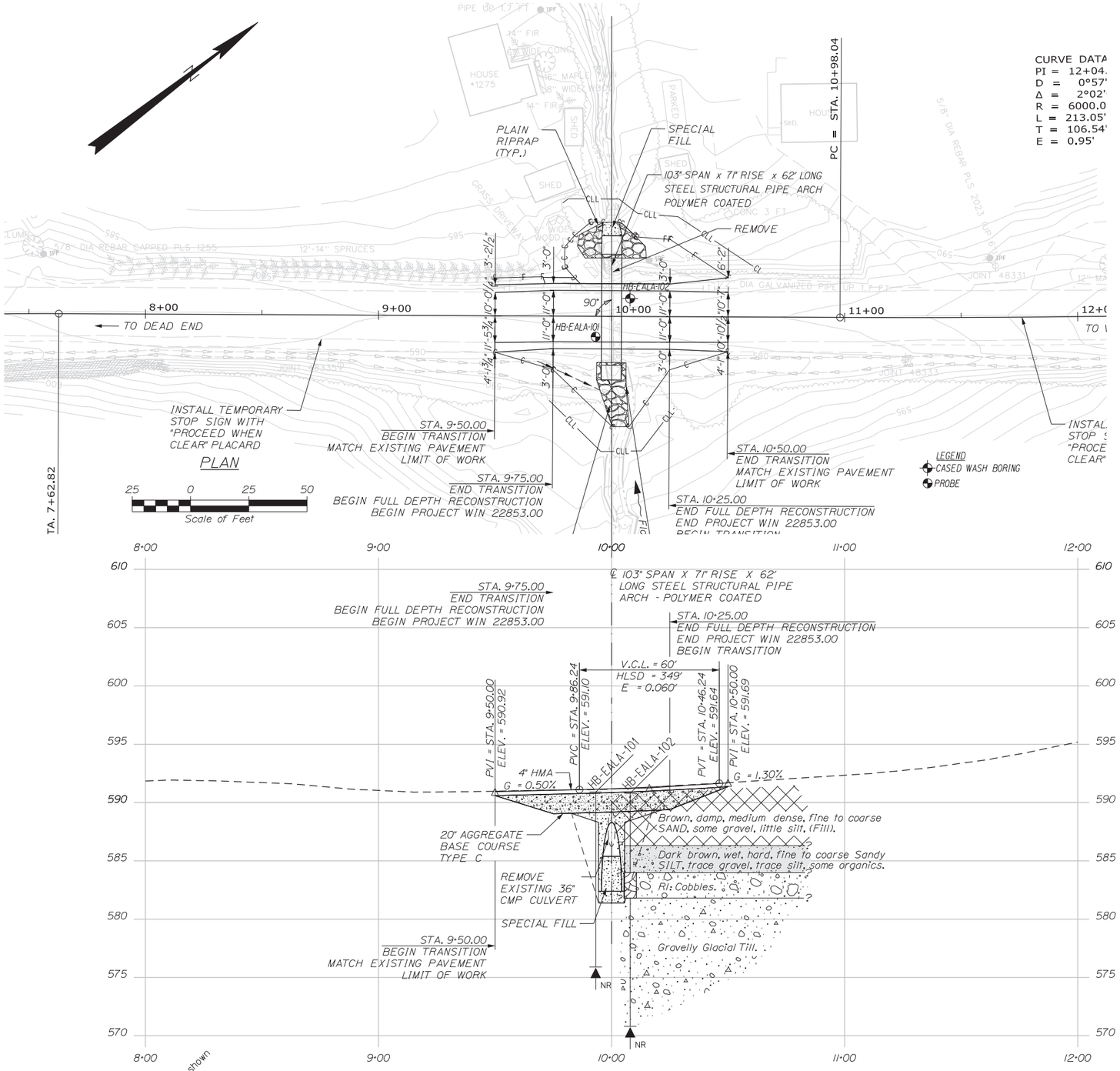

The Maine Department of Transportation provides this publication for information only. Reliance upon this information is at user risk. It is subject to revision and may be incomplete depending upon changing conditions. The Department assumes no liability if injuries or damages result from this information.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

0.15 Miles

1 inch = 0.18 miles

Date: 6/8/2020
Time: 9:31:31 AM

| | | |
|---|---|---|
| SHEET NUMBER<br>1<br>OF 2 | EAGLE LAKE<br>SLY BROOK ROAD<br>LOCATION MAP | STATE OF MAINE<br>DEPARTMENT OF TRANSPORTATION<br>CAPITAL PROJECTS<br>WIN<br>022853.00 HIGHWAY PLANS |




LEGEND

Boring No. / Offset, if shown
Weathered Bedrock, if applicable
Pavement Thickness, if applicable
Cobbles
Approximate Top of Bedrock
RQD= Rock Quality Designation of Bedrock Core Sample
BOE= Bottom of Exploration

No Refusal
NR
Refusal
(R)

PROFILE

HORIZ 25 0 25 50
VERT 5 0 5 10
SCALE

*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 and bedrock transitions may vary and are probably more erratic. For more specific information refer to the exploration logs.*

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

Project: Replacement of XC-180749 on Sly Brook Road
Location: Eagle Lake, Maine

Boring No.: HB-EALA-101
WIN: 22853.00

| | | | |
|---|---|---|---|
| Drilling Contractor: | MaineDOT | Auger ID/OD: | 5" Dia. |
| Operator: | Doggett | Sampler: | N/A |
| Logged By: | B. Wilder | Hammer Wt./Fall: | N/A |
| Date Start/Finish: | 5/17/2016 13:00-14:00 | Core Barrel: | N/A |
| Boring Location: | 9+93.2, 8.9 ft Rt. | Water Level*: | None Observed |
| | Elevation (ft.): 590.9 | | |
| | Datum: NAVD88 | | |
| | Rig Type: CME 45C | | |
| | Drilling Method: Solid Stem Auger | | |
| | Casing ID/OD: N/A | | |

Definitions: SPOONED = Split Spoon Sample; S = Sonic Core Sample; D = Split Spoon Sample; WS = Unsuccessful Split Spoon Sample Attempt; U = Thin Wall Tube Sample; WT = Unsuccessful Thin Wall Tube Sample Attempt; W = Unsuccessful Field Vane Shear Test Attempt; V = Field Vane Shear Test; PP= Pocket Penetrometer; WH = Weight of 140-lb. Hammer; WOH = Weight of 140-lb. Hammer; WOR = Weight of Rods or Casing; R = Rock Core Sample; HSA = Hollow Stem Auger; RC = Roller Cone; MW = Monitoring Well Installation; $S_u$ = Peak/Remolded Field Vane Undrained Shear Strength (psf); $S_{u(UC)}$ = Lab Vane Undrained Shear Strength (psf); $q_u$ = Unconfined Compressive Strength (tsf); Unconfined = Raw Field SPT N-value; Hammer Efficiency Factor = Rig Specific Annual Calibration Value; $T_v$ = Pocket Torvane Shear Strength (psf); $N_{60}$ = SPT N-value Corrected to 60% Hammer Efficiency; $N_{1(60)}$ = SPT N-value Corrected to 60% Hammer Efficiency & Normalized to 1 tsf Overburden Pressure; WOH = Weight of Hammer; WC = Water Content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

| Depth (ft.) | Sample No. | Rec./Pen. (in.) | Sample Depth (ft.) | Blows/6in. or Strength (tsf) or RQD (%) | N-value | Casing Blows | Elevation (ft.) | Graphic Log | Visual Description and Remarks | Laboratory Testing Results/ AASHTO and Unified Class |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 5/4 | | | Power Auger Probe, no material description taken. | |
| 15 | | | | | | | 575.9 | | Bottom of Exploration at 15.0 feet below ground surface. NO REFUSAL | 15.0 |

Remarks:

Stratification lines represent approximate boundaries between soil types; transitions may be gradual.
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Page 1 of 1
Boring No.: HB-EALA-101

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

Project: Replacement of XC-180749 on Sly Brook Road
Location: Eagle Lake, Maine

Boring No.: HB-EALA-102
WIN: 22853.00

| | | | |
|---|---|---|---|
| Drillers: | MaineDOT | Auger ID/OD: | 5" Solid Stem |
| Operator: | Doggett | Sampler: | Standard Split Spoon |
| Logged By: | B. Wilder | Hammer Wt./Fall: | 140lb/30" |
| Date Start/Finish: | 5/17/2016 13:00-14:00 | Core Barrel: | N/A |
| Boring Location: | 10+08, 7.6 ft Lt. | Water Level*: | None Observed |
| | Elevation (ft.): 590.8 | | |
| | Datum: NAVD88 | | |
| | Rig Type: CME 45C | | |
| | Drilling Method: Cased Wash Boring | | |
| | Casing ID/OD: NW-3" | | |

Hammer Efficiency Factors 0.908 — Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐

Definitions: R = Rock Core Sample; SSA = Solid Stem Auger; HSA = Hollow Stem Auger; RC = Roller Cone; MW = Monitoring Well Installation; WOH = Weight of Hammer; WOR = Weight of Rods or Casing; $S_u$ = Peak/Remolded Field Vane Undrained Shear Strength (psf); $S_{u(UC)}$ = Lab Vane Undrained Shear Strength (psf); $q_u$ = Unconfined Compressive Strength (tsf); Unconfined = Raw Field SPT N-value; Hammer Efficiency Factor = Rig Specific Annual Calibration Value; $N_{60}$ = SPT N-value Corrected to 60% Hammer Efficiency; $N_{1(60)}$ = SPT N-value Corrected to 60% Hammer Efficiency & Normalized to 1 tsf Overburden Pressure; $T_v$ = Pocket Torvane Shear Strength (psf); WC = Water Content, percent; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index; G = Grain Size Analysis; C = Consolidation Test

| Depth (ft.) | Sample No. | Rec./Rec. (in.) | Sample Depth (ft.) | Blows/6in. (& Hammer Efficiency) or Strength (tsf) or RQD (%) | Unconfined | N60 | Casing Blows | Elevation (ft.) | Graphic Log | Visual Description and Remarks | Laboratory Testing Results/ AASHTO and Unified Class |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | 5/4 | | | | |
| | 1D | 24/13 | 1.00 - 3.00 | 9/10/6/6 | 16 | 24 | | | | Brown, damp, medium dense, fine to coarse SAND, some gravel, little silt, (Fill). | GM070914 A-1-b, SM WC=7.1% |
| 5 | | | | | | | 5/4 | 586.3 | | | |
| | 2D | 21.6/18 | 5.00 - 6.80 | 4/11/16/30(3.6") | 27 | 41 | 26 | | | Dark brown, wet, hard, fine to coarse Sandy SILT, trace gravel, trace clay, some organics. | GM070915 A-4, CL WC=21.4% |
| | R1 | | 6.80 - 9.00 | | | | Q100 NQ-2 | 584.0 | | 4.5<br>R1:COBBLES. | |
| | | | | | | | | 581.8 | | 6.8<br>Auto Hammer Broke, auger to 20.0 ft bgs. | 9.0 |
| 10 | | | | | | | 5/4 | | | | |
| 15 | | | | | | | | | | Gravelly Till, occasional cobbles on Auger. | |
| | | | | | | | | 570.8 | | | 20.0 |
| 20 | | | | | | | | | | Bottom of Exploration at 20.0 feet below ground surface. NO 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.

Page 1 of 1
Boring No.: HB-EALA-102

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

**CAPITAL PROJECTS**

WIN 22853.00

HIGHWAY PLANS

| | BY | DATE |
|---|---|---|
| PROJ. MANAGER | ------ | ------ |
| DESIGN-DETAILED | C.RUSSELL | JUN 2020 |
| CHECKED-REVIEWED | ------ | ------ |
| DESIGN2-DETAILED2 | ------ | ------ |
| DESIGN3-DETAILED3 | ------ | ------ |
| REVISIONS 1 | ------ | ------ |
| REVISIONS 2 | ------ | ------ |
| REVISIONS 3 | ------ | ------ |
| REVISIONS 4 | ------ | ------ |
| FIELD CHANGES | ------ | ------ |

SIGNATURE

P.E. NUMBER

DATE

EAGLE LAKE
SLY BROOK ROAD

BORING LOCATION PLAN &
INTERPRETIVE SUBSURFACE PROFILE
WITH BORING LOGS

SHEET NUMBER
2
OF 2

Filename: ...\MSTA\004_BLP&ISP WBL1.dgn Username: Cody.A.Russell Division: GEOTECH Date:6/22/2020

## UNIFIED SOIL CLASSIFICATION SYSTEM

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

**Desired Soil Observations (in this order, if applicable):**

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

## MODIFIED BURMISTER SYSTEM

| Descriptive Term | Portion of Total (%) |
|---|---|
| trace | 0 - 10 |
| little | 11 - 20 |
| some | 21 - 35 |
| adjective (e.g. Sandy, Clayey) | 36 - 50 |

## TERMS DESCRIBING DENSITY/CONSISTENCY

**Coarse-grained soils** (more than half of material is larger than No. 200 sieve): Includes (1) clean gravels; (2) Silty or Clayey gravels; and (3) Silty, Clayey or Gravelly sands. Density is rated according to standard penetration resistance (N-value).

| Density of Cohesionless Soils | Standard Penetration Resistance N-Value (blows per foot) |
|---|---|
| Very loose | 0 - 4 |
| Loose | 5 - 10 |
| Medium Dense | 11 - 30 |
| Dense | 31 - 50 |
| Very Dense | > 50 |

**Fine-grained soils** (more than half of material is smaller than No. 200 sieve): Includes (1) inorganic and organic silts and clays; (2) Gravelly, Sandy or Silty clays; and (3) Clayey silts. Consistency is rated according to undrained shear strength as indicated.

| Consistency of Cohesive soils | SPT N-Value (blows per foot) | Approximate Undrained Shear Strength (psf) | Field Guidelines |
|---|---|---|---|
| Very Soft | WOH, WOR, WOP, <2 | 0 - 250 | Fist easily penetrates |
| Soft | 2 - 4 | 250 - 500 | Thumb easily penetrates |
| Medium Stiff | 5 - 8 | 500 - 1000 | Thumb penetrates with moderate effort |
| Stiff | 9 - 15 | 1000 - 2000 | Indented by thumb with great effort |
| Very Stiff | 16 - 30 | 2000 - 4000 | Indented by thumbnail |
| Hard | >30 | over 4000 | Indented by thumbnail with difficulty |

**Rock Quality Designation (RQD):**

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

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

**Rock Quality Based on RQD**

| Rock Quality | RQD (%) |
|---|---|
| Very Poor | ≤25 |
| Poor | 26 - 50 |
| Fair | 51 - 75 |
| Good | 76 - 90 |
| Excellent | 91 - 100 |

**Desired Rock Observations (in this order, if applicable):**

Color (Munsell color chart)
Texture (aphanitic, fine-grained, etc.)
Rock Type (granite, schist, sandstone, etc.)
Hardness (very hard, hard, mod. hard, etc.)
Weathering (fresh, very slight, slight, moderate, mod. severe, severe, etc.)
Geologic discontinuities/jointing:
-dip (horiz - 0-5 deg., low angle - 5-35 deg., mod. dipping - 35-55 deg., steep - 55-85 deg., vertical - 85-90 deg.)
-spacing (very close - <2 inch, close - 2-12 inch, mod. close - 1-3 feet, wide - 3-10 feet, very wide >10 feet)
-tightness (tight, open, or healed)
-infilling (grain size, color, etc.)
Formation (Waterville, Ellsworth, Cape Elizabeth, etc.)
RQD and correlation to rock quality (very poor, poor, etc.)
ref: ASTM D6032 and FHWA NHI-16-072 GEC 5 - Geotechnical Site Characterization, Table 4-12
Recovery (inch/inch and percentage)
Rock Core Rate (X.X ft - Y.Y ft (min:sec))

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

**Sample Container Labeling Requirements:**

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

# Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

**Project:** Replacement of XC-180749 on Sly Brook Road
**Location:** Eagle Lake, Maine

**Boring No.:** HB-EALA-101
**WIN:** 22853.00

| | | | | | |
|---|---|---|---|---|---|
| **Drilling Contractor:** | MaineDOT | **Elevation (ft.)** | 590.9 | **Auger ID/OD:** | 5" Dia. |
| **Operator:** | Daggett | **Datum:** | NAVD88 | **Sampler:** | N/A |
| **Logged By:** | B. Wilder | **Rig Type:** | CME 45C | **Hammer Wt./Fall:** | N/A |
| **Date Start/Finish:** | 5/17/2016; 13:00-14:00 | **Drilling Method:** | Solid Stem Auger | **Core Barrel:** | N/A |
| **Boring Location:** | 9+93.2, 8.9 ft Rt. | **Casing ID/OD:** | N/A | **Water Level*:** | None Observed |

Definitions:
D = Spilt Spoon Sample
S = Sample off Auger Flights
B = Bucket Sample off Auger Flights
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MV = Unsuccessful Field Vane Shear Test Attempt
V = Field Vane Shear Test, PP= Pocket Penetrometer
MU = Unsuccessful Thin Wall Tube Sample 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 1 Person
$S_u$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
$q_p$ = Unconfined Compressive Strength (ksf)
N-value = Raw Field SPT N-value
$T_v$ = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent ≅ = Similar or Equal too
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

| Depth (ft.) | Sample Information: Sample No. | Pen./Rec. (in.) | Sample Depth (ft.) | Blows (/6 in.) Shear Strength (psf) or RQD (%) | N-value | Casing Blows | Elevation (ft.) | Graphic Log | Visual Description and Remarks | Laboratory Testing Results/ AASHTO and Unified Class. |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | SSA | | | Power Auger Probe, no material description taken. | |
| 5 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 15 | | | | | | | 575.9 | | 15.0 **Bottom of Exploration at 15.0 feet below ground surface.** NO REFUSAL | |
| 20 | | | | | | | | | | |
| 25 | | | | | | | | | | |

**Remarks:**

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

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

# Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

**Project:** Replacement of XC-180749 on Sly Brook Road
**Location:** Eagle Lake, Maine

**Boring No.:** HB-EALA-102
**WIN:** 22853.00

| | | | | | |
|---|---|---|---|---|---|
| **Driller:** | MaineDOT | **Elevation (ft.)** | 590.8 | **Auger ID/OD:** | 5" Solid Stem |
| **Operator:** | Daggett | **Datum:** | NAVD88 | **Sampler:** | Standard Split Spoon |
| **Logged By:** | B. Wilder | **Rig Type:** | CME 45C | **Hammer Wt./Fall:** | 140#/30" |
| **Date Start/Finish:** | 5/17/2016; 13:00-14:00 | **Drilling Method:** | Cased Wash Boring | **Core Barrel:** | N/A |
| **Boring Location:** | 10+08, 7.6 ft Lt. | **Casing ID/OD:** | NW-3" | **Water Level*:** | None Observed |
| **Hammer Efficiency Factor:** 0.908 | | **Hammer Type:** | Automatic ☒ Hydraulic ☐ Rope & Cathead ☐ | | |

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
MU = Unsuccessful Thin Wall Tube Sample Attempt
V = Field Vane Shear Test, PP = Pocket Penetrometer
MV = Unsuccessful Field Vane Shear Test Attempt
R = Rock Core Sample
SSA = Solid Stem Auger
HSA = Hollow Stem Auger
RC = Roller Cone
WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
$S_u$ = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
$q_p$ = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
$N_{60}$ = SPT N-uncorrected Corrected for Hammer Efficiency
$N_{60}$ = (Hammer Efficiency Factor/60%)*N-uncorrected
$T_v$ = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

| Depth (ft.) | Sample Information: Sample No. | Pen./Rec. (in.) | Sample Depth (ft.) | Blows (/6 in.) Shear Strength (psf) or RQD (%) | N-uncorrected | $N_{60}$ | Casing Blows | Elevation (ft.) | Graphic Log | Visual Description and Remarks | Laboratory Testing Results/ AASHTO and Unified Class. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | SSA | | | | |
| | 1D | 24/13 | 1.00 - 3.00 | 9/10/6/6 | 16 | 24 | | | | Brown, damp, medium dense, fine to coarse SAND, some gravel, little silt, (Fill). | G#270914 A-1-b, SM WC=7.1% |
| | | | | | | | | 586.3 | | 4.5 | |
| 5 | 2D | 21.6/18 | 5.00 - 6.80 | 4/11/16/30(3.6") | 27 | 41 | 26 | | | Dark brown, wet, hard, fine to coarse Sandy SILT, trace gravel, trace clay, some organics. [a]100 blows for 0.8 ft. | G#270915 A-4, CL WC=21.4% |
| | R1 | | 6.80 - 9.00 | | | | [a]100 NQ-2 | 584.0 | | 6.8 R1:COBBLES. | |
| | | | | | | | | 581.8 | | 9.0 | |
| 10 | | | | | | | SSA | | | Auto Hammer Broke, auger to 20.0 ft bgs. | |
| 15 | | | | | | | | | | Gravelly Till, occasional cobbles on Auger. | |
| 20 | | | | | | | | 570.8 | | 20.0 **Bottom of Exploration at 20.0 feet below ground surface.** NO REFUSAL | |
| 25 | | | | | | | | | | | |

**Remarks:**

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

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

**State of Maine - Department of Transportation**

## Laboratory Testing Summary Sheet

# Town(s): Eagle Lake Work Number: 22853.00

| 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 |
| HB-EALA-102, 1D | 10+08 | 7.6 Lt. | 1.0-3.0 | 270914 | 1 | 7.1 | | | SM | A-1-b | II |
| HB-EALA-102, 2D | 10+08 | 7.6 Lt. | 5.0-6.8 | 270915 | 1 | 21.4 | | | CL | A-4 | IV |

**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)

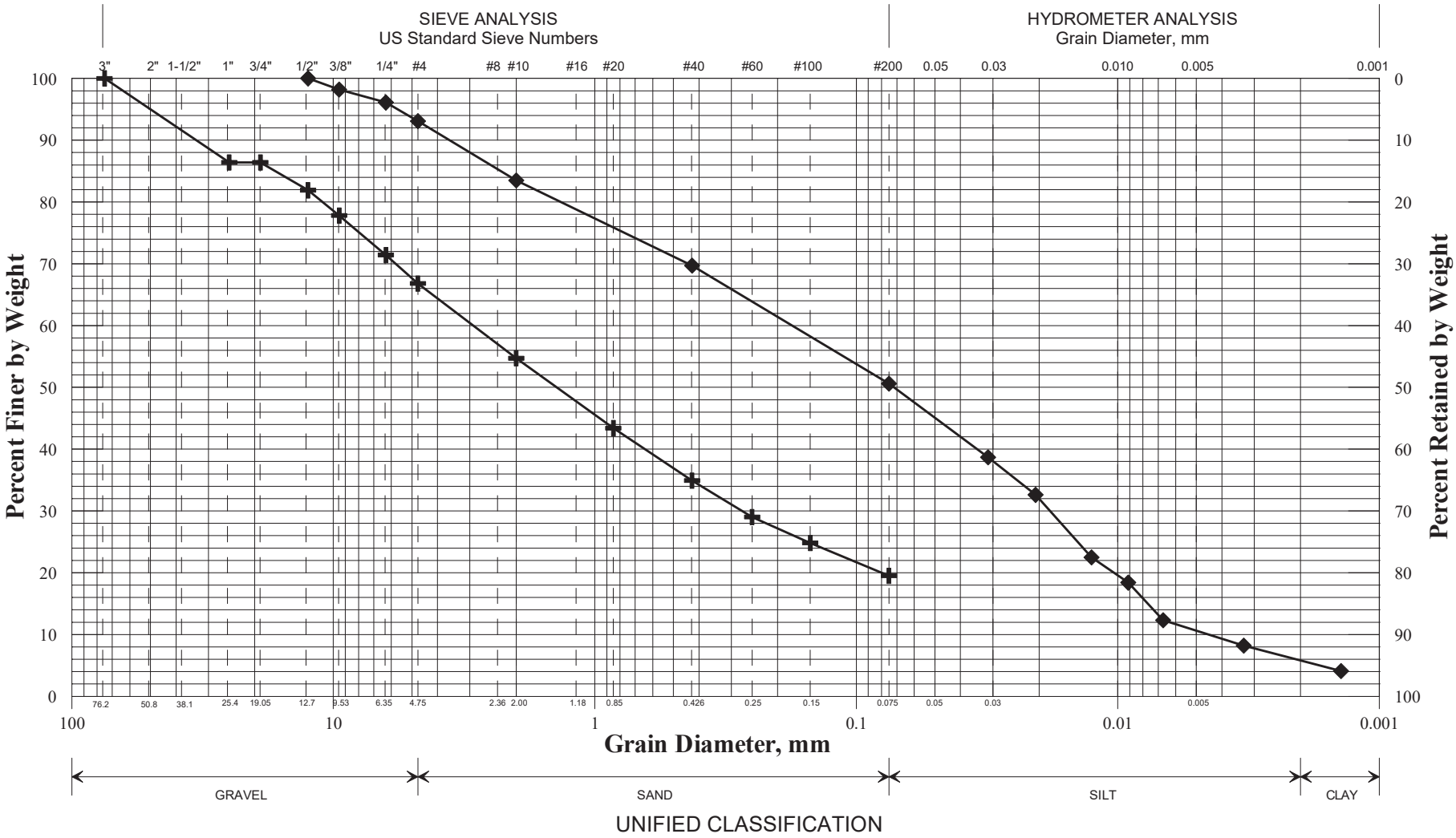
WC = water content as determined by AASHTO T 265-93 and/or ASTM D 2216-98

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**




| | Boring/Sample No. | Station | Offset, ft | Depth, ft | Description | W, % | LL | PL | PI |
|---|---|---|---|---|---|---|---|---|---|
| ✚ | HB-EALA-102/1D | 10+08 | 7.6 LT | 1.0-3.0 | SAND, some gravel, little silt. | 7.1 | | | |
| ◆ | HB-EALA-102/2D | 10+08 | 7.6 LT | 5.0-6.9 | Sandy SILT, trace gravel, trace clay. | 21.4 | | | |
| ■ | | | | | | | | | |
| ● | | | | | | | | | |
| ▲ | | | | | | | | | |
| ✖ | | | | | | | | | |

| WIN |
|---|
| 022853.00 |
| Town |
| Eagle Lake |
| Reported by/Date |
| WHITE, TERRY A 6/29/2017 |