MAINE DEPARTMENT OF TRANSPORTATION
HIGHWAY PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE

GEOTECHNICAL DESIGN REPORT

For the Construction of:

DANNY BOYS BRIDGE
U.S. ROUTE 2
WILTON, MAINE

Prepared by:
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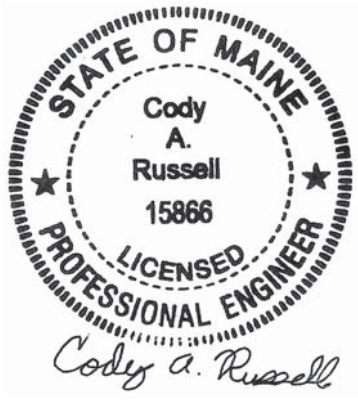
Geotechnical Engineer



Reviewed by:
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Franklin County
WIN 23799.00

Soils Report 2020-46
Bridge No. 6628

December 14, 2020

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Appendices

1.0 INTRODUCTION

The purpose of this Geotechnical Design Report is to present subsurface information and make geotechnical recommendations for the replacement of an existing large culvert (#46542) on U.S. Route 2 in Wilton, Maine. A subsurface investigation has been completed at the site to evaluate subsurface conditions and to develop geotechnical design and construction recommendations for the replacement structure. This report presents the subsurface information obtained during the subsurface investigation and soil laboratory testing programs and provides design and construction recommendations and geotechnical design parameters for the culvert replacement.

The existing structure consists of an approximately 8-foot span by 5.75-foot rise by 86-foot long steel plate pipe arch culvert on a skew of approximately 23 degrees to the roadway centerline. The steel pipe arch is in poor condition and has rusted through along the waterline at the inlet and outlet ends. Hydraulic forces from the stream have caused erosion at the toe of the roadway embankment downstream of the existing culvert. U.S. Route 2 is a Highway Corridor Priority 1 road.

The proposed replacement structure will be a 13-foot span by 6-foot rise by 132-foot long precast concrete box culvert on a skew of approximately 40.5 degrees to the roadway centerline. To facilitate fish passage, Habitat Connectivity Design elements will be used inside the precast concrete box culvert as shown on the Culvert Streambed Details Sheets in the Plans. The invert of the proposed culvert is approximately 12.6 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 to protect against erosion. Downstream of the proposed structure the stream will be relocated away from the roadway and the embankment slopes will be flattened as shown on the Cross Sections and Stream Cross Sections in the Plans.

2.0 GEOLOGIC SETTING

The existing culvert carries an unnamed stream under U.S. Route 2 in Wilton and is located approximately 0.13 of a mile east of Gammon Hill Road as shown on Sheet 1 – Location Map.

According to the Maine Geological Survey (MGS) map titled Surficial Geology East Dixfield Quadrangle, Maine, Open File 18-18 (2018) the surficial soils at the site primarily consist of Till. Till consists of a mixture of sand, silt and gravel.

According to the map titled Bedrock Geologic Map of Maine (1985) published by the MGS, the bedrock in the vicinity of the site consists of sulfidic/carbonaceous pelite of the Temple Stream Member of the Seboomook Formation.

3.0 SUBSURFACE INVESTIGATION

One (1) boring (HB-WIL-101) and two (2) probes (HB-WIL-102 and HB-WIL-102A) were drilled on opposite, diagonal corners of the existing structure on August 27, 2018 by the MaineDOT drill crew using a trailer mounted drill rig. Exploration locations are shown on Sheet 2 – Boring

Location Plan & Interpretive Subsurface Profile. with Boring Logs. Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are presented on the Boring Log in Appendix A.

Boring HB-WIL-101 was drilled using solid stem auger, cased wash boring, and rock core drilling techniques. Soil samples were obtained in boring HB-WIL-101 at 5-foot intervals using Standard Penetration Test (SPT) methods. The MaineDOT drill rig is equipped with an automatic hammer to drive the split spoon. The MaineDOT calibrated automatic hammer delivers approximately 55 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 0.928 to the raw field N-values. Probes HB-WIL-102 and HB-WIL-102A was drilled using solid stem auger techniques. No soil samples were obtained in the probes.

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 in the boring and probe. The boring and probe were located in the field by taping to surveyed site features after completion of the drilling program.

4.0 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 two (2) standard grain size analysis with natural water content and one (1) standard grain size analyses with hydrometer and natural water content. The results of the laboratory testing program are discussed in the following section and are included in Appendix B – Laboratory Test Results. Laboratory test information is also shown on the Boring Logs in Appendix A.

5.0 SUBSURFACE CONDITIONS

Subsurface conditions encountered at the test boring and probe generally consisted fill gravelly sand and sand underlain by native glacial till underlain by bedrock. An interpretive subsurface profile depicting the generalized soil stratigraphy at the boring location is shown on Sheet 2 – Boring Location Plan & Interpretive Subsurface Profile with Boring Logs.

Boring HB-WIL-101 was drilled to a depth of approximately 20.0 feet below ground surface (bgs) including a 5-foot bedrock core. Probes HB-WIL-102 and HB-WIL-102A were drilled to depths of approximately 8.3 feet bgs and 9.0 feet bgs, respectively, where they encountered a refusal surface. The exact nature of the refusal surface was not determined in the probes.

The table below summarizes the field and laboratory information obtained in boring HB-WIL-101:

Approx. Depth BGS[1] (feet)	Soil Description	AASHTO[2] Classification	USCS[3]	WC%[4]
0.0 – 0.4	Pavement	--	--	--
0. – 10.0	Fill – Brown, dry, gravelly fine to coarse sand, trace silt. Brown, damp, fine to coarse sand, some silt, little gravel.	A-1-a A-2-4	SW-SM SM	3.8 10.2
10.0 – 15.0	Glacial Till – Light brown, moist, fine to coarse sand, some gravel, some silt, trace clay.	A-2-4	SC-SM	8.4
15.0 – 20.0	Bedrock – Sulfidic/carbonaceous pelite: Temple Stream Member of the Seboomook Formation	--	--	--

[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

Two (2) corrected N-values obtained in the fill ranged from 28 to 74 blows per foot (bpf) indicating that the fill is medium dense to very dense in consistency. One (1) corrected N-value obtained in the glacial till was 48 bpf indicating that the till is dense in consistency.

The table below summarizes the approximate bedrock or refusal elevations at the exploration locations.

Boring	Approximate Depth to Bedrock (feet)	Approximate Depth to Refusal (feet)	Approximate Elevation of Bedrock or Refusal Surface (feet)
HB-WIL-101	15.0	15.0	583.8
HB-WIL-102	Not Determined	8.3	588.9
HB-WIL-102A	Not Determined	9.0	588.0

The Rock Quality Designation (RQD) of the bedrock was determined to be 25 percent in boring HB-WIL-101 which correlates to a Rock Quality of very poor.

Groundwater level was recorded at a depth of approximately 9.0 feet bgs in boring HB-WIL-101. Groundwater level was not recorded in the probes. Groundwater levels can be expected to fluctuate subject to seasonal variations, local soil conditions, topography, precipitation, and construction activity.

6.0 GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS

The proposed replacement structure will consist of a 13-foot span by 6-foot rise by 132-foot long precast concrete box culvert on a skew of approximately 40.5 degrees to the roadway centerline. The proposed structure inlet and outlet slopes shall be riprapped with slopes no steeper than 2H:1V to protect against erosion. The following sections discuss geotechnical recommendations for the design and construction of the proposed culvert.

6.1 Precast Concrete Box Culvert Design and Construction

The proposed replacement structure will consist of a 13-foot span by 6-foot rise by 132-foot long precast concrete box culvert at a skew of approximately 40.5 degrees to the roadway centerline. The proposed box culvert shall be designed and constructed in accordance with MaineDOT Standard Specification 534.

The invert elevation of the proposed box culvert ranges from approximately 586.8 feet at the inlet end to approximately 584.3 feet at the outlet end with an approximately 1.9 percent slope. To facilitate fish passage, Habitat Connectivity Design elements will be used inside the precast concrete box culvert as shown on the Streambed Details Sheets in the Plans.

Due to the presence of shallow bedrock at the proposed culvert location, bedrock removal will be necessary to construct the culvert at the planned elevations. Prior to placing the culvert bedding material, the bedrock surface shall be cleaned of all weathered bedrock, fractured material, loose soil, and/or ponded water. The full nature of the culvert bearing surface will not become evident until the culvert excavation is made.

Any cobbles or boulders in excess of 6 inches encountered at the bedding elevation 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.

6.2 Bedrock Removal and Bedrock Subgrade Preparation

To construct the culvert at the planned elevations bedrock removal will be necessary. The bedrock surface shall be prepared in accordance with MaineDOT standard practices. Construction activities should not be permitted to create any open fissures in the bedrock to remain. Any irregularities in

the existing bedrock surface or irregularities created during the excavation process should be backfilled with crushed stone to the bottom of the required bedding material.

The nature, slope, and degree of fracturing in the bedrock bearing surfaces will not be evident until the excavation from the precast concrete box culvert is made. The final bedrock surface slope shall be less than 4H:1V or it shall be benched in level steps.

The Contractor shall remove any overburden soil and weathered bedrock that can be removed using ordinary excavation equipment to expose competent bedrock at the required elevation. In accordance with MaineDOT standard practices, the bedrock shall be clean and free of debris, soil, or loose rock. The cleanliness and condition of the bedrock surface should be confirmed and accepted by the Resident prior to placing the structural bedding material. If soil is encountered at bedding material subgrade it shall be proof-rolled using multiple passes of a static roller to identify loose or weaving areas and to achieve a firm and stable surface for construction. 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.

Blasting shall be conducted in accordance with MaineDOT Standard Specifications Sections 105.2.7 and 203. The Contractor is required to conduct pre- and post-blast surveys, as well as blast vibrations monitoring at nearby structures in accordance with industry standards at the time of the blast.

It is anticipated that there will be seepage of water from fractures and joints exposed in the bedrock surface. Water should be controlled by pumping from sumps. The Contractor should maintain the excavation so that all work is completed in the dry.

6.3 Stream Relocation and Slope Flattening

The project scope includes shifting the stream at the left side of the road away from U.S. Route 2 to flatten the slopes along the road and provide a slope ranging from 2H:1V to 1.7H:1V. Any slope steeper than 2H:1V shall be protected with 2 feet of Plain Riprap conforming to MaineDOT Standard Specification Section 703.26 Plain and Hand Laid Riprap underlain by a non-woven Class 1 Erosion Control Geotextile that meets the requirements for MaineDOT Standard Specification 722.03 that is underlain by a 1-foot layer of Protective Aggregate Cushion conforming to MaineDOT Standard Specification 703.19 Granular Borrow Material for Underwater Backfill as shown in the Plans. A shelf or buffer area with a grade varying from approximately 1.3 to 7.2 percent shall extend from the toe of the proposed slope to the proposed stream channel on the left. The center of the proposed stream will be constructed between approximately 20.5 to 34.0 feet left of the toe of the proposed slope.

Between approximate Stations 13+50 and 14+25 right a proposed 1.5H:1V slope shall transition back into the existing slope. The proposed slope should be constructed as shown on the project Plans. The slope shall be armored with 2 feet of Plain Riprap conforming to MaineDOT Standard Specification Section 703.26 Plain and Hand Laid Riprap underlain by a non-woven Class 1 Erosion Control Geotextile that meets the requirements for MaineDOT Standard Specification

722.03 that is underlain by a 1-foot layer of Protective Aggregate Cushion conforming to MaineDOT Standard Specification 703.19 Granular Borrow Material for Underwater Backfill.

6.4 Settlement

No settlement issues are anticipated at the site. The proposed precast concrete box culvert is larger than the existing culvert and will result in a net unloading of the site soils at the 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 subgrade soils and bedding material will be immediate and negligible.

6.5 Bearing Resistance

The factored bearing resistances for the precast concrete box culvert bearing on compacted granular bedding material placed on native soils at the service and strength limit states are presented in the table below. Supporting calculations in accordance with AASHTO LRFD Bridge Design Specifications 9th Edition 2020 (LRFD) are provided in Appendix C – Calculations.

Limit State	Resistance Factor φ_b	AASHTO LRFD Reference	Factored Bearing Resistance (ksf)
Service	1.0	Article 10.5.5.1	10.0
Strength	0.45	Table 10.5.5.2.2-1	9.0

6.6 Modulus of Subgrade Reaction

A modulus of subgrade reaction (k_s) equal to 320 pounds per cubic inch shall be used for the structural design of the box culvert's base slab. Calculations are included in Appendix C – Calculations.

6.7 Scour and Riprap

Both the inlet and outlet of the precast concrete box culvert shall be protected against scour with riprap conforming to MaineDOT Standard Specification Section 703.26 Plain and Hand Laid Riprap. Slopes 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.

6.8 Seismic Design Considerations

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

6.9 Construction Considerations

Construction activities may 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 proposed precast concrete box culvert will require deep 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 native soils will be necessary to allow for the excavation and maintenance of a stable excavation bottom. The presence of shallow bedrock may impact the ability to drive sheets for excavation support. 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.

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.

7.0 CLOSURE

This report has been prepared for the use of the MaineDOT Highway Program for specific application to the proposed replacement of an existing large culvert (#46542) under U.S. Route 2 in Wilton, 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.

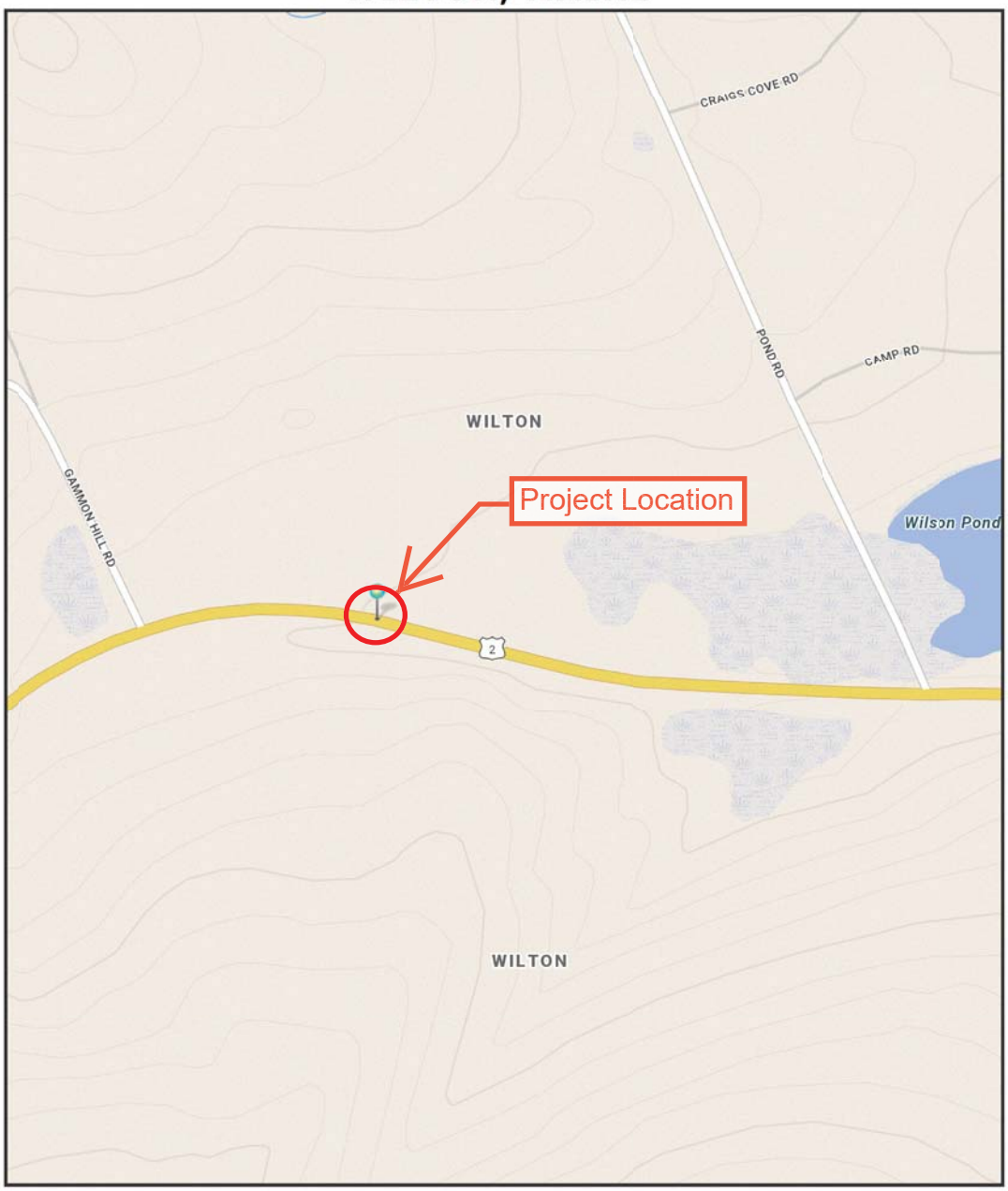
Sheets

Date:1/5/2021

Division: GEOTECH

Username: Terry.White

WILTON, 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.

0.09 Miles

1 inch = 0.1 miles

Date: 12/11/2020
Time: 8:59:38 AM

SHEET NUMBER 1 OF 2	WILTON U.S. ROUTE 2 LOCATION MAP	STATE OF MAINE DEPARTMENT OF TRANSPORTATION 23799.00 WIN 23799.00 HIGHWAY PLANS

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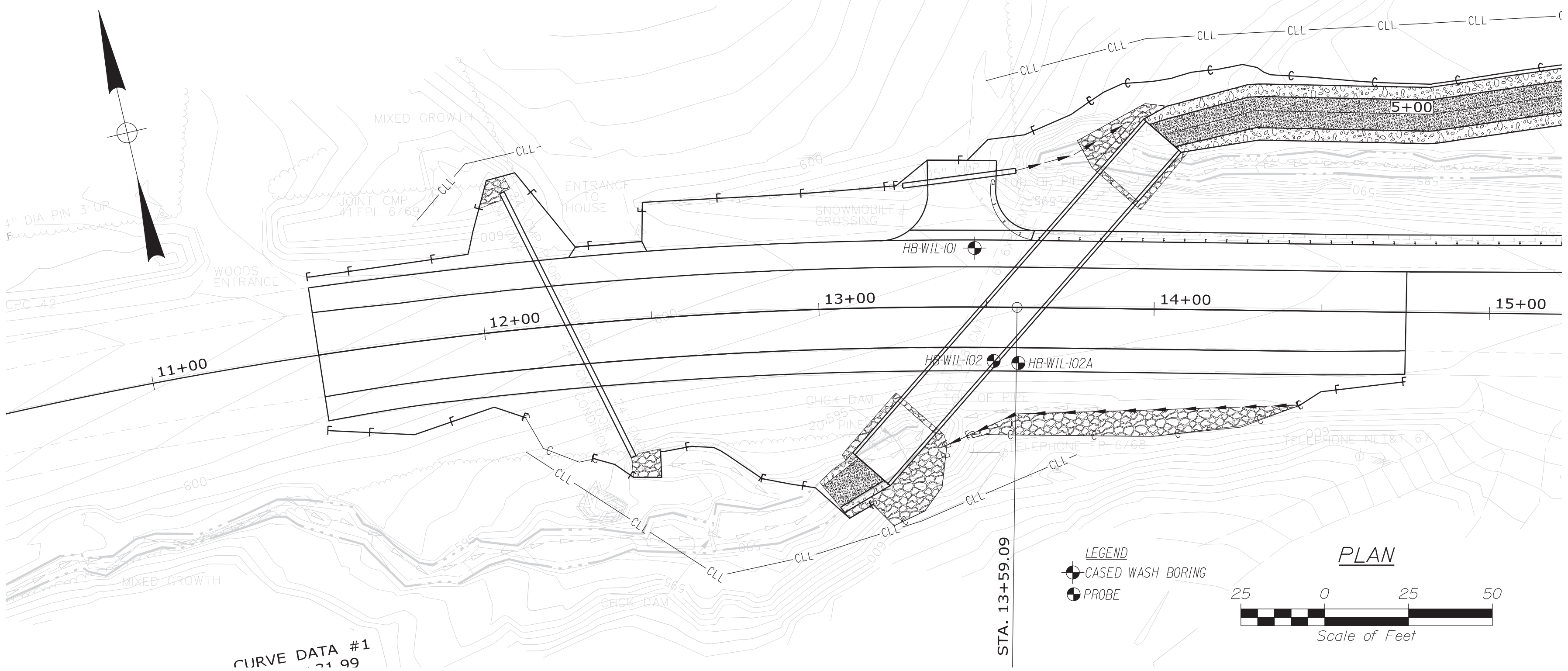

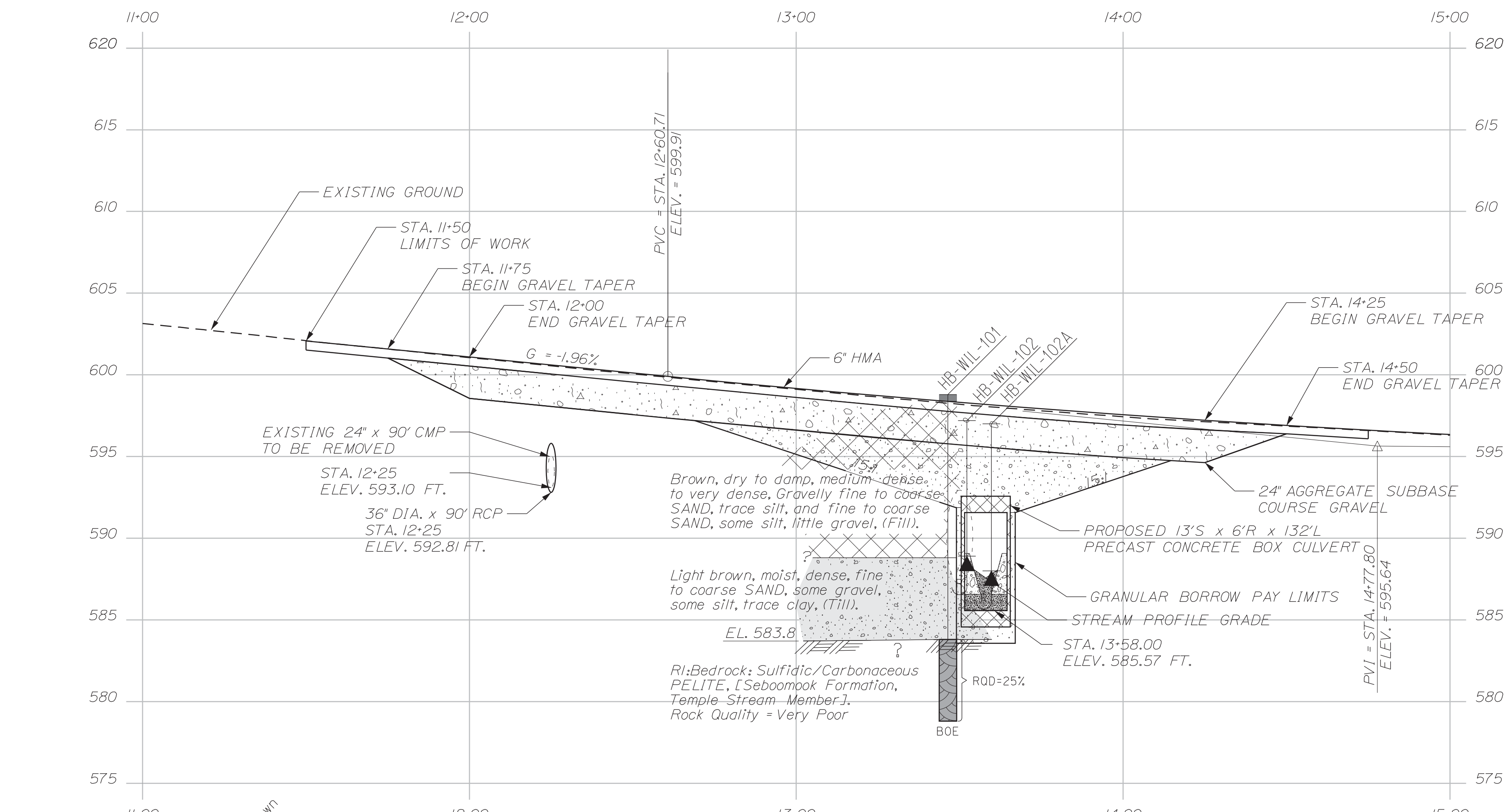

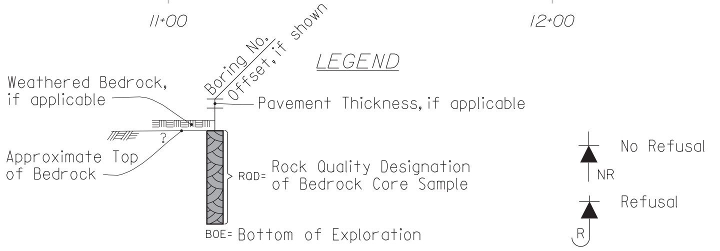

Note: This generalized interpretive soil profile is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and have been developed by interpretations of widely spaced explorations and samples. Actual soil and bedrock transitions may vary and are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

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

Project: Large Culvert Replacement on U.S. Route 2
Location: Wilton, Maine
Boring No.: HB-WIL-101
WIN: 23799.00

Driller:	MaineDOT	Elevation (ft.)	598.8	Auger ID/OD:	5" Solid Stem
Operator:	Daggett/Niles	Datum:	NAVD88	Sampler:	Standard Split Spoon
Logged By:	C. Russell	Rig Type:	CME 45C	Hammer Wt./Fall:	140#/30"
Date Start/Finish:	8/27/2018; 08:30-10:50	Drilling Method:	Cased Wash Boring	Core Barrel:	NQ-2"
Boring Location:	13+46.4, 17.6 ft Lt.	Casing ID/OD:	NW-3"	Water Level*:	9.0 ft bgs.
Hammer Efficiency Factor: 0.928		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 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	598.4		5" HMA. (0.4)	
	1D	24/16	1.00 - 3.00	8/18/30/40	48	74				Brown, dry, very dense, Gravelly fine to coarse SAND, trace silt, (Fill).	G#296612 A-1-a, SW-SM WC=3.8%
5	2D	24/15	5.00 - 7.00	6/9/9/9	18	28				Brown, damp, medium dense, fine to coarse SAND, some silt, little gravel, (Fill).	G#296613 A-2-4, SM WC=10.2%
10	3D	24/20	10.00 - 12.00	10/22/9/14	31	48	42	588.8		(10.0) Light brown, moist, dense, fine to coarse SAND, some gravel, some silt, trace clay, (Till).	G#296614 A-2-4, SC-SM WC=8.4%
							157				
							440			Roller Coned ahead to 15.0 ft bgs.	
							25				
							95				
15	R1 MD	60/50 0/0	15.00 - 20.00 15.00 - 15.00	RQD = 25% 20(0")	---		NQ-2	583.8		(15.0) Top of Bedrock at Elev. 583.8 ft. R1: Bedrock: Sulfidic/Carbonaceous PELITE, [Seboomook Formation, Temple Stream Member]. Rock Quality = Very Poor R1: Core Times (min:sec) 15.0-16.0 ft (1:12) 16.0-17.0 ft (2:18) 17.0-18.0 ft (1:38) 18.0-19.0 ft (1:48) 19.0-20.0 ft (1:43) 95% Recovery Failed sample attempt and Spoon REFUSAL at 15.0 ft bgs.	
20								578.8		(20.0) Bottom of Exploration at 20.0 feet below ground surface.	

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.

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Boring No.: HB-WIL-101

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

Project: Large Culvert Replacement on U.S. Route 2
Location: Wilton, Maine
Boring No.: HB-WIL-102
WIN: 23799.00

Drilling Contractor:	MaineDOT	Elevation (ft.)	597.2	Auger ID/OD:	5" Dia.
Operator:	Daggett/Niles	Datum:	NAVD88	Sampler:	N/A
Logged By:	C. Russell	Rig Type:	CME 45C	Hammer Wt./Fall:	N/A
Date Start/Finish:	8/27/2018; 11:00-11:15	Drilling Method:	Solid Stem Auger	Core Barrel:	N/A
Boring Location:	13+52.2, 16.0 ft Rt.	Casing ID/OD:	N/A	Water Level*:	None Observed

Definitions:
D = Split 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 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			Probe, no samples taken.	
5										
							588.90		(8.3) Bottom of Exploration at 8.3 feet below ground surface. REFUSAL	
10										

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.

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Boring No.: HB-WIL-102

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

Project: Large Culvert Replacement on U.S. Route 2
Location: Wilton, Maine
Boring No.: HB-WIL-102A
WIN: 23799.00

Drilling Contractor:	MaineDOT	Elevation (ft.)	597.0	Auger ID/OD:	5" Dia.
Operator:	Daggett/Niles	Datum:	NAVD88	Sampler:	N/A
Logged By:	C. Russell	Rig Type:	CME 45C	Hammer Wt./Fall:	N/A
Date Start/Finish:	8/27/2018; 11:15-11:30	Drilling Method:	Solid Stem Auger	Core Barrel:	N/A
Boring Location:	13+59.7, 16.5 ft Rt.	Casing ID/OD:	N/A	Water Level*:	None Observed

Definitions:
D = Split 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
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SSA = Solid Stem Auger
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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 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			Probe, no samples taken.	
5										
							588.00		(9.0) Bottom of Exploration at 9.0 feet below ground surface. REFUSAL	
10										

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-WIL-102A

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

23799.00

WIN 23799.00

HIGHWAY PLANS

	BY	DATE
PROJ. MANAGER J. G. WHITTINGTON		
DESIGN-DETAILED	L. KANDKO	
CHECKED-REVIEWED	C. RUSSELL	
DESIGN2-DETAILED2	T. WHITE	OCT 2020
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

WILTON
U.S. ROUTE 2

BORING LOCATION PLAN & INTERPRETIVE SUBSURFACE PROFILE WITH BORING LOGS

SHEET NUMBER

2

OF 2

Appendix A

Boring Logs

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

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

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))

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: Large Culvert Replacement on U.S. Route 2
Location: Wilton, Maine

Boring No.: HB-WIL-101
WIN: 23799.00

Driller:	MaineDOT	**Elevation (ft.)**	598.8	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/Niles	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	C. Russell	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	8/27/2018; 08:30-10:50	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	13+46.4, 17.6 ft Lt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	9.0 ft bgs.
Hammer Efficiency Factor: 0.928		**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	598.4		5" HMA.	
										0.4	
	1D	24/16	1.00 - 3.00	8/18/30/40	48	74				Brown, dry, very dense, Gravelly fine to coarse SAND, trace silt, (Fill).	G#296612 A-1-a, SW-SM WC=3.8%
5	2D	24/15	5.00 - 7.00	6/9/9/9	18	28				Brown, damp, medium dense, fine to coarse SAND, some silt, little gravel, (Fill).	G#296613 A-2-4, SM WC=10.2%
10	3D	24/20	10.00 - 12.00	10/22/9/14	31	48	42	588.8		10.0	
							157			Light brown, moist, dense, fine to coarse SAND, some gravel, some silt, trace clay, (Till).	G#296614 A-2-4, SC-SM WC=8.4%
							440				
							25			Roller Coned ahead to 15.0 ft bgs.	
							95				
15	R1 MD	60/50 0/0	15.00 - 20.00 15.00 - 15.00	RQD = 25% 20(0")	---		NQ-2	583.8		15.0	
										Top of Bedrock at Elev. 583.8 ft. R1: Bedrock: Sulfidic/Carbonaceous PELITE, [Seboomook Formation, Temple Stream Member]. Rock Quality = Very Poor R1: Core Times (min:sec) 15.0-16.0 ft (1:12) 16.0-17.0 ft (2:18) 17.0-18.0 ft (1:38) 18.0-19.0 ft (1:48) 19.0-20.0 ft (1:43) 95% Recovery Failed sample attempt and Spoon REFUSAL at 15.0 ft bgs.	
20								578.8		20.0	
										Bottom of Exploration at 20.0 feet below ground surface.	
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: Large Culvert Replacement on U.S. Route 2
Location: Wilton, Maine

Boring No.: HB-WIL-102
WIN: 23799.00

Drilling Contractor:	MaineDOT	**Elevation (ft.)**	597.2	**Auger ID/OD:**	5" Dia.
Operator:	Daggett/Niles	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	C. Russell	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	8/27/2018; 11:00-11:15	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	13+52.2, 16.0 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			Probe, no samples taken.	
5										
							588.9		8.3	
									Bottom of Exploration at 8.3 feet below ground surface. REFUSAL	
10										
15										
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: Large Culvert Replacement on U.S. Route 2
Location: Wilton, Maine

Boring No.: HB-WIL-102A
WIN: 23799.00

Drilling Contractor:	MaineDOT	**Elevation (ft.)**	597.0	**Auger ID/OD:**	5" Dia.
Operator:	Daggett/Niles	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	C. Russell	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	8/27/2018; 11:15-11:30	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	13+59.7, 16.5 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			Probe, no samples taken.	
5										
							588.0		9.0	
10									**Bottom of Exploration at 9.0 feet below ground surface.** REFUSAL	
15										
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.

Appendix B

Laboratory Test Results

State of Maine - Department of Transportation

Laboratory Testing Summary Sheet

Town(s): Wilton Work Number: 23799.00

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-WIL-101, 1D	TBD		1.0-3.0	296612	1	3.8			SW-SM	A-1-a	0
HB-WIL-101, 2D	TBD		5.0-7.0	296613	1	10.2			SM	A-2-4	II
HB-WIL-101, 3D	TBD		10.0-12.0	296614	1	8.4			SC-SM	A-2-4	III

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.

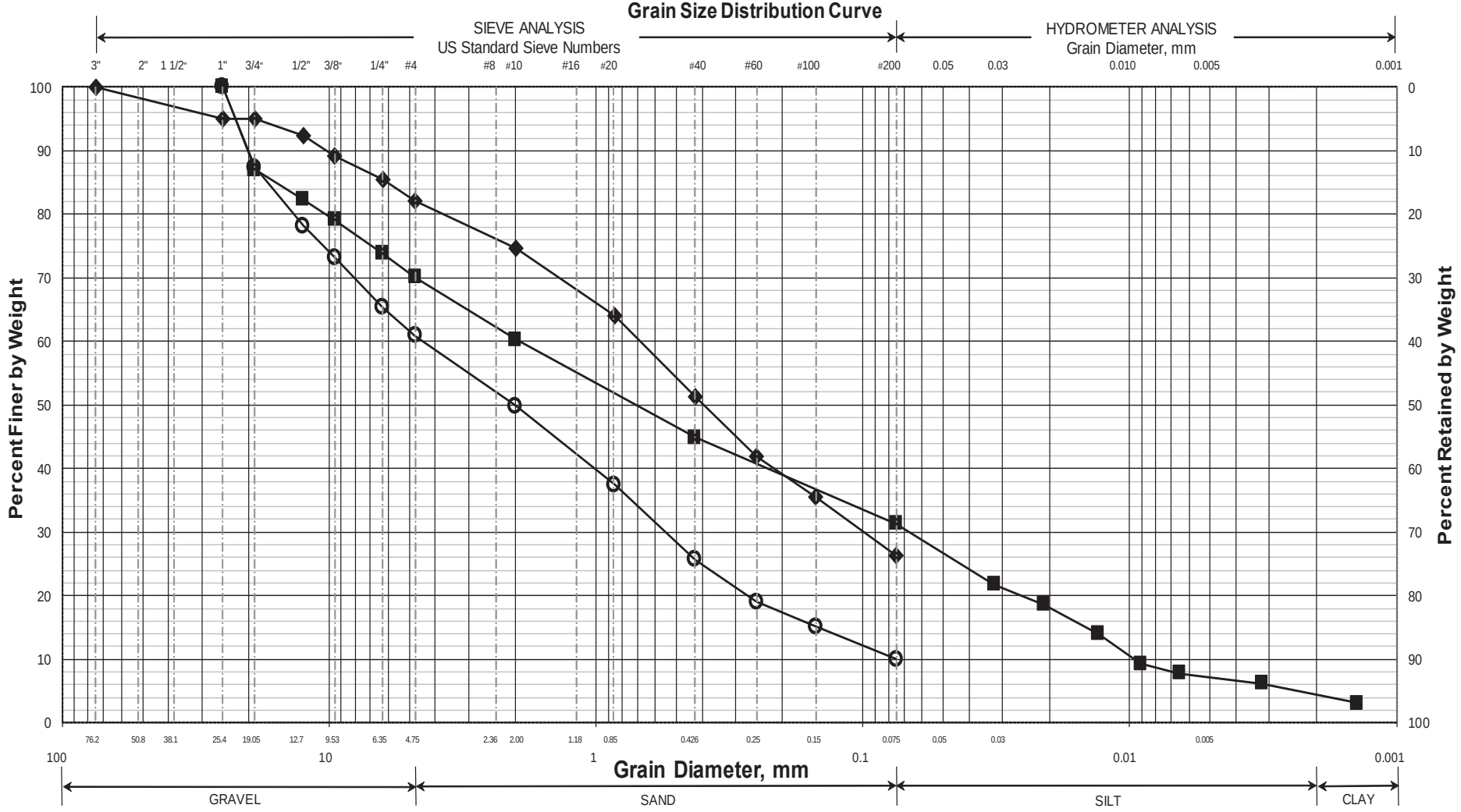
GSDC = Grain Size Distribution Curve as determined by AASHTO T 88-93 (1996) and/or ASTM D 422-63 (Reapproved 1998)

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

Maine Department of Transportation
Grain Size Distribution Curve



UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-WIL-101/1D	TBD		1.0-3.0	Gravelly SAND, trace silt.	3.8			
◆	HB-WIL-101/2D	TBD		5.0-7.0	SAND, some silt, little gravel.	8.4			
■	HB-WIL-101/2D	TBD		10.0-12.0	SAND, some gravel, some silt, trace clay.	10.2			
●									
▲									
×									

WIN
023799.00
Town
Wilton
Reported by/Date
WHITE, TERRY A 9/24/2018