

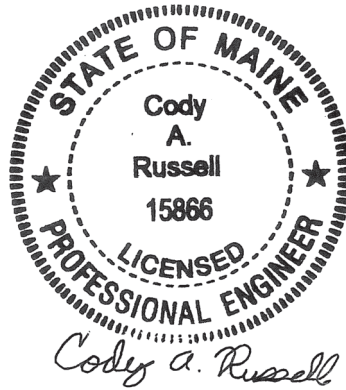
**MAINE DEPARTMENT OF TRANSPORTATION
HIGHWAY PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE**

GEOTECHNICAL DESIGN REPORT

For the Replacement of

**LARGE CULVERT #988887
ROUTE 166
PENOBSCOT, MAINE**

Prepared by:
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Geotechnical Engineer



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

Penobscot County
WIN 24273.00

Soils Report 2022-25
Federal Project No. 2427300

September 16, 2022

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 large culvert (#988887) consisting of twin approximately 52-foot long, 36-inch diameter corrugated metal pipes (CMPs) on Route 166 in Penobscot. The existing culvert is rusted and a joint has failed on the inlet end. The culvert is located approximately 0.16 of a mile south of Route 175 as shown in the attached Location Map. Route 166 is a Highway Corridor Priority 4 road.

The proposed replacement structure will be an 81-inch span by 59-inch rise, 70-foot long corrugated metal 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 to protect against erosion.

SUBSURFACE INVESTIGATION

One (1) probe (HB-PEN-101) and one (1) boring (HB-PEN-102) were drilled for this project on March 2, 2020 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-PEN-101 and boring HB-PEN-102 were drilled using solid stem auger techniques. No soil samples were obtained in the probe. Soil samples were obtained in boring HB-PEN-102 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 48 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 0.886 to the raw field N-values.

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 two (2) standard grain size analysis with natural water content and two (2) 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 consisting of silt. 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-PEN-101 was drilled to a depth of approximately 15.0 feet below ground surface (bgs) and did not encounter a refusal surface. Boring HB-PEN-102 was drilled to a depth of approximately 17.0 feet bgs and did not encounter a refusal surface.

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

Approx. Depth BGS ¹ (feet)	Soil Description	AASHTO ² Classification	USCS ³	WC% ⁴
0.0 – 0.5	HMA Pavement	--	--	--
0.5 – 5.0	Fill: Brown, moist, fine to coarse sand, little gravel, little silt.	A-1-b	SM	8.8
5.0 – 10.5	Grey-brown, wet, fine to coarse sandy silt, little gravel.	A-4	SM	13.5
10.5 – 17.0	Glacial Till Olive and grey, moist, silt, little to some fine to coarse sand, little clay, trace to some gravel.	A-4	CL or SC-SM	8.0 to 10.1

¹BGS = below ground surface

²AASHTO = American Association of State Highway and Transportation Officials

³USCS = Unified Soil Classification System

⁴WC% = Water content in percent

One (1) N₆₀-value obtained in the fill was 24 blows per foot (bpf) indicating that the fill is medium dense in consistency. One (1) N₆₀-value obtained in the sandy silt was 18 bpf indicating that the sandy silt is very stiff in consistency. Two (2) N₆₀-values obtained in the glacial till were 44 bpf and 86 bpf, indicating that the glacial till is hard in consistency.

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

Corrugated Metal Pipe Arch Culvert Construction – The proposed replacement structure will be an 81-inch span by 59-inch rise, 70-foot long corrugated metal pipe arch culvert. The proposed

corrugated metal pipe arch culvert shall be furnished and installed in accordance with MaineDOT Standard Specification 603.

The invert of the proposed corrugated metal pipe arch culvert ranges from approximately 29.07 feet at the inlet end to approximately 28.34 feet at the outlet end with a 1.0% 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 $\frac{3}{4}$ -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 corrugated metal 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 corrugated metal 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 corrugated metal 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 large culvert (#988887) under Route 166 in Penobscot, 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



PENOBSCOT, 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.

0.1 Miles
1 inch = 0.14 miles

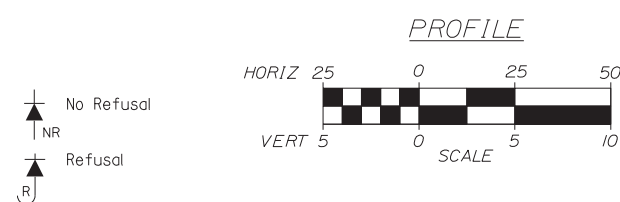
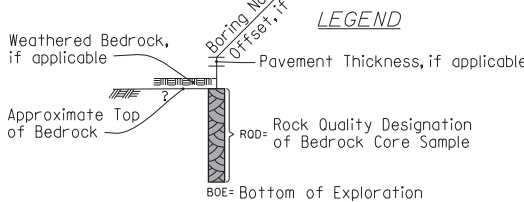
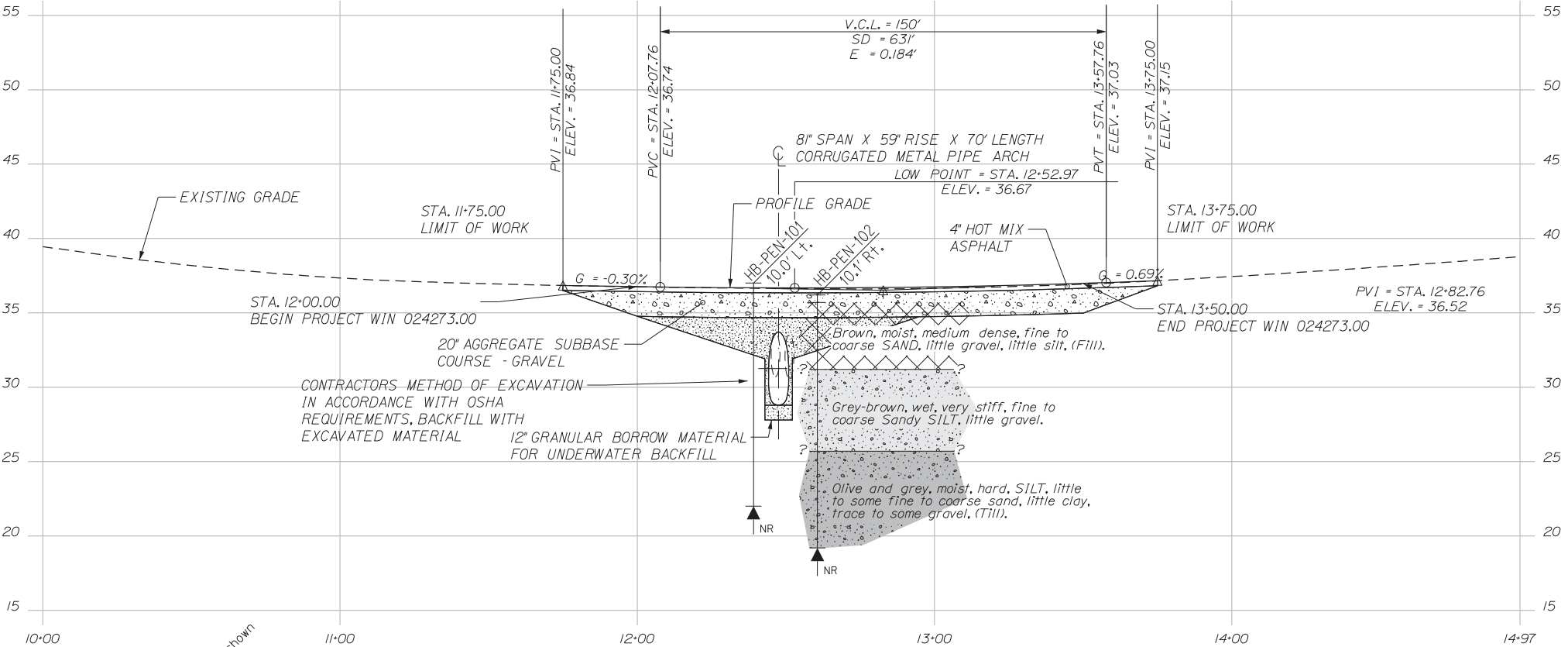
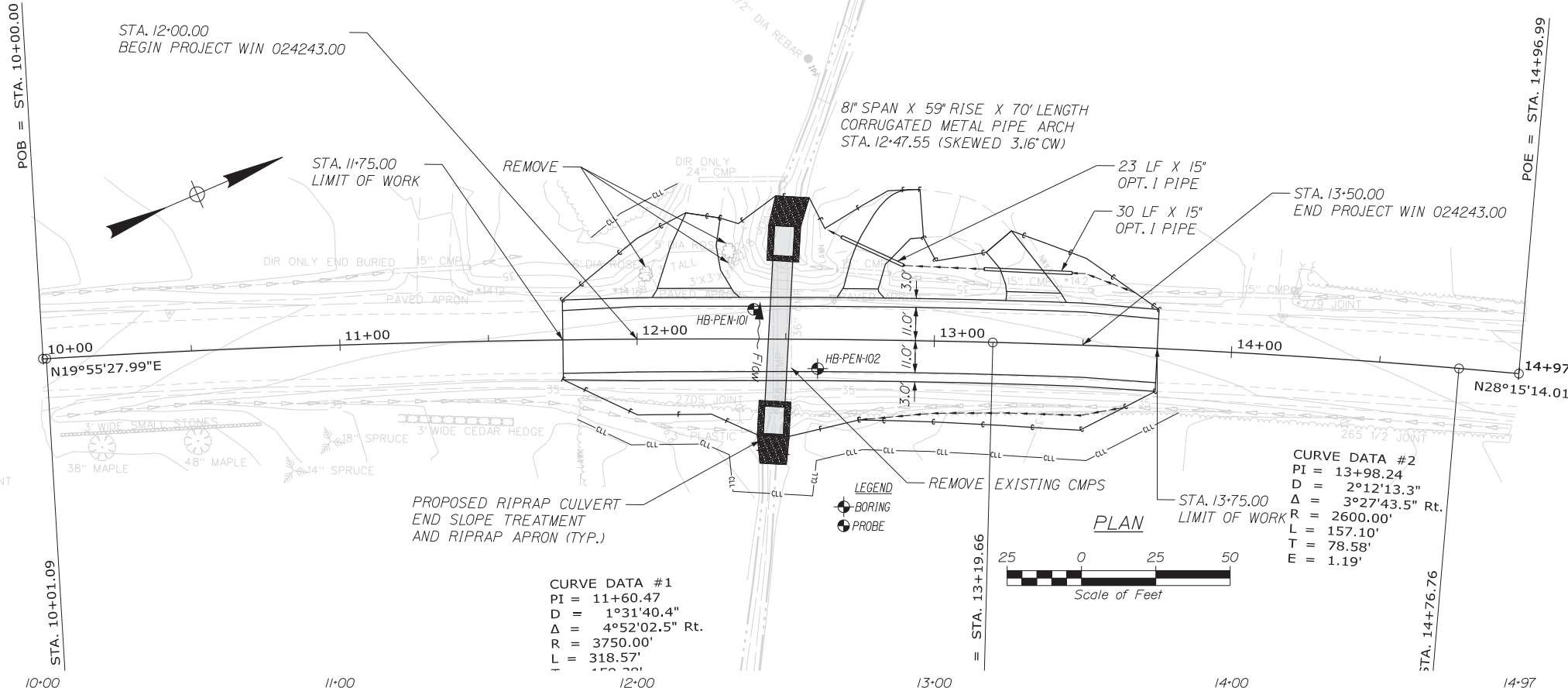
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SHEET NUMBER 1	PENOBSCOT ROUTE 166	STATE OF MAINE DEPARTMENT OF TRANSPORTATION	
		2427300	
OF 2	LOCATION MAP	WIN 24273.00	HIGHWAY PLANS

Username: Cody A. Russell Date: 9/16/2022

Division: GEOTECH

Filename: ... \MSTA002_BLP8\SP_WBL1.dgn



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/Borehole Exploration Log US CUSTOMARY UNITS		Project: Route 166 Large Culvert Location: Penobscot, Maine	Boring No.: HB-PEN-101 WIN: 24273.00
Drilling Contractor: Metredot	Elevation (ft.): 37.0	Operator: Doggett/Bestrock	Auger ID/OD: 5" Dia.
Logged By: B. Wilder	Date: NAO88	Drilling Method: Solid Stem Auger	Sampler: N/A
Date Started/Finished: 3/2/2020 09:00-12:00	Drilling Method: Solid Stem Auger	Core Barrels: N/A	Water Level: None Observed
Boring Location: 12+29.11, 10.0 ft Lt.	Casing ID/OD: N/A	Water Level: None Observed	
Sample Information			
Depth (ft.)	Sample No.	Pen./Rel. (ft.)	Visual Description and Remarks
4			Probe, similar soils as HB-PEN-102.
5			
10			
15			
20			
22.00			Bottom of Exploration at 15.0 feet below ground surface. NO REFUSAL.
25			
30			
35			
40			
45			
50			
55			

Maine Department of Transportation Soil/Borehole Exploration Log US CUSTOMARY UNITS		Project: Route 166 Large Culvert Location: Penobscot, Maine	Boring No.: HB-PEN-102 WIN: 24273.00		
Driller: Metredot	Elevation (ft.): 36.2	Operator: Doggett/Bestrock	Auger ID/OD: 5" Dia.		
Logged By: B. Wilder	Date: NAO88	Drilling Method: Solid Stem Auger	Sampler: Standard Split Spoon		
Date Started/Finished: 3/2/2020 09:00-12:00	Drilling Method: Solid Stem Auger	Core Barrels: N/A	Water Level: None Observed		
Boring Location: 12+60.41, 10.1 ft Rt.	Casing ID/OD: N/A	Water Level: None Observed			
Sample Information					
Depth (ft.)	Sample No.	Pen./Rel. (ft.)	Visual Description and Remarks		
0			E' HMA.		
10	24/18	1.50 - 3.50	11/10/6/11 16 24	Brown, moist, medium dense, fine to coarse SAND, little gravel, little silt, (FILL).	
5	20	24/20	5.00 - 7.00	11/6/6/10 12 18	Mud from 4.5-5.0 ft. deep. Grey-brown, wet, very stiff, fine to coarse sandy SILT, little gravel.
10	30	24/20	10.00 - 12.00	8/15/17/20 30 44	Dry, moist, hard, SILT, little clay, little fine to coarse sand, trace gravel, (FILL).
15	40	24/15	15.00 - 17.00	11/27/31/23 58 86	Grey, moist, hard, SILT, some fine to coarse sand, some gravel, little clay, (FILL).
19.2				Bottom of Exploration at 17.0 feet below ground surface. NO REFUSAL.	
20					
25					
30					
35					
40					
45					
50					
55					

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION
2427300
WIN 24273.00
HIGHWAY PLANS

PROJECT: PENOBSCOT ROUTE 166
BORING LOCATION PLAN & INTERPRETIVE SUBSURFACE PROFILE WITH BORING LOGS

BY: T. WHITE
DATE: SEP 2022
SIGNATURE: C. RUSSELL
P.E. NUMBER: _____
DATE: _____

DESIGN-DETAILED: _____
CHECKED-REVIEWED: _____
DESIGNS-DETAILED: C. RUSSELL
DESIGNS-DETAILED: T. WHITE
REVISIONS: 1
REVISIONS: 2
REVISIONS: 3
REVISIONS: 4
FIELD CHANGES: _____

SHEET NUMBER
2
OF 2

Driller: MaineDOT	Elevation (ft.): 36.2	Auger ID/OD: 5" Dia.
Operator: Daggett/Westrack	Datum: NAVD88	Sampler: Standard Split Spoon
Logged By: B. Wilder	Rig Type: CME 45C	Hammer Wt./Fall: 140#/30"
Date Start/Finish: 3/2/2020; 09:00-12:00	Drilling Method: Solid Stem Auger	Core Barrel: N/A
Boring Location: 12+60.6, 10.1 ft Rt.	Casing ID/OD: N/A	Water Level*: None Observed

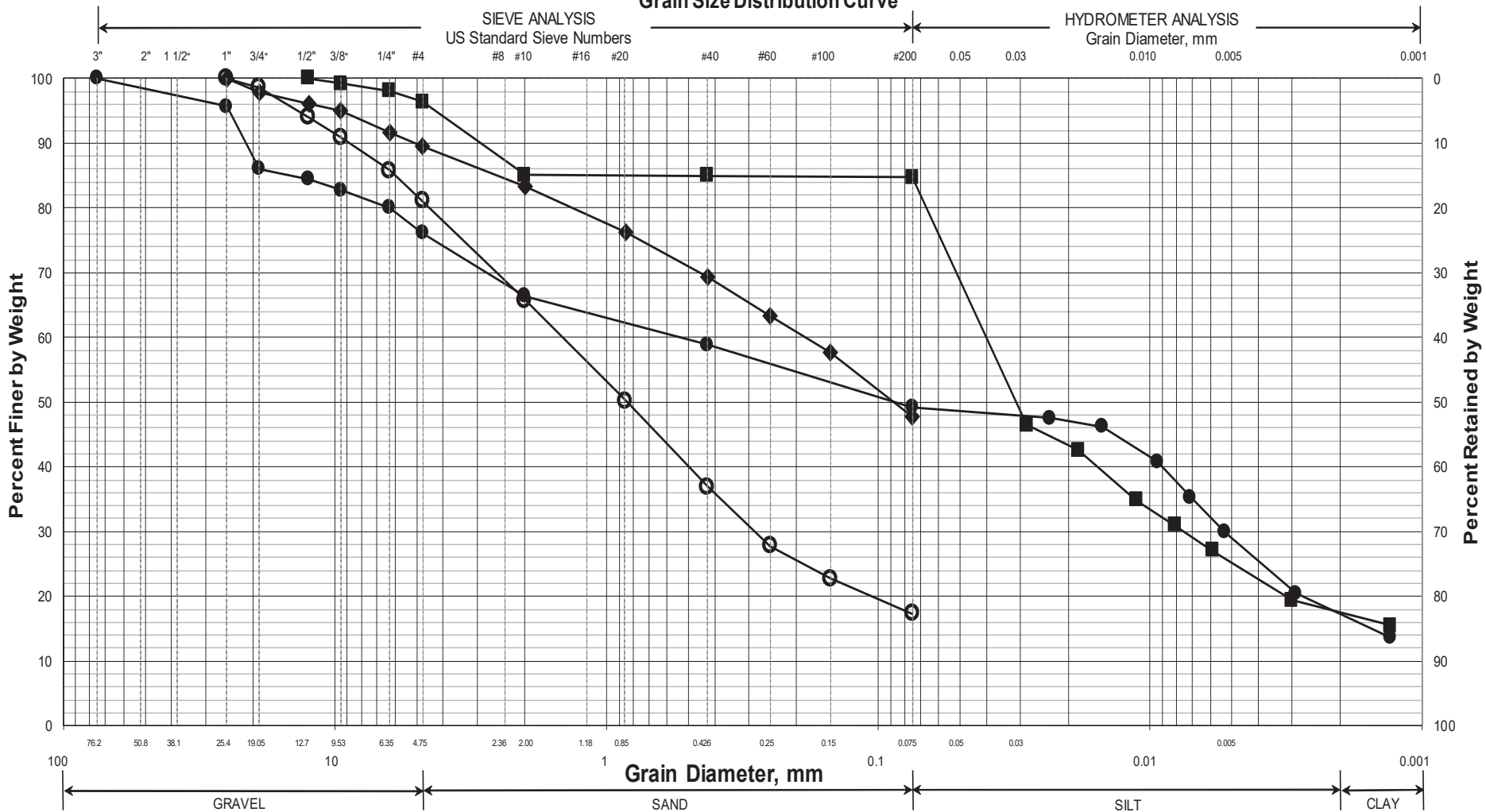
Hammer Efficiency Factor: 0.886 **Hammer Type:** Automatic Hydraulic Rope & Cathead

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

Depth (ft.)	Sample Information								Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows					
0									35.7	6" HMA.		
	1D	24/18	1.50 - 3.50	11/10/6/11	16	24				Brown, moist, medium dense, fine to coarse SAND, little gravel, little silt, (Fill).	G#340706 A-1-b, SM WC=8.8%	
5									31.2	Wood from 4.5-5.0 ft bgs.		
	2D	24/20	5.00 - 7.00	11/6/6/10	12	18				Grey-brown, wet, very stiff, fine to coarse Sandy SILT, little gravel.	G#340707 A-4, SM WC=13.5%	
10									25.7	Olive, moist, hard, SILT, little clay, little fine to coarse sand, trace gravel, (Till).	G#340708 A-4, CL WC=10.1%	
15									22.2			
	4D	24/15	15.00 - 17.00	11/27/31/23	58	86			19.2	Grey, moist, hard, SILT, some fine to coarse sand, some gravel, little clay, (Till).	G#340709 A-4, SC-SM WC=8.0%	
										Bottom of Exploration at 17.0 feet below ground surface. NO REFUSAL		

Remarks:

Maine Department of Transportation Grain Size Distribution Curve



UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	HB-PEN-102/1D	12+60.6	10.1 RT	1.5-3.5	SAND, little gravel, little silt.	8.8			
◆	HB-PEN-102/2D	12+60.6	10.1 RT	5.0-7.0	Sandy SILT, little gravel.	13.5			
■	HB-PEN-102/3D	12+60.6	10.1 RT	10.5-12.0	SILT, little clay, little sand, trace gravel.	10.1			
●	HB-PEN-102/4D	12+60.6	10.1 RT	15.0-17.0	SILT, some sand, some gravel, little clay.	8.0			
▲									
X									

WIN
024273.00
Town
Penobscot
Reported by/Date
WHITE, TERRY A 8/24/2022