

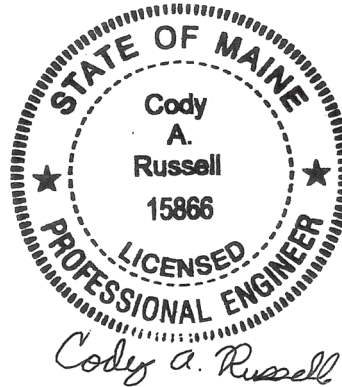
**MAINE DEPARTMENT OF TRANSPORTATION
HIGHWAY PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE**

GEOTECHNICAL DESIGN REPORT

For the Replacement of:

**CROSS CULVERT #XC-97545
FOREST AVENUE
FORT FAIRFIELD, MAINE**

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Senior Geotechnical Engineer

Aroostook County
WIN 22859.00

Soils Report 2021-11
April 5, 2021

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 50-foot long, 36-inch diameter corrugated metal pipe (CMP) cross culvert (#XC-97545) on Forest Avenue in Fort Fairfield. The invert of the existing culvert has rusted out. The culvert is located approximately 1.43 miles south of Dumond Road as shown on the attached Location Map. Forest Avenue is a Highway Corridor Priority 4 road.

The proposed replacement structure will be an 84-foot long, 96-inch diameter Polymer Coated CMP culvert on a skew of approximately 12 degrees to the roadway centerline. To facilitate fish passage, Habitat Connectivity Design elements will be used inside the Polymer Coated CMP culvert as shown on the Special Details Sheet in the Plans. The invert of the proposed culvert is approximately 12.5 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

Three (3) probes (HB-FOFA-101, HB-FOFA-103, and HB-FOFA-104) and one (1) boring (HB-FOFA-102) were drilled in the road near the existing structure on October 17, 2017 by the MaineDOT drill crew using a trailer mounted drill rig. Exploration locations are shown on the attached Boring Location Plan & Interpretive Subsurface Profile. Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are shown on the attached boring logs.

Probes HB-FOFA-101, HB-FOFA-103, and HB-FOFA-104 were drilled using solid stem auger drilling techniques. No soils samples were obtained in the probes. Boring HB-FOFA-102 was drilled using solid stem auger, cased wash boring, and rock core drilling techniques. Soil samples were obtained in the boring 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 42 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 0.854 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 Program (NETTCP) certified Subsurface Investigator logged the subsurface conditions encountered. The borings 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 three (3) standard grain size analyses with 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 Curves.

SUBSURFACE CONDITIONS

Subsurface conditions encountered at the test boring generally consisted of sandy gravel fill, underlain by native sandy gravel which is underlain by bedrock. An interpretive subsurface profile depicting the generalized soil stratigraphy at the boring location is shown on the attached Boring Location Plan & Interpretive Subsurface Profile.

Probes HB-FOFA-101, HB-FOFA-103, and HB-FOFA-104 were drilled to depths ranging from approximately 16.1 to 17.5 feet bgs where they all encountered a refusal surface. Boring HB-FOFA-102 was drilled to a depth of approximately 22.0 feet below ground surface (bgs) including a 5-foot bedrock core.

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

Approx. Depth BGS ¹ (feet)	Soil Description	AASHTO ² Classification	USCS ³	WC% ⁴
0.0 – 0.3	Pavement			
0.3 – 14.0	Fill: Brown and light brown, moist to wet, fine to coarse sandy gravel, little to some silt, occasional cobble, wood.	A-1-b	GM	6.3 to 13.9
14.0 – 16.0	Till: Light brown, wet, fine to coarse sandy gravel, little silt.	A-1-a	GM	9.0
16.0 – 17.0	Weathered Bedrock.	--	--	--
17.0 – 22.0	Bedrock: Interbedded pelite and limestone and/or dolostone.	--	--	--

¹BGS = below ground surface

²AASHTO = American Association of State Highway and Transportation Officials

³USCS = Unified Soil Classification System

⁴WC% = Water content in percent

Two (2) corrected N-values obtained in the fill were 19 and 30 blows per foot (bpf), indicating that the fill is medium dense in consistency. One (1) corrected N-value obtained in the till was 161 bpf, indicating that the till is very dense in consistency.

Groundwater was recorded at a depth of 9.5 feet bgs in boring HB-FOFA-102. Groundwater 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.

GEOTECHNICAL DESIGN AND CONSTRUCTION RECOMMENDATIONS

Polymer Coated Corrugated Metal Pipe Culvert Construction – The proposed replacement structure will be an 84-foot long, 96-inch diameter Polymer Coated CMP culvert on a skew of approximately 12 degrees to the roadway centerline. The proposed pipe culvert shall be furnished and installed in accordance with MaineDOT Standard Specification 603.

The invert of the proposed culvert pipe ranges from approximately 551.37 feet at the inlet end to approximately 547.17 feet at the outlet end with a 5.01% slope. To facilitate fish passage, Habitat Connectivity Design elements will be used inside the Polymer Coated CMP culvert as shown on the Special Details Sheet in the Plans.

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 – The proposed vertical alignment will include raising the roadway grade between approximately 0 to 2.5 feet along the roadway centerline. Due to the presence of granular soils at the site, no settlement issues are anticipated. The proposed Polymer Coated CMP culvert is larger in diameter than the existing culvert and will result in a net unloading of the site soils at the structure location. Any settlement due to elastic compression of the site soils and bedding material will be immediate and negligible.

Scour and Riprap – Both the inlet and outlet of the Polymer Coated CMP 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.

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 proposed Polymer Coated CMP 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 firm soils underlying the native silt and silty clay 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 for specific application to the proposed replacement of cross culvert #XC-97545 under Forest Avenue in Fort Fairfield, 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
Key to Soil and Rock Descriptions and Terms
Boring Logs
Laboratory Testing Summary Sheet
Grain Size Distribution Curve Sheet



FORT FAIRFIELD, 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.

0.4 Miles
1 inch = 0.44 miles

Date: 2/22/2021
Time: 9:40:48 AM

SHEET NUMBER

1

OF 2

FORT FAIRFIELD FOREST AVENUE

LOCATION MAP

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

2285900

WIN

22859.00

HIGHWAY PLANS

Date: 4/6/2021

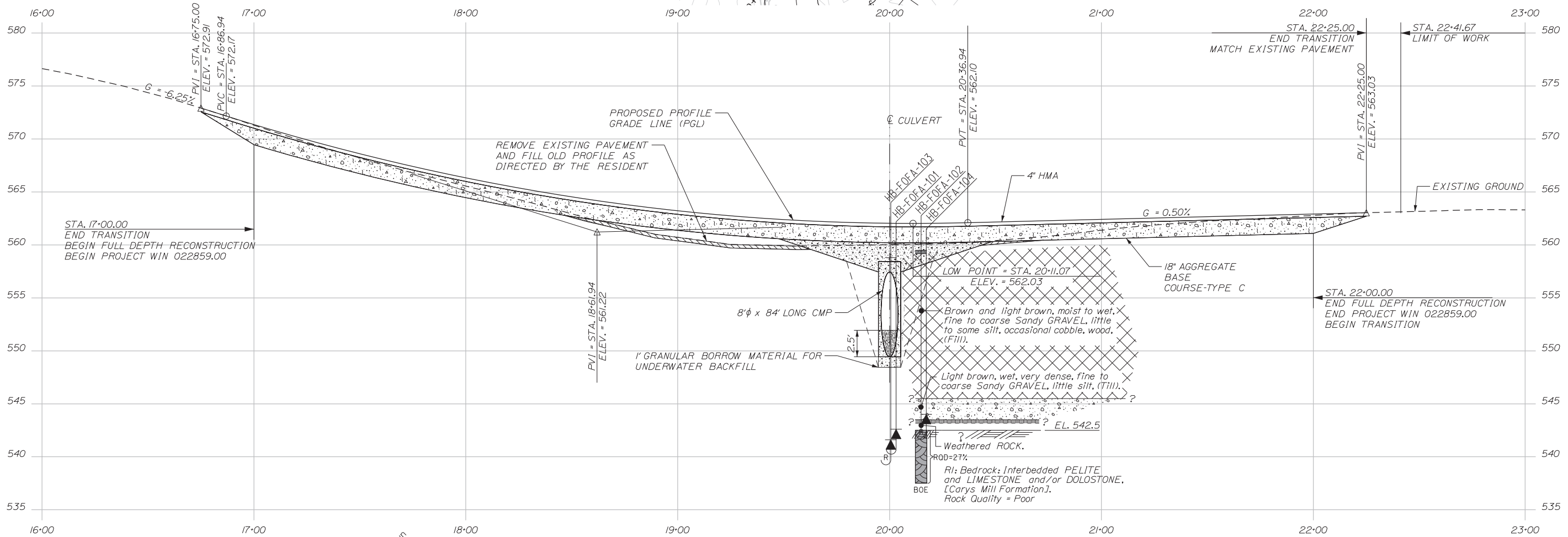
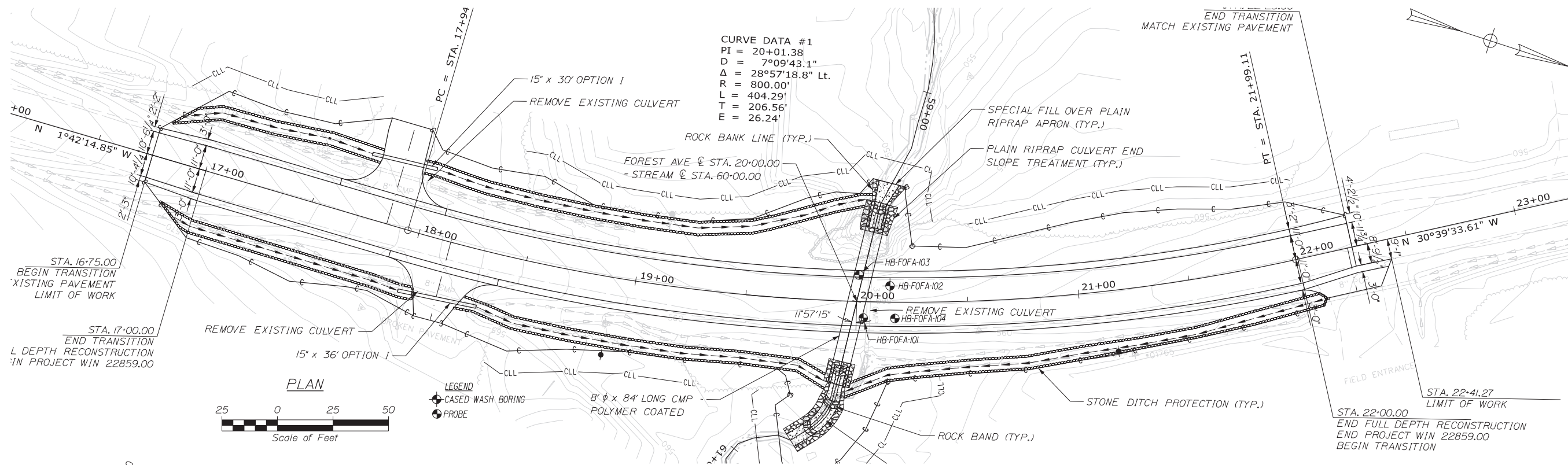
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PROJ. MANAGER	DATE	BY	DATE
DESIGN-DETAILED			
CHECKED-REVIEWED			
DESIGN-DETAILED	C. RUSSELL	T. WHITE	FEB 2021
DESIGN-DETAILED			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

FORT FAIRFIELD
FOREST AVENUE
BORING LOCATION PLAN &
INTERPRETIVE SUBSURFACE PROFILE

CURVE DATA #1
PI = 20+01.38
D = 7°09'43.1"
Δ = 28°57'18.8" Lt.
R = 800.00'
L = 404.29'
T = 206.56'
E = 26.24'



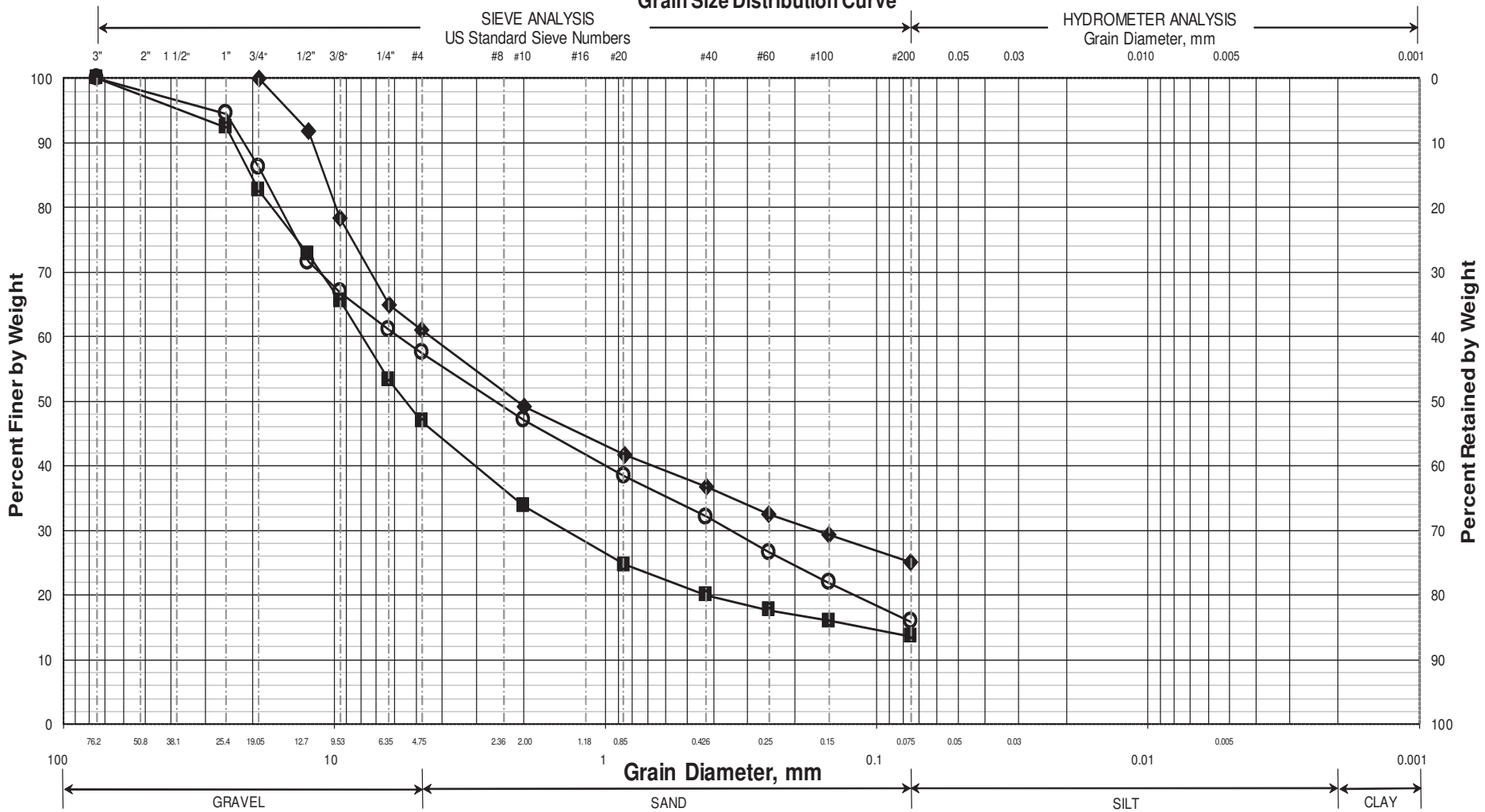
Driller: MaineDOT	Elevation (ft.): 559.5	Auger ID/OD: 5" Dia Solid Stem
Operator: Travis/Tyson	Datum: NAVD88	Sampler: Standard Split Spoon
Logged By: B. Wilder	Rig Type: CME 45C	Hammer Wt./Fall: 140#/30"
Date Start/Finish: 10/17/2017; 08:00-10:30	Drilling Method: Cased Wash Boring	Core Barrel: NQ-2"
Boring Location: 20+14.9, 7.3 ft Lt.	Casing ID/OD: NW-3"	Water Level*: 9.5 ft bgs.

Hammer Efficiency Factor: 0.854 **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 N₆₀ = SPT N-uncorrected Corrected for Hammer Efficiency G = Grain Size Analysis
 MV = Unsuccessful Field Vane Shear Test Attempt WO1P = Weight of One Person N₆₀ = (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								SSA	559.2	4" HMA.		
5	1D	24/19	5.00 - 7.00	5/9/12/20	21	30	38			Brown, moist, medium dense, fine to coarse Sandy GRAVEL, little silt, occasional cobble, (Fill).	G#302634 A-1-b, GM WC=6.3%	
10	2D	24/4	10.00 - 12.00	4/5/8/8	13	19	14			Light brown, wet, medium dense, fine to coarse Sandy GRAVEL, some silt, wood, (Fill).	G#302636 A-1-b, GM WC=13.9%	
15	3D	18/13	15.00 - 16.50	42/48/70	113	161			545.5	Light brown, wet, very dense, fine to coarse Sandy GRAVEL, little silt, (Till).	G#302637 A-1-a, GM WC=9.0%	
									543.5	Some Weathered Rock in Tip of Spoon.		
	R1	60/59	17.00 - 22.00	RQD = 27%				NQ-2	542.5	Weathered ROCK. Roller Coned ahead to 17.0 ft bgs.		
20										Top of Bedrock at Elev. 542.5 ft. R1: Bedrock: Interbedded PELITE and LIMESTONE and/or DOLOSTONE [Carys Mill Formation]. Rock Quality = Poor. R1: Core Times (min:sec) 17.0-18.0 ft (2:34) 18.0-19.0 ft (2:50) 19.0-20.0 ft (3:16) 20.0-21.0 ft (3:22) 21.0-22.0 ft (3:31) 98% Recovery		
25									537.5	Bottom of Exploration at 22.0 feet below ground surface.		

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-FOFA-102/1D	20+14.9	7.3 LT	5.0-7.0	Sandy GRAVEL, little silt.	6.3			
◆	HB-FOFA-102/2D	20+14.9	7.3 LT	10.0-12.0	Sandy GRAVEL, some silt.	13.9			
■	HB-FOFA-102/3D	20+14.9	7.3 LT	15.0-16.5	Sandy GRAVEL, little silt.	9.0			
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Town
Fort Fairfield
Reported by/Date
WHITE, TERRY A 2/24/2021