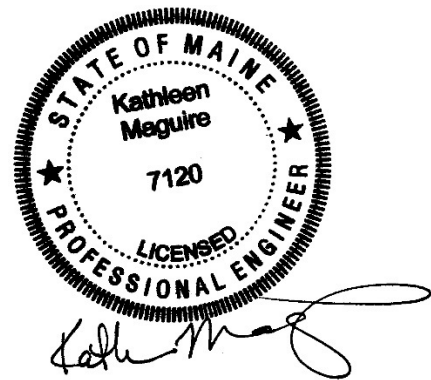


**MAINE DEPARTMENT OF TRANSPORTATION
HIGHWAY PROGRAM
GEOTECHNICAL SECTION
AUGUSTA, MAINE**

GEOTECHNICAL DATA REPORT

For Slope Stabilization on:
**U.S. ROUTE 1
WEST BATH, MAINE**

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Sagadahoc County
WIN 23897.00

Soils Report 2019-07
February 28, 2019

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1.0 INTRODUCTION

The purpose of this Geotechnical Data Report is to present subsurface information collected in conjunction with an on-going slope failure and settlement of the roadway in the westbound passing lane of U.S. Route 1 in West Bath, Maine. Figure 1 in Appendix A shows the crescent-shaped area of concern in the roadway as it looked in April 2018. This report presents the results of a record review, limited geotechnical investigation performed at the project site, and makes recommendations for further monitoring of the slope to help determine a fix for the problem. U.S. Route 1 is a Highway Corridor Priority 1 road.

This area of embankment settlement has been an on-going problem since 1965. Over the years, the roadway has been repaired by the addition of pavement to smooth out the settlement (shimming) and occasionally the thickened pavement section has been completely removed and replaced with a traditional pavement section. Observationally, the rate of settlement seems to be decreasing each year.

During a site walkover in April 2018, the Region Engineer along with the Geotechnical Section and the Region Maintenance Superintendent decided to initiate a subsurface exploration program to support an engineering fix to the problem. The Region determined that they that they would remove the thickened pavement section and reconstruct the area to improve the roadway conditions while the final engineering fix was developed. This reconstruction work was completed in the spring of 2018.

To develop a solution to this problem, the installation of three (3) slope inclinometers is planned. The inclinometers will be used to monitor movements in the site soils below the ground surface. The proposed inclinometers will be installed as a part of a highway rehabilitation project which is scheduled for the summer of 2019. Periodic readings will be collected at the inclinometers to assist in developing a fix.

2.0 GEOLOGIC SETTING

The slope failure is located on U.S. Route 1 approximately 0.6 miles west of the Congress Avenue on-ramp in Bath.

The Maine Geologic Survey (MGS) map titled Surficial Geology, Bath Quadrangle, Maine Open-File No. 02-145 (2002) indicates the surficial geology along the project consists of thin drift areas. Thin drift areas are areas with generally less than 10 feet of drift overlying bedrock, with Presumpscot Formation silty clays in the depressions. The borings conducted at the site found significantly more overburden soils at the site than the less than 10 feet indicated by this map.

The Bedrock Geologic Map of Maine, MGS (1985) cites bedrock at the site as interbedded pelite and limestone of the Cape Elizabeth Formation.

3.0 RECORD REVIEW

The 1964 soils report for the original construction of this segment of U.S. Route 1, West Bath-Bath Volumes I, II, and III (Soils Report 64-41, 64-42, and 64-43) identifies the native soils in the area prior to the construction of Route 1 as approximately 30 to 33 feet of very weak peat, underlain by

approximately 17 to 24 feet of very soft clay, underlain by dense sand, as shown in Appendix A, Figures 2 and 3. The report recommends displacing the peat and clay during construction to beyond the extents of the proposed embankment, as shown in Appendix A, Figure 4.

According to the 2003 report Geotechnical Engineering Evaluation for Route 1 Embankment Settlement, West Bound Lanes in the Town of Bath, Sagadahoc County (Soils Report 2003-108), this area on Route 1 has had settlement and movement issues since its original construction in 1965. Approximately one month after being opened to traffic, there was a partial slope failure here when the embankment settled approximately 12 to 15 inches. The existing pavement was removed and the roadway was reconstructed with new fill, subbase, and pavement. By 1968 the roadway had experience approximately 6 inches of additional settlement. Maintenance & Operations (M&O) shimmed over the resulting sag. Several 2 to 4-inch shim repairs were made between 1968 and 2002. The frequency of the repairs has decreased over time, indicating that the embankment settling and creep is decelerating.

Refer to Soils Reports 64-41, 64-42, 64-43, and 2013-108 for additional information on the embankment construction and maintenance issues.

4.0 SUBSURFACE INVESTIGATION

Subsurface conditions were explored by drilling two (2) test borings at the site of the slope failure. S.W. Cole Explorations of Sidney, Maine drilled borings HB-WBATH-101 and HB-WBATH-102 from May 20, 2018 to May 21, 2018 using solid stem auger and cased washed boring techniques. The approximate exploration locations are shown in Appendix B – Boring Location Sketch.

Soil samples were obtained at 5-foot or 2-foot intervals in the borings using Standard Penetration Test (SPT) methods. The S.W. Cole drill rig is equipped with an automatic hammer to drive the split spoon. The calibrated automatic hammer delivers approximately 53 percent more energy during driving than the standard rope and cathead system. Corrected N-values (N_{60}), computed by applying an average energy transfer factor of 0.918 to the raw field N-values, are shown on the boring logs. Details and sampling methods used, field data obtained, and soil conditions encountered are presented in the boring logs provided in Appendix C – Boring Logs.

An experienced geotechnical engineer logged the subsurface conditions encountered. The MaineDOT geotechnical engineer selected the boring location and drilling methods, designated type and depth of sampling techniques, reviewed boring logs and identified field testing requirements. The borings were located in the field using taped measurements at the completion of the drilling program.

5.0 SUBSURFACE CONDITIONS

Subsurface conditions encountered in the test borings generally consisted of approximately 2.0 to 2.5 feet of pavement overlying approximately 27.5 to 28.0 feet of fill sand overlying more than approximately 30.0 feet of native sand. In boring HB-WBATH-102 an approximately 2-foot thick layer of clayey silt was encountered at a depth of approximately 88 feet bgs and weathered rock was encountered at a depth of approximately 91.0 feet bgs. Boring HB-WBATH-101 was drilled to a depth of approximately 62.0 feet below ground surface (bgs) without encountered a refusal surface. Boring

HB-WBATH-102 was drilled to a depth of approximately 92.0 feet bgs. Groundwater was observed in boring HB-WBATH-102 at a depth of approximately 28.0 feet bgs.

6.0 SHORT-TERM ROADWAY REPAIR

In the spring of 2018, following the recommendations of the Geotechnical Section, Region 1 M&O removed the existing thickened pavement section, brought the road back up to grade with new gravel, and repaved. Replacing the excess pavement with granular material reduced loading on the soils and will slow the movement of the slope. The repaired roadway is shown in Appendix A, Figure 5.

7.0 RECOMMENDATIONS FOR SLOPE MONITORING

The displacement of the underlying peat and soft clay during construction of the U.S. Route 1 embankments in 1965 appears to have been very effective. No peat was found in the borings conducted in May 2018. It appears that the peat and clay were displaced into the land area between the two barrels of U.S. Route 1. The slow-moving slope failure (creep) that exists at this location today is likely caused by lateral movement of the embankment into these displaced materials or into similar materials left in place between the barrels in 1965. Removal of the materials at the toe of the slope today is unlikely and once creep has started it is very difficult to stop.

To evaluate the current slope conditions and develop a long-term slope stabilization fix for this site the installation of three (3) slope inclinometers is planned. The inclinometers will be read by the Department to determine the location of the failure surface. Inclinometers will be installed during the 2019 highway rehabilitation project in accordance with Appendix D – Special Provision 639. The Geotechnical Section will monitor the slope and evaluate alternatives for a future slope stabilization repair.

8.0 CLOSURE

This Geotechnical Data Report has been prepared for the use of the MaineDOT Highway Program for specific application to the slope evaluation on U.S. Route 1 in West Bath, Maine in accordance with generally accepted geotechnical and foundation engineering practices. No other intended use or warranty is expressed or implied.

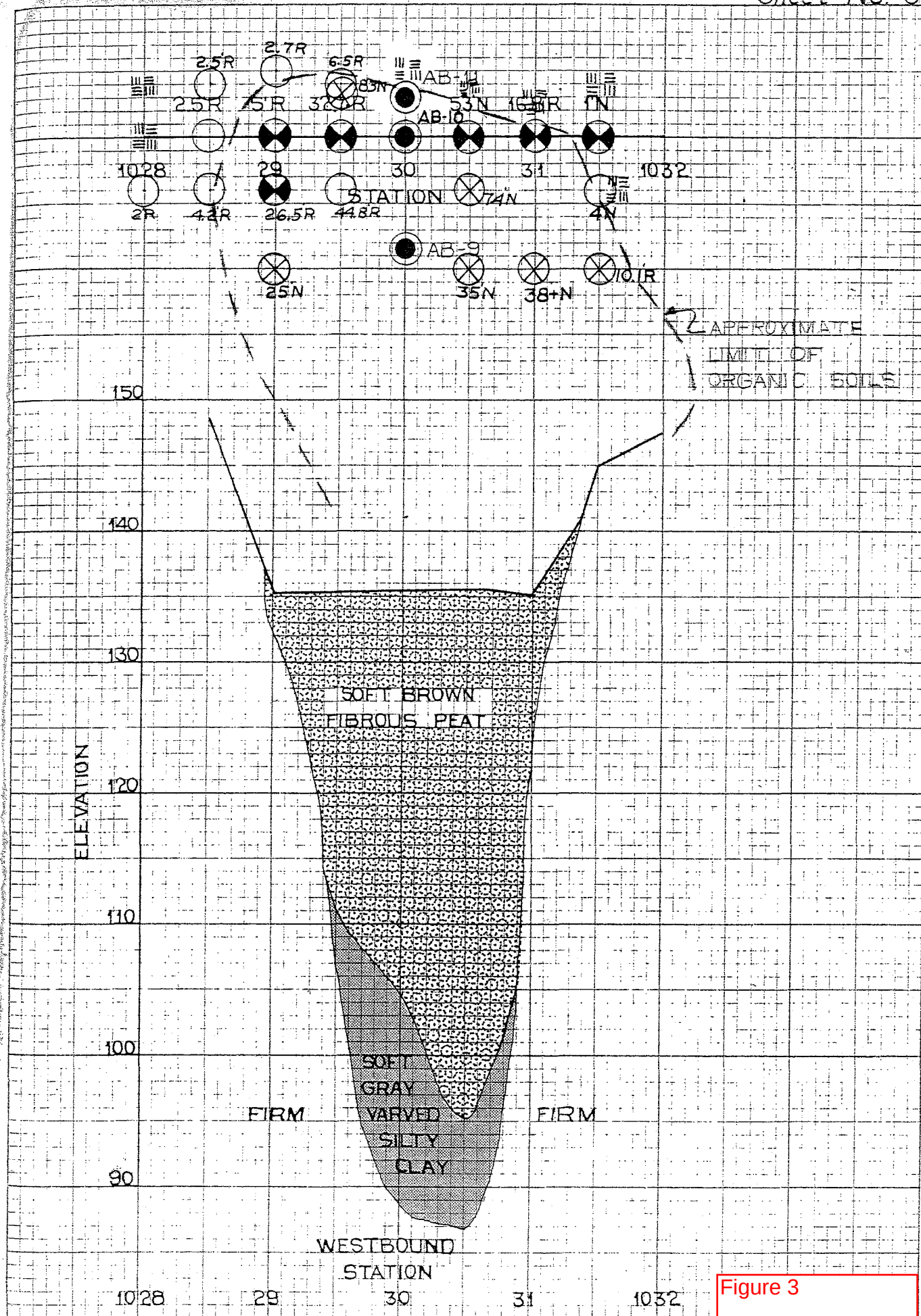
MaineDOT conducted a limited number of soil explorations at discrete locations along the project. MaineDOT shall not be responsible for the Bidder's or Contractor's interpretations, estimates, or conclusions derived from the geotechnical information. Data provided may not be representative of the subsurface conditions between boring locations

Appendix A

Figures



Figure 1 – April 2018



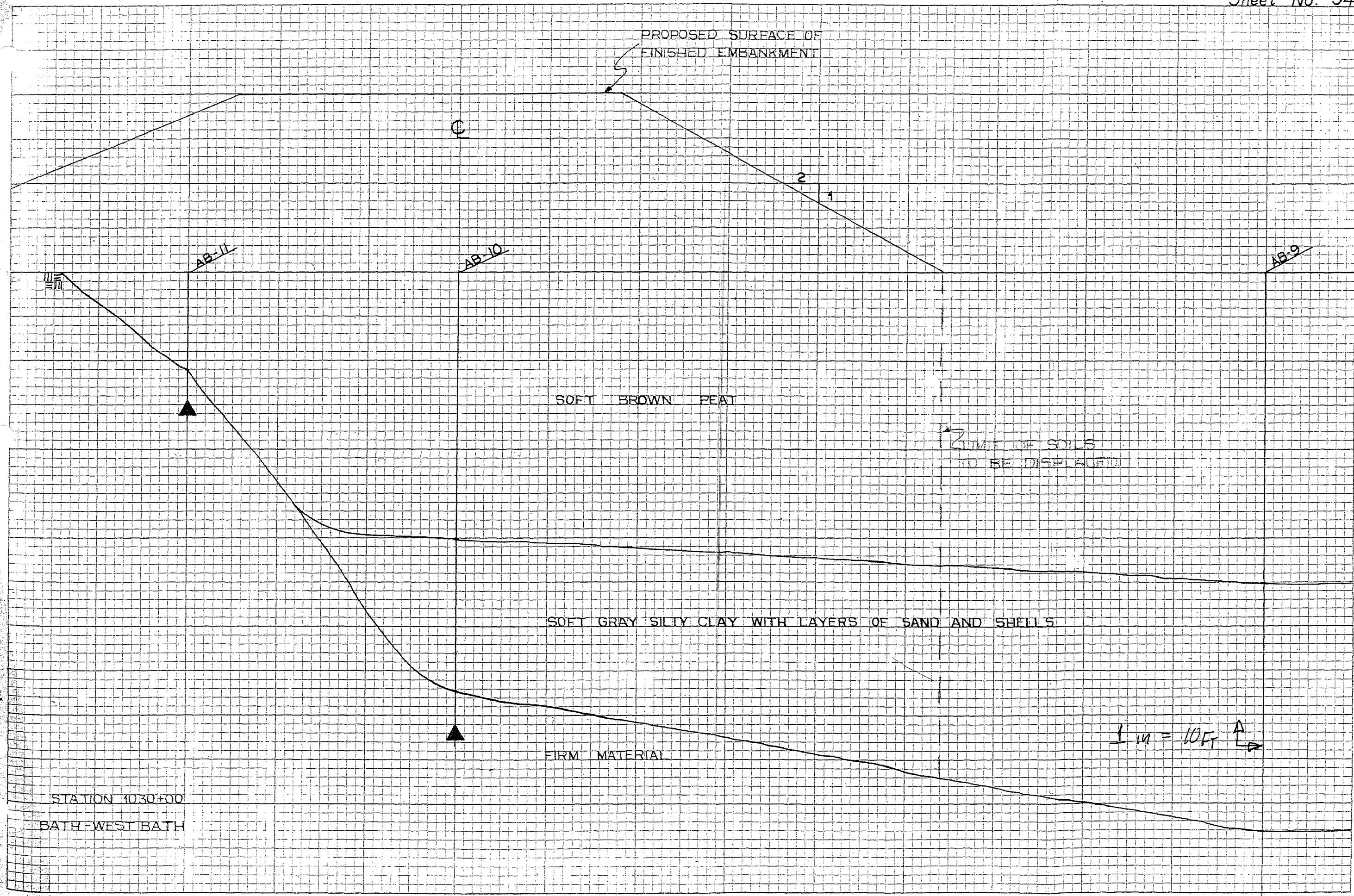


Figure 4

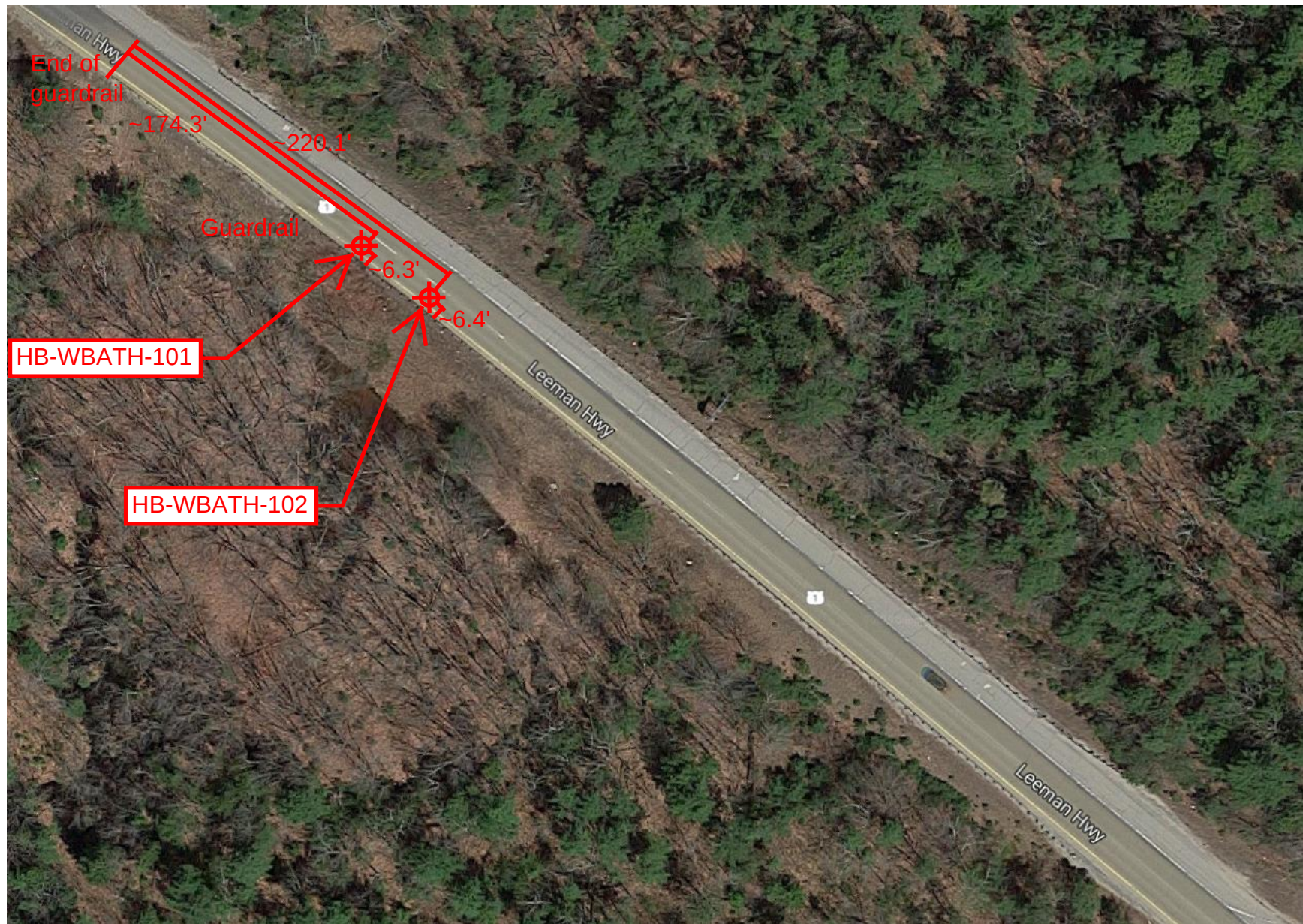


Figure 5 – August 2018

Appendix B

Boring Location Sketch

23897.00 West Bath
Boring Location Sketch



Appendix C

Boring Logs

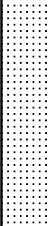
Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: US Route 1 Slope Repair Location: West Bath, Maine				Boring No.: HB-WBATH-101 WIN: 23897.00			
Driller: S. W. Cole Explorations, LLC				Elevation (ft.) --				Auger ID/OD: 5 inch Solid Stem			
Operator: K. Hanscom				Datum: --				Sampler: Standard Split Spoon			
Logged By: M. St. Pierre				Rig Type: Diedrich D-50				Hammer Wt./Fall: 140 lbs / 30 inch			
Date Start/Finish: 05-20-2018 / 05-21-2018				Drilling Method: Cased Wash				Core Barrel: N/A			
Boring Location: See Boring Location Sketch - Appendix				Casing ID/OD: HW 4/4.5 inch				Water Level*: Not observed.			
Hammer Efficiency Factor: 0.918				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								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	Elevation (ft.)			
0							SSA			Pavement	
	1D	24/7	3.00 - 5.00	6/8/8/5	16	24				Brown-grey, damp, medium dense, GRAVEL, some sand, little silt, (Fill).	
5											
	2D	24/5	5.00 - 7.00	3/3/2/2	5	8				Brown, damp, loose, fine to medium SAND, little gravel, trace silt, (Fill).	
10											
	3D	24/12	10.00 - 12.00	3/2/3/3	5	8	87			Brown, damp, loose, fine to medium SAND, little gravel, little silt, (Fill).	
							98				
							109			Cobble.	
							106				
							127				
15											
	4D	24/16	15.30 - 17.30	6/8/9/10	17	26	42			Brown, moist, medium dense, SAND, little gravel, trace silt, (Fill).	
							57				
							76				
							99				
							104				
20											
	5D	24/9	20.00 - 22.00	9/11/12/13	23	35	40			Brown, wet, dense, SAND, little gravel, trace silt, (Fill).	
							62				
							87				
							116				
25							122				
Remarks: Autohammer SN 367 Borehole caved at 26 feet bgs following casing removal.											
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 1 of 3	
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.										Boring No.: HB-WBATH-101	

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: US Route 1 Slope Repair Location: West Bath, Maine				Boring No.: HB-WBATH-101 WIN: 23897.00								
Driller: S. W. Cole Explorations, LLC				Elevation (ft.) --				Auger ID/OD: 5 inch Solid Stem								
Operator: K. Hanscom				Datum: --				Sampler: Standard Split Spoon								
Logged By: M. St. Pierre				Rig Type: Diedrich D-50				Hammer Wt./Fall: 140 lbs / 30 inch								
Date Start/Finish: 05-20-2018 / 05-21-2018				Drilling Method: Cased Wash				Core Barrel: N/A								
Boring Location: See Boring Location Sketch - Appendix				Casing ID/OD: HW 4/4.5 inch				Water Level*: Not observed.								
Hammer Efficiency Factor: 0.918				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 140 lb. 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 _u = 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							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									
25	6D	24/5	25.00 - 27.00	8/9/10/10	19	29	42		Similar to above except medium dense.							
							47									
							68									
							65									
							63									
30	7D	24/4	30.00 - 32.00	4/2/3/3	5	8	35					Brown, wet, loose, fine to medium SAND, little gravel, trace silt.				
							43									
	8D	24/5	32.00 - 34.00	2/4/5/9	9	14	54									
							57									
							67									
35	9D	24/7	35.00 - 37.00	3/1/2/3	3	5	41								Similar to above except medium dense.	
							43									
	10D	24/13	37.00 - 39.00	3/4/6/7	10	15	55									
							64									
							76									
40	11D	24/10	40.00 - 42.00	2/1/3/3	4	6	46		Similar to above except loose.							
							52									
	12D	24/11	42.00 - 44.00	4/5/10/10	15	23	63									
							79									
							86									
45	13D	24/4	45.00 - 47.00	3/3/4/5	7	11	78					Brown, wet, fine to medium SAND, little fine gravel, little silt, trace wood fragments.				
							83									
	14D	24/12	47.00 - 49.00	4/5/6/8	11	17	94									
							97									
							81									
50															Brown, wet, SAND, little gravel, trace silt.	

Remarks:
 Autohammer SN 367
 Borehole caved at 26 feet bgs following casing removal.

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: US Route 1 Slope Repair Location: West Bath, Maine				Boring No.: HB-WBATH-101 WIN: 23897.00											
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Operator: K. Hanscom				Datum: --				Sampler: Standard Split Spoon											
Logged By: M. St. Pierre				Rig Type: Diedrich D-50				Hammer Wt./Fall: 140 lbs / 30 inch											
Date Start/Finish: 05-20-2018 / 05-21-2018				Drilling Method: Cased Wash				Core Barrel: N/A											
Boring Location: See Boring Location Sketch - Appendix				Casing ID/OD: HW 4/4.5 inch				Water Level*: Not observed.											
Hammer Efficiency Factor: 0.918				Hammer Type: Automatic ☒ Hydraulic ☐ Rope & Cathead ☐															
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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												
50	15D	24/9	50.00 - 52.00	3/4/4/5	8	12	69			Brown, wet, fine to medium SAND, little silt, trace fine gravel.									
							76												
							101												
							96												
							113												
55	16D	24/11	55.00 - 57.00	4/4/5/5	9	14	94							Similar to above.					
							98												
							107												
							117												
							129												
60	17D	24/10	60.00 - 62.00	5/5/6/6	11	17												17D(A) Brown, wet, medium dense, SAND, little silt, trace gravel, with 17D(B) SILT, some sand seams.	
65										Bottom of Exploration at 62.0 feet below ground surface. No Refusal.									
70																			
75																			
Remarks: Autohammer SN 367 Borehole caved at 26 feet bgs following casing removal.																			
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 3 of 3 Boring No.: HB-WBATH-101									

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: US Route 1 Slope Repair Location: West Bath, Maine				Boring No.: HB-WBATH-102 WIN: 23897.00			
Driller: S. W. Cole Explorations, LLC				Elevation (ft.): --				Auger ID/OD: 5 inch Solid Stem			
Operator: K. Hanscom				Datum: --				Sampler: Standard Split Spoon			
Logged By: M. St. Pierre				Rig Type: Diedrich D-50				Hammer Wt./Fall: 140 lbs / 30 inch			
Date Start/Finish: 05-21-2018 / 05-23-2018				Drilling Method: Cased Wash				Core Barrel: N/A			
Boring Location: See Boring Location Sketch Appendix				Casing ID/OD: HW 4/4.5 inch / NW 3/3.5 inch				Water Level*: 28 feet (on 05-22-2018)			
Hammer Efficiency Factor: 0.918				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								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	Elevation (ft.)			
0							SSA			Pavement	
	1D	24/5	2.00 - 4.00	31/6/5/5	11	17				-----2.5'	
										Grey, damp, medium dense, GRAVEL, little sand, trace silt, asphalt fragments, (Fill).	
5											
	2D	24/17	5.00 - 7.00	1/2/2/3	4	6				2D(A) Brown, damp, loose, SAND, some gravel, trace silt, (Fill). 2D(B) Brown, damp, loose, fine to medium SAND, trace silt, trace fine gravel, (Fill).	
10											
	3D	24/19	10.00 - 12.00	5/4/5/4	9	14	42			Similar to above except medium dense.	
							39				
							41				
							49				
							68				
15											
	4D	24/10	15.00 - 17.00	8/9/9/9	18	28	43			Similar to above except wet.	
							59				
							75				
							79				
							93				
20											
	5D	24/14	20.00 - 22.00	12/13/15/18	28	43	57		Brown, wet, dense, SAND, little silt, trace gravel, (Fill).		
							81				
							103				
							131				
25							186				
Remarks: Autohammer SN 367 bgs = below ground surface Water at 28 feet bgs within casing at beginning of drilling on 05-22-2018.											
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 1 of 4	
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.										Boring No.: HB-WBATH-102	

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: US Route 1 Slope Repair Location: West Bath, Maine				Boring No.: HB-WBATH-102 WIN: 23897.00								
Driller: S. W. Cole Explorations, LLC				Elevation (ft.) --				Auger ID/OD: 5 inch Solid Stem								
Operator: K. Hanscom				Datum: --				Sampler: Standard Split Spoon								
Logged By: M. St. Pierre				Rig Type: Diedrich D-50				Hammer Wt./Fall: 140 lbs / 30 inch								
Date Start/Finish: 05-21-2018 / 05-23-2018				Drilling Method: Cased Wash				Core Barrel: N/A								
Boring Location: See Boring Location Sketch Appendix				Casing ID/OD: HW 4/4.5 inch / NW 3/3.5 inch				Water Level*: 28 feet (on 05-22-2018)								
Hammer Efficiency Factor: 0.918				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 140 lb. 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 _u = 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							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									
25	6D	24/12	25.00 - 27.00	21/22/18/18	40	61	88		Similar to above except very dense.							
							97									
							139									
							144									
							107									
30	7D	24/9	30.00 - 32.00	12/8/10/8	18	28	53					Brown, wet, medium dense, fine to medium SAND, little silt, trace fine gravel.				
							62									
							89									
							103									
							97									
35	MD	24/0	35.00 - 37.00	9/5/5/5	10	15	67								No recovery.	
							78									
							91									
							106									
							79									
40	8D	24/7	40.00 - 42.00	5/4/3/4	7	11	63		Brown, wet, medium dense, SAND, little silt.							
							80									
							87									
							79									
							88									
45	9D	24/13	45.00 - 47.00	6/6/9/10	15	23	70					9D(A) Similar to above. 9D(B) Dark brown, organic silt seam at ±46.1 feet bgs.				
							56									
							108									
							106									
							112									
50																
Remarks: Autohammer SN 367 bgs = below ground surface Water at 28 feet bgs within casing at beginning of drilling on 05-22-2018.																
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 2 of 4						
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.										Boring No.: HB-WBATH-102						

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: US Route 1 Slope Repair Location: West Bath, Maine				Boring No.: HB-WBATH-102 WIN: 23897.00			
Driller: S. W. Cole Explorations, LLC				Elevation (ft.) --				Auger ID/OD: 5 inch Solid Stem			
Operator: K. Hanscom				Datum: --				Sampler: Standard Split Spoon			
Logged By: M. St. Pierre				Rig Type: Diedrich D-50				Hammer Wt./Fall: 140 lbs / 30 inch			
Date Start/Finish: 05-21-2018 / 05-23-2018				Drilling Method: Cased Wash				Core Barrel: N/A			
Boring Location: See Boring Location Sketch Appendix				Casing ID/OD: HW 4/4.5 inch / NW 3/3.5 inch				Water Level*: 28 feet (on 05-22-2018)			
Hammer Efficiency Factor: 0.918				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 140 lb. 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 _u = 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							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				
50	10D	24/6	50.00 - 52.00	5/3/3/4	6	9	71			Brown, wet, loose, fine to medium SAND, little silt.	
							107				
							84				
							111				
							104				
55	11D	24/1	55.00 - 57.00	6/3/3/4	6	9	92			Similar to above.	
							96				
							107				
							126				
							149				
60	12D	24/14	60.00 - 62.00	6/4/5/5	9	14	87			Similar to above. Placed NW casing.	
							96				
							100				
							97				
							102				
65	13D	24/15	65.00 - 67.00	6/6/7/8	13	20	79			Similar to above with trace organic (root) fragment.	
							82				
							109				
							105				
							108				
70	14D	24/13	70.00 - 72.00	4/4/4/4	8	12	105			Brown, wet, medium dense, SAND, trace silt, trace fine gravel.	
							101				
							122				
							121				
							113				
75											
Remarks: Autohammer SN 367 bgs = below ground surface Water at 28 feet bgs within casing at beginning of drilling on 05-22-2018.											
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 3 of 4	
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.										Boring No.: HB-WBATH-102	

[illegible]

Appendix D

Special Provision 639

SPECIAL PROVISION
SECTION 639 - ENGINEERING FACILITIES
(Instrumentation - Geotechnical)

Supplement Standard Specification SECTION 639 – ENGINEERING FACILITIES with the following:

639.01 Description The work shall consist of all necessary supervision, labor, materials, equipment (including drill rig and drilling activities), and related services necessary to furnish and install instrumentation to monitor soil behavior as specified in this Special Provision. Instruments for monitoring soil behavior includes three (3) slope inclinometer casings installed at locations and depths specified by the MaineDOT geotechnical engineer. Slope inclinometer casings shall be provided by and installed by the Contractor, their drilling Subcontractor, and their qualified geotechnical engineering firm. All work performed under this Special Provision shall be coordinated with geotechnical personnel from the Department. The Contractor's construction schedule shall consider the timing of the instrumentation installation as described in this Special Provision. The work also includes protecting the instrumentation from damage and repairing or replacing damaged and/or inoperative instruments. All instruments are to be the property of the Department and will not be decommissioned without the authorization of the Department.

This item includes the furnishing of boring logs, as-built drawings of actual locations where instrumentation is installed, survey data recorded (i.e. the elevations of the slope inclinometer casings obtained during casing installation), and slope inclinometer installation field reports.

The Contractor shall provide continuous access to the slope inclinometer casings by the Department to obtain readings in accordance with the Department's needs for the entire duration of the project. The Contractor shall provide access to the slope inclinometer casings for the purpose of reading the instrumentation after project completion as required by the Department. Readings will be the responsibility of the Department or their representative.

Geotechnical information obtained by the Department including existing geotechnical boring logs and historic plans are available upon request.

639.02 Materials The slope inclinometer casing shall be made of ABS plastic (acrylonitrile butadiene styrene) and shall have an outside diameter (OD) of 2.75 inches. The casing shall have four (4) internal grooves located 90° apart. Each groove shall provide a regular, flat surface for the wheels of the probe. The grooves shall be slightly wider than the probe wheels, to permit some side to side movement as the probe passes through curves. The connections between individual pieces of slope inclinometer casing shall be waterproof and shall have self-aligning couplings and top and bottom end caps.

The proposed slope inclinometer casings shall be submitted for review and acceptance by the geotechnical engineer prior to installation. Acceptable products include the following or approved equal:

QC Casing as manufactured by Slope Indicator
RST Inclinometer Casing as manufactured RST Instruments

The slope inclinometer casing installations will require the following additional materials, which shall be supplied and paid for by the Contractor or their drilling Subcontractor:

- Pea stone (3/8" Gravel)
- Cement grout (as specified in Section 639.041)
- Bentonite pellets
- Above ground protective casing (steel) with lock

The Contractor shall employ a qualified geotechnical engineering firm for installation of the slope inclinometer casings. The firm shall have at least 4 years' experience in installation of slope inclinometer casings. The qualified geotechnical engineering firm shall prepare detailed step-by-step installation based on the general installation procedure provided in this Special Provision. These procedures shall be submitted to the Resident for review five (5) days prior to installation. The qualified geotechnical engineering firm shall be present during the installation of all slope inclinometer casings.

693.03 Submittals Slope Inclinometer Casing Installation Plan: At least five (5) calendar days before installing the slope inclinometer casing, the Contractor shall submit for review the personnel qualification and installation plan. Include in the installation plan as a minimum the following information:

- The manufacturer's specification sheet for the proposed slope inclinometer casings. The Contractor shall coordinate with the Department so that slope inclinometer casings and the slope inclinometer instrument owned by the Department are compatible.
- Proposed installation method.
- Proposed method to protect the slope inclinometer casings during and after construction from construction equipment, vandalism, and weather.
- Identify the licensed surveyor who will be responsible for providing survey services during the installation of the slope inclinometer casings to include staking out the proposed slope inclinometer casing locations and providing as-built locations and elevations of all slope inclinometer casing locations.
- Identify the selected geotechnical engineering firm to install the slope inclinometer casings. Document the firm's experience in installing slope inclinometer casings in accordance with the plans and Contract Documents. The documentation shall include a project summary, of at least three (3) projects, that includes for each project the project name, role in providing instrumentation services, type of slope inclinometer casing, equipment used, duration of the project (i.e. dates), magnitude of displacements (lateral and vertical), client name and address, name and phone number of representative of the consultant and owner for whom the work was performed and who can attest to the successful completion of the work, and any other information relevant to demonstrating the geotechnical engineer's qualifications.

- The selected geotechnical engineering firm shall provide a soil test boring log indicating the soils encountered during the installation of the slope inclinometer casings no later than five (5) calendar days after completion of the slope inclinometer casing installation. Soil sampling and soil test boring log format shall comply with the requirements of MaineDOT.

The manufacturer/supplier shall be available during the initial installation of the slope inclinometer casing to answer any questions during installation. The manufacturer/supplier shall also be available for questions from either the geotechnical engineering firm responsible for maintaining the slope inclinometer casings or from the Department concerning the data being collected.

Acceptance of the personnel qualification and the installation plan by the Department shall not relieve the Contractor of its responsibility to successfully install the slope inclinometer casings in accordance with the Plans and Specifications. Approval by the Department of the Slope Inclinometer Casing Installation Plan shall be contingent upon satisfactory demonstration that the slope inclinometer casings meet the objectives of the Department. If the Department and/or the Resident considers that the slope inclinometer casings do not produce satisfactory results, the Contractor shall alter the method and/or equipment as necessary to comply with this Special Provision. The Resident and the geotechnical engineer will be the sole judge in determining the adequacy of the Contractor's slope inclinometer casings.

Within one (1) week following installation, the Contractor shall submit an installation record for each slope inclinometer casing, which includes: the slope inclinometer designation (SI-1, SI-2 and SI-3), station, offset, and elevation of the top of each slope inclinometer casing. Installation records shall be provided to both the Resident and the geotechnical engineer. The slope inclinometer casings shall be located to an accuracy of 0.01 feet (both vertically and horizontally). The benchmark shall be located on stable ground that is not subject to settlement and is located away from any earthwork/construction activities.

The slope inclinometer casings shall be installed at the locations specified by the geotechnical engineer during construction. Locations cannot be changed without the approval of the geotechnical engineer.

639.04 Delivery Storage and Handling Check all materials and equipment upon delivery to ensure that the proper items are received and are not damaged. Store and maintain all materials in a clean, uncontaminated condition throughout the course of the project. Upon receipt of the slope inclinometer casings, submit copies of the manufacturer's installation and instruction manual for review and acceptance by the geotechnical engineer.

639.05 Construction Requirements Three (3) slope inclinometer casings shall be installed in the shoulder of US Route 1 as specified by the geotechnical engineer. The final location of the slope inclinometer casings shall be behind the guardrail away from traffic. The slope inclinometer casing locations shall be clearly marked on the working surface with stakes or paint, as approved by the Resident.

The Contractor shall notify the Resident at least 14 calendar days prior to the installation of slope inclinometer casings. The slope inclinometer casings shall be furnished and installed by the Contractor in accordance with this Special Provision.

The Contractor shall work in conjunction with the Department to locate the slope inclinometers in the field and ensure that no conflicts exist between slope inclinometers and foundations, structures, utilities or other construction proposed or present at the site. Slope inclinometer casing locations may be adjusted, with the prior approval of the geotechnical engineer, to avoid utilities, foundations, and all other underground construction.

The Contractor shall install slope inclinometer casings in accordance with the manufacturer's recommendations as presented in their instruction and installation manual. The Contractor shall maintain the top of the slope inclinometer casing above the exposed shoulder surface. The top of the casing shall not be more than 4 feet above the exposed shoulder surface.

The Contractor shall protect slope inclinometer casing locations from damage and vandalism for the duration of the Contract and repair or replace damaged or inoperative slope inclinometer casings at no cost to the Department that is not caused by slope movement.

639.051 Slope Inclinometer Casing Installation Drilling for slope inclinometer casings installation shall be performed by one of the following drilling contractors, or approved equal:

S.W. Cole Explorations, LLC Sidney, Maine	Telephone: 207.626.0600
Northern Test Boring Gorham, Maine	Telephone: 207.839.9880

Slope inclinometer casings shall be installed in 4.5-inch diameter borehole using schedule HW, flush joint borehole casing. Borehole casing shall be advanced by driving with a 300-lb hammer falling a distance of 16 inches, with sampling as designated by the geotechnical engineer, to 2 feet below the desired bottom elevation of the slope inclinometer casing. Sampling shall be with 1-3/8-inch ID split-spoon sampler, driven with a 140-lb hammer falling a distance of 30 inches.

The slope inclinometer casings shall be installed a minimum of 2 feet into a firm soil layer located beneath the elevation of the toe of the existing embankment. Based on borings conducted by the Department in May 2018 it appears that the slope inclinometer casings will be approximately 90 feet long (minimum). The length of the slope inclinometers casings will be dependent on the actual soil conditions found during drilling activities.

The slope inclinometer casings shall be installed in accordance with the manufacturer's requirements and recommendations. Pipe clamps shall be used to hold the casing at the borehole collar.

The borehole shall be flushed with clean water prior to installation of the slope inclinometer casing.

Place pea-stone fill above the bottom of the boring to the bottom of the slope inclinometer casing.

Assemble the slope inclinometer casing with the end cap and the grout hose attached at the bottom per the manufacturer's procedure.

Align the slope inclinometer casings so that 1 pair of grooves (i.e. grooves that are 180° apart) is perpendicular to the slope.

The annular space between the slope inclinometer casing and the borehole wall from the bottom of the borehole to a depth of five (5) feet below ground surface shall be filled with cement grout having the following composition:

Material	Quantity
Portland Cement	94 lbs (1 bag)
Water	75 gallons
Bentonite	±39 lbs (as required)

Mix cement with water first, then add bentonite. Adjust the amount of bentonite to produce a grout with the consistence of heavy cream. A watery mix is not acceptable.

Slope inclinometer casings will float in water-filled boreholes. Slope inclinometer casings shall be filled with water to counter this buoyancy. Slope inclinometer casings may become buoyant again when grout is pumped into the annular space. Care should be taken not to apply downward forces on the slope inclinometer casing that will compress the slope inclinometer casing and effect the straightness of the slope inclinometer casing. Rods can be paced in the slope inclinometer casing to counteract the buoyancy forces. Care shall be taken not to displace the slope inclinometer casing end cap if rods are placed in the slope inclinometer casing. Care should be taken to ensure that 1 pair of grooves (i.e. grooves that are 180° apart) is perpendicular to the slope if the casing is moved by buoyant forces. Slope inclinometer casings that do not have 1 pair of grooves perpendicular to the slope will not be accepted.

Place a 2-foot layer of bentonite pellets above the cement grout.

Fill the remainder of borehole with pea stone backfill.

The borehole casing will be withdrawn during installation. More grout will be required during and after the casing removal.

Install protective weather tight cap at top of the slope inclinometer casing.

Install a steel protective casing with a lock above ground to protect the slope inclinometer casing from traffic, vandalism and debris.

The slope inclinometer casing shall extend a minimum of 2 inches above the steel protective casing in order to attach the pulley for readings.

The location of each slope inclinometer casing shall be determined using conventional survey methods. The elevation, station and offset are required. The slope inclinometer casing locations shall become part of the record for each instrument.

The Department or their Representative shall read the slope inclinometers at the end of installation and then 1 reading per week for a period of 4 weeks after installation.

639.10 Method of Measurement The slope inclinometer casings will be paid for at the contract unit price bid of Lump Sum which shall include all labor, equipment (including drilling equipment), materials, mobilization; surveys and incidentals required by this Special Provision. Payment will not be made for slope inclinometer casings that are installed incorrectly or are rejected for their inability to perform, or do not meet the requirements of this Special Provision.

693.11 Basis of Payment Instrumentation - Geotechnical will be paid for at the contract Lump Sum price, which shall be full compensation for all labor, materials, equipment, and incidentals required to install the instrumentation described in this Special Provision as directed by the geotechnical engineer. Removal and replacement of instrumentation damaged by the Contractor shall be incidental to the work.

Payment will be made under:

Pay Item	Pay Unit
639.26 Instrumentation - Geotechnical	Lump Sum