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GEOTECHNICAL DESIGN REPORT

Mitchell Bridge Culvert Replacement
BRIDGE NO. 0216
MAINE DOT WIN 022238.00
GORHAM, MAINE

October 2024
09.0026220.00

Prepared for:
Maine Department of Transportation
Augusta, Maine

Prepared by:
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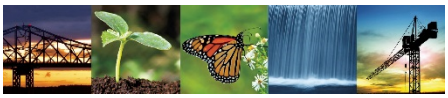

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VIA EMAIL

October 21, 2024
File No. 09.0026220.00

Ms. Laura Krusinski, P.E.
Maine Department of Transportation
16 State House Station
Augusta, Maine 04333-0016

Re: Geotechnical Design Report
Mitchell Bridge No. 0216 Culvert Replacement
Mitchell Hill Road over Nonesuch River
Maine Department of Transportation WIN 022238.00
Gorham, Maine

Dear Laura:

We are pleased to provide this Geotechnical Design Report, which includes geotechnical design recommendations for the replacement of Mitchell Bridge Culvert, Mitchell Hill Road over Nonesuch River in Gorham, Maine. Our work was completed in accordance with GZA GeoEnvironmental, Inc.'s (GZA's) June 30, 2020, Multi-PIN contract number 20200603000000000709 with the Maine Department of Transportation (MaineDOT) Bridge Program and Assignment Letter No. 11 dated January 3, 2024 for WIN 022238.00, and the attached *Limitations* contained in **Appendix A** of this report.

It has been a pleasure serving MaineDOT on this phase of the project, and we look forward to our continued work with you through project completion. If you have any questions regarding the report, please do not hesitate to contact the undersigned.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Blaine M. Cardali, P.E.
Senior Project Manager

Andrew R. Blaisdell, P.E.
Consultant Reviewer

Christopher L. Snow, P.E.
Principal

BMC/ARB/CLS:erc
p:\09 jobs\0026200s\09.0026220.00 - medot - mitchell bridge, gorham\report\draft 26220.00 gorham mitchel bridge culvert gdr 09.27.24.docx

Attachment: Geotechnical Design Report

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1.0 INTRODUCTION

This report presents the results of the geotechnical evaluation by GZA GeoEnvironmental, Inc. (GZA) for the replacement of Mitchell Bridge No. 0216 Culvert in Gorham, Maine. Our work was completed in accordance with GZA's June 30, 2020, Multi-PIN contract number 20200603000000000709 with the Maine Department of Transportation (MaineDOT) Bridge Program and Assignment Letter No. 11 dated January 3, 2024 for WIN 022238.00, and the attached *Limitations* contained in **Appendix A** of this report.

1.1 BACKGROUND

The project includes replacement of the Mitchell Bridge No. 0216 carrying Mitchell Hill Road over the Nonesuch River in Gorham, Maine, the location of which is shown on **Figure 1**. The bridge was originally constructed in 1928 or earlier and had consisted of timber stringers resting on stone abutments. Prior to 1990 the structure had been updated with steel-ribbed decking on steel beams supported by concrete capped stone abutments and was replaced in 1990. The 1990 bridge is a two-span, steel-bolted, pipe culvert with a maximum span of 14 feet per pipe. Recent inspections have shown that the condition of the culverts is structurally deficient. It was noted that rust nodules and scaling have occurred over the lengths of the culverts and the northern culvert pipe has experienced minor deflections at the center.

We understand plans are to construct a new, 74-foot-long box culvert with a span of 25 feet, a rise of 8 feet, and an 11-degree skew. The culvert will have 1-foot-tall precast headwalls and 2-foot-deep toe walls at the inlet and outlet. The box culvert invert will be embedded with 12 inches of special fill to create a natural streambed. The prepared subgrade is anticipated to consist of a 1-foot-thick layer of Underdrain backfill material placed on stabilization/reinforcement geotextile overlying the natural subgrade, as will be discussed further herein. The project is planned to maintain the current road alignment, as shown on **Figure 2**.

1.2 OBJECTIVES AND SCOPE OF SERVICES

The objectives of our work were to evaluate subsurface conditions and to provide geotechnical engineering recommendations for the proposed culvert replacement. To meet these objectives, GZA completed the following Scope of Services:

- Reviewed the results of three test borings and laboratory testing completed by MaineDOT;
- Conducted final design phase geotechnical engineering analyses for:
  - soil and bedrock properties;
  - stability and settlement of approach embankments;
  - frost susceptibility and drainage of approach subgrade materials;
  - AASHTO LRFD load and resistance factors associated with geotechnical design elements;
  - spread footing design considerations, including bearing resistance, sliding resistance and settlement;
  - seismic design considerations;

- Developed geotechnical engineering recommendations including spread footings bearing on soil, culvert backfill type and properties, earth pressures and seismic design parameters; geotechnical construction considerations; and
- Prepared this report summarizing our findings and design recommendations.

2.0 SUBSURFACE EXPLORATIONS

Three test borings were drilled and logged by MaineDOT between May 20 and 27, 2021 at the locations shown on **Figure 2, Boring Location Plan**. Borings BB-GNR-101 and -101A were drilled on the northwest side of the existing culverts, and BB-GNR-102 was drilled on the southeast side. BB-GNR-101A was terminated on a probable cobble/boulder in the upper portion of the fill and was offset and redrilled as BB-GNR-101. The test borings were drilled using a CME-45C drill rig to depths ranging from approximately 80 to 88 feet below ground surface (bgs) and were terminated in the bedrock.

The borings were drilled using 3- and 4-inch driven casing and drive-and-wash drilling techniques. Standard penetration testing (SPT) and split-spoon sampling were performed at 5-foot typical intervals using a 24-inch-long, 1-3/8-inch inside-diameter sampler. The sampler was driven with a 140-lb calibrated automatic hammer with a 30-inch drop from a truck-mounted drill rig. The boring logs indicate a hammer efficiency factor at the time of drilling of 0.89. In situ field vane shear tests were conducted at typical 5- to 10-foot depth intervals in clay soils. Two vane shear tests were attempted at each test interval. Three thin-walled tube samples were collected in BB-GNR-102 to provide samples for use in laboratory compressibility testing. Approximately 5 to 10 feet of bedrock core was obtained in borings BB-GNR-101 and -102 using NQ2 coring equipment. At the completion of drilling, the borings were backfilled with cuttings and sand. The as-drilled locations and elevations were surveyed by MaineDOT.

Drafts of the logs were prepared in Geosystem Logdraft® by MaineDOT. GZA subsequently reviewed the logs and made edits to reflect laboratory soil test results and our interpretation of stratification. The final logs are provided in **Appendix B**.

3.0 LABORATORY TESTING

Soil testing was performed by MaineDOT Testing Laboratories in Bangor, Maine. The testing program included:

- Ten (10) gradation analysis with hydrometer / MaineDOT Frost Classification / Unified Soil Classification System (USCS) assessments;
- Eight (8) sets of Atterberg Limits;
- Ten (10) moisture content tests; and
- Three (3) 1-dimensional consolidation (compressibility) tests.

Results of the testing are included in **Appendix D**.

4.0 SUBSURFACE CONDITIONS

4.1 SURFICIAL AND BEDROCK GEOLOGY

Based on available geologic mapping[1], the surficial unit in the vicinity of the bridges consists of Stream alluvium, described as gravel, sand, and silt deposited on floodplains of modern streams. The Presumpscot Formation, which consists of a stratified mixture of sand, silt and clay deposited by glacial melt, is also present. Thin drift areas and glacial till are mapped east of the bridge and described as less than 10 feet of a poorly sorted mixture of gravel, sand, silt and clay over bedrock.

Marine regressive sand deposits were also mapped in the area surrounding the subject site.

Bedrock mapping[2] in the vicinity of the site shows the bridge is located near the Nonesuch River Fault which separates the Berwick and Eliot formations. The site lies just west of the fault within the Berwick Formation, which is described as medium-bedded, medium grey plagioclase biotite granofels, locally with abundant calcite that can have interbeds of two-mica garnet schist. The Eliot Formation, east of the fault, is described as fine-grained, medium grey phyllite with ankerite and calcite.

4.2 SUBSURFACE PROFILE

Five soil units were encountered in the test borings below surficial asphalt and above bedrock: Fill, Alluvium Clay and Silt, Alluvium Sand, Marine Clay, and Glacial Till. Approximately 6 inches of asphalt pavement was encountered in the test borings. The thicknesses and generalized descriptions of the soil units are presented in the following table in descending order from the ground surface. Detailed descriptions of the materials encountered at specific locations are provided in the boring logs in **Appendix B**. An interpretive subsurface profile based on the test boring results is presented as **Figure 3**, **Interpretive Subsurface Profile**.

[1] Retelle, Michael J. (compiler) , 1999, Surficial geology of the Old Orchard Beach quadrangle, Maine: Maine Geological Survey, Open-File Map 99-94, map, scale 1:24,000. Maine Geological Survey Maps. 1012. http://digitalmaine.com/mgs_maps/1012

[2] Hussey, Arthur M., II, 2003, Bedrock geology of the Old Orchard Beach quadrangle, Maine: Maine Geological Survey, Open-File Map 03-96, 7 p. report, 13 figures, 1 plate, photographs, color map, scale 1:24,000. Maine Geological Survey Maps. 32. http://digitalmaine.com/mgs_maps/32

GENERALIZED SUBSURFACE CONDITIONS		
Subsurface Unit	**Approximate Encountered Thickness (ft)**	**Generalized Description**
Fill	11 to 12	Brown, medium dense to dense, fine to coarse SAND, some to trace silt, little to trace gravel, with probable cobbles and boulders. (USCS: SP-SM, SM). MaineDOT Frost Classification = 0-II *Encountered in all borings.*
Alluvium – Clay/Silt	4 to 8	Grey, medium stiff to stiff, Silty CLAY, little sand. (USCS: SC-SM, SM, ML, CL) MaineDOT Frost Classification = III-IV *Encountered in boring BB-GNR-101 and -102.*
Alluvium – Sand	4 to 5	Grey, loose to medium dense, SAND, trace to some silt. (USCS: SP-SM, SM, SC-SM) MaineDOT Frost Classification = II *Encountered in boring BB-GNR-101 and -102.*
Marine Clay	46 to 53	Grey, soft to stiff, Silty CLAY to Clayey SILT, trace fine sand. (USCS: CL) MaineDOT Frost Classification = III-IV *Encountered in boring BB-GNR-101 and -102.*
Glacial Till	3 to 5	Variable from: Grey, very dense, Gravelly SAND, some Silt to: Very dense, fine to coarse SAND, some gravel, little silt. (USCS: SM) *Encountered in boring BB-GNR-101 and -102.*
Top of Bedrock Elevation	Approximately El. -30.6 to -42.7 (70.5 to 87.7 feet bgs)	

4.2.1 Bedrock

Bedrock was cored in two test borings. Bedrock was described as very hard to hard, fresh to slightly weathered, fine grained, tan to black, GRANOFELS. Joints are very close to moderately spaced, horizontal to high angle, fresh to slightly weathered, planar to undulating, fresh to discolored, tight, with calcite infilling. The Rock Quality Designation in the core runs ranged from 67 to 92 percent indicating fair to excellent quality rock.

4.2.2 Groundwater

The groundwater level was measured in boring BB-GNR-101 at a depth of 10 feet bgs, corresponding to El. 29.9, which is roughly coincident with the Q 1.1 (EL 29.0). The water level was recorded in a boring completed using wash boring techniques that typically affect the water level. Fluctuations in groundwater levels will occur due to variations in season, precipitation, river levels and construction activity in the area. Consequently, water levels during and after construction are likely to vary from those encountered in the borings at the time the observations were made.

5.0 ENGINEERING EVALUATIONS

5.1 GENERAL

GZA has conducted geotechnical engineering evaluations in accordance with *2020 AASHTO LRFD Bridge Design Specifications, 9th Edition* (herein designated as AASHTO) and the *MaineDOT Bridge Design Guide, 2003 Edition*, with updates through 2018 (MaineDOT BDG). The sections that follow describe the evaluations and the geotechnical basis for each element. Supporting calculations are included in **Appendix E**.

5.2 APPROACH EMBANKMENTS

The proposed embankment will remain on the current horizontal alignment and vertical profile. Minor grading of the side slopes is anticipated to achieve the final slope angles of 2 feet horizontal to 1 foot vertical (2H:1V) or flatter.

We anticipate that the embankments will be reconstructed over primarily loose to medium dense Alluvium and Fill overlying stiff to soft Marine Clay. Due to the typical strength and moderate compressibility of the Marine Clay and since no raise in grade is proposed, embankment global stability and settlement are not considered to be concerns for the project.

5.3 FOUNDATION TYPE

The culvert is proposed to consist of a box culvert with a span of 25 feet and a rise of 8 feet bearing on a 1-foot-thick layer of Underdrain Backfill Material, Type C (MaineDOT Pay Item 203.55 Culvert Bedding Stone), separated from the natural Alluvium – Sand on the bottom and sides by Stabilization/Reinforcement Geotextile (MaineDOT Standard Specification 722.01).

5.4 LOAD AND RESISTANCE FACTORS

AASHTO LRFD load factors should be applied to horizontal earth pressure (EH), vertical earth pressure (EV), earth surcharge (ES), and live load surcharge (LS) loads, using the load factors for permanent loads (γ_p) provided in LRFD Table 3.4.1-2 for strength limit state foundation design.

The recommended LRFD resistance factors for strength limit state design of foundations were derived from LRFD Tables 10.5.5.2.2-1, 10.5.5.2.3-1 and 10.5.5.2.4-1 and are presented in the following table.

GEOTECHNICAL RESISTANCE FACTORS – STRENGTH LIMIT STATE			
Foundation Resistance Type	**Method/Condition**	**Resistance Factor (ϕ)**	**AASHTO Reference**
Bearing	Theoretical Method in Sand using SPT	0.45	10.5.5.2.2-1
Sliding	Precast Concrete Placed on Sand	0.90	10.5.5.2.2-1

Resistance factors for service and extreme limit state design should be taken as 1.0.

5.5 SPREAD FOOTING DESIGN CONSIDERATIONS

The bottom of the culvert and inlet and outlet walls will be underlain by 12 inches of Underdrain Backfill Material, resulting in excavation depths of approximately 14 to 15 feet below existing grades. At these depths, the exposed soils are anticipated to consist of loose to medium dense Alluvium - Sand. However, the Alluvium - Sand is underlain by a stiff to soft layer of Marine Clay. The following sections discuss settlement and bearing related to the proposed culvert foundations.

5.5.1 Settlement

GZA evaluated the effective stress at the bearing elevation of the proposed box culvert under the existing conditions and the proposed conditions. The results indicate that the proposed construction will result in a slight decrease in effective stress. Therefore, consolidation of the underlying clay is not anticipated. However, elastic settlement is anticipated during foundation construction and backfill placement. We estimate the post-construction foundation settlement will be 1 inch or less. Calculations are presented in **Appendix E**.

5.5.2 Strength Bearing Resistance

The Alluvium - Sand stratum located below the bearing elevation is relatively thin, ranging between 5 to 7 feet thick, and is underlain by a stiff to soft marine clay. GZA considered this two-layer system in evaluating the bearing resistance. The bearing resistance values for the strength condition were developed using AASHTO Equation C10.6.3.1.2f-1 which accounts for a two-layer system with a strong layer overlying a weak layer.

The calculated bearing resistance values are presented in **Appendix E** and are presented in the table below for the culvert.

BEARING RESISTANCE VALUES FOR FOOTINGS ON SOIL				
Footing	**Footing Width (feet)**	**Nominal Bearing Resistance (ksf)**	**Factored Bearing Resistance, Strength Limit State (ksf)**	**Service Bearing Resistance (ksf)**
Precast Culvert	27	7.2	3.3	3.3

Service Bearing Resistance

GZA evaluated the effective stress at the bearing elevation of the proposed box culvert under the existing conditions and the proposed conditions. The results indicate that the proposed construction will result in a slight decrease in effective stress. For the service condition, GZA considered the anticipated no-stress-increase situation, indicating that consolidation of the underlying clay is not anticipated, and any clay settlement would be elastic. Since the Alluvium – Sand is a granular material, we anticipate that any compression of that layer would occur elastically as the fill is placed. Based on the elastic settlement anticipated, we estimate the post-construction foundation settlement will be 1 inch or less. Calculations are presented in **Appendix E**.

5.6 SEISMIC DESIGN CONSIDERATIONS

Per AASHTO LRFD Article 3.10.1, seismic analysis is not required for buried structures except where they cross active faults. The site is located adjacent to a known fault. However, the Nonesuch Fault[3] is documented to be inactive. Therefore, seismic design parameters are not required.

5.7 LATERAL EARTH PRESSURE

The precast culvert walls will be restrained from lateral movement at the top and bottom. Therefore, the box culvert walls should be designed for at-rest earth pressure conditions. Culvert inlet and outlet headwalls are a few feet high or shorter. These short walls should be designed for at-rest earth pressure conditions. Inlet and Outlet Walls that extend beyond the box culvert and are independent of the box culvert are considered free to rotate and should be designed for Rankine active earth pressure with a 2H:1V backslope. The material properties will be controlled by the backfill material, which is anticipated to consist of BDG Type 4 soil. Soil properties for Type 4 soil are provided in **Section 6.2** of this report.

5.8 FROST PROTECTION

Fill soils are anticipated to be present at the culvert, inlet/outlet walls and embankments, either as existing fill, imported backfill, or Alluvial - Sand deposits. Based on the MaineDOT BDG, Section 5.2.1, the Freezing Index for the site is 1,275, and with fine to coarse-grained moderate-moisture content (10 to 20 percent) soils near the riverbed, the estimated depth of frost penetration is approximately 5.1 feet. However, the BDG does not specify frost embedment requirements for culverts.

6.0 RECOMMENDATIONS

6.1 EMBANKMENT DESIGN CONSIDERATIONS

Embankment side slopes should be designed with MaineDOT typical slope angles of 2H:1V or flatter for a loam and seed surface finish. Where a riprap surface treatment is used, a 1.75H:1V slope angle is acceptable. Riprap should also be provided for scour protection where the embankment side slopes will be near or below typical water levels in the Nonesuch River. The extent and nature of scour countermeasures will be evaluated by others.

6.2 BOX CULVERT AND INLET AND OUTLET WALL DESIGN

- Backfill between the culvert and inlet and outlet walls should consist of MaineDOT 703.19 Granular Borrow, MaineDOT BDG Type 4 soil. Recommended soil properties for Type 4 soils are as follows:
  - Internal Friction Angle of Soil = 32°
  - Soil Total Unit Weight = 125 pcf

[3] Hussey, Arthur M., II, 2003, Bedrock geology of the Old Orchard Beach quadrangle, Maine: Maine Geological Survey, Open-File Map 03-96, 7 p. report, 13 figures, 1 plate, photographs, color map, scale 1:24,000. Maine Geological Survey Maps. 32. http://digitalmaine.com/mgs_maps/32

  - At-rest Earth Pressure, K_o = 0.47 (use for design of box culvert walls and inlet and outlet headwalls)
  - Rankine Active Earth Pressure, K_a = 0.46 (use for design of culvert inlet and outlet walls unsupported from box and free to rotate, assumes slope of 2H:1V behind wall)

- Live load surcharge should be applied as a uniform lateral surcharge pressure using the equivalent fill height (H_{eq}) values developed in accordance with LRFD Section 3.11.6.4, based on the culvert/inlet and outlet wall height and distance from the wall backface to the edge of traffic. A minimum H_{eq} of 2 feet is recommended.

6.3 RECOMMENDATIONS FOR FOUNDATIONS

- The proposed box culvert and footings should be supported on 12 inches of MaineDOT 703.22 Underdrain Backfill Material, Type C separated on bottom and sides by Stabilization/Reinforcement Geotextile installed over undisturbed Alluvium -Sand, except for the precast concrete toe walls, which should bear directly on naturally deposited Alluvium – Sand or Alluvium - Clay/Silt. Culvert bearing pressures should be checked to confirm that they are less than the resistance values presented in **Section 5.5** of this report.
- In order to limit seepage beneath the culvert, the Underdrain backfill should not extend upstream or downstream beyond the limits of the key/cutoff walls on the base. The cutoff walls should bear directly on naturally deposited Alluvium – Sand or Alluvium - Clay/Silt or compacted Granular Borrow for Underwater Backfill MaineDOT 703.19.
- The culvert subgrade surfaces should be cleaned of soil that is loosened by the excavation process prior to placement of the Underdrain Backfill Material, and if the subgrade is dry, the surface may be proof-compacted. Bearing surface preparation should be in accordance with **Section 7.2**.
- The Underdrain Backfill Material, Type C bedding for the culvert should be placed in maximum 6-inch lifts and densified with several passes of a walk-behind roller or large plate compactor.
- The base resistance against sliding was evaluated in accordance with AASHTO Article 10.6.3.4 using ϕ_f' = 32 degrees and C = 0.8 for the culvert (precast concrete). Nominal sliding resistance coefficient for culvert was calculated as C*tan ϕ_f' and is equal to 0.50. The factored sliding resistance coefficient for the strength condition is 0.45 for the culvert and inlet/outlet walls, based on a resistance factor ($\phi\tau$) of 0.9 for the strength limit state.
- Passive resistance on the toe of footings should be neglected when evaluating sliding and overturning.

7.0 CONSTRUCTION CONSIDERATIONS

This section provides guidance regarding quality control during excavation, dewatering, and foundation subgrade preparation and protection. These items are discussed in the paragraphs that follow.

7.1 EXCAVATION, TEMPORARY LATERAL SUPPORT AND DEWATERING

Excavations for culvert foundations are anticipated to extend approximately 14 to 16 feet below existing grades and up to 4 feet below the Q 1.1 (El. 29). Sheet-pile-supported and/or open cut excavation techniques are anticipated to be suitable for this project. If temporary sheet piling is used, approximately ½ to 1 inch of additional settlement would be anticipated due disturbance of the underlying Marine Clay. Therefore, the removal of temporary sheeting should occur prior to final paving of the roadway.

Damming and diversion and/or temporary dewatering are anticipated to be necessary to control groundwater and/or stream inflow in excavations. Depending on permitting and water levels at the time of construction, we anticipate that it would be possible to dam the stream with sandbags and an impermeable membrane, and temporarily divert the flow through a pipe so the contractor can construct foundations in the dry. It may also be necessary to employ localized pumping from sumps to maintain dewatering. It is anticipated that inflow of surface water or runoff to excavations can be handled by open pumping from sumps installed at the bottoms of excavations. Sumps should be fitted with geotextile or sand filters to prevent loss of subgrade fines during pumping. Dewatering discharge should be managed in accordance with the contractor's Stormwater Prevention Plan and MaineDOT Best Management Practices.

7.2 SUBGRADE PREPARATION

Even with damming and diversion, excavation bases may be wet. If the exposed surface of the Alluvium – Sand is saturated, Stabilization/Reinforcement Geotextile (MaineDOT Standard Specification 722.01) Should be placed directly on the subgrade, and then the first lift of Underdrain Backfill, Type C may be placed. The surface of the Type C material may then be densified as previously described. In the event that the subgrade exhibits weaving or rutting, compaction should be continued without vibration.

TABLES

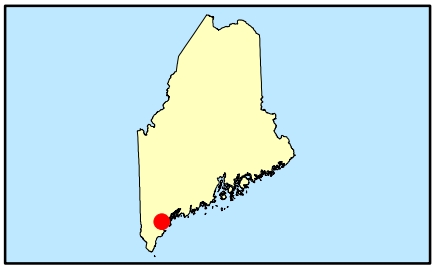
TABLE 1
Summary of Subsurface Explorations
Mitchell Bridge #0216 carries Mitchell Hill Road
Gorham, Maine
GZA job#: 09.0026220.00

Boring ID	Station	Offset	Ground Surface El. (ft)	Top of Stratum Elevation (ft)							Stratum Thickness (ft)						Bedrock Depth (ft)	Bottom of Boring Depth (ft)	Bottom of Boring El. (ft)	Groundwater	
				Asphalt	Fill	Alluvium Clay/Silt	Alluvium Sand	Marine Clay	Glacial Till	Bedrock	Asphalt	Fill	Alluvium Clay/Silt	Alluvium Sand	Marine Clay	Glacial Till				El. (ft)	Depth (ft)
BB-GNR-101	5+50.5	7.7' Rt.	39.9	NE	39.9	28.9	24.4	19.7	-27.1	-30.6	NE	11.0	4.5	4.7	46.8	3.5	70.5	80.5	-40.6	29.9	10
BB-GNR-101A	5+52.2	7.7' Rt.	39.9	NE	39.9	NE	NE	NE	NE	NE	NE	> 4.5	NE	NE	NE	NE	NE	4.5	35.4	NE	NE
BB-GNR-102	5+94.4	7.5' Lt.	40.0	40.0	39.5	28.0	20.0	15.0	-38.0	-42.7	0.5	11.5	8.0	5.0	53.0	4.7	82.7	87.7	-47.7	NM	NM

El. = Elevation, NE = Not Encountered, NM = Not Measured, NP = Not Penetrated, > = Boring Terminated in Stratum

Notes:
1. Refer to the boring logs in Appendix B for additional information.
2. Project elevation datum is North American Vertical Datum (NAVD 88), unless noted otherwise.
3. As-drilled locations were surveyed by MaineDOT and provided to GZA.
4. Stratum depths, thickness and elevations are rounded to the nearest 0.1 foot as interpreted on the boring logs, but this does not represent the precision of the data.

FIGURES



SOURCE : USGS TOPOGRAPHIC QUADRANGLES SCANNED BY THE NATIONAL GEOGRAPHIC SOCIETY & I-CUBED, COPYRIGHT 2011

Data Supplied by : esri

0 1,000 2,000 4,000 6,000

SCALE IN FEET

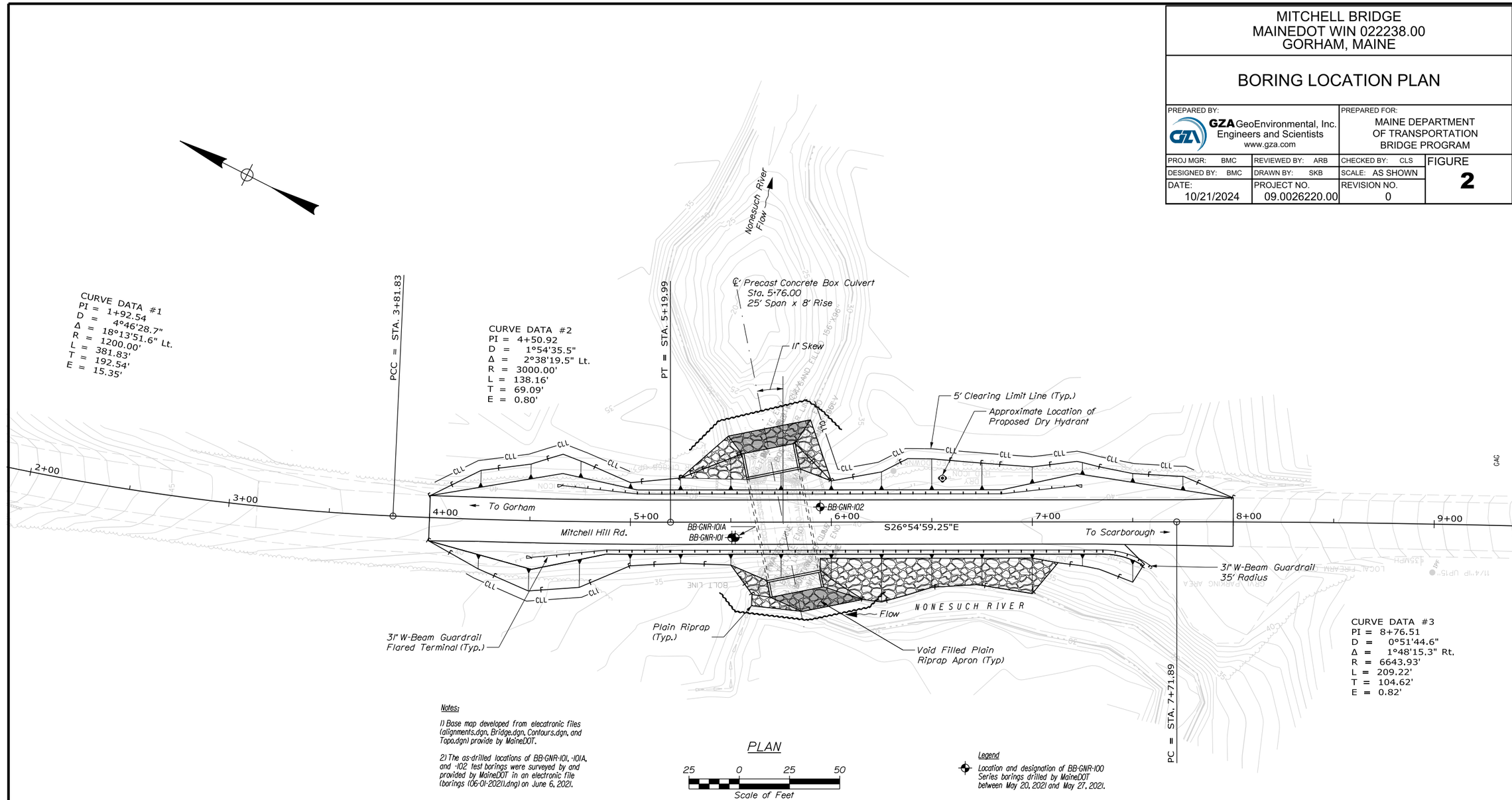
N W E S

GZA	PROJ. MGR.: BMC DESIGNED BY: SKB REVIEWED BY: ARB OPERATOR: SKB DATE: 07-16-2024	LOCUS PLAN	JOB NO. 09.0026220.00
		MITCHELL BRIDGE (#0216) MITCHELL HILL ROAD OVER NONESUCH RIVER GORHAM, MAINE	FIGURE NO. 1

MITCHELL BRIDGE
MAINEDOT WIN 022238.00
GORHAM, MAINE

BORING LOCATION PLAN

PREPARED BY:		PREPARED FOR:	
GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		MAINE DEPARTMENT OF TRANSPORTATION BRIDGE PROGRAM	
PROJ MGR: BMC	REVIEWED BY: ARB	CHECKED BY: CLS	FIGURE 2
DESIGNED BY: BMC	DRAWN BY: SKB	SCALE: AS SHOWN	
DATE: 10/21/2024	PROJECT NO. 09.0026220.00	REVISION NO. 0	



Notes:

1) Base map developed from elecatronic files (alignments.dgn, Bridge.dgn, Contours.dgn, and Topo.dgn) provide by MaineDOT.

2) The as-drilled locations of BB-GNR-101, -101A, and -102 test borings were surveyed by and provided by MaineDOT in an electronic file (borings (06-01-2021).dng) on June 6, 2021.

PLAN

25 0 25 50

Scale of Feet

Legend

Location and designation of BB-GNR-100 Series borings drilled by MaineDOT between May 20, 2021 and May 27, 2021.

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

02223800

WIN 022238.00

BRIDGE NO. 0216

BRIDGE PLANS

PROJ. MANAGER	DEVAN EATON			
DESIGN-DETAILED	EDB	BJN	08\2024	
CHECKED-REVIEWED	GAG	DCE	08\2024	SIGNATURE
DESIGN2-DETAILED2	B.CARDIAL	T. WHITE	10/2024	
DESIGN3-DETAILED3				P.E. NUMBER
REVISIONS 1				
REVISIONS 2				
REVISIONS 3				DATE
REVISIONS 4				
FIELD CHANGES				

MITCHELL BRIDGE
NONESUCH RIVER
GORHAM-SCARBOROUGH CUMBERLAND COUNTY

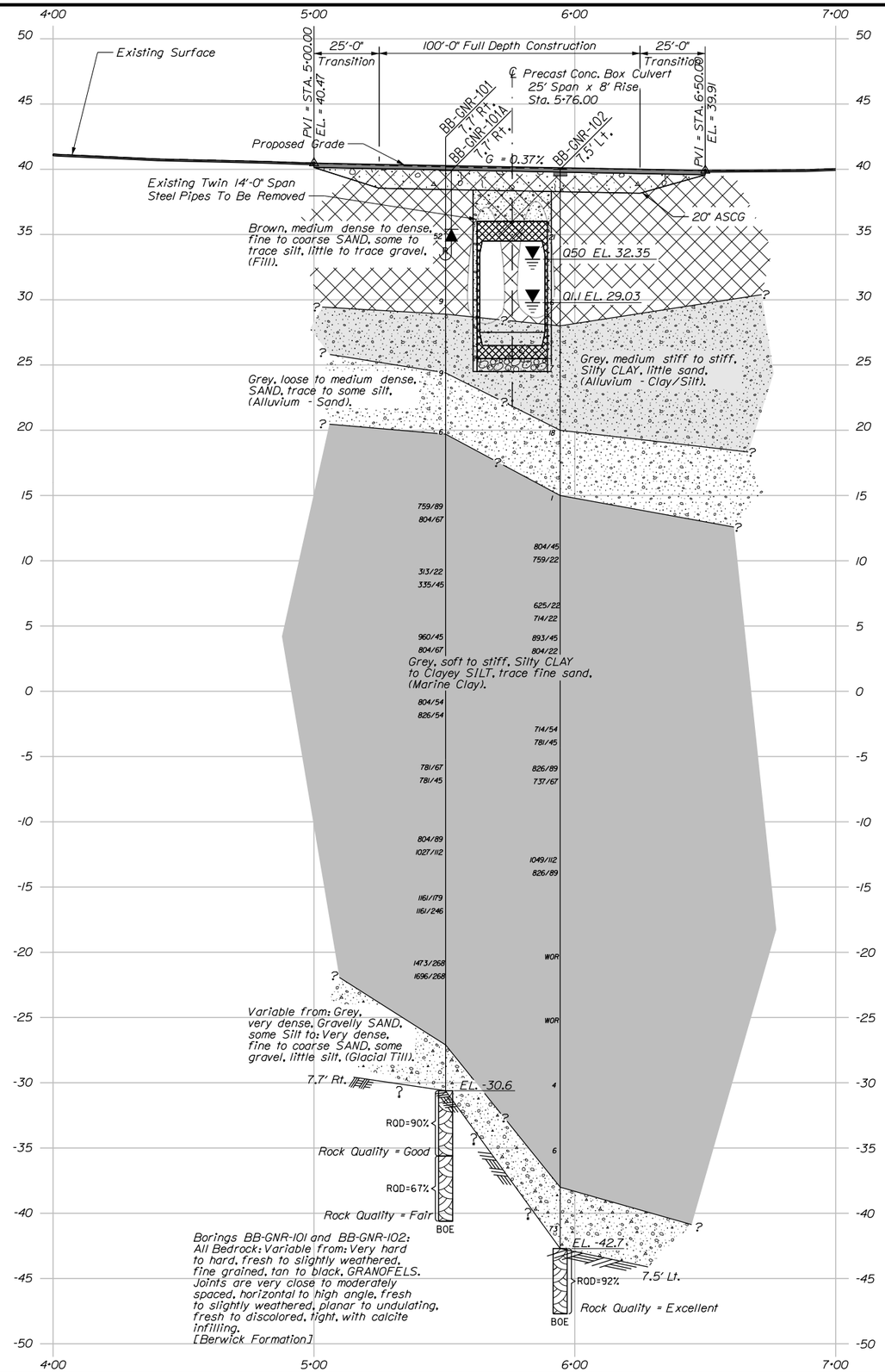
BORING LOCATION PLAN

SHEET NUMBER

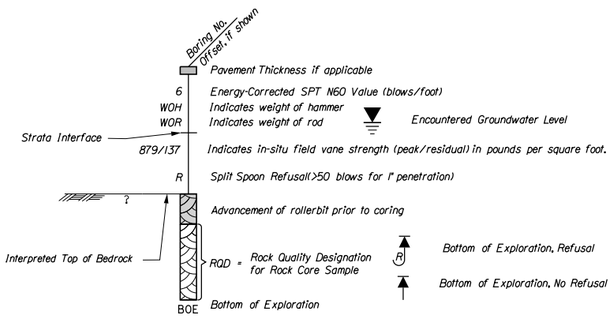
5

OF 21

Filename: ...\00\GEOTECH\MSTA\005_BLP1.dgn Division: GEOTECH Username: Terry.White Date:10/21/2024



LEGEND



PROFILE

Notes:

1) Base Profile developed from electronic file (Profile.dgn) provide by MaineDOT.

2) The as-drilled locations of BB-GNR-101, -101A, and -102 test borings were surveyed by and provided by MaineDOT in an electronic file (borings (06-01-2021).dng) on June, 6, 2021.

3) 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.

MITCHELL BRIDGE
MAINEDOT WIN 022238.00
GORHAM, MAINE

INTERPRETIVE SUBSURFACE PROFILE

PREPARED BY:		PREPARED FOR:	
GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com		MAINE DEPARTMENT OF TRANSPORTATION BRIDGE PROGRAM	
PROJ MGR: BMC	REVIEWED BY: ARB	CHECKED BY: CLS	FIGURE 3
DESIGNED BY: BMC	DRAWN BY: SKB	SCALE: AS SHOWN	
DATE: 10/21/2024	PROJECT NO. 09.0026220.00	REVISION NO. 0	

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

02223800

WIN 022238.00

BRIDGE PLANS

BRIDGE NO. 0216

PROJ. MANAGER	DEVAN EATON	BY	DATE
DESIGN-DETAILED	EDB	B.JN	08\2024
CHECKED-REVIEWED	GAC	DCE	08\2024
DESIGN2-DETAILED2	B.CARDALI	T. WHITE	10/2024
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE

P.E. NUMBER

DATE

MITCHELL BRIDGE
NONESUCH RIVER
GORHAM-SCARBOROUGH CUMBERLAND COUNTY

INTERPRETIVE SUBSURFACE PROFILE

SHEET NUMBER
6
OF 21

Filename: ...\00\GEOTECH\MSTA\006_ISP1.dgn Username: Terry.White Date:10/21/2024 Division: GEOTECH

APPENDIX A – LIMITATIONS

GEOTECHNICAL LIMITATIONS

Use of Report

1. GZA GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of our Client for the stated purpose(s) and location(s) identified in the Proposal for Services and/or Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not expressly identified in the contract documents, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

Standard of Care

2. GZA's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in Proposal for Services and/or Report, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. If conditions other than those described in this report are found at the subject location(s), or the design has been altered in any way, GZA shall be so notified and afforded the opportunity to revise the report, as appropriate, to reflect the unanticipated changed conditions .

3. GZA's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made.

4. In conducting our work, GZA relied upon certain information made available by public agencies, Client and/or others. GZA did not attempt to independently verify the accuracy or completeness of that information. Inconsistencies in this information which we have noted, if any, are discussed in the Report.

Subsurface Conditions

5. The generalized soil profile(s) provided in our Report are based on widely-spaced subsurface explorations and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated. For more specific information on soil conditions at a specific location refer to the exploration logs. The nature and extent of variations between these explorations may not become evident until further exploration or construction. If variations or other latent conditions then become evident, it will be necessary to reevaluate the conclusions and recommendations of this report.

6. In preparing this report, GZA relied on certain information provided by the Client, state and local officials, and other parties referenced therein which were made available to GZA at the time of our evaluation. GZA did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this evaluation.

7. Water level readings have been made in test holes (as described in this Report) and monitoring wells at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this Report. Fluctuations in the level of the groundwater however occur due to temporal or spatial variations in areal recharge rates, soil heterogeneities, the presence of subsurface utilities, and/or natural or artificially induced perturbations. The water table encountered in the course of the work may differ from that indicated in the Report.

8. GZA's services did not include an assessment of the presence of oil or hazardous materials at the property. Consequently, we did not consider the potential impacts (if any) that contaminants in soil or groundwater may have on construction activities, or the use of structures on the property.

9. Recommendations for foundation drainage, waterproofing, and moisture control address the conventional geotechnical engineering aspects of seepage control. These recommendations may not preclude an environment that allows the infestation of mold or other biological pollutants.

Compliance with Codes and Regulations

10. We used reasonable care in identifying and interpreting applicable codes and regulations. These codes and regulations are subject to various, and possibly contradictory, interpretations. Compliance with codes and regulations by other parties is beyond our control.

Cost Estimates

11. Unless otherwise stated, our cost estimates are only for comparative and general planning purposes. These estimates may involve approximate quantity evaluations. Note that these quantity estimates are not intended to be sufficiently accurate to develop construction bids, or to predict the actual cost of work addressed in this Report. Further, since we have no control over either when the work will take place or the labor and material costs required to plan and execute the anticipated work, our cost estimates were made by relying on our experience, the experience of others, and other sources of readily available information. Actual costs may vary over time and could be significantly more, or less, than stated in the Report.

Additional Services

12. GZA recommends that we be retained to provide services during any future: site observations, design, implementation activities, construction and/or property development/redevelopment. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.

APPENDIX B – TEST BORING LOGS (BY MAINEDOT)

UNIFIED SOIL CLASSIFICATION SYSTEM

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

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

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

MODIFIED BURMISTER SYSTEM

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

TERMS DESCRIBING DENSITY/CONSISTENCY

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

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

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

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

Rock Quality Designation (RQD):

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

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

Rock Quality Based on RQD

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

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

Color (Munsell color chart)
Texture (aphanitic, fine-grained, etc.)
Rock Type (granite, schist, sandstone, etc.)
Hardness (very hard, hard, mod. hard, etc.)
Weathering (fresh, very slight, slight, moderate, mod. severe, severe, etc.)
Geologic discontinuities/jointing:
- -dip (horiz - 0-5 deg., low angle - 5-35 deg., mod. dipping - 35-55 deg., steep - 55-85 deg., vertical - 85-90 deg.)
- -spacing (very close - <2 inch, close - 2-12 inch, mod. close - 1-3 feet, wide - 3-10 feet, very wide >10 feet)
- -tightness (tight, open, or healed)
- -infilling (grain size, color, etc.)

Formation (Waterville, Ellsworth, Cape Elizabeth, etc.)
RQD and correlation to rock quality (very poor, poor, etc.)
ref: ASTM D6032 and FHWA NHI-16-072 GEC 5 - Geotechnical Site Characterization, Table 4-12
Recovery (inch/inch and percentage)
Rock Core Rate (X.X ft - Y.Y ft (min:sec))

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

Sample Container Labeling Requirements:

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

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Mitchell Bridge #0216 carries Mitchell Hill Road over Nonesuch River
Location: Gorham, Maine

Boring No.: BB-GNR-101
WIN: 22238.00

Driller:	MaineDOT	**Elevation (ft.)**	39.9	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/Jay	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	J. Manahan	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/20/2021, 5/25/2021	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	5+50.5, 7.7 ft Rt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	10.0 ft bgs.
Hammer Efficiency Factor:	0.89	**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				
5	1D	24/8	5.00 - 7.00	15/21/14/13	35	52				Brown, damp, very dense, fine to coarse SAND, little gravel, (Fill).	
10	2D/A	24/16	10.00 - 12.00	WOH/3/3/5	6	9	4			2D (10.0-11.0 ft bgs.) Brown, moist, loose, fine to coarse SAND, some silt, little gravel, wood (timber cribbing), (Fill).	
							15	28.9		11.0 2D/A (11.0-12.0 ft bgs.) Grey, damp, stiff, Silty CLAY, little sand, (Alluvium-Clay/Silt).	
							17				
							26				
							27				
15	3D/MV	24/16	15.50 - 17.50	3/3/3/3	6	9	[a]14	24.4		[a] Casing sunk to 15.5 ft bgs. 15.5 Grey, wet, loose, fine SAND, some silt, trace clay, trace medium sand (Alluvium-Sand). Failed 55x110 mm vane attempt, would not push.	G#340968 A-2-4, SC-SM WC=21.1% Non-Plastic
							25				
							27				
							30				
							29				
20	4D/A	24/24	20.00 - 22.00	1/2/2/2	4	6	HYD PUSH	19.7		4D (20.0-20.2 ft bgs.) Grey, moist, loose, SAND, trace silt, (Alluvium-Sand) . 20.2 4D/A (20.2-22.0 ft bgs.) Grey, moist, medium stiff, Silty CLAY, trace fine sand (Marine Clay).	G#340969 A-6, CL WC=38.8% LL=39 PL=23 PI=16
25											

Remarks:

Left 50 ft of NW Casing in bore hole on 5/20/2021, until we returned on 5/25/2021.

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

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WIN: 22238.00

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Operator:	Daggett/Jay	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	J. Manahan	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/20/2021, 5/25/2021	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	5+50.5, 7.7 ft Rt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	10.0 ft bgs.
Hammer Efficiency Factor: 0.89		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
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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_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.
25	5D	24/24	25.00 - 27.00	WOR/WOR/WOR/ WOH	---		OPEN HOLE			Grey, wet, medium stiff, Silty CLAY, (Marine Clay).	
	V1		25.63 - 26.00	Su=759/89 psf						55x100 mm vane raw torque readings:	
	V1/2		26.63 - 27.00	Su=804/67 psf						V1: 17.0/2.0 ft-lbs	
										V1/2: 18.0/1.5 ft-lbs	
30	6D	24/24	30.00 - 32.00	WOR/WOR/WOR/ WOR	---					Grey, wet, soft, Silty CLAY, trace fine sand, (Marine Clay).	G#340970 A-6, CL WC=37.6% LL=33 PL=22 PI=11
	V2		30.63 - 31.00	Su=313/22 psf						55x100 mm vane raw torque readings:	
	V2/2		31.63 - 32.00	Su=335/45 psf						V2: 7.0/0.5 ft-lbs	
										V2/2: 7.5/1.0 ft-lbs	
35	7D	24/14	35.00 - 37.00	WOR/WOR/WOR/ WOR	---		HYD PUSH			Similar to 6D, except medium stiff.	
	V3		35.63 - 36.00	Su=960/45 psf						55x100 mm vane raw torque readings:	
	V3/2		36.63 - 37.00	Su=804/67 psf						V3: 21.5/1.0 ft-lbs	
										V3/2: 18.0/1.5 ft-lbs	
40	8D	24/15	40.00 - 42.00	WOR/WOR/WOR/ WOR	---					Similar to above.	
	V4		40.63 - 41.00	Su=804/54 psf						55x100 mm vane raw torque readings:	
	V4/2		41.63 - 42.00	Su=826/54 psf						V4: 18.0/1.2 ft-lbs	
										V4/2: 18.5/1.2 ft-lbs	
45	9D	24/13	45.00 - 47.00	WOR/WOR/WOR/ WOR	---					Similar to above.Grey, wet, medium stiff, Silty CLAY, trace fine sand, (Marine Clay).	G#340971 A-6, CL WC=37.0% LL=36 PL=23 PI=13
	V5		45.63 - 46.00	Su=781/67 psf						55x100 mm vane raw torque readings:	
	V5/2		46.63 - 47.00	Su=781/45 psf						V5: 17.5/1.5 ft-lbs	
										V5/2: 17.5/1.0 ft-lbs	
50											

Remarks:

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Date Start/Finish:	5/20/2021, 5/25/2021	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	5+50.5, 7.7 ft Rt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	10.0 ft bgs.
Hammer Efficiency Factor: 0.89		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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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.
				Sample Information							
50	10D	24/24	50.50 - 52.50	WOR/WOR/WOR/ WOR	---					Grey, wet, medium stiff, Silty CLAY, trace fine sand, (Marine Clay).	
	V6		51.13 - 51.50	Su=804/89 psf						55x100 mm vane raw torque readings: V6: 18.0/2.0 ft-lbs	
	V6/2		52.13 - 52.50	Su=1027/112 psf						V6/2: 23.0/2.5 ft-lbs	
55	11D	24/24	55.00 - 57.00	WOR/WOH/WOR/ WOR	---					Grey, wet, stiff, Silty CLAY, (Marine Clay).	
	V7		55.63 - 56.00	Su=1161/179 psf						55x100 mm vane raw torque readings: V7: 26.0/4.0 ft-lbs	
	V7/2		56.63 - 57.00	Su=1161/246 psf						V7/2: 26.0/5.5 ft-lbs	
60	12D	24/24	60.00 - 62.00	WOR/WOR/WOR/ WOR	---					Similar to above.	
	V8		60.63 - 61.00	Su=1473/268 psf						55x100 mm vane raw torque readings: V8: 33.0/6.0 ft-lbs	
	V8/2		61.63 - 62.00	Su=1696/268 psf						V8/2: 38.0/6.0 ft-lbs	
65	13D	24/24	65.00 - 67.00	WOR/WOR/WOH/14	---		17			Grey, wet, stiff, Clayey SILT, little fine sand, (Marine Clay).	
	MV		65.63 - 65.63	Would Not Push			31			Failed 4=55x110 mm vane attempt.	
							29	-27.1		67.0	
							62				
							47				
70	14D	6/5	70.00 - 70.50	50	---		NQ-2	-30.6		Grey, wet, very dense, Gravelly SAND, some silt, (Glacial Till).	
	R1	60/60	70.50 - 75.50	RQD = 90%						70.5	
										Top of Bedrock at Elev. -30.6 ft. R1: Bedrock: Tan to black, fine-grained, GRANOFELS, hard, fresh to slightly weathered. Joints are very close to moderately spaced, horizontal to low angle, fresh to slightly weathered, planar, smooth, fresh to discolored, tight, with calcite infilling. [Berwick Formation] Rock Quality = Good R1: Core Times (min:sec) 70.5-71.5 ft (4:02)	
75											

Remarks:

Left 50 ft of NW Casing in bore hole on 5/20/2021, until we returned on 5/25/2021.

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

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Mitchell Bridge #0216 carries Mitchell Hill Road over Nonesuch River
Location: Gorham, Maine

Boring No.: BB-GNR-101
WIN: 22238.00

Driller:	MaineDOT	**Elevation (ft.)**	39.9	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/Jay	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	J. Manahan	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/20/2021, 5/25/2021	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	5+50.5, 7.7 ft Rt.	**Casing ID/OD:**	NW-3"	**Water Level*:**	10.0 ft bgs.
Hammer Efficiency Factor: 0.89		**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_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.
75	R2	60/60	75.50 - 80.50	RQD = 67%				-35.6		71.5-72.5 ft (3:55) 72.5-73.5 ft (2:47) 73.5-74.5 ft (1:30) 74.5-75.5 ft (2:12) 100% Recovery	
										75.5 R2: Bedrock: Tan to black, fine-grained, GRANOFELS, fresh to slightly weathered. Primary joints are very close to moderately spaced, horizontal to low angle, fresh to slightly weathered, planar, smooth, fresh to discolored, tight, with calcite infilling. Secondary joints are moderately spaced, high angle, undulating, smooth fresh, tight. [Berwick Formation]	
80								-40.6		Rock Quality = Fair R2: Core Times (min:sec) 75.5-76.5 ft (1:54) 76.5-77.5 ft (1:54) 77.5-78.5 ft (1:47) 78.5-79.5 ft (1:49) 79.5-80.5 ft (1:53) 100% Recovery	
										80.5 **Bottom of Exploration at 80.5 feet below ground surface.**	
85											
90											
95											
100											

Remarks:

Left 50 ft of NW Casing in bore hole on 5/20/2021, until we returned on 5/25/2021.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Mitchell Bridge #0216 carries Mitchell Hill Road over Nonesuch River
Location: Gorham, Maine

Boring No.: BB-GNR-101A
WIN: 22238.00

Drilling Contractor:	MaineDOT	**Elevation (ft.)**	39.9	**Auger ID/OD:**	5" Dia.
Operator:	Daggett/Jay	**Datum:**	NAVD88	**Sampler:**	N/A
Logged By:	J. Manahan	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	N/A
Date Start/Finish:	5/20/2021; 08:00-0815	**Drilling Method:**	Solid Stem Auger	**Core Barrel:**	N/A
Boring Location:	5+52.2, 7.7 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			Brown Sand and Gravel cuttings.	
							35.4		4.5	
5									**Bottom of Exploration at 4.5 feet below ground surface.** REFUSAL, Boring was terminated due to probable cobble/boulder. Offset and drilled BB-GNR-101.	
10										
15										
20										
25										

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Mitchell Bridge #0216 carries Mitchell Hill Road over Nonesuch River
Location: Gorham, Maine

Boring No.: BB-GNR-102
WIN: 22238.00

Driller:	MaineDOT	**Elevation (ft.)**	40.0	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/Jay	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	J. Manahan	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/25-27/2021	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	5+94.4, 7.5 ft Lt.	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	None Observed
Hammer Efficiency Factor: 0.89		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
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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	39.5		6" HMA. 0.5	
5	1D	24/20	5.00 - 7.00	12/7/7/13	14	21				Brown, damp, medium dense, fine to coarse SAND, trace silt, trace gravel, (Fill).	G#340972 A-1-b, SW-SM WC=2.9%
10	2D	24/19	10.00 - 12.00	4/2/2/2	4	6	27			Dark grey, fine to coarse SAND, some silt, little gravel, trace organics, (Fill).	
							36				
							40	28.0		12.0	
							52				
							64				
15	3D	24/2	15.00 - 17.00	3/2/3/3	5	7	50			Grey, wet, medium stiff, Silty CLAY, little fine sand, (Alluvium-Clay/ Silt).	
							53				
							60				
							45				
							52			Roller Coned ahead from 19.0-20.0 ft bgs.	
20	4D	24/3	20.00 - 22.00	5/5/7/7	12	18	55	20.0		20.0	
							56			Grey, wet, medium dense, fine to coarse SAND, trace silt, (Alluvium-Sand).	
							123				
							96				
25							84				

Remarks:

5/25/2021, left 25.0 ft of casing in hole.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Mitchell Bridge #0216 carries Mitchell Hill Road over Nonesuch River
Location: Gorham, Maine

Boring No.: BB-GNR-102
WIN: 22238.00

Driller:	MaineDOT	**Elevation (ft.)**	40.0	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/Jay	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	J. Manahan	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/25-27/2021	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	5+94.4, 7.5 ft Lt.	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	None Observed
Hammer Efficiency Factor: 0.89		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
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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_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.
				Sample Information							
25	5D	24/24	25.00 - 27.00	WOH/WOH/1/WOH	1	1	65	15.0		25.0 Grey, wet, very soft, Clayey SILT, trace fine sand, trace gravel (Marine Clay).	G#303113 A-6, CL WC=35.9% LL=32 PL=20 PI=12
							47				
							46				
	V1		28.63 - 29.00	Su=804/45 psf			44			55x110 mm vane raw torque readings: V1: 18.0/1.0 ft-lbs	
	V1/2		29.63 - 30.00	Su=759/22 psf			36			V1/2: 17.0/0.5 ft-lbs	
30	1U	24/24	30.50 - 32.50				OPEN HOLE			Grey, moist, medium stiff, Silty CLAY, trace fine sand, (Marine Clay).	G,C#340973 A-6, CL WC=37.0% LL=35 PL=23 PI=12
	V2		33.13 - 33.50	Su=625/22 psf						55x110 mm vane raw torque readings: V2: 14.0/1.0 ft-lbs	
	V2/2		34.13 - 34.50	Su=714/22 psf						V2/2: 16.0/0.5 ft-lbs	
35	MD	24/0	35.00 - 37.00	WOR/WOR/WOR/ WOR	---					Failed sample attempt.	
	V3		35.63 - 36.00	Su=893/45 psf						55x110 mm vane raw torque readings: V3: 20.0/1.0 ft-lbs	
	V3/2		36.63 - 37.00	Su=804/22 psf						V3/2: 18.0/0.5 ft-lbs	
40	2U	24/24	40.00 - 42.00							Grey, moist, Silty CLAY, trace sand,, trace gravel (Marine Clay).	G,C#340974 A-6, CL WC=35.5% LL=32 PL=21 PI=11
	V4		42.63 - 43.00	Su=714/54 psf						55x110 mm vane raw torque readings: V4: 16.0/1.2 ft-lbs	
	V4/2		43.63 - 44.00	Su=781/45 psf						V4/2: 17.5/1.0 ft-lbs	
45	6D	24/16	45.00 - 47.00	WOR/WOR/WOR/ WOR	---					Grey, wet, medium stiff, Silty CLAY, (Marine Clay).	
	V5		45.63 - 46.00	Su=826/89 psf						55x110 mm vane raw torque readings: V5: 18.5/2.0 ft-lbs	
	V5/2		46.63 - 47.00	Su=737/67 psf						V5/2: 16.5/1.5 ft-lbs	
50											

Remarks:

5/25/2021, left 25.0 ft of casing in hole.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Mitchell Bridge #0216 carries Mitchell Hill Road over Nonesuch River
Location: Gorham, Maine

Boring No.: BB-GNR-102
WIN: 22238.00

Driller:	MaineDOT	**Elevation (ft.)**	40.0	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/Jay	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	J. Manahan	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/25-27/2021	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	5+94.4, 7.5 ft Lt.	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	None Observed
Hammer Efficiency Factor: 0.89		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
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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_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.
50	3U	24/24	50.00 - 52.00	WOR/WOR						Grey, moist, medium stiff, Silty CLAY, trace sand, (Marine Clay).	G,C#340975 A-4, CL WC=33.8% LL=30 PL=20 PI=10
	V6		52.63 - 53.00	Su=1049/112 psf						55x110 mm vane raw torque readings: V6: 23.5/2.5 ft-lbs	
	V6/2		53.63 - 54.00	Su=826/89 psf						V6/2: 18.5/2.0 ft-lbs	
55										Dropped in NW Casing 55.0 ft bgs., then casing sank to 60.0 ft bgs.	
60	7D	24/24	60.00 - 62.00	WOR/WOR/WOR/ WOR	---					Grey, wet, very soft, Silty CLAY, trace fine sand, (Marine Clay).	
65	8D	24/24	65.00 - 67.00	WOR/WOR/WOR/ WOR	---					Grey, wet, very soft, Clayey SILT, trace fine sand, trace gravel (Marine Clay).	G#303114 A-6, CL WC=30.3% LL=34 PL=22 PI=12
							WOR				
							WOH				
							10				
70	9D	24/16	70.00 - 72.00	WOR/WOR/3/2	3	4	7			Grey, wet, very soft, Silty CLAY, trace fine sand, (Marine Clay).	
							7				
							10				
							9				
75							14				

Remarks:

5/25/2021, left 25.0 ft of casing in hole.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Mitchell Bridge #0216 carries Mitchell Hill Road over Nonesuch River
Location: Gorham, Maine

Boring No.: BB-GNR-102
WIN: 22238.00

Driller:	MaineDOT	**Elevation (ft.)**	40.0	**Auger ID/OD:**	5" Solid Stem
Operator:	Daggett/Jay	**Datum:**	NAVD88	**Sampler:**	Standard Split Spoon
Logged By:	J. Manahan	**Rig Type:**	CME 45C	**Hammer Wt./Fall:**	140#/30"
Date Start/Finish:	5/25-27/2021	**Drilling Method:**	Cased Wash Boring	**Core Barrel:**	NQ-2"
Boring Location:	5+94.4, 7.5 ft Lt.	**Casing ID/OD:**	HW-4" & NW-3"	**Water Level*:**	None Observed
Hammer Efficiency Factor: 0.89		**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
D = Split Spoon Sample
MD = Unsuccessful Split Spoon Sample Attempt
U = Thin Wall Tube Sample
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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_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.
75	10D	24/24	75.00 - 77.00	WOR/1/3/10	4	6	12			Grey, wet, medium stiff, SILT, some clay, some fine to medium sand, trace gravel (Marine Clay).	
							16				
							9				
							18	-38.0		78.0	
							20				
80							23				
	11D	19.2/16	81.00 - 82.60	13/19/30/30(1.2)	49	73	38			Brown, wet, very dense, fine to coarse SAND, some gravel, little silt, (Glacial Till).	
	R1	60/60	82.70 - 87.70	RQD = 92%			NQ-2	-42.7		82.7	
										Top of Bedrock at Elev. -42.7 ft. R1: Bedrock: Black, fine-grained, GRANOFELS, very hard, fresh. Joints are close to moderately spaced, low angle, fresh, planar, smooth, tight, with calcite infilling. Rock Quality = Excellent [Berwick Formation] R1: Core Times (min:sec) 82.7-83.7 ft (1:08) 83.7-84.7 ft (1:40) 84.7-85.7 ft (1:29) 85.7-86.7 ft (1:51) 86.7-87.7 ft (1:50) 100% Recovery	
85											
								-47.7		87.7	
										Bottom of Exploration at 87.7 feet below ground surface.	
90											
95											
100											

Remarks:

5/25/2021, left 25.0 ft of casing in hole.

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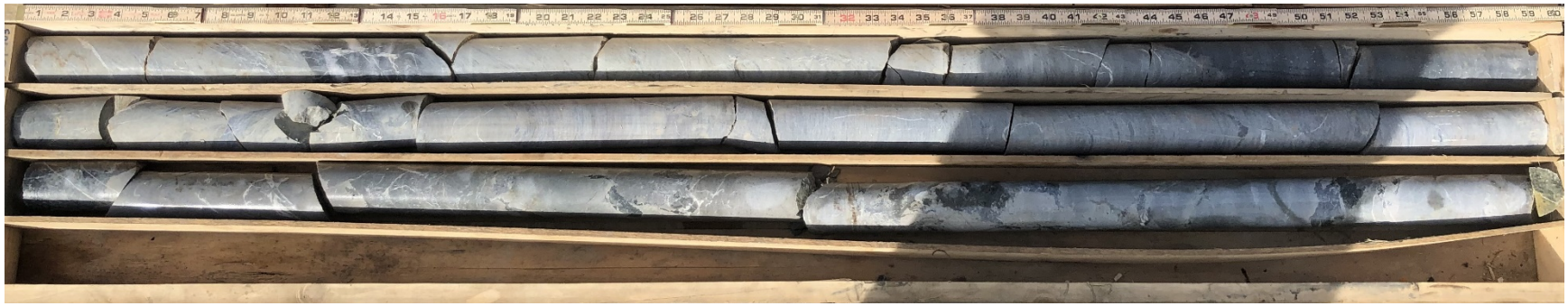
APPENDIX C – ROCK CORE PHOTO LOG

Mitchell Bridge No. 0216 Culvert Replacement
MaineDOT WIN 022238.00, Gorham, Maine
Rock Core Photographs

Boring No.	Run	Depth (ft)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)	Rock Type	Box Row
BB-GNR-101	R1	70.5 - 75.5	60	100	54	90	GRANOFELS	1
BB-GNR-101	R2	75.5 - 80.5	60	100	40	67	GRANOFELS	2
BB-GNR-102	R1	82.7 - 87.7	60	100	55	92	GRANOFELS	3



Notes: 1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 3=Bottom.
2. Top of each core run is on the left and increases with depth to the right.
3. Photos presented above show rock cores in the dry.

APPENDIX D – LABORATORY TEST RESULTS

State of Maine - Department of Transportation

Laboratory Testing Summary Sheet

Town(s): Gorham Work Number: 22238.00

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
BB-GNR-101, 3D	5+50.5	7.7 Rt.	15.5-17.5	340968	1	21.1	-N	P-	SC-SM	A-2-4	II
BB-GNR-101, 4D/A	5+50.5	7.7 Rt.	20.2-22.0	340969	1	38.8	39	16	CL	A-6	III
BB-GNR-101, 6D	5+50.5	7.7 Rt.	30.0-32.0	340970	1	37.6	33	11	CL	A-6	IV
BB-GNR-101, 9D	5+50.5	7.7 Rt.	45.0-47.0	340971	1	37.0	36	13	CL	A-6	III
BB-GNR-102, 1D	5+94.4	7.5 Lt.	5.0-7.0	340972	2	2.9			SW-SM	A-1-b	0
BB-GNR-102, 5D	5+94.4	7.5 Lt.	25.0-27.0	303113	2	35.9	32	12	CL	A-6	III
BB-GNR-102, 1U	5+94.4	7.5 Lt.	30.5-32.5	340973	3	37.0	35	12	CL	A-6	III
BB-GNR-102, 2U	5+94.4	7.5 Lt.	40.0-42.0	340974	3	35.5	32	11	CL	A-6	IV
BB-GNR-102, 3U	5+94.4	7.5 Lt.	50.0-52.0	340975	3	33.8	30	10	CL	A-4	IV
BB-GNR-102, 8D	5+94.4	7.5 Lt.	65.0-67.0	303114	2	30.3	34	12	CL	A-6	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.

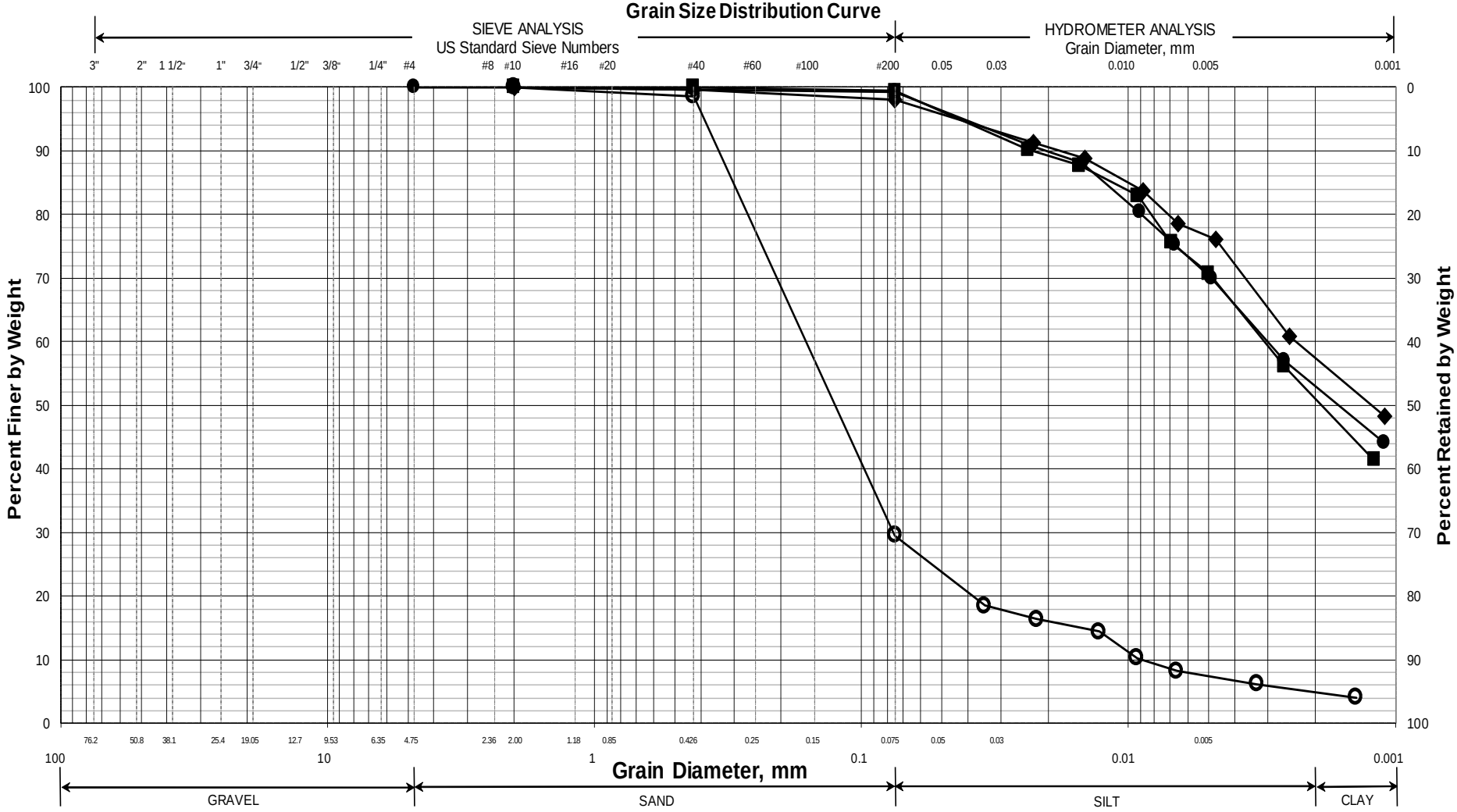
GSDC = Grain Size Distribution Curve as determined by AASHTO T 88-93 (1996) and/or ASTM D 422-63 (Reapproved 1998)

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

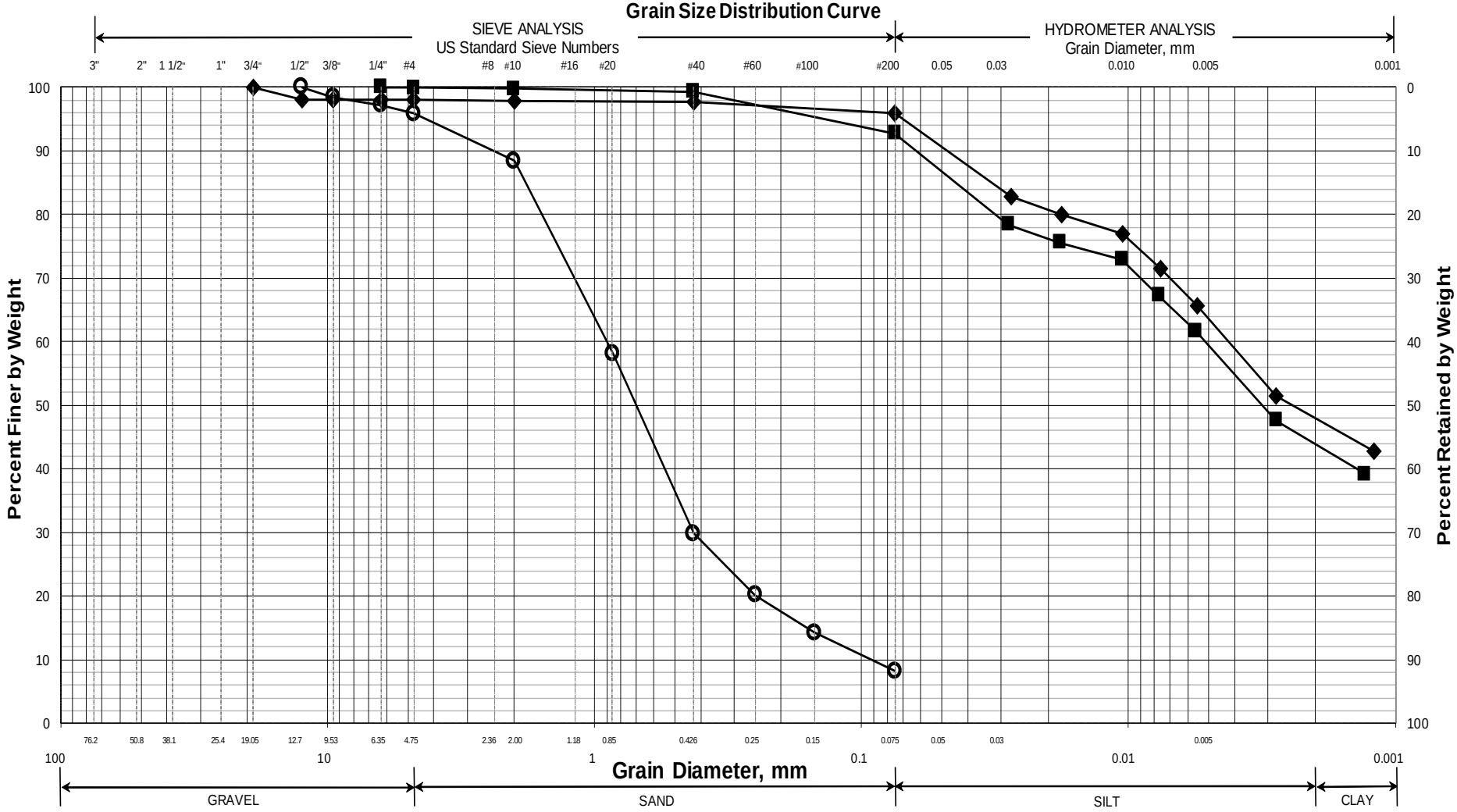


UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	BB-GNR-101/3D	5+50.5	7.7 RT	15.5-17.5	SAND, some silt, trace clay.	21.2			NP
◆	BB-GNR-101/4DA	5+50.5	7.7 RT	20.2-22.0	Silty CLAY, trace sand.	38.8	39	23	16
■	BB-GNR-101/6D	5+50.5	7.7 RT	30.0-32.0	Silty CLAY, trace sand.	37.6	33	22	11
●	BB-GNR-101/9D	5+50.5	7.7 RT	45.0-47.0	Silty CLAY, trace sand.	37	36	23	13
▲									
×									

WIN
022238.00
Town
Gorham
Reported by/Date
WHITE, TERRY A 6/23/2021

Maine Department of Transportation
Grain Size Distribution Curve

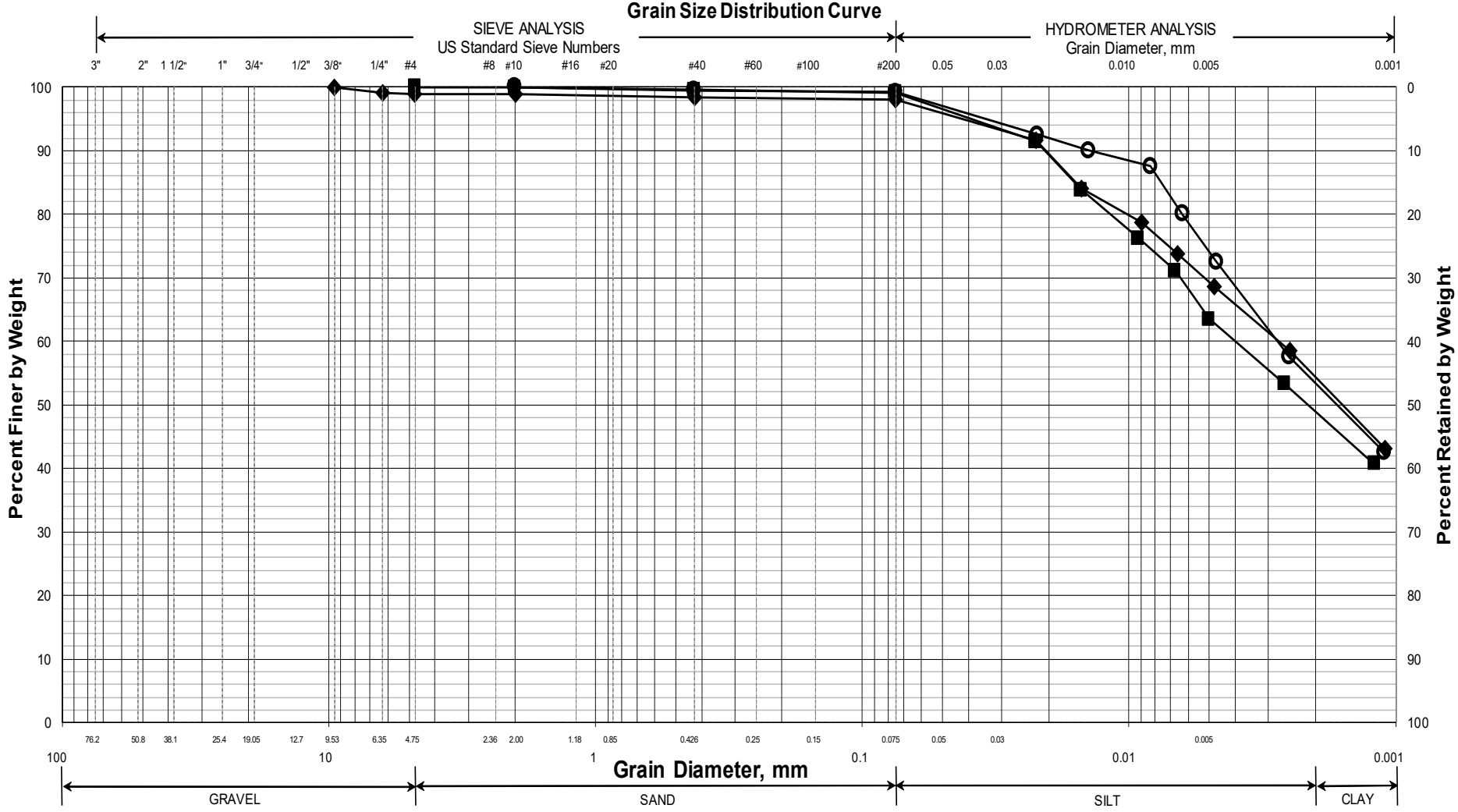


UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	BB-GNR-102/1D	5+94.4	7.5 LT	5.0-7.0	SAND, trace silt, trace gravel.	2.9			
◆	BB-GNR-102/5D	5+94.4	7.5 LT	25.0-27.0	Clayey SILT, trace sand, trace gravel.	35.9	32	20	12
■	BB-GNR-102/8D	5+94.4	7.5 LT	65.0-67.0	Clayey SILT, trace sand, trace gravel.	30.3	34	22	12
●									
▲									
×									

WIN
022238.00
Town
Gorham
Reported by/Date
WHITE, TERRY A 6/23/2021

Maine Department of Transportation
Grain Size Distribution Curve



UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
○	BB-GNR-102/1U	5+94.4	7.5 LT	30.5-32.5	Silty CLAY, trace sand.	37	35	23	12
◆	BB-GNR-102/2U	5+94.4	7.5 LT	40.0-42.0	Silty CLAY, trace sand, trace gravel.	35.5	32	21	11
■	BB-GNR-102/3U	5+94.4	7.5 LT	50.0-52.0	Clayey SILT, trace sand.	33.8	30	20	10
●									
▲									
×									

WIN
022238.00
Town
Gorham
Reported by/Date
WHITE, TERRY A 9/13/2023

MaineDOT

GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
340968	**BB-GNR-101/3D**	**GEOTECHNICAL (DISTURBED)**	**5/20/2021**	**6/8/2021**

Sample Type: **GEOTECHNICAL** Location: Station: **5+50.5** Offset, ft: **7.7** **RT** Dbfg, ft: **15.5-17.5**

WIN/Town **022238.00 - GORHAM** Sampler: **JAMES MANAHAN**

TEST RESULTS

Sieve Analysis (T 88)

Wash Method

SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	
½ in. [12.5 mm]	
⅜ in. [9.5 mm]	
¼ in. [6.3 mm]	
No. 4 [4.75 mm]	
No. 10 [2.00 mm]	**100.0**
No. 20 [0.850 mm]	
No. 40 [0.425 mm]	**98.6**
No. 60 [0.250 mm]	
No. 100 [0.150 mm]	
No. 200 [0.075 mm]	**29.6**
[0.0345 mm]	**18.5**
[0.0221 mm]	**16.4**
[0.0129 mm]	**14.4**
[0.0093 mm]	**10.3**
[0.0066 mm]	**8.2**
[0.0033 mm]	**6.2**
[0.0014 mm]	**4.1**

Miscellaneous Tests

Liquid Limit @ 25 blows (T 89), %	
Plastic Limit (T 90), %	
Plasticity Index (T 90), %	**NP**
Specific Gravity, Corrected to 20°C (T 100)	**2.63**
Loss on Ignition, % (T 267)	
Water Content (T 265), %	**21.2**

Consolidation (T 216)

Trimmings, Water Content, %

	Initial	Final		Void Ratio	% Strain
Water Content, %			Pmin		
Dry Density, lbs/ft³			Pp		
Void Ratio			Pmax		
Saturation, %			Cc/C'c		

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth taken in tube, ft	3 In.		6 In.		Water Content, %	Description of Material Sampled at the Various Tube Depths
	U. Shear tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

Comments:

AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **6/21/2021**

Paper Copy: Lab File; Project File; Geotech File

MaineDOT

GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
340969	**BB-GNR-101/4DA**	**GEOTECHNICAL (DISTURBED)**	**5/20/2021**	**6/8/2021**

Sample Type: **GEOTECHNICAL** Location: Station: **5+50.5** Offset, ft: **7.7** **RT** Dbfg, ft: **20.2-22.0**

WIN/Town **022238.00 - GORHAM** Sampler: **JAMES MANAHAN**

TEST RESULTS

Sieve Analysis (T 88)

Wash Method

SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	
½ in. [12.5 mm]	
⅜ in. [9.5 mm]	
¼ in. [6.3 mm]	
No. 4 [4.75 mm]	
No. 10 [2.00 mm]	**100.0**
No. 20 [0.850 mm]	
No. 40 [0.425 mm]	**99.6**
No. 60 [0.250 mm]	
No. 100 [0.150 mm]	
No. 200 [0.075 mm]	**98.1**
[0.0227 mm]	**91.3**
[0.0146 mm]	**88.8**
[0.0088 mm]	**83.7**
[0.0065 mm]	**78.6**
[0.0047 mm]	**76.1**
[0.0025 mm]	**60.9**
[0.0011 mm]	**48.2**

Miscellaneous Tests

Liquid Limit @ 25 blows (T 89), %	**39**
Plastic Limit (T 90), %	**23**
Plasticity Index (T 90), %	**16**
Specific Gravity, Corrected to 20°C (T 100)	**2.75**
Loss on Ignition, % (T 267)	
Water Content (T 265), %	**38.8**

Consolidation (T 216)

Trimmings, Water Content, %	

	Initial	Final		Void Ratio	% Strain
Water Content, %			Pmin		
Dry Density, lbs/ft³			Pp		
Void Ratio			Pmax		
Saturation, %			Cc/C'c		

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth taken in tube, ft	3 In.		6 In.		Water Content, %	Description of Material Sampled at the Various Tube Depths
	U. Shear tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

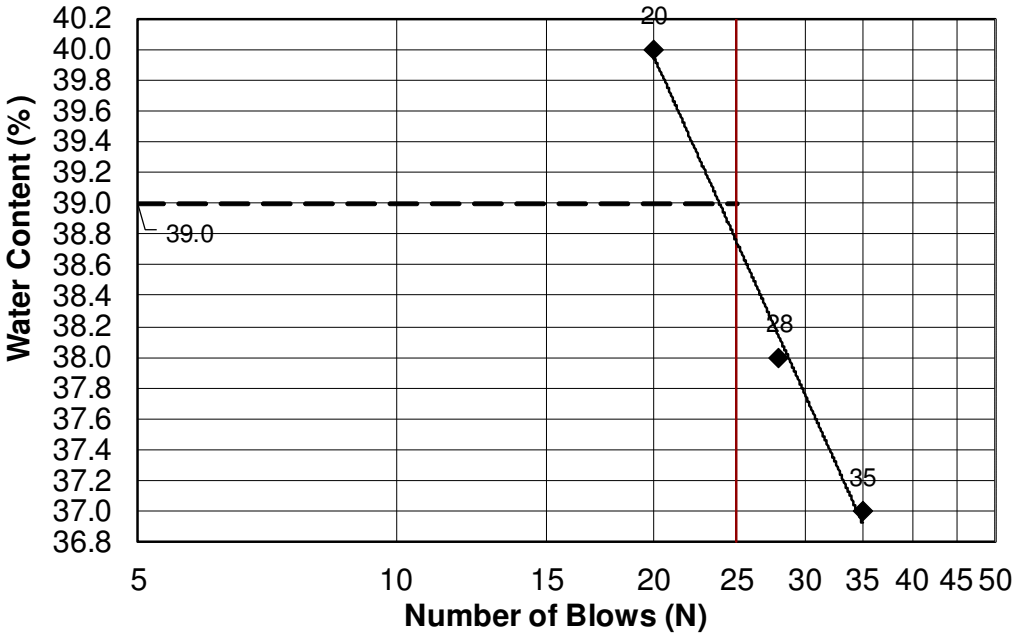
Comments:

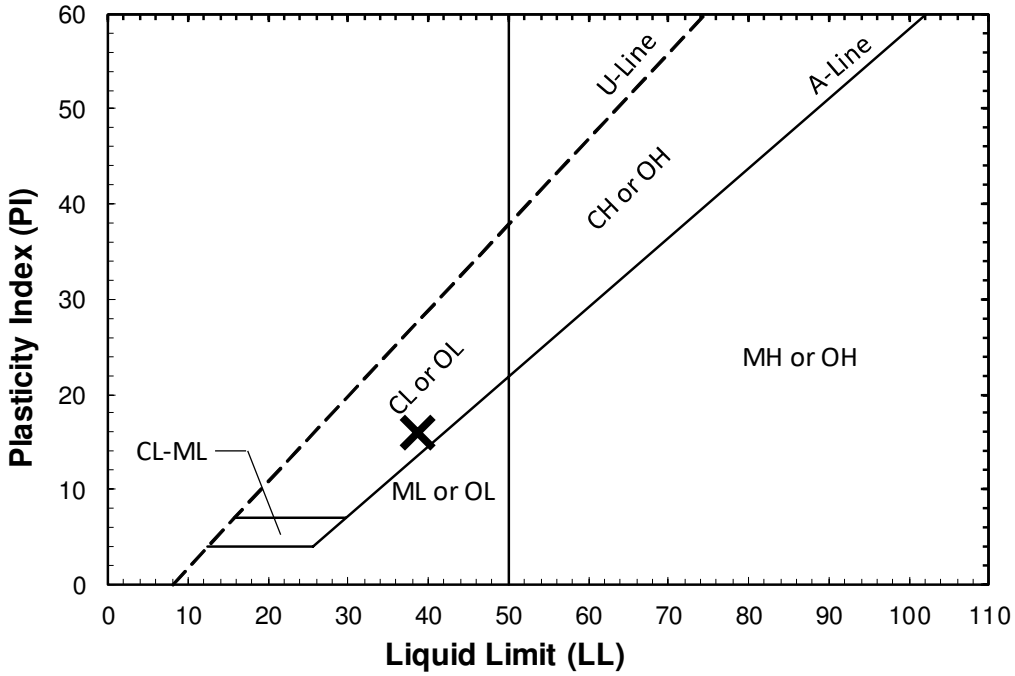
AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **6/21/2021**

Paper Copy: Lab File; Project File; Geotech File

TOWN	Gorham	Reference No.	340969
WIN	022238.00	Water Content, %	38.8
Sampled	5/20/2021	Liquid Limit @ 25 blows (T 89), %	39
Boring No./Sample No.	BB-GNR-101/4DA	Plastic Limit (T 90), %	23
Station	5+50.5	Plasticity Index (T 90), %	16
Depth	20.2-22.0	Tested By	BBURR





MaineDOT

GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
340970	**BB-GNR-101/6D**	**GEOTECHNICAL (DISTURBED)**	**5/20/2021**	**6/8/2021**

Sample Type: **GEOTECHNICAL** Location: Station: **5+50.5** Offset, ft: **7.7** **RT** Dbfg, ft: **30.0-32.0**

WIN/Town **022238.00 - GORHAM** Sampler: **JAMES MANAHAN**

TEST RESULTS

Sieve Analysis (T 88)	
Wash Method	
SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	
½ in. [12.5 mm]	
⅜ in. [9.5 mm]	
¼ in. [6.3 mm]	
No. 4 [4.75 mm]	
No. 10 [2.00 mm]	**100.0**
No. 20 [0.850 mm]	
No. 40 [0.425 mm]	**100.0**
No. 60 [0.250 mm]	
No. 100 [0.150 mm]	
No. 200 [0.075 mm]	**99.4**
[0.0238 mm]	**90.2**
[0.0153 mm]	**87.7**
[0.0092 mm]	**82.9**
[0.0069 mm]	**75.6**
[0.0050 mm]	**70.7**
[0.0026 mm]	**56.1**
[0.0012 mm]	**41.4**

Miscellaneous Tests	
Liquid Limit @ 25 blows (T 89), %	**33**
Plastic Limit (T 90), %	**22**
Plasticity Index (T 90), %	**11**
Specific Gravity, Corrected to 20°C (T 100)	**2.70**
Loss on Ignition, % (T 267)	
Water Content (T 265), %	**37.6**

Consolidation (T 216)

Trimmings, Water Content, %	

	Initial	Final		Void Ratio	% Strain
Water Content, %			Pmin		
Dry Density, lbs/ft³			Pp		
Void Ratio			Pmax		
Saturation, %			Cc/C'c		

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth taken in tube, ft	3 In.		6 In.		Water Content, %	Description of Material Sampled at the Various Tube Depths
	U. Shear tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

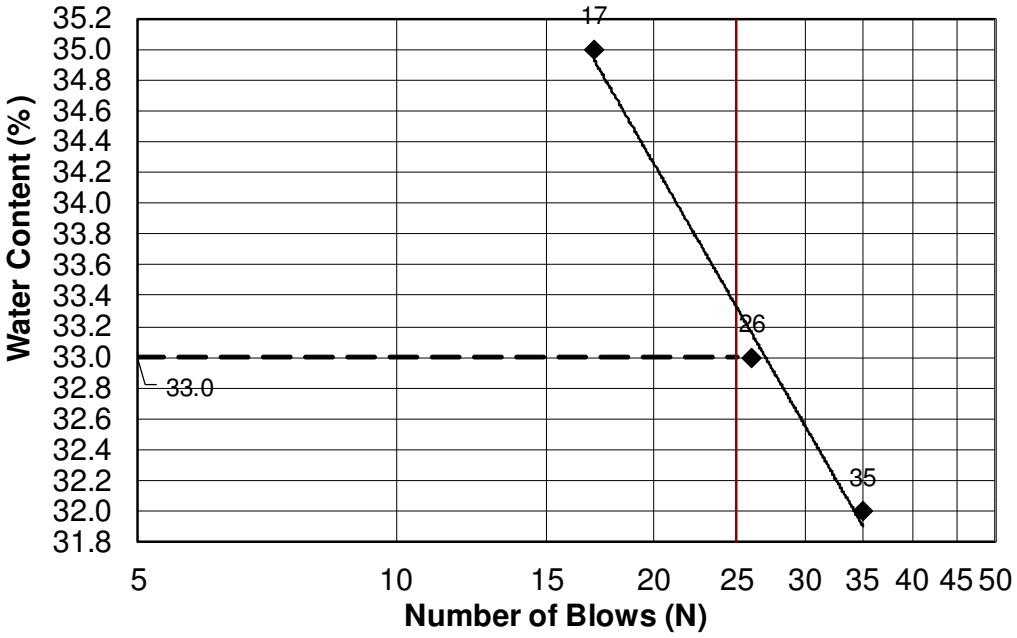
Comments:

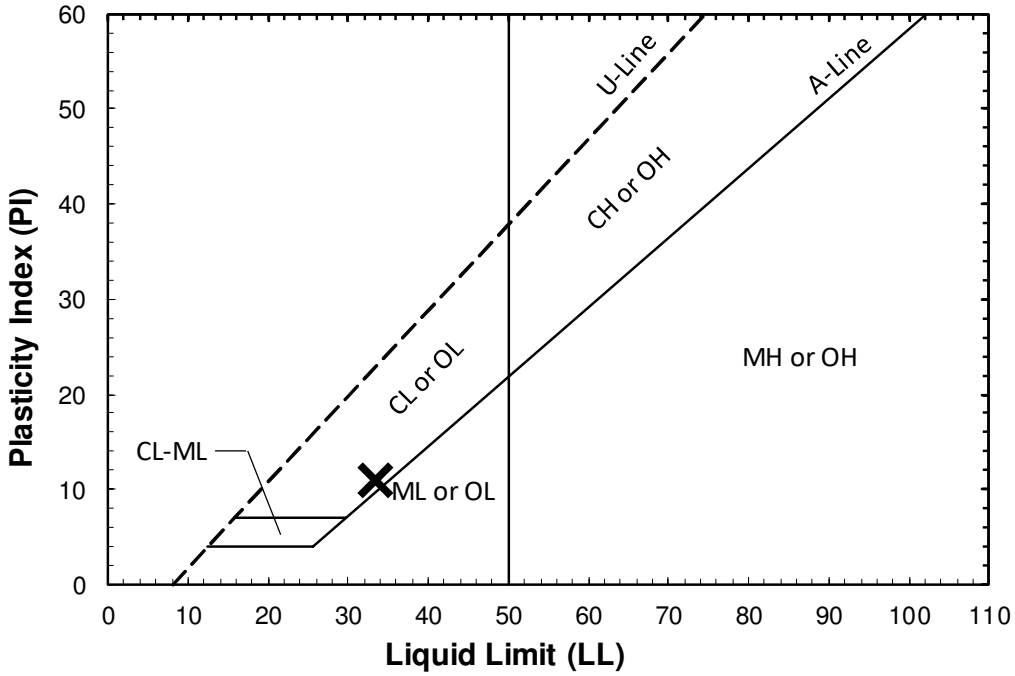
AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **6/21/2021**

Paper Copy: Lab File; Project File; Geotech File

TOWN	Gorham	Reference No.	340970
WIN	022238.00	Water Content, %	37.6
Sampled	5/20/2021	Liquid Limit @ 25 blows (T 89), %	33
Boring No./Sample No.	BB-GNR-101/6D	Plastic Limit (T 90), %	22
Station	5+50.5	Plasticity Index (T 90), %	11
Depth	30.0-32.0	Tested By	BBURR





MaineDOT

GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
340971	**BB-GNR-101/9D**	**GEOTECHNICAL (DISTURBED)**	**5/20/2021**	**6/8/2021**

Sample Type: **GEOTECHNICAL** Location: Station: **5+50.5** Offset, ft: **7.7** **RT** Dbfg, ft: **45.0-47.0**

WIN/Town **022238.00 - GORHAM** Sampler: **JAMES MANAHAN**

TEST RESULTS

Sieve Analysis (T 88)

Wash Method

SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	
½ in. [12.5 mm]	
⅜ in. [9.5 mm]	
¼ in. [6.3 mm]	
No. 4 [4.75 mm]	**100.0**
No. 10 [2.00 mm]	**100.0**
No. 20 [0.850 mm]	
No. 40 [0.425 mm]	**99.7**
No. 60 [0.250 mm]	
No. 100 [0.150 mm]	
No. 200 [0.075 mm]	**99.3**
[0.0230 mm]	**90.7**
[0.0149 mm]	**88.1**
[0.0091 mm]	**80.4**
[0.0067 mm]	**75.2**
[0.0049 mm]	**70.0**
[0.0026 mm]	**57.0**
[0.0011 mm]	**44.1**

Miscellaneous Tests

Liquid Limit @ 25 blows (T 89), %	**36**
Plastic Limit (T 90), %	**23**
Plasticity Index (T 90), %	**13**
Specific Gravity, Corrected to 20°C (T 100)	**2.77**
Loss on Ignition, % (T 267)	
Water Content (T 265), %	**37.0**

Consolidation (T 216)

Trimmings, Water Content, %	

	Initial	Final		Void Ratio	% Strain
Water Content, %			Pmin		
Dry Density, lbs/ft³			Pp		
Void Ratio			Pmax		
Saturation, %			Cc/C'c		

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth taken in tube, ft	3 In.		6 In.		Water Content, %	Description of Material Sampled at the Various Tube Depths
	U. Shear tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

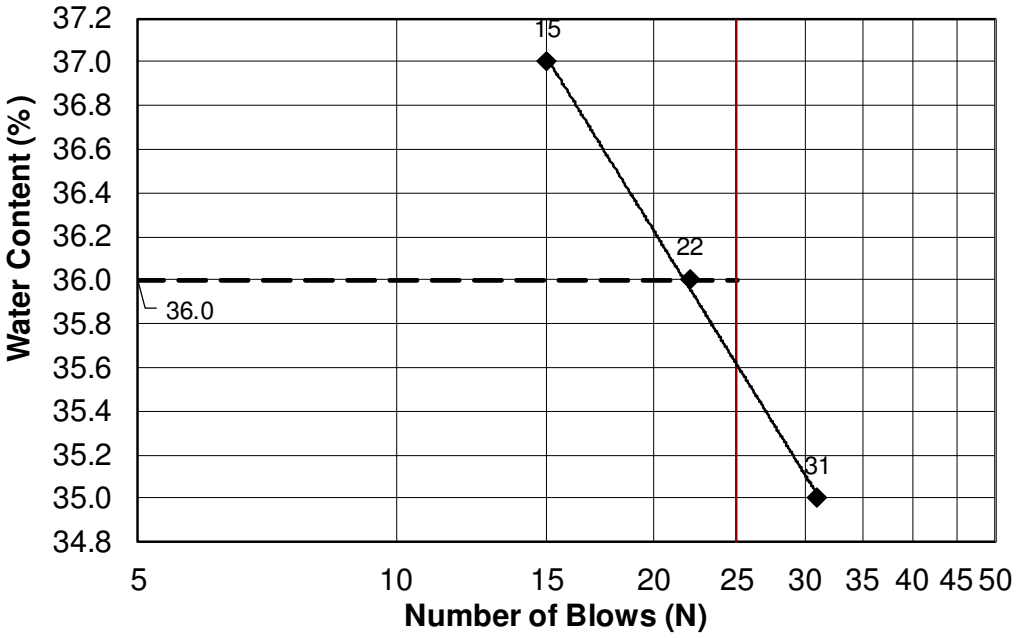
Comments:

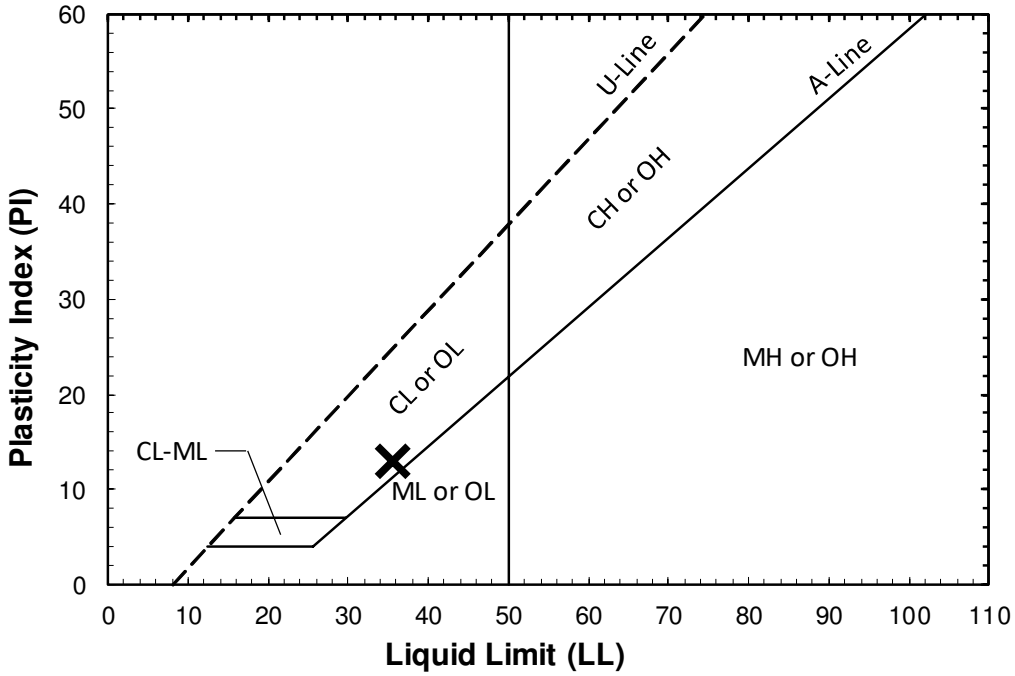
AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **6/18/2021**

Paper Copy: Lab File; Project File; Geotech File

TOWN	Gorham	Reference No.	340971
WIN	022238.00	Water Content, %	37
Sampled	5/20/2021	Liquid Limit @ 25 blows (T 89), %	36
Boring No./Sample No.	BB-GNR-101/9D	Plastic Limit (T 90), %	23
Station	5+50.5	Plasticity Index (T 90), %	13
Depth	45.0-47.0	Tested By	BBURR





MaineDOT

GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
340972	**BB-GNR-102/1D**	**GEOTECHNICAL (DISTURBED)**	**5/25/2021**	**6/8/2021**

Sample Type: **GEOTECHNICAL** Location: Station: **5+94.4** Offset, ft: **7.5** **LT** Dbfg, ft: **5.0-7.0**

WIN/Town **022238.00 - GORHAM** Sampler: **JAMES MANAHAN**

TEST RESULTS

Sieve Analysis (T 27, T 11)

Wash Method

Procedure A

SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	
½ in. [12.5 mm]	**100.0**
⅜ in. [9.5 mm]	**98.4**
¼ in. [6.3 mm]	**97.2**
No. 4 [4.75 mm]	**95.9**
No. 10 [2.00 mm]	**88.4**
No. 20 [0.850 mm]	**58.1**
No. 40 [0.425 mm]	**29.8**
No. 60 [0.250 mm]	**20.2**
No. 100 [0.150 mm]	**14.2**
No. 200 [0.075 mm]	**8.2**

Miscellaneous Tests

Liquid Limit @ 25 blows (T 89), %	
Plastic Limit (T 90), %	
Plasticity Index (T 90), %	
Specific Gravity, Corrected to 20°C (T 100)	
Loss on Ignition, % (T 267)	
Water Content (T 265), %	**2.9**

Consolidation (T 216)

Trimmings, Water Content, %	

	Initial	Final		Void Ratio	% Strain
Water Content, %			Pmin		
Dry Density, lbs/ft³			Pp		
Void Ratio			Pmax		
Saturation, %			Cc/C'c		

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth taken in tube, ft	3 In.		6 In.		Water Content, %	Description of Material Sampled at the Various Tube Depths
	U. Shear tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

Comments:

AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **6/11/2021**

Paper Copy: Lab File; Project File; Geotech File

MaineDOT

GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
303113	**BB-GNR-102/5D**	**GEOTECHNICAL (DISTURBED)**	**5/25/2021**	**6/8/2021**

Sample Type: **GEOTECHNICAL** Location: Station: **5+94.4** Offset, ft: **7.5** **LT** Dbfg, ft: **25.0-27.0**

WIN/Town **022238.00 - GORHAM** Sampler: **JAMES MANAHAN**

TEST RESULTS

Sieve Analysis (T 88)

Wash Method

SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	**100.0**
½ in. [12.5 mm]	**98.1**
⅜ in. [9.5 mm]	**98.0**
¼ in. [6.3 mm]	**98.0**
No. 4 [4.75 mm]	**98.0**
No. 10 [2.00 mm]	**97.9**
No. 20 [0.850 mm]	
No. 40 [0.425 mm]	**97.7**
No. 60 [0.250 mm]	
No. 100 [0.150 mm]	
No. 200 [0.075 mm]	**95.9**
[0.0276 mm]	**82.8**
[0.0178 mm]	**80.0**
[0.0105 mm]	**77.0**
[0.0076 mm]	**71.4**
[0.0055 mm]	**65.7**
[0.0028 mm]	**51.4**
[0.0012 mm]	**42.8**

Miscellaneous Tests

Liquid Limit @ 25 blows (T 89), %	**32**
Plastic Limit (T 90), %	**20**
Plasticity Index (T 90), %	**12**
Specific Gravity, Corrected to 20°C (T 100)	**2.71**
Loss on Ignition, % (T 267)	
Water Content (T 265), %	**35.9**

Consolidation (T 216)

Trimmings, Water Content, %	

	Initial	Final		Void Ratio	% Strain
Water Content, %			Pmin		
Dry Density, lbs/ft³			Pp		
Void Ratio			Pmax		
Saturation, %			Cc/C'c		

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth taken in tube, ft	3 In.		6 In.		Water Content, %	Description of Material Sampled at the Various Tube Depths
	U. Shear tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

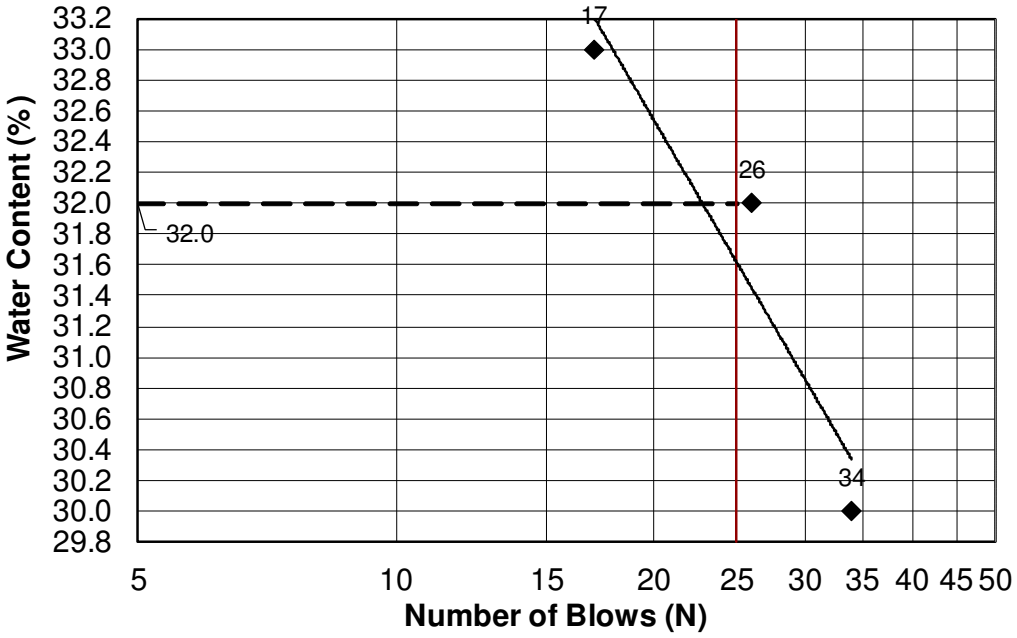
Comments:

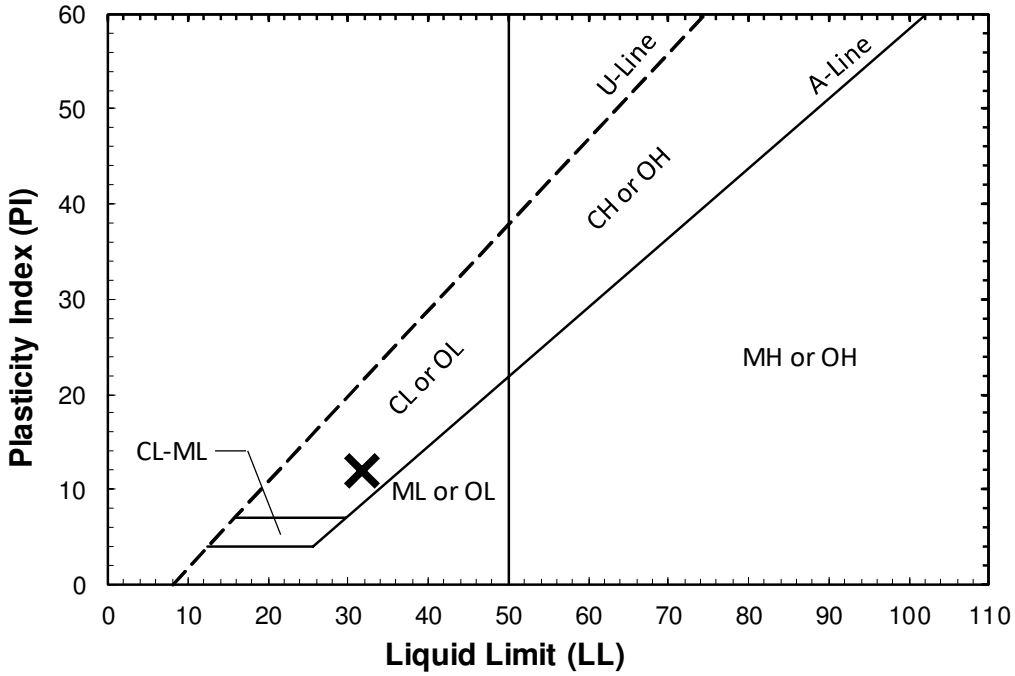
AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **6/21/2021**

Paper Copy: Lab File; Project File; Geotech File

TOWN	Gorham	Reference No.	303113
WIN	022238.00	Water Content, %	35.9
Sampled	5/25/2021	Liquid Limit @ 25 blows (T 89), %	32
Boring No./Sample No.	BB-GNR-102/5D	Plastic Limit (T 90), %	20
Station	5+94.4	Plasticity Index (T 90), %	12
Depth	25.0-27.0	Tested By	BBURR





MaineDOT

GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
340973	**BB-GNR-102/1U**	**GEOTECHNICAL (UNDISTURBED)**	**5/26/2021**	**6/8/2021**

Sample Type: **GEOTECHNICAL** Location: Station: **5+94.4** Offset, ft: **7.5** **LT** Dbfg, ft: **30.5-32.5**

WIN/Town **022238.00 - GORHAM** Sampler: **JAMES MANAHAN**

TEST RESULTS

Sieve Analysis (T 88)	
Wash Method	
SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	
½ in. [12.5 mm]	
⅜ in. [9.5 mm]	
¼ in. [6.3 mm]	
No. 4 [4.75 mm]	
No. 10 [2.00 mm]	**100.0**
No. 20 [0.850 mm]	
No. 40 [0.425 mm]	**99.5**
No. 60 [0.250 mm]	
No. 100 [0.150 mm]	
No. 200 [0.075 mm]	**99.2**
[0.0220 mm]	**92.5**
[0.0142 mm]	**90.0**
[0.0083 mm]	**87.5**
[0.0063 mm]	**80.0**
[0.0047 mm]	**72.5**
[0.0025 mm]	**57.5**
[0.0011 mm]	**42.5**

Miscellaneous Tests	
Liquid Limit @ 25 blows (T 89), %	**35**
Plastic Limit (T 90), %	**23**
Plasticity Index (T 90), %	**12**
Specific Gravity, Corrected to 20°C (T 100)	**2.77**
Loss on Ignition, % (T 267)	
Water Content (T 265), %	**37.0**

Consolidation (T 216)

Trimmings, Water Content, % **40.1**

	Initial	Final		Void Ratio	% Strain
Water Content, %	**41.39**	**29.05**	Pmin		
Dry Density, lbs/ft³	**81.351**	**95.963**	Pp		
Void Ratio	**1.13**	**0.807**	Pmax		
Saturation, %	**101.63**	**100**	Cc/C'c		

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth taken in tube, ft	3 In. U. Shear tons/ft²	3 In. Remold tons/ft²	6 In. U. Shear tons/ft²	6 In. Remold tons/ft²	Water Content, %	Description of Material Sampled at the Various Tube Depths
0.0-0.5	0.21	0	0.18	0	37.9	Alternating layers of light to dark grey clay, occasional black lines and spots, silt line at 3 in.
0.75-1.25	0.18	0	0.14	0	38.4	Alternating layers of light to dark grey clay, occasional black lines and spots, silt line at 12.5 in.
1.25-1.65	0.17	0	0.19	0	36.6	Alternating layers of light to dark grey clay, occasional black lines and spots, silt lines at 16.5, 18.5, and 19.5 in.
1.65-2.0	0.16	0	0.19	0	44.1	Alternating layers of light to dark grey clay, occasional black lines and spots, silt line at 22 in.

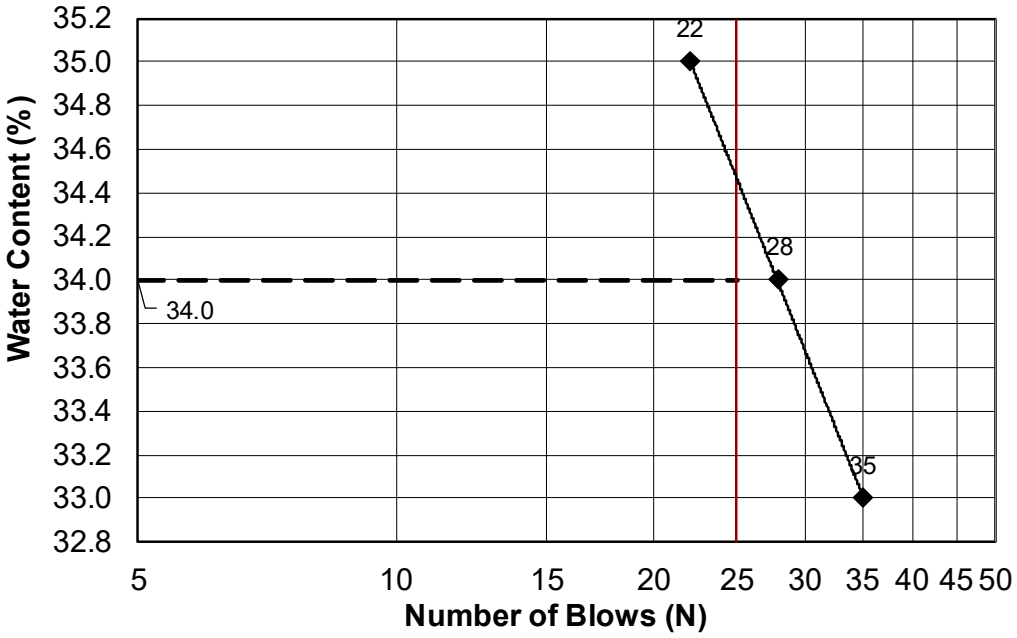
Comments:

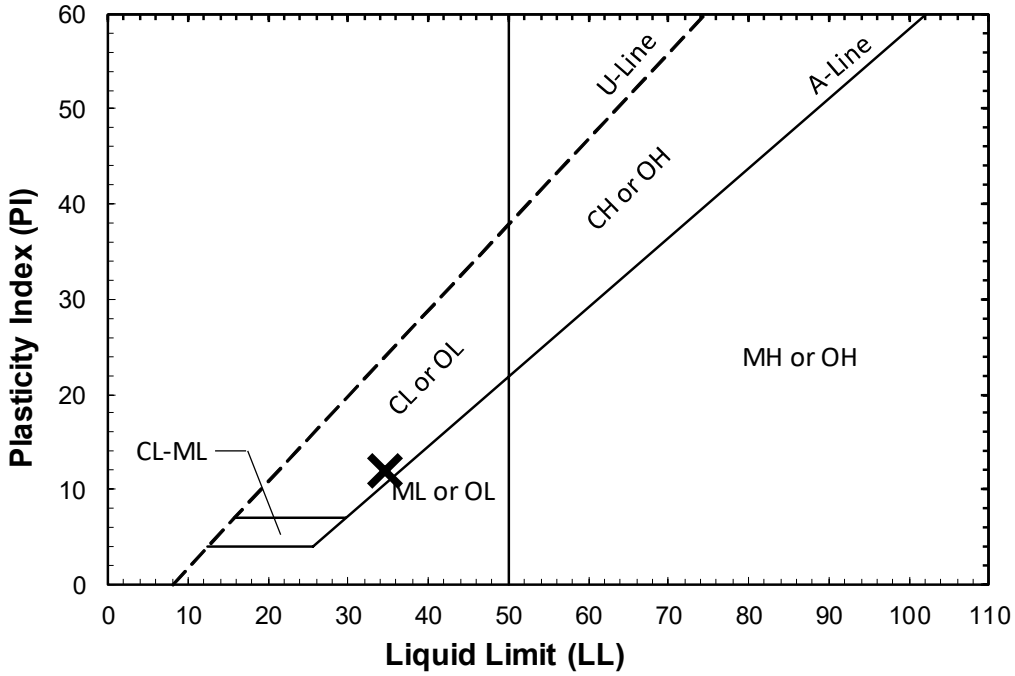
AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **9/15/2021**

Paper Copy: Lab File; Project File; Geotech File

TOWN	Gorham	Reference No.	340973
WIN	022238.00	Water Content, %	37
Sampled	5/26/2021	Liquid Limit @ 25 blows (T 89), %	35
Boring No./Sample No.	BB-GNR-102/1U	Plastic Limit (T 90), %	23
Station	5+94.4	Plasticity Index (T 90), %	12
Depth	30.5-32.5	Tested By	BBURR





MaineDOT

GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
340974	**BB-GNR-102/2U**	**GEOTECHNICAL (UNDISTURBED)**	**5/26/2021**	**6/8/2021**

Sample Type: **GEOTECHNICAL** Location: Station: **5+94.4** Offset, ft: **7.5** **LT** Dbfg, ft: **40.0-42.0**

WIN/Town **022238.00 - GORHAM** Sampler: **JAMES MANAHAN**

TEST RESULTS

Sieve Analysis (T 88)	
Wash Method	
SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	
½ in. [12.5 mm]	
⅜ in. [9.5 mm]	**100.0**
¼ in. [6.3 mm]	**99.1**
No. 4 [4.75 mm]	**99.0**
No. 10 [2.00 mm]	**98.9**
No. 20 [0.850 mm]	
No. 40 [0.425 mm]	**98.4**
No. 60 [0.250 mm]	
No. 100 [0.150 mm]	
No. 200 [0.075 mm]	**98.1**
[0.0224 mm]	**91.6**
[0.0151 mm]	**84.0**
[0.0090 mm]	**78.8**
[0.0066 mm]	**73.8**
[0.0048 mm]	**68.6**
[0.0025 mm]	**58.5**
[0.0011 mm]	**43.2**

Miscellaneous Tests	
Liquid Limit @ 25 blows (T 89), %	**32**
Plastic Limit (T 90), %	**21**
Plasticity Index (T 90), %	**11**
Specific Gravity, Corrected to 20°C (T 100)	**2.77**
Loss on Ignition, % (T 267)	
Water Content (T 265), %	**35.5**

Consolidation (T 216)

Trimmings, Water Content, % **38.3**

	Initial	Final		Void Ratio	% Strain
Water Content, %	**45.12**	**29.36**	Pmin		
Dry Density, lbs/ft³	**80.54**	**95.71**	Pp		
Void Ratio	**1.16**	**0.819**	Pmax		
Saturation, %	**108.34**	**100**	Cc/C'c		

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth taken in tube, ft	3 In. U. Shear tons/ft²	3 In. Remold tons/ft²	6 In. U. Shear tons/ft²	6 In. Remold tons/ft²	Water Content, %	Description of Material Sampled at the Various Tube Depths
0.0-0.5	0.2	0	0.19	0	40.7	Alternating layers of light to dark grey clay. Silt lines at 1", 1.25", 5.5". 0.75" concretion at 6.25".
0.8-1.3	0.22	0	0.16	0	38.9	Alternating layers of light to dark grey clay. Silt lines at 11", 12.5", 14.25". 1" concretion at 11.25". Shell fragments at 14.25".
1.3-1.8	0.2	0	0.19	0	39.9	Alternating layers of light to dark grey clay. Silt lines at 17", 17.75". Few very small shell fragments 19.25" to 20.25".
1.8-2.2	0.19	0	0.19	0	39.7	Alternating layers of light to dark grey clay. Silt lines at 23", 25". Few very small shell fragments 25" to 26".

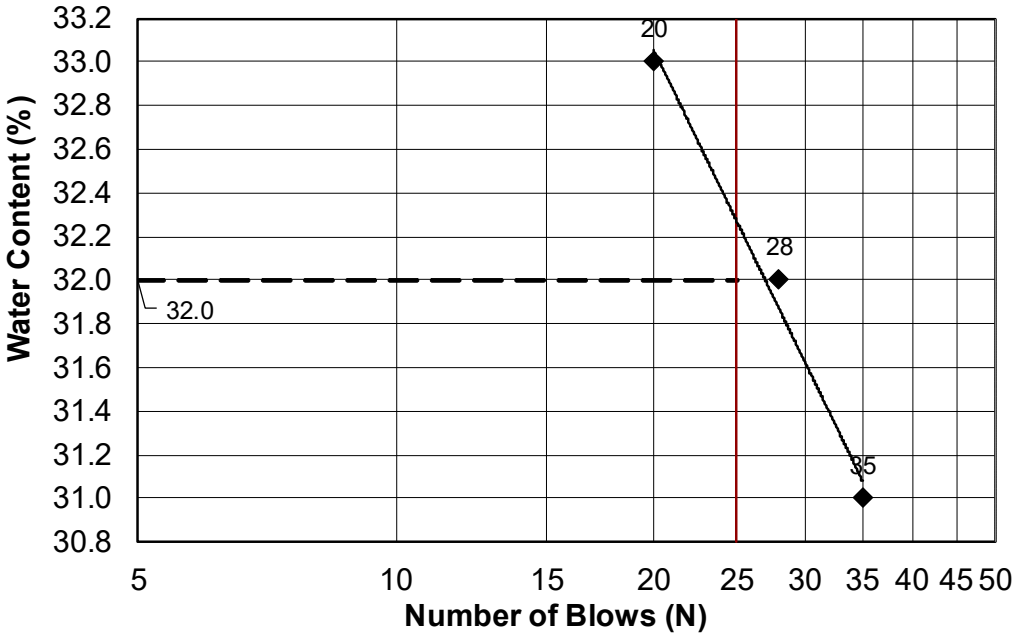
Comments:

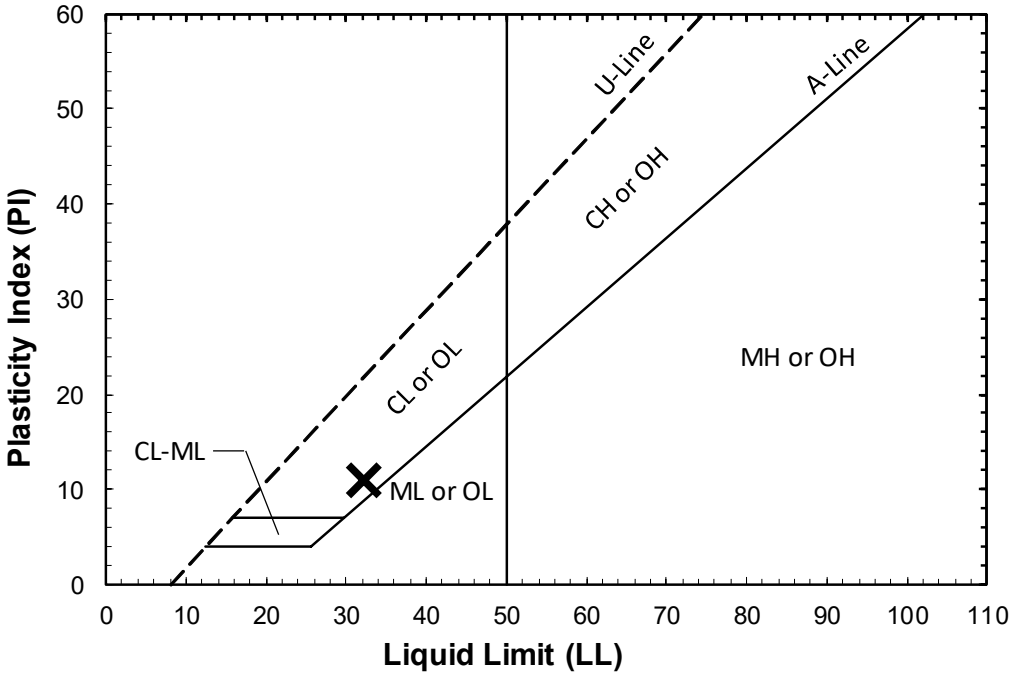
AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **9/15/2021**

Paper Copy: Lab File; Project File; Geotech File

TOWN	Gorham	Reference No.	340974
WIN	022238.00	Water Content, %	35.5
Sampled	5/26/2021	Liquid Limit @ 25 blows (T 89), %	32
Boring No./Sample No.	BB-GNR-102/2U	Plastic Limit (T 90), %	21
Station	5+94.4	Plasticity Index (T 90), %	11
Depth	40.0-42.0	Tested By	BBURR





MaineDOT

GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
340975	**BB-GNR-102/3U**	**GEOTECHNICAL (UNDISTURBED)**	**5/26/2021**	**6/8/2021**

Sample Type: **GEOTECHNICAL** Location: Station: **5+94.4** Offset, ft: **7.5** **LT** Dbfg, ft: **50.0-52.0**

WIN/Town **022238.00 - GORHAM** Sampler: **JAMES MANAHAN**

TEST RESULTS

Sieve Analysis (T 88)	
Wash Method	
SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	
½ in. [12.5 mm]	
⅜ in. [9.5 mm]	
¼ in. [6.3 mm]	
No. 4 [4.75 mm]	**100.0**
No. 10 [2.00 mm]	**99.9**
No. 20 [0.850 mm]	
No. 40 [0.425 mm]	**99.6**
No. 60 [0.250 mm]	
No. 100 [0.150 mm]	
No. 200 [0.075 mm]	**99.1**
[0.0224 mm]	**91.4**
[0.0151 mm]	**83.8**
[0.0092 mm]	**76.2**
[0.0067 mm]	**71.1**
[0.0050 mm]	**63.5**
[0.0026 mm]	**53.3**
[0.0012 mm]	**40.7**

Miscellaneous Tests	
Liquid Limit @ 25 blows (T 89), %	**30**
Plastic Limit (T 90), %	**20**
Plasticity Index (T 90), %	**10**
Specific Gravity, Corrected to 20°C (T 100)	**2.74**
Loss on Ignition, % (T 267)	
Water Content (T 265), %	**33.8**

Consolidation (T 216)

Trimmings, Water Content, % **37.3**

	Initial	Final		Void Ratio	% Strain
Water Content, %	**43.4**	**31.2**	Pmin		
Dry Density, lbs/ft³	**79.382**	**92.217**	Pp		
Void Ratio	**1.15**	**0.855**	Pmax		
Saturation, %	**102.99**	**100**	Cc/C'c		

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth taken in tube, ft	3 In.		6 In.		Water Content, %	Description of Material Sampled at the Various Tube Depths
	U. Shear tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		
0.0-0.5	0.24	0	0.21	0	35.0	Alternating layers of light to dark grey clay. Silt line with white residue 4" to 4.25".
0.625-1	0.17	0	0.14	0	40.7	Alternating layers of light to dark grey clay. Silt lines at 8.5", 10".
1-1.5	0.13	0	0.14	0	39.5	Alternating layers of light to dark grey clay. Silt lines at 12.25", 15.5", 16.5".
1.5-2	0.1	0	0.18	0	38.6	Alternating layers of light to dark grey clay. Silt lines at 18.75", 20.25", 22.5". 0.75" concretion at 23".

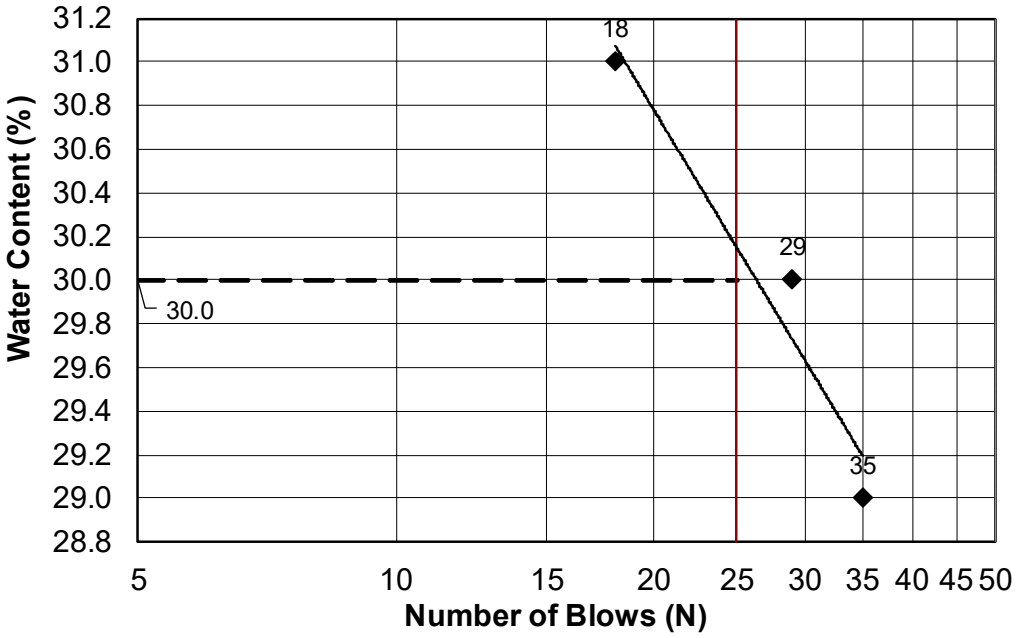
Comments:

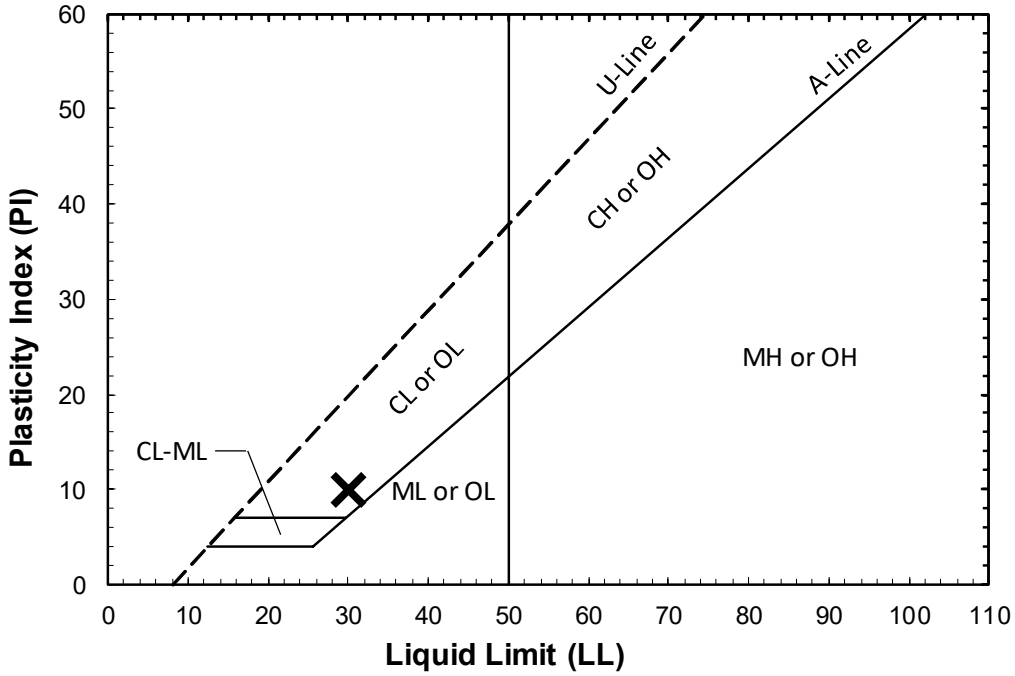
AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **9/15/2021**

Paper Copy: Lab File; Project File; Geotech File

TOWN	Gorham	Reference No.	340975
WIN	022238.00	Water Content, %	33.8
Sampled	5/26/2021	Liquid Limit @ 25 blows (T 89), %	30
Boring No./Sample No.	BB-GNR-102/3U	Plastic Limit (T 90), %	20
Station	5+94.4	Plasticity Index (T 90), %	10
Depth	50.0-52.0	Tested By	BBURR





MaineDOT

GEOTECHNICAL TEST REPORT
Central Laboratory

SAMPLE INFORMATION

Reference No.	Boring No./Sample No.	Sample Description	Sampled	Received
303114	**BB-GNR-102/8D**	**GEOTECHNICAL (DISTURBED)**	**5/26/2021**	**6/8/2021**

Sample Type: **GEOTECHNICAL** Location: Station: **5+94.4** Offset, ft: **7.5** **LT** Dbfg, ft: **65.0-67.0**

WIN/Town **022238.00 - GORHAM** Sampler: **JAMES MANAHAN**

TEST RESULTS

Sieve Analysis (T 88)	
Wash Method	
SIEVE SIZE U.S. [SI]	% Passing
3 in. [75.0 mm]	
1 in. [25.0 mm]	
¾ in. [19.0 mm]	
½ in. [12.5 mm]	
⅜ in. [9.5 mm]	
¼ in. [6.3 mm]	**100.0**
No. 4 [4.75 mm]	**99.9**
No. 10 [2.00 mm]	**99.8**
No. 20 [0.850 mm]	
No. 40 [0.425 mm]	**99.3**
No. 60 [0.250 mm]	
No. 100 [0.150 mm]	
No. 200 [0.075 mm]	**92.8**
[0.0281 mm]	**78.4**
[0.0181 mm]	**75.6**
[0.0106 mm]	**72.9**
[0.0077 mm]	**67.3**
[0.0056 mm]	**61.7**
[0.0028 mm]	**47.6**
[0.0013 mm]	**39.2**

Miscellaneous Tests	
Liquid Limit @ 25 blows (T 89), %	**34**
Plastic Limit (T 90), %	**22**
Plasticity Index (T 90), %	**12**
Specific Gravity, Corrected to 20°C (T 100)	**2.69**
Loss on Ignition, % (T 267)	
Water Content (T 265), %	**30.3**

Consolidation (T 216)

Trimmings, Water Content, %	

	Initial	Final		Void Ratio	% Strain
Water Content, %			Pmin		
Dry Density, lbs/ft³			Pp		
Void Ratio			Pmax		
Saturation, %			Cc/C'c		

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth taken in tube, ft	3 In.		6 In.		Water Content, %	Description of Material Sampled at the Various Tube Depths
	U. Shear tons/ft²	Remold tons/ft²	U. Shear tons/ft²	Remold tons/ft²		

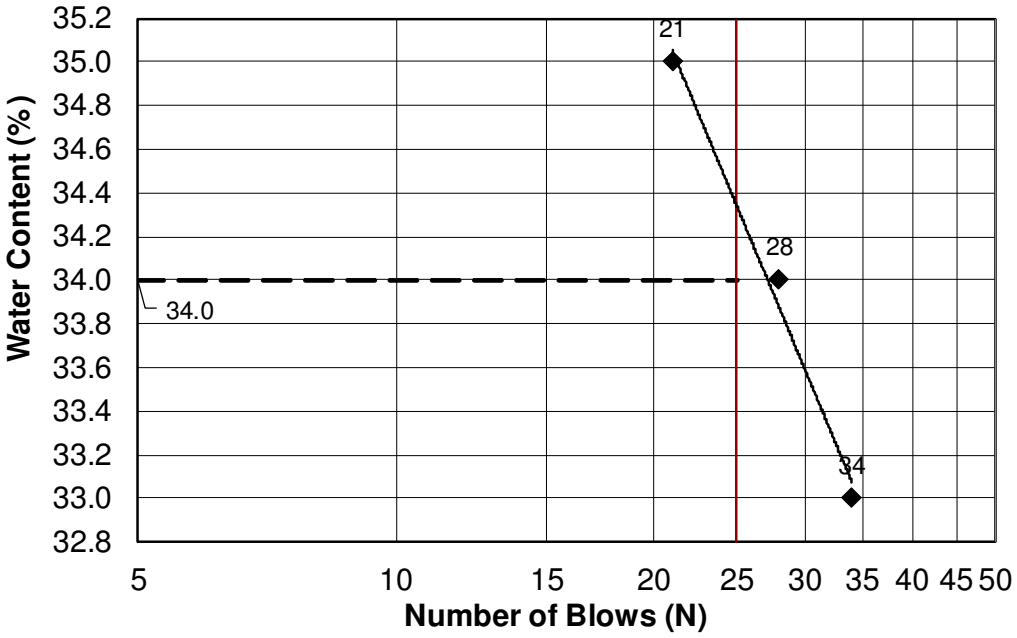
Comments:

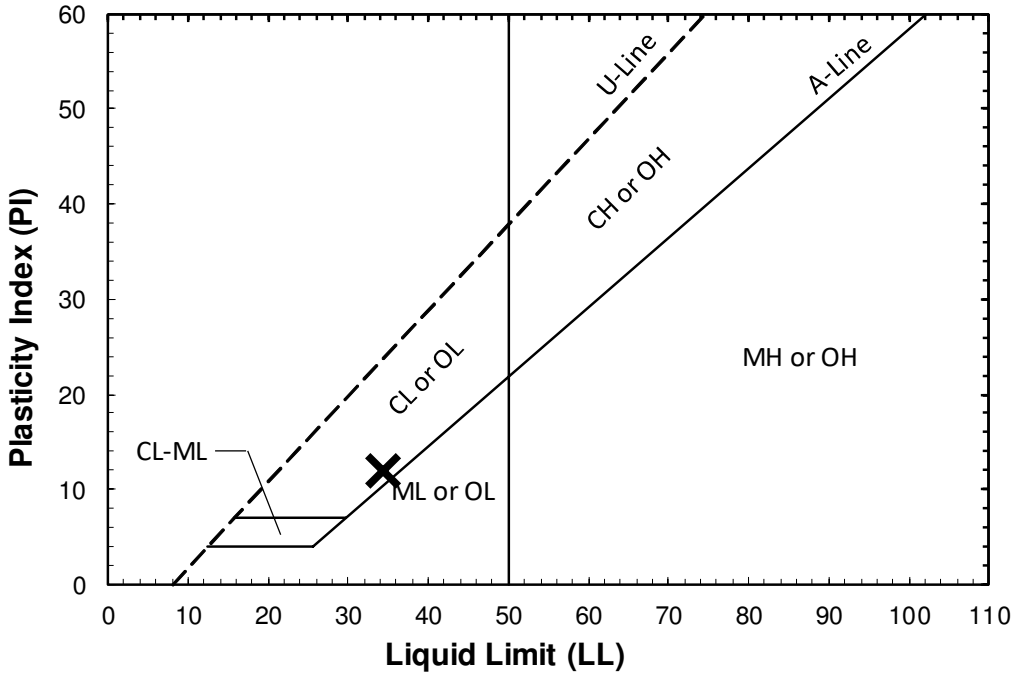
AUTHORIZATION AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE** Date Reported: **6/21/2021**

Paper Copy: Lab File; Project File; Geotech File

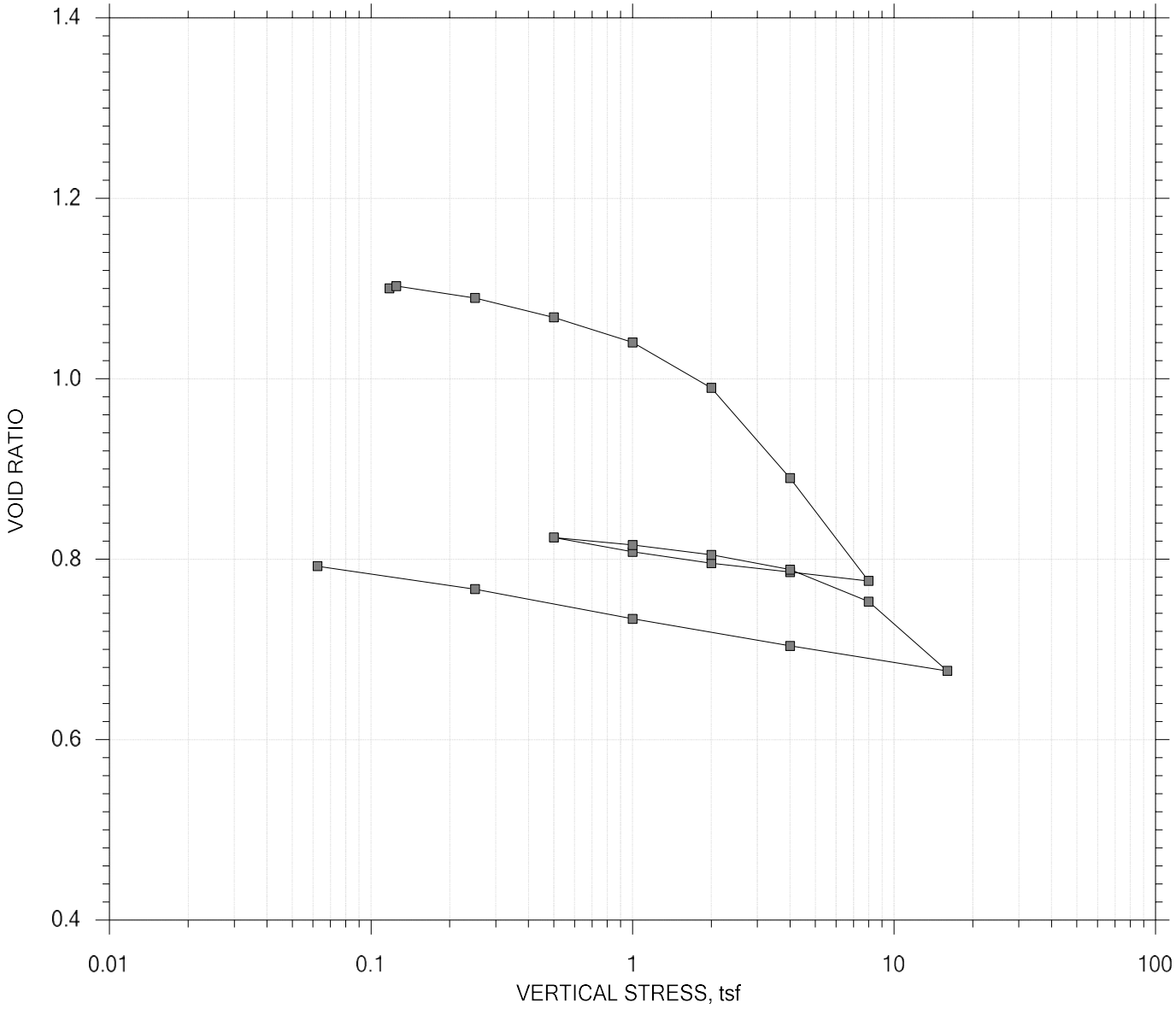
TOWN	Gorham	Reference No.	303114
WIN	022238.00	Water Content, %	30.3
Sampled	5/26/2021	Liquid Limit @ 25 blows (T 89), %	34
Boring No./Sample No.	BB-GNR-102/8D	Plastic Limit (T 90), %	22
Station	5+94.4	Plasticity Index (T 90), %	12
Depth	65.0-67.0	Tested By	BBURR





One-Dimensional Consolidation by ASTM D2435 - Method B

SUMMARY REPORT



					Before Test	After Test
Current Vertical Effective Stress: ---				Water Content, %	41.39	29.05
Preconsolidation Stress: ---				Dry Unit Weight, pcf	81.351	95.963
Compression Ratio: ---				Saturation, %	101.63	100.00
Diameter: 2.495 in		Height: 1.002 in		Void Ratio	1.13	0.81
LL: 35	PL: 23	PI: 12	GS: 2.78			

	Project: GORHAM	Location: --	Project No.: 22238.00
	Boring No.: BB-GNR-102/1U	Tested By: Greg Lidstone	Checked By: --
	Sample No.: --	Test Date: 8/6/2021	Test No.: 340973
	Depth: 30.5-32.5 FT	Sample Type: Intact	Elevation: --
	Description: Grey Clay		
	Remarks: Maine Sensitive Load/Unload/Reload/Unload Consolidation Test		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Project: GORHAM	Location: --	Project No.: 22238.00
Boring No.: BB-GNR-102/1U	Tested By: Greg Lidstone	Checked By: --
Sample No.: --	Test Date: 8/6/2021	Depth: 30.5-32.5 FT
Test No.: 340973	Sample Type: Intact	Elevation: --

Soil Description: Grey Clay
Remarks: Maine Sensitive Load/Unload/Reload/Unload Consolidation Test

Measured Specific Gravity: 2.78	Liquid Limit: 35	Specimen Diameter: 2.50 in
Initial Void Ratio: 1.13	Plastic Limit: 23	Initial Height: 1.00 in
Final Void Ratio: 0.807	Plasticity Index: 12	Final Height: 0.85 in

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	4	RING	RING+BASE	82
Wt. Container + Wet Soil, gm	111.77	410.01	397.10	199.52
Wt. Container + Dry Soil, gm	97.550	366.73	366.73	169.22
Wt. Container, gm	62.100	262.17	262.17	64.900
Wt. Dry Soil, gm	35.450	104.56	104.56	104.32
Water Content, %	40.11	41.39	29.05	29.05
Void Ratio	---	1.13	0.807	---
Degree of Saturation, %	---	101.63	100.00	---
Dry Unit Weight, pcf	---	81.351	95.963	---

One-Dimensional Consolidation by ASTM D2435 - Method B

Project: GORHAM
Boring No.: BB-GNR-102/1U
Sample No.: --
Test No.: 340973

Location: --
Tested By: Greg Lidstone
Test Date: 8/6/2021
Sample Type: Intact

Project No.: 22238.00
Checked By: --
Depth: 30.5-32.5 FT
Elevation: --

Soil Description: Grey Clay
Remarks: Maine Sensitive Load/Unload/Reload/Unload Consolidation Test

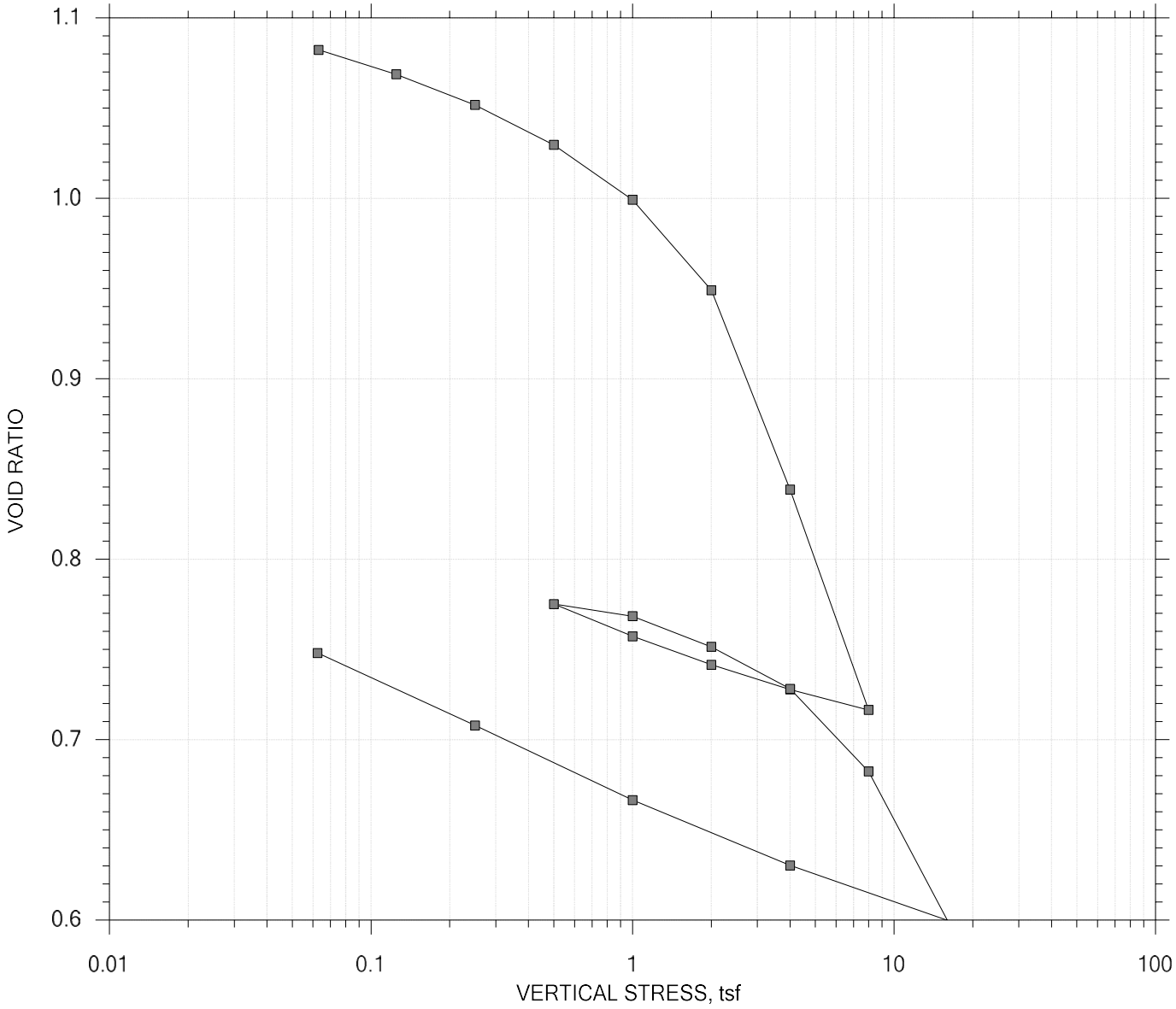
Displacement at End of Increment

	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt T90 min	Cv ft²/sec	Mv 1/tsf	k ft/day
1	0.118	0.01448	1.10	1.45	94.257	2.57e-007	1.23e-001	8.53e-005
2	0.125	0.01330	1.10	1.33	41.356	5.79e-007	-1.62e-001	-2.53e-004
3	0.250	0.01944	1.09	1.94	19.975	1.19e-006	4.90e-002	1.58e-004
4	0.500	0.02956	1.07	2.95	12.553	1.87e-006	4.04e-002	2.03e-004
5	1.00	0.04264	1.04	4.26	12.676	1.80e-006	2.61e-002	1.27e-004
6	2.00	0.06633	0.990	6.62	11.777	1.87e-006	2.37e-002	1.19e-004
7	4.00	0.1133	0.890	11.3	25.470	8.01e-007	2.35e-002	5.07e-005
8	8.00	0.1669	0.776	16.7	15.862	1.15e-006	1.34e-002	4.14e-005
9	4.00	0.1622	0.786	16.2	0.673	2.56e-005	1.16e-003	7.97e-005
10	2.00	0.1576	0.796	15.7	2.427	7.16e-006	2.31e-003	4.47e-005
11	1.00	0.1517	0.808	15.1	5.510	3.19e-006	5.86e-003	5.05e-005
12	0.500	0.1442	0.824	14.4	27.054	6.61e-007	1.49e-002	2.66e-005
13	1.00	0.1481	0.816	14.8	12.712	1.41e-006	7.74e-003	2.95e-005
14	2.00	0.1533	0.805	15.3	0.000	0.00e+000	5.16e-003	0.00e+000
15	4.00	0.1609	0.789	16.1	4.178	4.19e-006	3.82e-003	4.31e-005
16	8.00	0.1776	0.753	17.7	5.619	3.02e-006	4.17e-003	3.40e-005
17	16.0	0.2137	0.676	21.3	8.012	1.99e-006	4.50e-003	2.41e-005
18	4.00	0.2007	0.704	20.0	2.316	6.68e-006	1.08e-003	1.95e-005
19	1.00	0.1866	0.734	18.6	8.033	1.99e-006	4.71e-003	2.53e-005
20	0.250	0.1712	0.767	17.1	45.941	3.61e-007	2.05e-002	2.00e-005
21	0.0625	0.1592	0.792	15.9	0.000	0.00e+000	6.39e-002	0.00e+000

	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/sec	Mv 1/tsf	k ft/day	Ca %
1	0.118	0.01448	1.10	1.45	0.000	0.00e+000	1.23e-001	0.00e+000	0.00e+000
2	0.125	0.01330	1.10	1.33	0.000	0.00e+000	-1.62e-001	-0.00e+000	0.00e+000
3	0.250	0.01944	1.09	1.94	3.589	1.54e-006	4.90e-002	2.04e-004	0.00e+000
4	0.500	0.02956	1.07	2.95	5.435	1.00e-006	4.04e-002	1.09e-004	0.00e+000
5	1.00	0.04264	1.04	4.26	2.126	2.50e-006	2.61e-002	1.76e-004	0.00e+000
6	2.00	0.06633	0.990	6.62	0.000	0.00e+000	2.37e-002	0.00e+000	0.00e+000
7	4.00	0.1133	0.890	11.3	0.000	0.00e+000	2.35e-002	0.00e+000	0.00e+000
8	8.00	0.1669	0.776	16.7	4.407	9.60e-007	1.34e-002	3.46e-005	0.00e+000
9	4.00	0.1622	0.786	16.2	0.158	2.53e-005	1.16e-003	7.89e-005	0.00e+000
10	2.00	0.1576	0.796	15.7	0.000	0.00e+000	2.31e-003	0.00e+000	0.00e+000
11	1.00	0.1517	0.808	15.1	0.000	0.00e+000	5.86e-003	0.00e+000	0.00e+000
12	0.500	0.1442	0.824	14.4	0.000	0.00e+000	1.49e-002	0.00e+000	0.00e+000
13	1.00	0.1481	0.816	14.8	1.825	2.28e-006	7.74e-003	4.77e-005	0.00e+000
14	2.00	0.1533	0.805	15.3	1.158	3.56e-006	5.16e-003	4.96e-005	0.00e+000
15	4.00	0.1609	0.789	16.1	0.000	0.00e+000	3.82e-003	0.00e+000	0.00e+000
16	8.00	0.1776	0.753	17.7	0.996	3.96e-006	4.17e-003	4.45e-005	0.00e+000
17	16.0	0.2137	0.676	21.3	2.105	1.76e-006	4.50e-003	2.14e-005	0.00e+000
18	4.00	0.2007	0.704	20.0	0.000	0.00e+000	1.08e-003	0.00e+000	0.00e+000
19	1.00	0.1866	0.734	18.6	0.000	0.00e+000	4.71e-003	0.00e+000	0.00e+000
20	0.250	0.1712	0.767	17.1	12.319	3.13e-007	2.05e-002	1.73e-005	0.00e+000
21	0.0625	0.1592	0.792	15.9	0.000	0.00e+000	6.39e-002	0.00e+000	0.00e+000

One-Dimensional Consolidation by ASTM D2435 - Method B

SUMMARY REPORT



					Before Test	After Test
Current Vertical Effective Stress: ---				Water Content, %	45.12	29.36
Preconsolidation Stress: ---				Dry Unit Weight, pcf	80.54	95.71
Compression Ratio: ---				Saturation, %	108.34	100.00
Diameter: 2.495 in		Height: 1 in		Void Ratio	1.16	0.82
LL: 32	PL: 21	PI: 11	GS: 2.79			

	Project: GORHAM	Location: --	Project No.: 22238.00
	Boring No.: BB-GNR-102/2U	Tested By: Greg Lidstone	Checked By: --
	Sample No.: --	Test Date: 8/13/2021	Test No.: 340974
	Depth: 40.0-42.0 FT	Sample Type: Intact	Elevation: --
	Description: Grey Clay		
	Remarks: Maine Sensitive Load/Unload/Reload/Unload Consolidation Test		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Project: GORHAM	Location: --	Project No.: 22238.00
Boring No.: BB-GNR-102/2U	Tested By: Greg Lidstone	Checked By: --
Sample No.: --	Test Date: 8/13/2021	Depth: 40.0-42.0 FT
Test No.: 340974	Sample Type: Intact	Elevation: --

Soil Description: Grey Clay
Remarks: Maine Sensitive Load/Unload/Reload/Unload Consolidation Test

Estimated Specific Gravity: 2.79	Liquid Limit: 32	Specimen Diameter: 2.50 in
Initial Void Ratio: 1.16	Plastic Limit: 21	Initial Height: 1.00 in
Final Void Ratio: 0.819	Plasticity Index: 11	Final Height: 0.84 in

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	203	RING	RING	227
Wt. Container + Wet Soil, gm	105.14	412.17	395.88	196.52
Wt. Container + Dry Soil, gm	93.810	365.53	365.53	166.22
Wt. Container, gm	64.230	262.17	262.17	63.020
Wt. Dry Soil, gm	29.580	103.36	103.36	103.20
Water Content, %	38.30	45.12	29.36	29.36
Void Ratio	---	1.16	0.819	---
Degree of Saturation, %	---	108.34	100.00	---
Dry Unit Weight, pcf	---	80.540	95.710	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

One-Dimensional Consolidation by ASTM D2435 - Method B

Project: GORHAM | Location: -- | Project No.: 22238.00
Boring No.: BB-GNR-102/2U | Tested By: Greg Lidstone | Checked By: --
Sample No.: -- | Test Date: 8/13/2021 | Depth: 40.0-42.0 FT
Test No.: 340974 | Sample Type: Intact | Elevation: --

Soil Description: Grey Clay
Remarks: Maine Sensitive Load/Unload/Reload/Unload Consolidation Test

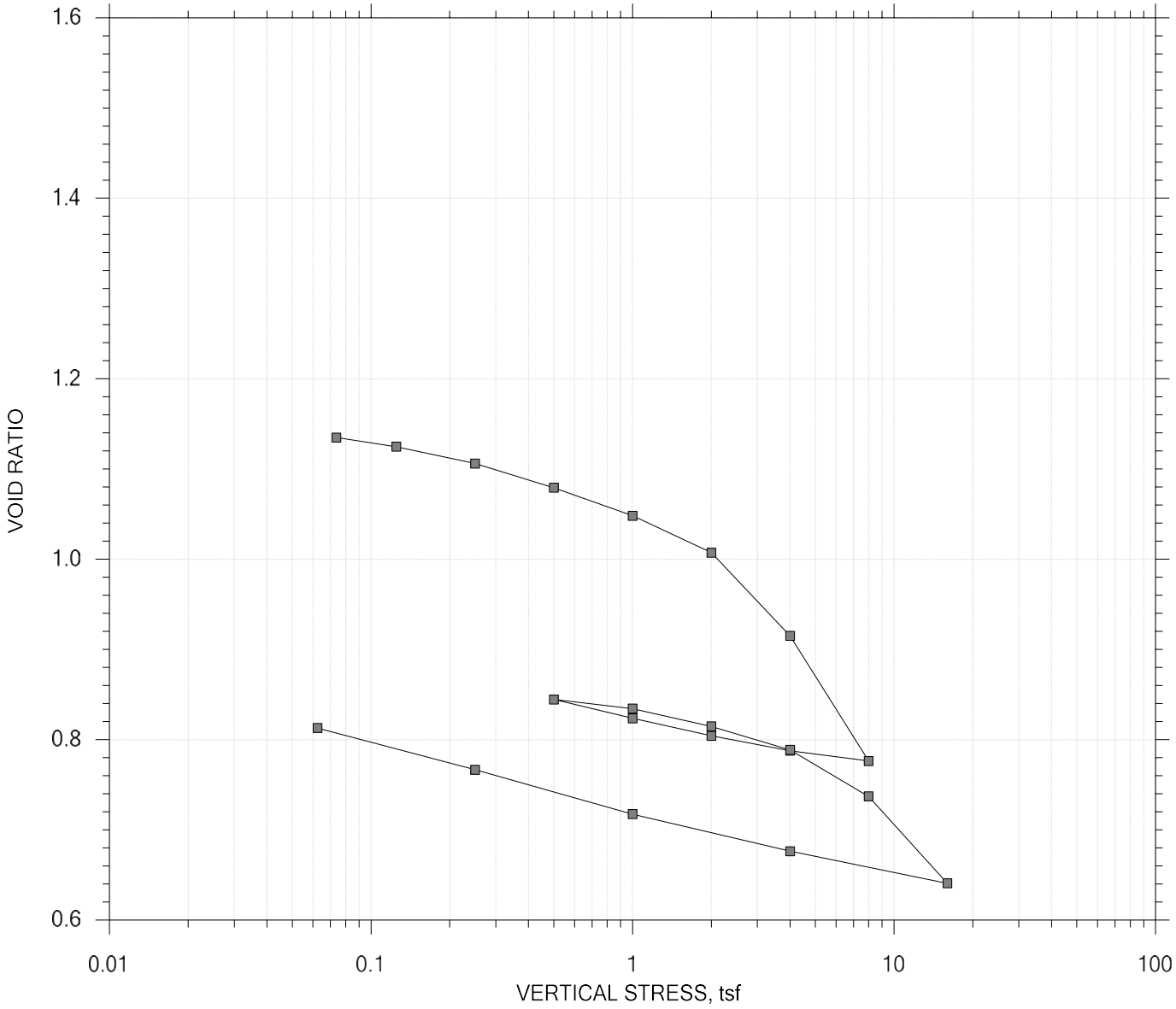
Displacement at End of Increment

	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt T90 min	Cv ft²/sec	Mv 1/tsf	k ft/day
1	0.0630	0.03650	1.08	3.65	24.805	9.53e-007	5.79e-001	1.49e-003
2	0.125	0.04275	1.07	4.27	56.920	3.98e-007	1.01e-001	1.08e-004
3	0.250	0.05061	1.05	5.06	33.918	6.57e-007	6.29e-002	1.12e-004
4	0.500	0.06084	1.03	6.08	21.919	9.98e-007	4.09e-002	1.10e-004
5	1.00	0.07495	0.999	7.49	11.475	1.86e-006	2.82e-002	1.41e-004
6	2.00	0.09810	0.949	9.81	12.536	1.63e-006	2.32e-002	1.02e-004
7	4.00	0.1492	0.839	14.9	18.841	1.00e-006	2.56e-002	6.90e-005
8	8.00	0.2058	0.716	20.6	18.998	8.74e-007	1.41e-002	3.33e-005
9	4.00	0.2005	0.728	20.1	3.597	4.33e-006	1.32e-003	1.54e-005
10	2.00	0.1941	0.742	19.4	6.062	2.61e-006	3.18e-003	2.23e-005
11	1.00	0.1869	0.757	18.7	13.288	1.21e-006	7.27e-003	2.37e-005
12	0.500	0.1786	0.775	17.9	39.351	4.16e-007	1.66e-002	1.86e-005
13	1.00	0.1817	0.768	18.2	5.066	3.26e-006	6.25e-003	5.48e-005
14	2.00	0.1896	0.751	19.0	10.683	1.52e-006	7.86e-003	3.23e-005
15	4.00	0.2003	0.728	20.0	8.468	1.88e-006	5.38e-003	2.73e-005
16	8.00	0.2216	0.682	22.2	10.179	1.50e-006	5.30e-003	2.15e-005
17	16.0	0.2597	0.600	26.0	16.165	8.75e-007	4.77e-003	1.13e-005
18	4.00	0.2456	0.630	24.6	1.879	7.29e-006	1.18e-003	2.31e-005
19	1.00	0.2289	0.667	22.9	16.819	8.49e-007	5.58e-003	1.28e-005
20	0.250	0.2097	0.708	21.0	66.260	2.26e-007	2.56e-002	1.56e-005
21	0.0625	0.1911	0.748	19.1	221.064	7.10e-008	9.91e-002	1.90e-005

	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/sec	Mv 1/tsf	k ft/day	Ca %
1	0.0630	0.03650	1.08	3.65	0.000	0.00e+000	5.79e-001	0.00e+000	0.00e+000
2	0.125	0.04275	1.07	4.27	10.415	5.05e-007	1.01e-001	1.37e-004	0.00e+000
3	0.250	0.05061	1.05	5.06	0.000	0.00e+000	6.29e-002	0.00e+000	0.00e+000
4	0.500	0.06084	1.03	6.08	4.841	1.05e-006	4.09e-002	1.16e-004	0.00e+000
5	1.00	0.07495	0.999	7.49	4.307	1.15e-006	2.82e-002	8.75e-005	0.00e+000
6	2.00	0.09810	0.949	9.81	4.114	1.16e-006	2.32e-002	7.22e-005	0.00e+000
7	4.00	0.1492	0.839	14.9	0.000	0.00e+000	2.56e-002	0.00e+000	0.00e+000
8	8.00	0.2058	0.716	20.6	0.000	0.00e+000	1.41e-002	0.00e+000	0.00e+000
9	4.00	0.2005	0.728	20.1	0.000	0.00e+000	1.32e-003	0.00e+000	0.00e+000
10	2.00	0.1941	0.742	19.4	1.130	3.25e-006	3.18e-003	2.78e-005	0.00e+000
11	1.00	0.1869	0.757	18.7	0.000	0.00e+000	7.27e-003	0.00e+000	0.00e+000
12	0.500	0.1786	0.775	17.9	0.000	0.00e+000	1.66e-002	0.00e+000	0.00e+000
13	1.00	0.1817	0.768	18.2	0.000	0.00e+000	6.25e-003	0.00e+000	0.00e+000
14	2.00	0.1896	0.751	19.0	2.414	1.57e-006	7.86e-003	3.32e-005	0.00e+000
15	4.00	0.2003	0.728	20.0	2.155	1.71e-006	5.38e-003	2.49e-005	0.00e+000
16	8.00	0.2216	0.682	22.2	2.314	1.53e-006	5.30e-003	2.19e-005	0.00e+000
17	16.0	0.2597	0.600	26.0	2.522	1.30e-006	4.77e-003	1.68e-005	0.00e+000
18	4.00	0.2456	0.630	24.6	0.531	6.00e-006	1.18e-003	1.90e-005	0.00e+000
19	1.00	0.2289	0.667	22.9	0.000	0.00e+000	5.58e-003	0.00e+000	0.00e+000
20	0.250	0.2097	0.708	21.0	0.000	0.00e+000	2.56e-002	0.00e+000	0.00e+000
21	0.0625	0.1911	0.748	19.1	0.000	0.00e+000	9.91e-002	0.00e+000	0.00e+000

One-Dimensional Consolidation by ASTM D2435 - Method B

SUMMARY REPORT



					Before Test	After Test
Current Vertical Effective Stress: ---				Water Content, %	43.40	31.20
Preconsolidation Stress: ---				Dry Unit Weight, pcf	79.382	92.217
Compression Ratio: ---				Saturation, %	102.99	100.00
Diameter: 2.495 in		Height: 1 in		Void Ratio	1.15	0.85
LL: 30	PL: 20	PI: 10	GS: 2.74			

	Project: GORHAM	Location: --	Project No.: 22238.00
	Boring No.: BB-GNR-102/3U	Tested By: Greg Lidstone	Checked By: --
	Sample No.: --	Test Date: 8/17/2021	Test No.: 340975
	Depth: 50.0-52.0 FT	Sample Type: Intact	Elevation: --
	Description: Grey Clay		
	Remarks: Maine Sensitive Load/Unload/Reload/Unload Consolidation Test		
	Displacement at End of Increment		

One-Dimensional Consolidation by ASTM D2435 - Method B

Project: GORHAM	Location: --	Project No.: 22238.00
Boring No.: BB-GNR-102/3U	Tested By: Greg Lidstone	Checked By: --
Sample No.: --	Test Date: 8/17/2021	Depth: 50.0-52.0 FT
Test No.: 340975	Sample Type: Intact	Elevation: --

Soil Description: Grey Clay
Remarks: Maine Sensitive Load/Unload/Reload/Unload Consolidation Test

Estimated Specific Gravity: 2.74	Liquid Limit: 30	Specimen Diameter: 2.50 in
Initial Void Ratio: 1.15	Plastic Limit: 20	Initial Height: 1.00 in
Final Void Ratio: 0.855	Plasticity Index: 10	Final Height: 0.86 in

	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	32	RING	RING+BASE	40
Wt. Container + Wet Soil, gm	100.15	408.36	395.92	195.01
Wt. Container + Dry Soil, gm	86.570	364.12	364.12	163.27
Wt. Container, gm	50.140	262.19	262.19	61.540
Wt. Dry Soil, gm	36.430	101.93	101.93	101.73
Water Content, %	37.28	43.40	31.20	31.20
Void Ratio	---	1.15	0.855	---
Degree of Saturation, %	---	102.99	100.00	---
Dry Unit Weight, pcf	---	79.382	92.217	---

One-Dimensional Consolidation by ASTM D2435 - Method B

Project: GORHAM
Boring No.: BB-GNR-102/3U
Sample No.: --
Test No.: 340975

Location: --
Tested By: Greg Lidstone
Test Date: 8/17/2021
Sample Type: Intact

Project No.: 22238.00
Checked By: --
Depth: 50.0-52.0 FT
Elevation: --

Soil Description: Grey Clay
Remarks: Maine Sensitive Load/Unload/Reload/Unload Consolidation Test

Displacement at End of Increment

	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt T90 min	Cv ft²/sec	Mv 1/tsf	k ft/day
1	0.0737	0.009261	1.13	0.926	129.840	1.87e-007	1.26e-001	6.35e-005
2	0.125	0.01394	1.12	1.39	75.220	3.19e-007	9.12e-002	7.85e-005
3	0.250	0.02261	1.11	2.26	31.296	7.56e-007	6.93e-002	1.41e-004
4	0.500	0.03505	1.08	3.50	13.567	1.71e-006	4.97e-002	2.29e-004
5	1.00	0.04948	1.05	4.95	17.600	1.28e-006	2.88e-002	9.96e-005
6	2.00	0.06848	1.01	6.85	10.958	1.98e-006	1.90e-002	1.02e-004
7	4.00	0.1113	0.915	11.1	17.592	1.16e-006	2.14e-002	6.67e-005
8	8.00	0.1757	0.776	17.6	28.853	6.25e-007	1.61e-002	2.71e-005
9	4.00	0.1704	0.788	17.0	2.404	6.99e-006	1.32e-003	2.49e-005
10	2.00	0.1627	0.804	16.3	4.618	3.69e-006	3.85e-003	3.83e-005
11	1.00	0.1537	0.824	15.4	21.093	8.25e-007	8.99e-003	2.00e-005
12	0.500	0.1440	0.845	14.4	47.866	3.72e-007	1.94e-002	1.94e-005
13	1.00	0.1487	0.835	14.9	12.678	1.41e-006	9.36e-003	3.57e-005
14	2.00	0.1579	0.815	15.8	14.454	1.22e-006	9.20e-003	3.02e-005
15	4.00	0.1700	0.789	17.0	8.859	1.94e-006	6.03e-003	3.15e-005
16	8.00	0.1939	0.737	19.4	12.117	1.36e-006	5.97e-003	2.19e-005
17	16.0	0.2386	0.641	23.9	17.851	8.45e-007	5.59e-003	1.27e-005
18	4.00	0.2221	0.676	22.2	2.186	6.66e-006	1.37e-003	2.46e-005
19	1.00	0.2030	0.718	20.3	12.158	1.25e-006	6.37e-003	2.15e-005
20	0.250	0.1801	0.767	18.0	88.614	1.81e-007	3.05e-002	1.49e-005
21	0.0625	0.1587	0.813	15.9	195.931	8.65e-008	1.14e-001	2.66e-005

	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft²/sec	Mv 1/tsf	k ft/day	Ca %
1	0.0737	0.009261	1.13	0.926	0.000	0.00e+000	1.26e-001	0.00e+000	0.00e+000
2	0.125	0.01394	1.12	1.39	0.000	0.00e+000	9.12e-002	0.00e+000	0.00e+000
3	0.250	0.02261	1.11	2.26	0.000	0.00e+000	6.93e-002	0.00e+000	0.00e+000
4	0.500	0.03505	1.08	3.50	0.000	0.00e+000	4.97e-002	0.00e+000	0.00e+000
5	1.00	0.04948	1.05	4.95	4.559	1.15e-006	2.88e-002	8.93e-005	0.00e+000
6	2.00	0.06848	1.01	6.85	3.956	1.28e-006	1.90e-002	6.54e-005	0.00e+000
7	4.00	0.1113	0.915	11.1	0.000	0.00e+000	2.14e-002	0.00e+000	0.00e+000
8	8.00	0.1757	0.776	17.6	0.000	0.00e+000	1.61e-002	0.00e+000	0.00e+000
9	4.00	0.1704	0.788	17.0	0.000	0.00e+000	1.32e-003	0.00e+000	0.00e+000
10	2.00	0.1627	0.804	16.3	1.857	2.14e-006	3.85e-003	2.22e-005	0.00e+000
11	1.00	0.1537	0.824	15.4	0.000	0.00e+000	8.99e-003	0.00e+000	0.00e+000
12	0.500	0.1440	0.845	14.4	11.178	3.70e-007	1.94e-002	1.93e-005	0.00e+000
13	1.00	0.1487	0.835	14.9	2.482	1.68e-006	9.36e-003	4.23e-005	0.00e+000
14	2.00	0.1579	0.815	15.8	4.450	9.19e-007	9.20e-003	2.28e-005	0.00e+000
15	4.00	0.1700	0.789	17.0	2.200	1.81e-006	6.03e-003	2.95e-005	0.00e+000
16	8.00	0.1939	0.737	19.4	4.206	9.08e-007	5.97e-003	1.46e-005	0.00e+000
17	16.0	0.2386	0.641	23.9	4.472	7.84e-007	5.59e-003	1.18e-005	0.00e+000
18	4.00	0.2221	0.676	22.2	0.865	3.91e-006	1.37e-003	1.45e-005	0.00e+000
19	1.00	0.2030	0.718	20.3	0.000	0.00e+000	6.37e-003	0.00e+000	0.00e+000
20	0.250	0.1801	0.767	18.0	0.000	0.00e+000	3.05e-002	0.00e+000	0.00e+000
21	0.0625	0.1587	0.813	15.9	0.000	0.00e+000	1.14e-001	0.00e+000	0.00e+000

APPENDIX E – CALCULATIONS

GZA
GeoEnvironmental, Inc.
707 Sable Oaks Drive, Suite 150
South Portland, ME 04106
(207) 879-9190
http://www.gza.com

Engineers and Scientists

JOB Mitchell Bridge No. 0216

SHEET NO

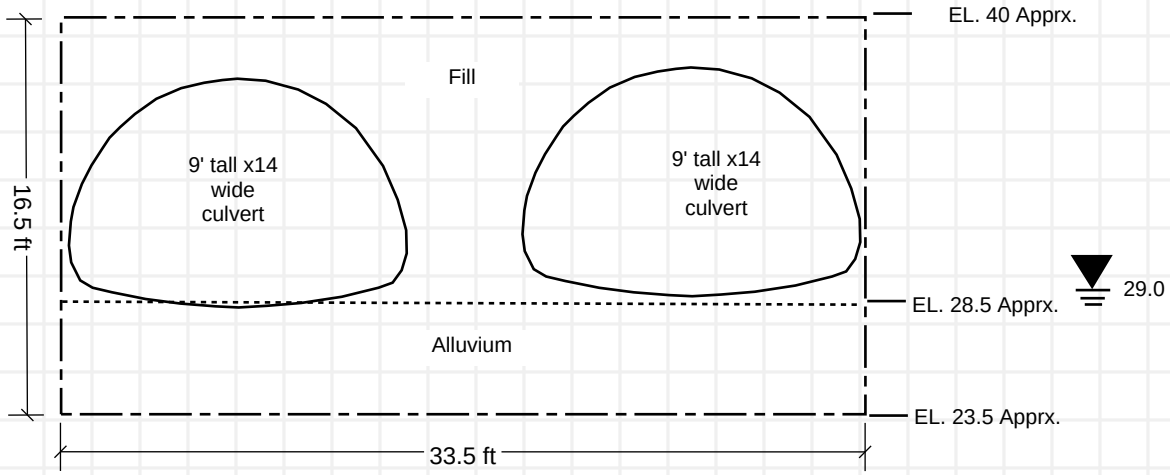
Calculated By B.Cardali Date August 22, 2024

Checked By C.Snow Date August 22, 2024

Scale

Objective: Calculate the net pressure from the existing culverts and the proposed culvert at the elevation of the bottom of the proposed bearing pad.

Existing Culvert Sketch and Pressure Calculation:



Area of an existing culvert = (pi x r_1 x r_2)/4 = (3.14 x 9' x14')/4 = 99 SF

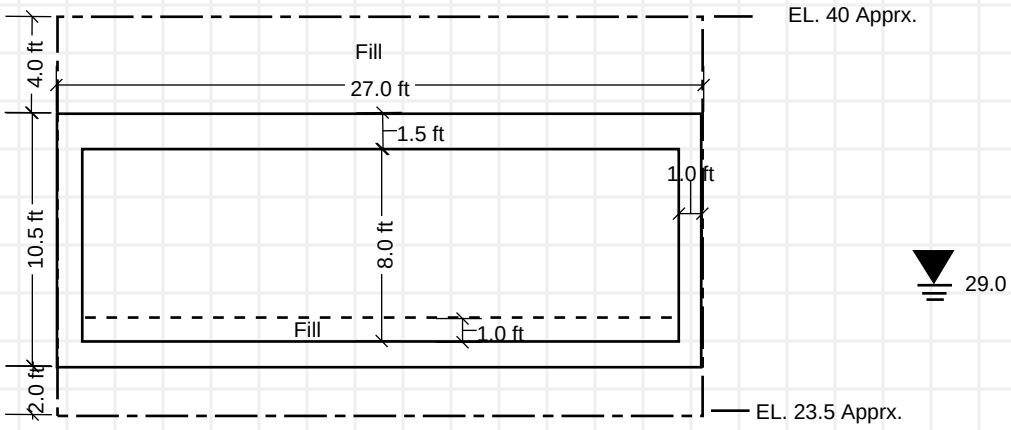
Two culverts total area = 99 SF x 2 = 198 SF

Soil Box = (16.5' x 33.5') - 198 SF = 354.75 SF

Average Unit Weight of Soil = (11' x 125 pcf) + [5.5' x (120 pcf - 62.4 pcf)]/16.5' = 102.5 pcf

Effective Stress at EL. 23.5 = (354.75 SF x 102.5 pcf)/33.5' = 1086 psf

Proposed Box Culvert Sketch and Pressure Calculation:



Area of open box culvert = 8' x 25' = 200 sf

Weight of Concrete = [2 (26+8.75) x 1 x150 pcf] 27 feet = 386 psf

Weight of Fill above, Fill in, and Crushed Stone below box = (4' x 125 pcf) + (1' x (125 pcf - 62.4pcf)) + (2' x (130 pcf - 62.4pcf)) = 698 psf

Weight of Concrete and Soil = 386 psf + 698 psf = 1084 psf

Conclusion:

The net pressure at the based of the proposed culvert is equal to existing, therefore consolidation of the underlying clay is anticipated to be negligible under the proposed box culvert .

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SUBJECT: Footings Bearing on Alluvial sand/ Marine Clay (Culvert)
SHEET: 1 OF 9
CALCULATED BY B. Cardali 9/18/2024
CHECKED BY C. Snow 9/18/2024

Objective

Calculate soil bearing resistance for a culvert bearing on naturally deposited alluvium - sand above a marine clay deposit for a sand over a weaker cohesive soil. Evaluate strength and service bearing resistance at the top of the clay. Additionally check bearing resistance of the upper sand for punching failure into the clay.

References

1. American Association of State Highway and Transportation Officials, AASHTO LRFD Bridge Design Specifications: Customary U.S. Units, 9th edition, 2020, (AASHTO LRFD), Articles 10.5.5.2.2 and 10.6.3.1.
2. Terzaghi, Peck & Mesri, Soil Mechanics in Engineering Practice, Third Edition, 1996.

Soil Properties and Geotechnical Inputs for Underlying Marine Clay

$\phi_f := 0deg$ Internal friction angle of cohesionless soil of underlying clay

$\phi_b := 0.45$ Bearing resistance factor as specified in Table 10.5.5.2.2-1 (Theoretical Method, SPT Data, Strength Limit, Spread Footing)

$c := .8ksf$ Cohesion of the Marine Clay (base) below the upper sand, taken as undrained shear strength

$\gamma := 120pcf$ Unit weight of soil above or below the bearing depth of the footing

$N_c := 5.14$ Cohesion term bearing capacity factor as specified in Table 10.6.3.1.2a-1

$N_q := 1$ Surcharge term bearing capacity factor as specified in Table 10.6.3.1.2a-1

$N_\gamma := 0$ Total unit weight term bearing capacity factor as specified in Table 10.6.3.1.2a-1

$C_{wq}, C_{w\gamma}$:= Correction factors to account for the location of the groundwater table as specified in Table 10.6.3.1.2a-2

Depth to water table at or below depth of footing (D_f) $C_{wq} := 0.5$ $C_{w\gamma} := 0.5$

Methodology

Utilize AASHTO equation C10.6.3.1.2f-1 to calculate the nominal bearing resistance of a sand over a weaker clay layer. Per 10.6.3.1.2, the nominal bearing resistance of the clay should be calculated assuming a "fictitious" footing of the same dimensions is supported directly on the weaker deposit. The calculated nominal resistance of the weaker layer is then used in equation 10.6.3.1.2f-1. Additionally, the bearing of the upper sand layer should be check for resistance of punching shear into the underlying marine clay layer.

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JOB: 09.0026220.00 Mitchell Bridge
SUBJECT: Footings Bearing on Alluvial sand/ Marine Clay (Culvert)
SHEET: 2 OF 9
CALCULATED BY B. Cardali 9/18/2024
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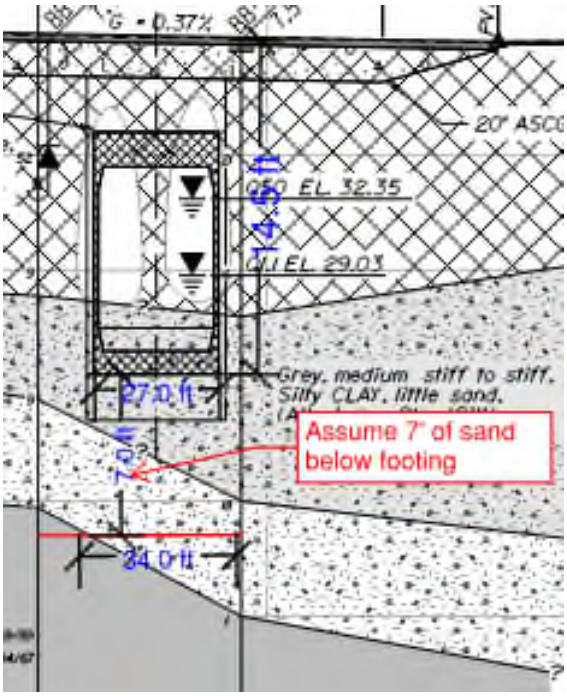
Footing Dimensions

$B_{1.max} := 42 \cdot ft$ Maximum Footing Width (Plans show a 27' wide culvert, 7 feet to top of clay) Use width of 27 feet at top of clay

$B_1 := 22 \cdot ft, 27 \cdot ft .. B_{1.max}$ Range of effective footing widths considered (includes eccentricity)

$L_1 := 73ft$ Length of culvert Base

$D_f := 21.5ft$ Footing embedment depth (top of clay)



Strength Limit Design

$q_n = cN_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5 \gamma B N_{\gamma m} C_{w\gamma}$ Nominal Bearing Resistance Formula

$q.D = \phi_b \times q_n$ Factored Bearing Resistance Formula

Correction Factors

$d_{qtable}(B_1) := \frac{D_f}{B_1}$ $d_{qtable}(B_1)$ Using Table 10.6.3.1.2a-4 $d_q := 1$ dq assumed soil above footing less competent than soil below footing.

$s_c(B_1) := 1 + \left(\frac{B_1}{L_1}\right)\left(\frac{N_q}{N_c}\right)$ $s_q(B_1) := 1 + \left(\frac{B_1}{L_1}\tan(\phi_f)\right)$ $s_\gamma(B_1) := 1 - 0.4\left(\frac{B_1}{L_1}\right)$

$s_c(B_1) =$	$s_q(B_1) =$	$s_\gamma(B_1) =$
1.06	1	0.88
1.07	1	0.85
1.09	1	0.82
1.1	1	0.8
1.11	1	0.77

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JOB: 09.0026220.00 Mitchell Bridge
SUBJECT: Footings Bearing on Alluvial sand/ Marine Clay (Culvert)
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Bearing Capacity Factors

$N_{cm}(B_1) := N_c \cdot s_c(B_1)$ $N_{cm}(B_1) =$

5.44
5.51
5.58
5.65
5.72

$N_{qm}(B_1) := N_q \cdot s_q(B_1) \cdot d_q$ $N_{qm}(B_1) =$

1
1
1
1
1

$N_{\gamma m}(B_1) := N_\gamma \cdot s_\gamma(B_1)$ $N_{\gamma m}(B_1) =$

0
0
0
0
0

Nominal Bearing Resistance

$$q_n(B_1) := \overrightarrow{\left(c \cdot N_{cm}(B_1) + \gamma \cdot D_f \cdot N_{qm}(B_1) \cdot C_{wq} + 0.5 \cdot \gamma \cdot B_1 \cdot N_{\gamma m}(B_1) \cdot C_{w\gamma}\right)}$$

$q_n(B_1) =$

5.6	·ksf
5.7	
5.8	
5.8	
5.9	

Check nominal bearing resistance using AASHTO equation C10.6.3.1.2f-1

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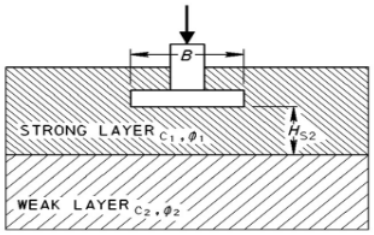
$q_b := 5.7 \cdot ksf$ Nominal bearing resistance of a a fictitious footing of the same dimensions (27 feet wide by 73 feet long) but supported directly on the lower layer surface. (Calculated above)

$H_{s2} := 7 \cdot ft$ Distance to top of clay below bottom of footing (thickness of sand layer)

$B := 27 \cdot ft$ Width of culvert base

$L_1 = 73 \cdot ft$ Length of culvert base

$$q_{n.layered} := q_b \cdot e^{0.67 \cdot \left(1 + \frac{B}{L_1}\right) \cdot \left(\frac{H_{s2}}{B}\right)} = 7.2 \cdot ksf$$ AASHTO Equation C.10.6.3.1.2f-1



(b)

Figure 10.6.3.1.2e-1—Two-Layer Soil Profiles

Factored Bearing Resistance - Strength Limit State

$q_D := \phi_b \cdot q_{n.layered} = 3.3\,ksf$

GZA recommends the use of the nominal bearing resistance of 7.2 ksf and a factored bearing resistance of 3.3 ksffor design.

Service Limit Design

GZA calculated the proposed and existing effective stress at the proposed culvert base elevation (see calculation in Appendix E) and concluded that the proposed construction will result in a net zero increase in bearing pressure. Therefore, GZA anticipates settlement will be limited to elastic settlement during construction.

AASHTO provides Table C10.6.2.5.1-1 (attached) of presumptive bearing resistances of spread footings when a settlement limited bearing resistance is required. This table may be used with sufficient knowledge of the geological conditions present at the site.

Type of Bearing Material	Consistency in Place	Bearing Resistance (ksf)	
		Ordinary Range	Recommended Value
Homogeneous Inorganic clay, sandy or silty clay (CL,CH)	Medium dense to dense	2 - 6	3.3

Check Nominal Bearing Resistance of Upper Sand

$\phi_{f.s} := 30deg$ Internal friction angle of cohesionless soil above weaker deposit

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$\phi_b = 0.45$ Bearing resistance factor as specified in Table 10.5.5.2.2-1 (Theoretical Method, SPT Data, Strength Limit, Spread Footing)

$c_s := 0ksf$ Cohesion of the upper sand, taken as undrained shear strength

$\gamma_s := 120pcf$ Unit weight of soil above or below the bearing depth of the footing

$N_{c.s} := 30.1$ Cohesion term bearing capacity factor as specified in Table 10.6.3.1.2a-1

$N_{q.s} := 18.4$ Surcharge term bearing capacity factor as specified in Table 10.6.3.1.2a-1

$N_{\gamma.s} := 22.4$ Total unit weight term bearing capacity factor as specified in Table 10.6.3.1.2a-1

$D_{f.s} := 14.5ft$ Footing embedment depth

Strength Limit Design for Sand Layer

Correction Factors

$d_{qtable.s}(B_1) := \frac{D_{f.s}}{B_1}$ $d_{qtable.s}(B_1)$ Using Table 10.6.3.1.2a-4 $d_q := 1$ dq assumed soil above footing less competent than soil below footing.

$s_{c.s}(B_1) := 1 + \left(\frac{B_1}{L_1}\right)\left(\frac{N_{q.s}}{N_{c.s}}\right)$ $s_{q.s}(B_1) := 1 + \left(\frac{B_1}{L_1}\tan(\phi_{f.s})\right)$ $s_{\gamma.s}(B_1) := 1 - 0.4\left(\frac{B_1}{L_1}\right)$

$s_c(B_1) =$

1.06
1.07
1.09
1.1
1.11

$s_q(B_1) =$

1
1
1
1
1

$s_\gamma(B_1) =$

0.88
0.85
0.82
0.8
0.77

Bearing Capacity Factors

$N_{cm.s}(B_1) := N_{c.s} \cdot s_{c.s}(B_1)$ $N_{cm.s}(B_1) =$

35.65
36.91
38.17
39.43
40.69

$N_{qm.s}(B_1) := N_{q.s} \cdot s_{q.s}(B_1) \cdot d_q$ $N_{qm.s}(B_1) =$

21.6
22.3
23.1
23.8
24.5

$N_{\gamma m.s}(B_1) := N_{\gamma.s} \cdot s_{\gamma.s}(B_1)$

$N_{\gamma m.s}(B_1) =$

19.7
19.1
18.5
17.9
17.2

Nominal Bearing Resistance

$q_{n.s}(B_1) := \left(c_s \cdot N_{cm.s}(B_1) + \gamma_s \cdot D_{f.s} \cdot N_{qm.s}(B_1) \cdot C_{wq} + 0.5 \cdot \gamma_s \cdot B_1 \cdot N_{\gamma m.s}(B_1) \cdot C_{w\gamma}\right)$

$q_{n.s}(B_1) =$

31.8	·ksf
34.9	
37.8	
40.5	
43.1	

Since the nominal bearing resistance ofthe upper sand is greater than the underlying clay. The bearing resistance ofthe lower clay controls.

Conclusion

GZA recommends a nominal bearing resistance of 7.2 ksf and a factored bearing resistance of 3.3 ksf based on a resistance factor of .45. Considering GZA's experience with the alluvial sand at the site and the underlying presumpscot formation clay, GZA recommends utilizing a service bearing resistance of 3.3 ksf, based on a a homogeneous inorganic clay, sandy or silty clay (CL,CH) that is medium stiff.

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SUBJECT: Footings Bearing on Alluvial sand/ Marine Clay (Culvert)
SHEET: 7 OF 9
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Table C10.6.2.5.1-1—Presumptive Bearing Resistance for Spread Footing Foundations at the Service Limit State Modified after U.S. Department of the Navy (1982)

Type of Bearing Material	Consistency in Place	Bearing Resistance (ksf)	
		Ordinary Range	Recommended Value of Use
Massive crystalline igneous and metamorphic rock: granite, diorite, basalt, gneiss, thoroughly cemented conglomerate (sound condition allows minor cracks)	Very hard, sound rock	120–200	160
Foliated metamorphic rock: slate, schist (sound condition allows minor cracks)	Hard sound rock	60–80	70
Sedimentary rock: hard cemented shales, siltstone, sandstone, limestone without cavities	Hard sound rock	30–50	40
Weathered or broken bedrock of any kind, except highly argillaceous rock (shale)	Medium hard rock	16–24	20
Compaction shale or other highly argillaceous rock in sound condition	Medium hard rock	16–24	20
Well-graded mixture of fine- and coarse-grained soil: glacial till, hardpan, boulder clay (GW-GC, GC, SC)	Very dense	16–24	20
Gravel, gravel-sand mixture, boulder-gravel mixtures (GW, GP, SW, SP)	Very dense Medium dense to dense Loose	12–20 8–14 4–12	14 10 6
Coarse to medium sand, and with little gravel (SW, SP)	Very dense Medium dense to dense Loose	8–12 4–8 2–6	8 6 3
Fine to medium sand, silty or clayey medium to coarse sand (SW, SM, SC)	Very dense Medium dense to dense Loose	6–10 4–8 2–4	6 5 3
Fine sand, silty or clayey medium to fine sand (SP, SM, SC)	Very dense Medium dense to dense Loose	6–10 4–8 2–4	6 5 3
Homogeneous inorganic clay, sandy or silty clay (CL, CH)	Very dense Medium dense to dense Loose	6–12 2–6 1–2	8 4 1
Inorganic silt, sandy or clayey silt, varved silt-clay-fine sand (ML, MH)	Very stiff to hard Medium stiff to stiff Soft	4–8 2–6 1–2	6 3 1

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SHEET: 8 OF 9
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Table 10.6.3.1.2a-1—Bearing Capacity Factors N_c (Prandtl, 1921), N_q (Reissner, 1924), and N_γ (Vesic, 1975)

ϕ_f	N_c	N_q	N_γ	ϕ_f	N_c	N_q	N_γ
0	5.14	1.0	0.0	23	18.1	8.7	8.2
1	5.4	1.1	0.1	24	19.3	9.6	9.4
2	5.6	1.2	0.2	25	20.7	10.7	10.9
3	5.9	1.3	0.2	26	22.3	11.9	12.5
4	6.2	1.4	0.3	27	23.9	13.2	14.5
5	6.5	1.6	0.5	28	25.8	14.7	16.7
6	6.8	1.7	0.6	29	27.9	16.4	19.3
7	7.2	1.9	0.7	30	30.1	18.4	22.4
8	7.5	2.1	0.9	31	32.7	20.6	26.0
9	7.9	2.3	1.0	32	35.5	23.2	30.2
10	8.4	2.5	1.2	33	38.6	26.1	35.2
11	8.8	2.7	1.4	34	42.2	29.4	41.1
12	9.3	3.0	1.7	35	46.1	33.3	48.0
13	9.8	3.3	2.0	36	50.6	37.8	56.3
14	10.4	3.6	2.3	37	55.6	42.9	66.2
15	11.0	3.9	2.7	38	61.4	48.9	78.0
16	11.6	4.3	3.1	39	67.9	56.0	92.3
17	12.3	4.8	3.5	40	75.3	64.2	109.4
18	13.1	5.3	4.1	41	83.9	73.9	130.2
19	13.9	5.8	4.7	42	93.7	85.4	155.6
20	14.8	6.4	5.4	43	105.1	99.0	186.5
21	15.8	7.1	6.2	44	118.4	115.3	224.6
22	16.9	7.8	7.1	45	133.9	134.9	271.8

Table 10.6.3.1.2a-2—Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

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SUBJECT: Footings Bearing on Alluvial sand/ Marine Clay (Culvert)
SHEET: 9 OF 9
CALCULATED BY B. Cardali 9/18/2024
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Table 10.6.3.1.2a-3—Shape Correction Factors s_c, s_γ, s_q

Factor	Friction Angle	Cohesion Term (s_c)	Unit Weight Term (s_γ)	Surcharge Term (s_q)
Shape Factors s_c, s_γ, s_q	$\phi_f = 0$	$1+\left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1+\left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$	$1-0.4\left(\frac{B}{L}\right)$	$1+\left(\frac{B}{L}\tan\phi_f\right)$

Table 10.6.3.1.2a-4—Depth Correction Factor d_q

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The depth correction factor should be used only when the soils above the footing bearing elevation are as competent as the soils beneath the footing level; otherwise, the depth correction factor should be taken as 1.0.

Linear interpolations may be made for friction angles in between those values shown in Table 10.6.3.1.2a-4.

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JOB: 09.0026220.00 Mitchell Bridge
SUBJECT: Lateral Earth Pressures
SHEET: 1 OF 1
CALCULATED BY B.Cardali 9/20/2024
CHECKED BY S.Snow 9/20/24

Subject:

Evaluate lateral earth pressure coefficients for a precast box culvert walls, inlet and outlet head walls and in-line wingwalls.

References:

1. MaineDOT Bridge Design Guide, Chapter 3
2. AASHTO LRFD Bridge Design Specifications, 9th Edition (2020)
3. U.S. Army Corps of Engineers Engineer Manual 1110-2-2502, Retaining and Flood Walls

Input Parameters:

$\phi := 32deg$ Effective angle of internal friction *(Granular borrow, Soil Type 4, BDG Table 3-3)*

$\delta_f := 19.5deg$ Average value, precast concrete against clean sand/silty sand-gravel mixture *(AASHTO LRFD Table 3.11.5.3-1)*

$\beta := 26.6deg$ Angle of backfill to the horizontal (2H:1V Backfill Slope behind unsupported in-line wingwalls)

$\theta := 90 \cdot deg$ Angle of back face of wall to the horizontal

Earth Pressure Coefficients:

Outlet Walls Fixed to Box Culvert:

Assume translation and rotation of culvert with inlet and outlet walls is inadequate to achieve active earth pressure. Therefore, design for at-rest earth pressure.

$K_o := 1 - \sin(\phi) = 0.47$ At-rest Earth Pressure Coefficient

Outlet Walls free to rotate:

The earth pressure is applied to a plane extending vertically up from the heel of the wall base, and the weight of the soil on the inside of the vertical plane is considered as part of the wall weight. The failure sliding surface is not restricted by the top of the wall or back face of wall. Use Rankine theory for active earth pressure.

For unsupported culvert walls extending beyond the box, with horizontal backslope:

$$K_{ar} := \tan\left(45deg - \frac{\phi}{2}\right)^2 \qquad K_{ar} = 0.31$$

For a sloped 2H:1V backfill:

$$K_{ar} := \cos(\beta) \cdot \frac{\left[\cos(\beta) - \sqrt{(\cos(\beta))^2 - (\cos(\phi))^2}\right]}{\left[\cos(\beta) + \sqrt{(\cos(\beta))^2 - (\cos(\phi))^2}\right]}$$

$K_{ar} = 0.46$

March 2014

Figure 5-1 Maine Design Freezing Index Map

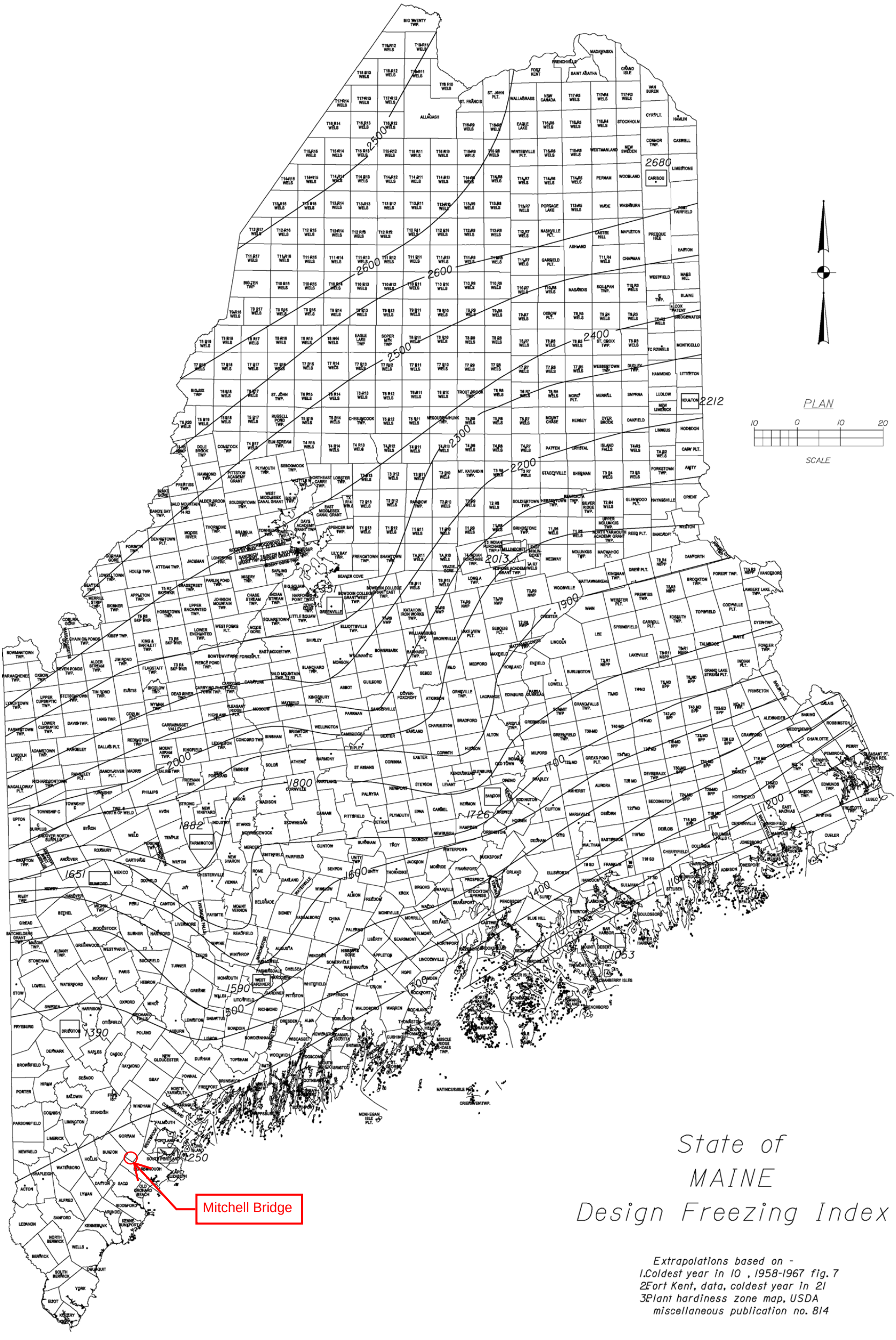

Table 5-1 Depth of Frost Penetration

Design Freezing Index	Frost Penetration (in)					
	Coarse Grained			Fine Grained		
	w=10%	w=20%	w=30%	w=10%	w=20%	w=30%
1000	66.3	55.0	47.5	47.1	40.7	36.9
1100	69.8	57.8	49.8	49.6	42.7	38.7
1200	73.1	60.4	52.0	51.9	44.7	40.5
1300	76.3	63.0	54.3	54.2	46.6	42.2
1400	79.2	65.5	56.4	56.3	48.5	43.9
1500	82.1	67.9	58.4	58.3	50.2	45.4
1600	84.8	70.2	60.3	60.2	51.9	46.9
1700	87.5	72.4	62.3	62.2	53.5	48.4
1800	90.1	74.5	64.0	64.0	55.1	49.8
1900	92.6	76.6	65.7	65.8	56.7	51.1
2000	95.1	78.7	67.5	67.6	58.2	52.5
2100	97.6	80.7	69.2	69.3	59.7	53.8
2200	100.0	82.6	70.8	71.0	61.1	55.1
2300	102.3	84.5	72.4	72.7	62.5	56.4
2400	104.6	86.4	74.0	74.3	63.9	57.6
2500	106.9	88.2	75.6	75.9	65.2	58.8
2600	109.1	89.9	77.1	77.5	66.5	60.0

1275

60.9" = 5.1'

Notes: 1. w = water content
2. Where the Freezing Index and/or water content is between the presented values, linear interpretation may be used to determine the frost penetration.

Granular and fine grained materials anticipated near the abutment bearing elevations have an average water content of 10 percent of coarse grained materials and fine grained materials near the abutment have an average water content of 20 percent. Based on the MaineDOT BDG, Section 5.2.1 and a Freezing index of 1,275 the estimated depth of frost penetration is 61 inches or 5.1 feet.