

GEOTECHNICAL DESIGN REPORT

Meadow Brook Bridge Culvert Replacement BRIDGE NO. 5856 MAINE DOT WIN 026442.00 Vassalboro, MAINE

November 2024 09.0026222.00

Prepared for: Maine Department of Transportation Augusta, Maine

Prepared by: GZA GeoEnvironmental, Inc.

707 Sable Oaks Drive | Suite 150 | South Portland, Maine 04106 207.879.9190

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VIA EMAIL

November 18, 2024 File No. 09.0026222.00

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

Re: Geotechnical Design Report Meadow Brook Bridge No. 5856 Culvert Replacement Bog Road over Meadow Brook Maine Department of Transportation WIN 026442.00 Vassalboro, Maine

Dear Laura:

We are pleased to provide this Geotechnical Design Report, which includes geotechnical design recommendations for the replacement of Meadow Brook Bridge Culvert, Bog Road over Meadow Brook in Vassalboro, Maine. Our work was completed in accordance with GZA GeoEnvironmental, Inc.'s (GZA's) August 19, 2020, Multi-PIN contract number 20200603000000000709 with the Maine Department of Transportation (MaineDOT) Bridge Program and Assignment Letter No. 15 dated February 5, 2024 for WIN 026442.00, 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

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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 Meadow Brook Bridge No. 5856 Culvert in Vassalboro, Maine. Our work was completed in accordance with GZA GeoEnvironmental, Inc.'s (GZA's) August 19, 2020, Multi-PIN contract number 2020060300000000709 with the Maine Department of Transportation (MaineDOT) Bridge Program and Assignment Letter No. 15 dated February 5, 2024 for WIN 026442.00, and the attached *Limitations* contained in **Appendix A** of this report.

1.1 BACKGROUND

The project includes the replacement of Meadow Brook Bridge No. 5856 carrying Bog Road over Meadow Brook in Vassalboro, Maine, the location of which is shown in **Figure 1**. The bridge was originally constructed in 1911 and consists of a 16-foot-long, single span structure consisting of a cast-in-place deck slab bearing on stone masonry abutments capped with concrete. The original plans do not show the bearing elevation but indicate that the foundations were to be carried down to a solid foundation. In 1960, it was widened to its current width and the original railing was replaced with a concrete curb and W-beam guardrails. These were replaced again in 2005, with patching done to the bridge's wearing surface. Recent inspections have shown that the condition of the bridge is structurally deficient. The wearing surface has transverse and longitudinal cracking. The bridge deck portion that consists of the original 1911 slab has numerous areas of deterioration and exposed rebar. The widened portion of the deck from 1960 has areas of exposed rebar and spalling.

We understand plans are to construct a new 64-foot-long box culvert with a span of 17 feet and a rise of 7 feet. The culvert will have a sheet of waterproofing membrane lining the top, separating it from the subbase. 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 have 12 inches of special fill placed above the concrete base to create a natural streambed. The typical 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. 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 bridge replacement. To meet these objectives, GZA completed the following Scope of Services:

- Reviewed the results of two test borings and laboratory testing results 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 bearing resistance of 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

Two test borings were drilled and logged by MaineDOT between November 14 and 15, 2022 at the locations shown on **Figure 2, Boring Location Plan & Interpretive Subsurface Profile**. Boring BB-VMB-101 was drilled in the southwest portion of the existing bridge, through the bridge deck, in front of the abutment and BB-VMB-102 was drilled on the northeast approach, behind the existing abutment. The test borings were drilled using a CME-45C drill rig to depths ranging from approximately 25 to 32 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 typical 5-foot intervals. Sampling was completed 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 0.906. 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. One thin-walled tube sample was collected in BB-VMB-101 to provide a sample for use in laboratory compressibility testing. Approximately 10 feet of bedrock core was obtained in the borings 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:

- Seven (7) gradation analysis with hydrometer / MaineDOT Frost Classification / Unified Soil Classification System (USCS) assessments;
- Four (4) sets of Atterberg Limits;
- Seven (7) moisture content tests; and
- One (1) 1-dimensional consolidation (compressibility) test.



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

4.0 SUBSURFACE CONDITIONS

4.1 SURFICIAL AND BEDROCK GEOLOGY

Based on available geologic mapping¹, the surficial unit in the vicinity of the bridge consists of Wetland Deposit, which is described as peat, muck, silt, and clay in poorly drained areas. An Esker deposit is mapped just south of the site and is described as sand and gravel deposited by glacial meltwater streams and Till, which consists of a poorly sorted, stratified mixture of sand, silt, and gravel-sized rock debris. Presumpscot Formation is mapped to the north and east of the bridge and described as glaciomarine silt, clay, and sand deposited on the late-glacial sea floor. The Presumpscot Formation includes an underlying ice-contact sediment, which is describes as areas of sand and gravel deposited as eskers and glaciomarine fans.

Bedrock mapping² in the vicinity of the site shows the bridge is mapped as the Mayflower Hill Formation. The Mayflower Hill Formation is described as thickly bedded metasandstone to very fine-grained quartzo-feldspathic schist. Furthermore, the bedrock can be medium dark grey to black fine to very fine-grained quartzo-feldspathic metawacke and very fine-grained quartz-plagioclase-biotite schist.

4.2 SUBSURFACE PROFILE

Four soil units were encountered in the test borings below surficial asphalt and above bedrock: Fill, Alluvium, Marine Clay, and Glacial Outwash. Approximately five 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 on **Figure 2**.

¹ Syverson, Kent M., and Mans, David P., 2015, Surficial geology of the China Lake quadrangle, Maine: Maine Geological Survey, Open-File Map 15-18, map, scale 1:24,000. Maine Geological Survey Maps. 2033. http://digitalmaine.com/mgs_maps/2033

² Pollock, Stephen G., and Bowdoin, Wyeth., 2011, Bedrock geology of the China Lake quadrangle, Maine: Maine Geological Survey, Open-File Map 11-148, color map, scale 1:24,000. Maine Geological Survey Maps. 49. http://digitalmaine.com/mgs_maps/49



		GENERALIZED SUBSURFACE CONDITIONS
Subsurface Unit	Approximate Encountered Thickness (ft)	Generalized Description
Fill	9	Variable from: brown, gravelly SAND and GRAVEL to: Olive-grey, stiff, Silty Clay, some sand, little gravel, trace wood organics (USCS: SP-SM, SM, CL). MaineDOT Frost Classification = 0-IV Encountered in BB-VMB-102 only, located on the approach.
Alluvium	1	Olive-grey, wet, fine to coarse SAND, some gravel, little silt, (USCS: SM, SP-SM) Encountered in BB-VMB-101 only, located in streambed
Marine Clay	6 to 8	Light grey to dark grey, wet, very soft to medium stiff, Silty CLAY, trace sand, layer of wood organics noted in upper samples (USCS: CL) MaineDOT Frost Classification = III-IV Encountered in both borings.
Glacial Outwash	6 to 7	Variable from: Light grey, medium dense, Silty SAND, trace gravel to: Dark grey, medium dense, GRAVEL, little fine to coarse sand, trace silt, trace clay (USCS: SM, GP-GM) Encountered in both borings.
Top of Bedrock Elevation		Approximately El. 146.4 to 145.8 (25.4 to 32.4 feet bgs)

4.2.1 Bedrock

Bedrock was cored in both test borings. Bedrock was described as hard, very fine to medium-grained, light to dark grey, METAWACKE. Joints are closely spaced, fresh and open. Additionally, bedrock included quartz/calcite stringers, and brecciated zones. The Rock Quality Designation in the core runs ranged from 20 to 83 percent, indicating very poor to good quality rock.

4.2.2 Groundwater

The groundwater level was measured in both BB-VMB-101 and -102 to be 4.7 feet bgs, which corresponds to El. 156.7 and 163.5. We note that these observations were made during drilling and may therefore have been influenced by drilling activities. Fluctuations in groundwater levels will occur due to variations in season, precipitation, brook 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 horizontal to 1 vertical (2H:1V) or flatter.

We anticipate that the embankments will be reconstructed over loose to medium dense Fill overlying stiff to soft Marine Clay. Due to the embankment height of only 5 feet and since no raise in grade is proposed, embankment global stability and settlement of the approach roadway are judged to be acceptable for the project.

5.3 FOUNDATION TYPE

The culvert is proposed to consist of a box culvert with a span of 17 feet and a rise of 7 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 Marine Clay 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 Clay	0.50	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 13 to 14 feet below existing grades. At these depths, the exposed soils are anticipated to consist of a thin layer soft to medium stiff Marine Clay underlain by a medium dense Glacial Outwash. The following sections discuss settlement and bearing resistance for the proposed culvert.

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 an increase in effective stress within the channel and between the existing abutments. Therefore, consolidation of the underlying 3 to 4 feet of medium stiff to soft Marine Clay is anticipated. Based on light overconsolidation of the clay interpreted from the consolidation test and the anticipated stress increase, we estimate the post-construction foundation settlement will be 1 inch or less including approximately the effects of primary consolidation and secondary compression. Calculations are presented in **Appendix E**.

5.5.2 Strength Bearing Resistance

The bearing resistance values for the strength condition were developed using the theoretical method (Munfakh et al., 2001) as shown in AASHTO Eq. 10.6.3.1.2a-1, which is based on an estimated shear strength of 600 psf for the Marine Clay. Bearing resistances were evaluated in accordance with Articles 10.6.3.1.1 and 10.6.3.1.2a of AASHTO LRFD.

The calculated bearing resistance values are presented in **Appendix D** and are presented in the table below.

5.5.3 Service Bearing Resistance

GZA evaluated the anticipated settlement for the service condition. We estimate it will include up to about 1/2 inch of primary consolidation plus an additional 1/2 inch or less of secondary compression, resulting in a total of approximately 1 inch over the first 15 years. Since the underlying Glacial Outwash is a granular material, we anticipate that any compression of that layer would occur elastically as the fill is placed and not contribute to post-construction settlement. Calculations are presented in **Appendix E**.

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 19 4.0 2.0 2.0												

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 not located on a known fault; 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 also 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 consideration for the design backslope, currently anticipated to be 2H:1V. 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

Marine Clay is anticipated to be present at the culvert bearing elevation, and new fill soils are anticipated to be present in the approach roadways, either as existing fill or imported backfill. Considering the Marine Clay is present at the bearing elevation, fine grained soils were considered for the frost penetration depth. Based on the MaineDOT BDG, Section 5.2.1, the Freezing Index for the site is 1,600, and with fine-grained soils with moisture content between 20 to 30 percent, the estimated depth of frost penetration is approximately 4.1 feet. However, the BDG does not specify frost embedment depth 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 Meadow Brook. The extent and nature of scour countermeasures will be evaluated by others.

6.2 BOX CULVERT AND INLET AND OUTLET WALL DESIGN

- Backfill placed between the culvert and existing roadway approaches 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
 - 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 existing masonry abutments should be removed to at least 1 foot below the bottom of the proposed culvert bearing elevation.



- The proposed box culvert and footings should be supported on 12 inches of MaineDOT 703.22 Underdrain Backfill Material, Type C separated on the bottom and sides by Stabilization/Reinforcement Geotextile installed over undisturbed stiff to medium stiff Marine Clay, except for the precast concrete toe walls, which should bear directly on the undisturbed stiff to medium stiff Marine Clay. Culvert bearing pressures should be checked to confirm that they are less than the bearing resistance values presented in Section 5.5 of this report.
- In order to limit seepage beneath the culvert, the Underdrain Backfill material should not extend upstream or downstream beyond the limits of the cutoff walls on the base. The cutoff walls and culvert ends should bear directly on natural Marine Clay.
- The culvert subgrade surfaces should be cleaned of any soil loosened by the excavation process prior to placement of Underdrain Backfill Material. 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 $\phi_f' = 32$ 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 (ϕ_T) 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 13 feet below existing grade and at least 5 feet below Q 1.1 (El. 160.4). We anticipate that either sheet-pile-supported or open cut excavation techniques may be suitable for this project.

Damming and diversion coupled with 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. Where the excavations are at/near measured groundwater levels, 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 Marine Clay is wet, 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 prior to commencing compaction. The surface of the Type C material may then be densified as previously described. Compaction should be completed in a manner at which the subgrade does not exhibit weaving or rutting.

11/18/2024 MAINE DEPARTMENT OF TRANSPORTATION MEADOW BROOK BRIDGE NO. 5856 CULVERT REPLACEMENT 09.0026222.00



TABLES



TABLE 1 Summary of Subsurface Explorations Meadow Brook Bridge #5856 carries Bog Road over Meadow Brook Vassalboro, Maine GZA job#: 09.0026222.00

				Top of Stratum Elevation							Stratum Thickness								Groundwater	
Boring ID	Station	Offset	Ground Surface El. (ft)	Asphalt	Fill	Alluvium	Marine Clay	Glacical Outwash	Bedrock	Asphalt	Fill	Alluvium	Marine Clay	Glacical Outwash	Depth to Bedrock (ft)	Top of Rock Elevation (ft)	Bottom of Boring Depth (ft)	Bottom of Boring El. (ft)	El. (ft)	Depth (ft)
BB-VMB-101	103+66.2	5.6' Rt.	161.4	NE	NE	161.4	160.4	152.4	146.4	NE	NE	1.0	8.0	6.0	15.0	146.4	25.4	136.0	156.7	4.7
BB-VMB-102	103+89.9	9.7' Lt.	168.2	168.2	167.8	NE	159.2	152.7	145.8	0.4	8.6	NE	6.5	6.9	22.4	145.8	32.4	135.8	163.5	4.7

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.

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.

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FIGURES



© 2024 - GZA GeoEnvironmental, Inc. \\GZAPORT1\Uob\09 Jobs\00262008\09.0026222.00 - MEDOT - Meadow Brk Bridge, VassalborolFigures\GIS\Figures\GIS\Figures\10024, 12:18:13 PM, Elizabeth.Fulton



11/18/2024 MAINE DEPARTMENT OF TRANSPORTATION MEADOW BROOK BRIDGE NO. 5856 CULVERT REPLACEMENT 09.0026222.00



APPENDIX A – LIMITATIONS



GEOTECHNICAL LIMITATIONS

Use of Report

 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.

P:\09 Jobs\0026200s\09.0026222.00 - MEDOT - Meadow Brk Bridge, Vassalboro\Report\26222.00 Vassalboro Meadow Brk Bridge Culvert GDR 11.18.2024.docx

11/18/2024 MAINE DEPARTMENT OF TRANSPORTATION MEADOW BROOK BRIDGE NO. 5856 CULVERT REPLACEMENT 09.0026222.00



APPENDIX B – TEST BORING LOGS

	UNIFIE	ED SOIL C	LASSIFIC	CATION SYSTEM		MODIFIED B	URMISTER S	YSTEM
МА			GROUP	TYPICAL NAMES				
IVI/AC					Descrip	otive Term	Port	ion of Total (%)
COARSE-	0000	CLEAN	GW	Well-graded gravels, gravel-	ti	race		0 - 10
GRAINED	GRAVELS	GRAVELS		sand mixtures, little or no fines.				11 - 20 21 - 35
30113	5e 0.4	(little or no	GP	Poorly-graded gravels. gravel	s adjective (e.d	. Sandy, Clavev)		21 - 33 36 - 50
	an N	fines)	-	sand mixtures, little or no fines.	, (3	5, - 5 57		
	lf of (r tha ize)					TERM	S DESCRIBIN	G
	n ha arge ve s					DENSITY	<u>Y/CONSISTEN</u>	ICY
	thai is is sie	GRAVEL	GM	Silty gravels, gravel-sand-silt	Coarse-grained	soils (more than half o	of material is larger t	han No. 200
L	ctior	WITH		mixtures.	sieve): Includes (1) clean gravels; (2) S	silty or Clayey gravel	s; and (3) Silty,
Irgei	fra fra	(Appreciable	GC	Clayey gravels, gravel-sand-clay	penetration resist	tance (N-value).	aled according to sta	nuaru
is la ze)		amount of		mixtures.		· · · ·		
erial ve si		fines)			<u>Der</u> Cobosio	<u>nsity of</u>	Standard Po	enetration Resistance
mat					Verv	v loose	14 ₆₀ - V al	0 - 4
lf of 200		CLEAN	SW	Well-graded sands, Gravelly	Lo	oose		5 - 10
n ha No.	SANDS	SANDS		sands, little or no fines	Mediu	m Dense		11 - 30
than than	0 · ·	(little or no	SP	Poorly-graded sands Gravelly	Verv	n Dense		> 50
nore	arse No ר	fines)	01	sand, little or no fines.	vory	Donoo		
Ľ	of cc thai e)				Fine-grained soi	i <u>ls</u> (more than half of r	naterial is smaller th	an No. 200
	half aller e siz	SANDS	SM	Silty sands, sand-silt mixtures	sieve): Includes (1) inorganic and organ	nic silts and clays; (2	?) Gravelly, Sandy
	han s sm sieve	WITH	Givi	ony sands, sand-sin mixtures	strength as indica	ated.	isistency is rated act	or any to unuranica shear
	on is	FINES			-		Approximate	
	(mo racti	(Appreciable	SC	Clayey sands, sand-clay	Consistency of	SPT NValue	Undrained Shear	Field
	Ŧ	fines)		mixtures.	Cohesive soils	(blows per foot)	Strength (psf)	Guidelines
					Very Soft	WOH, WOR,	0 - 250	Fist easily penetrates
			ML	Inorganic silts and very fine	Soft	WOP, <2	250 500	Thumh agaily ponetrates
				fine sands, or Clayey silts with	Medium Stiff	2 - 4 5 - 8	500 - 1000	Thumb penetrates with
	SILTS AN	ID CLAYS		slight plasticity.				moderate effort
				la construction of the state of	Stiff	9 - 15	1000 - 2000	Indented by thumb with
GRAINED			CL	plasticity, Gravelly clays, Sandy	Verv Stiff	16 - 30	2000 - 4000	great effort Indented by thumbnail
SOILS				clays, Silty clays, lean clays.	Hard	>30	over 4000	Indented by thumbnail
	(liquid limit l	less than 50)						with difficulty
			OL	Organic silts and organic Silty	Rock Quality De	signation (RQD):	of intent nices o	faarat > 1 inchaa
e .				clays of low plasticity.	RQD (%) -	sum of the lengths	length of core a	dvance
ial is e sizi						*Minimu	um NQ rock core (1.88 in. OD of core)
ater sieve			MH	Inorganic silts, micaceous or diatomaceous fine Sandy or		Rock Quality Ba	sed on POD	
of m 200 :	SILTS AN	ID CLAYS		Silty soils, elastic silts.		Rock Quality Ba	RQD (%)	
half No. 5						Very Poor	≤25	
han Jan I			СН	Inorganic clays of high		Poor	26 - 50 51 - 75	
ore t ler ti						Good	76 - 90	
m mal	(liquid limit gr	reater than 50)	ОН	Organic clays of medium to		Excellent	91 - 100	
				nign plasticity, organic silts.	Color (Mussell	color chart)	his order, if appli	caple):
					Texture (aphan	nitic, fine-grained, et	tc.)	
	HIGHLY		Pt	Peat and other highly organic	Rock Type (gra	nite, schist, sandst	one, etc.)	
	SO	115		SOIIS.	Weathering (fro	r nara, nara, mod. h esh verv slight slig	iara, erc.) ht moderate mod	d severe severe etc.)
Desired So	oil Observat	tions (in thi	s order i	f applicable):	Geologic disco	ntinuities/iointina	, moderate, mot	a. 350010, 360616, 610.)
Color (Mun	sell color ch	art)				-dip (horiz - 0-5 de	g., low angle - 5-3	5 deg., mod. dipping -
Moisture (d	ry, damp, m	oist, wet)				35-55 deg., stee	ep - 55-85 deg., v	ertical - 85-90 deg.)
Density/Cor	nsistency (fr	om above ri	ght hand	side)		-spacing (very clos	se - <2 inch, close	- 2-12 inch, mod.
Name (San	e, meaium, d. Siltv San	d. Clav. etc.) including	portions - trace little etc.)		-tightness (tight or	wide - 3-10 feet, pen, or healed)	very wide >10 feet)
Gradation (well-graded	, poorly-grad	ded, unifo	rm, etc.)		-infilling (grain size	, color, etc.)	
Plasticity (n	on-plastic, s	slightly plast	ic, modera	ately plastic, highly plastic)	Formation (Wa	terville, Ellsworth, C	Cape Elizabeth, et	c.)
Structure (la	ayering, frac	ctures, crack	s, etc.)		RQD and corre	lation to rock qualit	y (very poor, poor	, etc.)
Cementatio	eii, moderat	ely, 100Sely, oderate or (eic.,)		Site Character	pusz and FHWA NF	יו-10-072 GEC 5 - ס	Geotecnnical
Geologic O	rigin (till. ma	arine clav. al	luvium. et	c.)	Recovery (inch	/inch and percentad	<u>-</u> ge)	
Groundwate	er level		, 00	,	Rock Core Rate	e (X.X ft - Y.Y ft (mi	n:sec))	
					Sample Cont	tainer Labeling F	Requirements	
	Maine L	Departme	nt of Tra	ansportation	WIN	Lasting I	Blow Counts	-
		Geotechi	nical Se	ction	Bridge Name	/ Town	Sample Recov	ery
Ke	y to Soil a	and Rock	Descrip	otions and Terms	Boring Numb	er	Date	
	Fiel	d Identific	ation Inf	ormation	Sample Num	per b	Personnel Initia	ais
1								

	Main	e Dep	artment	ation Project: Meadow Brook Bridge #5856 carries B							Boring No.:	BB-VN	MB-101	
		-	Soil/Rock Exp	loration Log			Locat	ion	Road of Vass	over M alboro	eadow Brook Maine			
			US CUSTOM	<u>ARY UNITS</u>								WIN:	2644	42.00
Drill	er:		MaineDOT		Ele	vatior	n (ft.)		161.4	1		Auger ID/OD:	N/A	
Ope	rator:		Daggett/Broo	k	Dat	um:			NAV	D88		Sampler:	Standard Split	Spoon
Log	ged By:		J. Manahan		Rig	Туре	:		CME	E 45C		Hammer Wt./Fall:	140#/30"	
Date	e Start/F	inish:	11/15/2022; 0	8:45-15:00	Dril	ling N	lethoo	1:	Case	d Was	n Boring	Core Barrel:	NQ-2"	
Bori	ing Loca	tion:	103+66.2, 5.6	ft Rt.	Cas	ing II	D/OD:		HW-4" & NW-3"			Water Level*:	4.7 ft bgs.	
Han	nmer Eff	iciency F	actor: 0.906	R - Rock (Han	nmer	Туре:	A	Automa	tic 🛛	Hydraulic	Rope & Cathead	- Pocket Torvane She	ar Strength (nsf)
D = S	Split Spoon	Sample	oon Somple Attor	SSA = Soli	d Stem A	uger			S _{u(lal}	_{o)} = Lat	Vane Undrained Shear Strength (psf) WC	= Water Content, per	cent
U = T	hin Wall Tu	ibe Sample		RC = Rolle	r Cone				N-unc	orrecte	d = Raw Field SPT N-value	PL :	= Plastic Limit	
V = F	ield Vane S	Shear Test,	PP = Pocket Pe	enetrometer WOR/C = V	Neight of 14	Rods o	r Casing	I	N ₆₀ =	SPT N	-uncorrected Corrected for Hamme	er Efficiency G =	Grain Size Analysis	
	Unsuccess	siul Fleid Va	ne Snear Test Al	Sample Information	reigni or C	Jie Pei	SOL		1960 =	: (⊓ami			Consolidation Test	
		in.)	oth	(·	ed					-				Laboratory Testing
Ĵ.	No.	ec. (Del	/6 in h) (%)	rrect				u	, Loç	Visual De	scription and Remarks		Results/
bt)	mple	n./R	mple	ws (ear engt f) RQD	opur	0	sing	ŝ	vatio	aphic				and
De De	Sa	Pe	(ft.	Str Sh	ź	2 N ⁰	S S		(ft.	Ö				Unified Class.
0	1D	24/7	0.00 - 2.00	4/5/3/2	8	12	a31				Olive grey, wet, medium de little silt, (Alluvium).	ense, fine to coarse SAN	D, some gravel,	
							a19	,	160.4	Ŵ	<u></u>		1.0	
							915	_						
				WOH/WOH/WOH/			"I.	,		H	Light grey, wet, very soft. S	Silty CLAY, trace sand, 1	aver of wood	G#303227
	2D	24/24	3.00 - 5.00	WOH			OPE HOL	N E			organics, (Marine Clay).	,		A-6, CL
														LL=32
- 5	1U	24/24	5.00 - 7.00	WOR/WOR/WOR/							Grey, varved, very soft, Sil	ty CLAY, trace sand (Ma	arine Clay).	PL=19 PI=13
				WOR			+	-		łł				G,C#303226
				WOD/WOD/WOD/			+	_		1D	Light grev wet medium st	iff Silty CLAY trace say	nd (Marine Clav)	WC=23.5%
	3D V1	24/21	7.00 - 9.00	WOR/WOR/WOR/ WOH							55x110 mm vane raw torqu	le readings:	ild, (Marine Ciay).	LL=21 PL=15
	V2		8.63 - 9.00	Su=335/67 psf Su=625/156 psf						11	V1: 7.5/1.5 ft-lbs			PI=6 G#303228
	4D	24/8	9.00 - 11.00	4/10/10/14	20	30			152.4		Last $1/2$ " of V2 much harde	er to push.	0.0	A-4, CL-ML
- 10 -					-		+	-			Light grey, wet, medium de	ense, Silty SAND, trace g	gravel, (Glacial	LL=23
							+ +	_			Outwash). Drove NW Casing to 20.0 f	t bgs.		PL=19 PI=4
	5D	24/7	13.00 - 15.00	17/9/10/17	19	29		/			Dark grey, wet, medium de	nse, GRAVEL, little fine	e to coarse sand,	
					-	-	++	Н			trace sin, trace cray, (Glacia	ar Outwash).		
- 15 -	-						<u> </u> V	_	146.4	1818			15.0	-
	R1	60/60	15.40 - 20.40	RQD = 63%			NQ-	2			Top of Bedrock at Elev. 14 Roller Coned ahead, to 15.4	6.4 ft. 4 ft. bgs. and set up to co	re.	
											R1: Bedrock: Light to dark METAWACKE fresh and	grey, very fine to mediu	m-grained, hard,	
											brecciated zones.		uoturos,	
							+	\neg			[Maynower Hill Formation Rock Quality = Fair	1		
								-			100% Recovery R1: Core Times (min:sec)			
20											15.4-16.4 ft (1:37)			
20	R2	60/60	20.40 - 25.40	RQD = 20%							17.4-18.4 ft (1:45) no water	return		
											18.4-19.4 ft (2:01) 19.4-20.4 ft (2:51)			
							+	-			R2: Bedrock: Similar to R1 Rock Quality – Very Poor			
							+ +	_			100% Recovery			
											20.4-21.4 ft (1:26)			
25							$ \rangle $	/			21.4-22.4 ft (1:19) 22.4-23.4 ft (1:21)			
Ren	harks:	1	1					_			(1,21)			
7.0	7.0 ft from Bridge Deck to bottom of Stream.													
	a HW-4" Casing.													
Strati	Stratification lines represent approximate boundaries between soil types; transitions may be gradual. Page 1 of 2													
* Wat thar	ter level rea n those pre	dings have sent at the t	been made at tim ime measuremen	nes and under conditions sta ts were made.	ited. Gro	undwat	er fluctua	ation	s may oo	cur du	to conditions other	Boring No	.: BB-VMB	-101

Ι	Mair	ie Dej	partment	t of Transpo	ortation	n	Project:	Meado	ow Bro	ok Bridge #5856 carries Bog	Boring No.:	BB-VN	MB-101
		-	Soil/Rock Ex	ploration Log			Locatio	Road on Road o	over M alboro	eadow Brook , Maine			
			US CUSTON	MARY UNITS							WIN:	2644	42.00
Drill	er:		MaineDOT		Ele	vatior	n (ft.)	161.	4		Auger ID/OD:	N/A	
Ope	rator:		Daggett/Bro	ok	Dat	tum:		NAV	/D88		Sampler:	Standard Split	Spoon
Log	ged By	:	J. Manahan		Rig	у Туре	:	CMI	E 45C		Hammer Wt./Fall:	140#/30"	
Date	e Start/	Finish:	11/15/2022;	08:45-15:00	Dri	lling N	Method: Cased Wash			h Boring	Core Barrel:	NQ-2"	
Bori	ng Loo	ation:	103+66.2, 5.	6 ft Rt.	Ca	sing II	D/OD:	HW-	4" & 1	IW-3"	Water Level*:	4.7 ft bgs.	
Ham	mer E	fficiency	Factor: 0.900	6	Hai	mmer	Туре:	Automa	tic⊠ Deek/B	Hydraulic	Rope & Cathead	Desket Terrore Che	or Strongth (nof)
Defini D = S MD = U = TI MU = V = Fi MV =	tions: plit Spoo Unsucce hin Wall ⁻ Unsucce ield Vane Unsucce	n Sample essful Split S Tube Samp essful Thin V e Shear Tes essful Field V	poon Sample Atte e /all Tube Sample , PP = Pocket F /ane Shear Test /	R = K SSA = empt HSA = RC = Attempt WOR Attempt WO1F Sample Informati	CC Core Sam Solid Stem A Hollow Stem Roller Cone = Weight of 1 C = Weight of 0 On	Auger Auger 40 lb. Ha f Rods o <u>One Per</u>	ammer r Casing rson	$S_{U(ab)} = Lab Vane Undrained Shara Streqp = Unconfined Compressive Strength (kN-uncorrected = Raw Field SPT N-valueHammer Efficiency Factor = Rig Specific AN60 = SPT N-uncorrected Corrected for HN60 = (Hammer Efficiency Factor/60%)*N$			par Strength (pst) $V_{V} = psf$ WC LL = PL = I Calibration Value PI = ar Efficiency G = rrected C =	Pocket forvane She = Water Content, per Liquid Limit Plastic Limit Plastic Limit Plasticity Index Grain Size Analysis Consolidation Test	ar Strength (psr) cent
epth (ft.)	Jepth (ft.) Sample No. Sample Depth (ft.) Slows (/6 in.) Shear strength pst) or ROD (%)					30	asing ows	evation .)	raphic Log	Visual De	scription and Remarks		Laboratory Testing Results/ AASHTO and Unified Class
25	Й	<u> </u>	<u>i i i i i i i i i i i i i i i i i i i </u>	<u>ಹೆಂಸ್ ಅ</u> ಶಿ	ż	ž	U V V	重 ま 136.0	Ū	23.4-24.4 ft (4:12)			
	-							150.0		24.4-25.4 ft (3:04)		25.4-	
										Bottom of Exploration	n at 25.4 feet below grou	ind surface.	
								-					
- 30 -													
- 35 -													
- 40 -													
					_								
	<u> </u>												
- 45 -													
<u>50</u> <u>Rem</u>	arks:						1						
7.0 a H	ft from W-4" C	Bridge De asing.	eck to bottom of	f Stream.									
Stratif	ication lir	nes represe	nt approximate bo	oundaries between soil ty	pes; transitior	ns may t	pe gradual.				Page 2 of 2		
* Wate than	er level re those pr	eadings hav resent at the	e been made at ti time measureme	imes and under condition ents were made.	is stated. Gro	oundwat	er fluctuatio	ns may o	ccur du	e to conditions other	Boring No	: BB-VMB	-101

I	Aain	e Depa	artment	of Transport	atio	n	Project	: Meado	w Bro	ok Bridge #5856 carries Bog	Boring No.:	BB-VN	MB-102
		5	Soil/Rock Exp	loration Log			Locatio	Road on: Vass	over M alboro	eadow Brook . Maine			
		<u>l</u>	JS CUSTOM	ARY UNITS						· · ·	WIN:	2644	42.00
Drille			MaineDOT		Fle	vation	(ft)	168	,		Auger ID/OD:	5" Solid Stem	
Oner	ator.		Daggett/Brool	k	Dat	tum	. ()	NAV	- /D88		Sampler:	Standard Split	Spoon
	ed Bv		I Manahan		Ric	1 Type		CMI	F 45C		Hammer Wt /Fall	140#/30"	Броон
Date	Start/F	inish	11/14/2022· 0	9.15-13.30	Dri	lling N	lethod:	Case	d Wasl	h Boring	Core Barrel:	NO-2"	
Bori		tion.	103+89.9.9.7	ft I t	Ca	Casing ID/OD: HW-4" & NW-3" Water Level*: 4.7 ft hos							
Ham	mor Eff	icionev E	105+69.9, 9.7	It Et.	Ha	ammer Type: Automatic \square Hydraulic \square Pope & Cathead \square							
Definit	ions:	leichey ra	0.900	R = Rock C	Core Sam	nple	1990.	S _u =	Peak/Re	emolded Field Vane Undrained She	ear Strength (psf) $T_V = Pc$	ocket Torvane She	ar Strength (psf)
D = Sp MD =	olit Spoon Unsucces	Sample sful Split Spo	on Sample Atter	SSA = Soli HSA = Holl	d Stem A ow Stem	Auger Auger		S _{u(la}	_{b)} = Lab Unconfir	Vane Undrained Shear Strength (ned Compressive Strength (ksf)	psf) WC = \ LL = Li	Vater Content, per puid Limit	cent
U = Th	in Wall Tu	ube Sample	I Tubo Somolo A	RC = Rolle	r Cone	4016 La	mmor	N-un	correcte	d = Raw Field SPT N-value	PL = Pl Calibration Value PL = Pl	astic Limit	
V = Fie	eld Vane S	Shear Test,	PP = Pocket Pe	enetrometer $WOR/C = V$	Neight of	f Rods o	r Casing	N ₆₀ :	= SPT N	-uncorrected Corrected for Hamme	er Efficiency G = Gr	ain Size Analysis	
<u> IVIV = </u>	Jnsucces	stul Field Var	ne Snear Test At	sample Information	eight of	One Per	son	N60 -	= (Hamn	her Efficiency Factor/60%)*N-uncor	rected $C = Co$	nsolidation lest	
		(··	Ę	<u>_</u>	ð								Laboratory Testing
$\widehat{}$	ġ	j. j	Dep	3 in. (%)	ecte				Log	Visual Dev	scription and Remarks		Results/
h (ft	ole I	Řec	ole [s (/6 DD)	corr		وره	atior	hic	visual De			AASHTO
ept	ami	en./	t.)	llow thea trer stf) r R(-n	60	asir	t.)	irap				Unified Class.
0	0 0	<u> </u>	<u> </u>	<u></u>	2	2		ше	0	5" HMA			
							SSA	167.8	****	Proventional contractions			-
										Brown sand and gravel cutt	ings, (Fill).		
								1					
								1	***				
								1					
- 5 -								4		Olive grey damp stiff Silt	v CLAV some cand little	wavel trace	G#303220
	1D	24/23	5.00 - 7.00	7/5/5/3	10	15				wood organics, (Fill).	y CLAT, some sand, intre g	graver, trace	A-4, CL
								1					WC=20.0%
								-					
								1					
								159.2	нини			9.0	
- 10 -													G #202220
10	2D	24/24	10.00 - 12.00	WOH/WOH/WOH/ WOH			1		H H	Light grey, moist, very soft. Clay).	, Silty CLAY, trace fine sar	id, (Marine	G#303230 A-6, CL
				won			5	1					WC=29.8%
							5	-					LL=34 PL=19
							6						PI=15
							6	1					
								-	HH				
- 15 -							7						~~~~
15	3D	6/4	15.00 - 15.50	WOR			20	152.7		Grey, wet, Silty CLAY, trac	ce fine sand, (Marine Clay)	15.5-	G#303231 A-4, CL
	MV						20	1		Failed 55x110 mm vane att	empt, vane refusal.		WC=23.9%
							50	4					
							56	1					
							67	1					
								-					
20							70	1	H ill		1. OT 1.		
2.5	4D	21.6/21.6	20.00 - 21.80	14/23/14/33(3.6)	37	56	53	1		Light brown, damp, hard, S (Glacial Outwash).	iity CLAY, some sand, trac	e gravel,	G#303232 A-4, CL
							70	1		· · · · · · · · · · · · · · · · · · ·			WC=16.7%
							/8	4		a95 blows for 0.4 ft			
	R1	24/19	22.40 - 24.40	RQD = 46%			a95	145.8	U PUT KSK	The of D 1 1 2 21 1	= 0 fr	22.4-	
							1 NQ-2	1		R1: Bedrock at Elev. 14: R1: Bedrock: light to dark	5.8 It. grey, very fine to medium-9	rained, hard.	
								-		METAWACKE, fresh, oper	n joints, close.	,,	
25	R2	60/60	24.40 - 29.40	RQD = 45%						[Maynower Hill Formation]	1		
Remarks:													
<u> </u>	Stratification lines represent approximate boundaries between soil types: transitions may be gradual Page 1 of 2												
Stratifi	Stratification lines represent approximate boundaries between soil types; transitions may be gradual.												
Wate	those pro	adings have b sent at the tir	been made at tim	es and under conditions sta ts were made	ited. Gro	oundwate	er fluctuatio	ons may o	ccur due	e to conditions other	Boring No ·	BB-VMR	-102

I	Main	e Depa	artment	of Tran	sporta	tion		Project:	Meado	ow Br	bok Bridge #5856 carries Bog Boring No.: BB-VM	IB-102	
		<u>s</u>	Soil/Rock Exp	loration Log				Locatio	Road n: Vas	over N salbor	leadow Brook o, Maine	2.00	
		<u> </u>		ARY UNITS							WIN:	2.00	
Drill	er:		MaineDOT			Eleva	tion	(ft.)	168.	2	Auger ID/OD: 5" Solid Stem		
Оре	rator:		Daggett/Brool	k		Datur	n:		Sampler: Standard Split S	poon			
Log	ged By:		J. Manahan			Rig T	ype		CM	E 45C	Hammer Wt./Fall: 140#/30"		
Date	e Start/F	inish:	11/14/2022; 0	9:15-13:30		Drillin	ng N	lethod:	Case	ed Wa	sh Boring Core Barrel: NQ-2"		
Bori	ng Loca	ation:	103+89.9, 9.7	ft Lt.		Casin	g IC	D/OD:	HW	-4" &	NW-3" Water Level*: 4.7 ft bgs.		
Ham Defini	mer Eff	iciency F	actor: 0.906		R = Rock Co	Hamn	ner	Туре:	Automa S=	atic 🛛 Peak/F	Hydraulic Rope & Cathead remolded Field Vane Undrained Shear Strength (psf) Tu = Pocket Torvane Shea	r Strength (psf)	
D = S MD = U = T MU = V = F MV =	iplit Spoon Unsuccess hin Wall Tu Unsuccess ield Vane S <u>Unsuccess</u>	Sample sful Split Spo ube Sample sful Thin Wa Shear Test, <u>sful Field Va</u>	oon Sample Atter III Tube Sample A PP = Pocket Pe <u>ne Shear Test At</u>	npt Attempt enetrometer tempt	SSA = SolidHSA = HollowRC = Roller (WOH = WeigWOR/C = WeigWO1P = Weig	Stem Auge w Stem Au Cone ght of 140 I eight of Ro ight of One	er ger b. Ha ids of <u>e Pers</u>	ammer r Casing son	Su(la 9 _p = N-un Ham N ₆₀ :	ab) = La Uncon correct mer Eff = SPT <u>= (Ham</u>	b Vane Undrained Shear Strength (psf) WC = Water Content, percer ined Compressive Strength (ksf) LL = Liquid Limit ad = Raw Field SPT N-value PL = Plastic Limit iciency Factor F Rig Specific Annual Calibration Value PI = Plasticity Index v-uncorrected Corrected for Hammer Efficiency G = Grain Size Analysis mer Efficiency Factor/60%)*N-uncorrected C = Consolidation Test	ent	
	<u> </u>	<u> </u>		Sample Info	rmation	σ						Laboratory	
Depth (ft.)	Sample No.	Pen./Rec. (in	Sample Dept (ft.)	Blows (/6 in.) Shear Strength	(psf) or RQD (%)	N-uncorrecte	N ₆₀	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Results/ AASHTO and Jnified Class.	
25											Rock Quality = Poor. 79% Recovery		
											R1: Core Times (min:sec)		
											22.4-23.4 ft (0:48)		
											fractures.		
											[Mayflower Hill Formation] Rock Ouality = Poor.		
	R3	36/34	29.40 - 32.40	RQD = 8	33%						100% Recovery		
- 30 -											24.4-25.4 ft (2:03)		
											25.4-26.4 ft (1:51) 26.4-27.4 ft (1:45)		
								/			27.4-28.4 ft (1:47)		
								V V	135.8		28.4-29.4 ft (2:19) R3: Bedrock: Similar to R1.		
											[Mayflower Hill Formation] Rock Quality = Good.		
											94% Recovery		
- 35 -											R3: Core Times (min:sec) 29.4-30.4 ft (1:40)		
											30.4-31.4 ft (2:28) 31.4-32.4 ft (2:30)		
											Bottom of Exploration at 32.4 feet below ground surface		
											bottom of Exploration at 52.4 feet below ground surface.		
10													
- 40 ·													
										1			
										1			
									1	1			
- 45 ·										1			
										1			
										1			
										1			
50													
<u>Rem</u>	<u>iarks:</u>												
Strot	fication line		approvimato bo::	Indaries botwood	soil types: tr	ansitions ~	1917 P	e aradual			Page 2 of 2		
* Wat	er level rea	adings have	been made at tim	nes and under co	onditions state	ed. Ground	dwate	er fluctuation	ns may o	iccur di	ie to conditions other		
thar	those pre	sent at the ti	me measuremen	ts were made.					,-		Boring No.: BB-VMB-	102	

11/18/2024 MAINE DEPARTMENT OF TRANSPORTATION MEADOW BROOK BRIDGE NO. 5856 CULVERT REPLACEMENT 09.0026222.00



APPENDIX C – CORE PHOTO LOG



Meadow Brook Bridge No. 5856 MaineDOT WIN 26442.00, Vassalboro, Maine

Rock Core Photographs

			Recovery Recovery					Вох
Boring No.	Run	Depth (ft)	(in)	(%)	RQD (in)	RQD (%)	Rock Type	Row
BB-VMB-102	R1	22.4 - 24.4	19	79	11	46	Metawacke	1
BB-VMB-102	R2	24.4 - 29.4	60	100	27	45	Metawacke	1&2
BB-VMB-102	R3	29.4 - 32.4	34	94	30	83	Metawacke	2
BB-VMB-101	R1	22.4 - 27.4	60	100	38	63	Metawacke	3
BB-VMB-101	R2	27.4 - 32.4	60	100	12	20	Metawacke	4



Notes: 1. Box row corresponds to the core box section in which the rock core sample is contained; Row 1=Top, Row 4=Bottom. 2. Photo is dry, no wet photo was provided.

11/18/2024 MAINE DEPARTMENT OF TRANSPORTATION MEADOW BROOK BRIDGE NO. 5856 CULVERT REPLACEMENT 09.0026222.00



APPENDIX D – LABORATORY TEST RESULTS

State of Maine - Department of Transportation Laboratory Testing Summary Sheet

Town(s):	Vassa	assalboro Work Number: 26442.00										
Boring & Sample	Station	Offset	Depth	Reference	G.S.D.C.	W.C.	L.L.	P.I.	Cla	ssification	1	
Identification Number	(Feet)	(Feet)	(Feet)	Number	Sheet	%			Unified	AASHTO	Frost	
BB-VMB-101, 2D	103+66.2	5.6 Rt.	3.0-5.0	303227	1	30.9	32	13	CL	A-6		
*BB-VMB-101, 1U	103+66.2	5.6 Rt.	5.0-7.0	303226	1	23.5	21	6	CL-ML	A-4	IV	
BB-VMB-101, 3D	103+66.2	5.6 Rt.	7.0-9.0	303228	1	26.3	23	4	CL-ML	A-4	IV	
BB-VMB-102, 1D	103+89.9	9.7 Lt.	5.0-7.0	303229	2	20.0			CL	A-4	IV	
BB-VMB-102, 2D	103+89.9	9.7 Lt.	10.0-12.0	303230	2	29.8	34	15	CL	A-6		
BB-VMB-102, 3D	103+89.9	9.7 Lt.	15.0-15.5	303231	2	23.9			CL	A-4	IV	
BB-VMB-102, 4D	103+89.9	9.7 Lt.	20.0-21.8	303232	2	16.7			CL	A-4	IV	
* See Geotechnical T	est Reports	for Cons	olidation (T	216) and V	ane She	ar Tes	t on S	Shelh	v Tubes	(Maine D	OT)	
											,o1).	
Classification of th	iese soil samp	oles is in a	ccordance with	h AASHTO C	lassificatio	on Syst	em M-	145-4	0. This cla	ssification		
is followed by the	"Frost Suscep	tibility Rat	ing" from zero	o (non-frost s	usceptible	e) to Cla	ass IV	(high	ly frost su	sceptible).		
The "Frost Sus	The "Frost Susceptibility Rating" is based upon the MaineDOT and Corps of Engineers Classification Systems.											
GSDC = Grain Size Distribution	ution Curve as	aetermined	by AASHTO T	88-93 (1996)	and/or AS	IM D 4	22-63	(Кеар	proved 199	98)		

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



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
0	BB-VMB-101/2D	103+66.2	5.6 RT	3.0-5.0	Clayey SILT, trace sand.	30.9	32	19	13
۲	BB-VMB-101/1U	103+66.2	5.6 RT	5.0-7.0	SILT, little clay, trace sand.	23.5	21	15	6
	BB-VMB-101/3D	103+66.2	5.6 RT	7.0-9.0	SILT, little clay, trace sand.	26.3	23	19	4
X									

WIN 026442.00 Town Vassalboro Reported by/Date WHITE, TERRY A 3/21/2023



UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	WC, %	LL	PL	PI
0	BB-VMB-102/1D	103+89.9	9.7 LT	5.0-7.0	SILT, some sand, little gravel.	20			
۲	BB-VMB-102/2D	103+89.9	9.7 LT	10.0-12.0	SILT, some clay, trace sand.	29.8	34	19	15
	BB-VMB-102/3D	103+89.9	9.7 LT	15.0-15.5	SILT, little clay, trace sand.	23.9			
	BB-VMB-102/4D	103+89.9	9.7 LT	20.0-21.8	SILT, some sand, trace gravel.	16.7			
X									

WI	N
)26442.00	
Tov	vn
/assalboro	
Reported	by/Date
WHITE, TERRY A	1/9/2023

MaineDOT TESTING LABORATORIES

GEOTECHNICAL TEST REPORT Control Loboratory

🍪 MaineD01	-	GE	C	CHNIC entral	AL IE Labo	STR ratory	EP(/	DRI				
		S A	ΜP	LE I	NFO	RMA	Υ Ι	ΟΝ				
Reference No.	Boring	No./Sampl	e No.		Sa	ample De	scriptio	on		Sa	mpled	Received
303227	BB-\	/MB-101	/2D		GEOTEC	HNICAL	(DIST	URBED)	11/1	5/2022	12/7/2022
Sample Type: GEO	TECHNIC	AL Loca	ation:		Station:	103+66	. 2 Of	ffset, ft:	5.6	RT D	bfg, ft:	3.0-5.0
WIN/Town 026442.0	0 - VASS	ALBORO						Sample	r: JAN	IES M	ANAHA	AN
			т	FST	RFS	н т	S	-				
							0					
Sieve Analysis (T 88)				Mi	scellan	eous	Tests				
			Lic	quid Limit @ 2	25 blows (T	89), %				32		
Wash Metho	d		Pla	astic Limit (T	90), %					19		
			Pla	asticity Index	(T 90), %					13		
SIEVE SIZE	_ %		Sp	pecific Gravity	, Corrected	to 20°C (T	100)			2.74		
0.8. [81]	Passing		Lo	ss on Ignition	i, % (T 267)							
3 in. [75.0 mm]			\mathbf{W}	ater Content	(T 265), %					30.9		
1 in. [25.0 mm]												
³ ⁄₄ in. [19.0 mm]												
½ in. [12.5 mm]					Co	nsolida	tion	(T 216))			
<u>%</u> in. [9.5 mm]					Trimmings	Water Cont	tont %	(• /		1		
⁷ / ₄ In. [6.3 mm]	100.0				iiiiiiiiigs,		lenii, 70				0/	
No. 4 [4.75 mm]	00.0					Initial	Final		VOI Rati	a io S	% train	
No. 20 [0.850 mm]	99.0		M	/ater Content	. %			Pmin				
No. 40 [0 425 mm]	99.5		D	rv Densitv. Ib	, s/ft³			Pp				
No. 60 [0.250 mm]			V	oid Ratio				Pmax				
No. 100 [0.150 mm]			S	aturation, %				Cc/C'c				
No. 200 [0.075 mm]	98.9											
[0.0223 mm]	91.1		,	Vane Sh	ear Tes	t on Sh	elby	Tubes	(Mai	ne DO	OT)	
[0.0146 mm]	86.0	Depth		3 In.	6	In.	Wat	ter	o o o vi n ti	on of M	atorial C	ampled of the
[0.0091 mm]	75.8	taken in	U. Shea	r Remold	U. Shear	Remold	Cont	ent, De	escription	Various	Tube De	epths
[0.0069 mm]	65.8	tube, it	tons/ft	tons/ft ²	tons/ft ²	tons/ft ²	70					
[0.0051 mm]	58.2											
[0.0027 mm]	43.0											
[0.0012 mm]	30.3											

Comments:

A U T H O R I Z A T I O N AND DISTRIBUTION

Reported by: **GREGORY LIDSTONE**

Date Reported: 1/4/2023

TOWN	Vassalboro	Reference No.	303227
WIN	026442.00	Water Content, %	30.9
Sampled	11/15/2022	Liquid Limit @ 25 blows (T 89), %	32
Boring No./Sample No.	BB-VMB-101/2D	Plastic Limit (T 90), %	19
Station	103+66.2	Plasticity Index (T 90), %	13
Depth	3.0-5.0	Tested By	BBURR



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MaineDOT TESTING LABORATORIES

GEOTECHNICAL TEST REPORT Central Laboratory

		S A	ΜP	L	E I	NFO	RM	Α	ΤI	ΟΝ				
Reference No.	Boring	No./Sample	e No.			Sa	ample D)es	criptic	n		Sample	ed	Received
303226	BB-	/MB-101	/1U		G	ЕОТЕСН		. (U	NDIS	TURBE	ED)	11/15/20	22	12/7/2022
Sample Type: GEO		AL Loca	tion:			Station:	103+6	6.2	2 Of	fset. ft:	5.6	RT Dbfa.	ft:	5.0-7.0
WIN/Town 026442 0	0 - VASS								_	Sample	er JAM		нΔ	N
			т	F	ст	пге	11 1	т	0	oumpio	. .			
				E	31	RE 3	UL		3					
Sieve Analysis (T 88)			Miscellaneous Tests										
_	,		I	Liquid	Limit @ 2	5 blows (T	89), %					21		
Wash Metho	d		I	Plasti	c Limit (T 9	0), %						15		
	-		I	Plasti	city Index (T 90), %						6		
SIEVE SIZE	%		\$	Speci	fic Gravity,	Corrected	to 20°C ((T 1	00)			2.71		
U.S. [SI]	Passing		I	Loss	on Ignition,	% (T 267)								
3 in. [75.0 mm]			١	Water	r Content (1	Г 265), %						23.5		
1 in. [25.0 mm]			_											
¾ in. [19.0 mm]														
½ in. [12.5 mm]						Co	neolia	lat	ion (T 216	3			
¾ in. [9.5 mm]						00	1150110	ιαι		1 210	·/			
¼ in. [6.3 mm]					Т	rimmings,	Water Co	onte	nt, %		29.6			
No. 4 [4.75 mm]							Initial	F	inal		Void	I %		
No. 10 [2.00 mm]	100.0					0/	00.74		0.40	Durin	Ratio	Strain		
No. 20 [0.850 mm]				vvate	er Content,	%	33.71	2	2.18	Pmin			_	
No. 40 [0.425 mm]	99.7			Dry L	Density, Ibs	/ft ³ 2	39.583	10	15.66	Рр			_	
No. 60 [0.250 mm]				Void	Ratio		0.889	0	.601	Pmax				
No. 100 [0.150 mm]	00.0			Satur	ration, %		102.01		100					
10. 200 [0.075 mm]	90.0 59 3			Va	ne She	ar Tes	t on S	he	hv '	Tubes	(Main			
[0.0201 mm]	47.0	Donth		3 Ir	n.	6	In.		Wat		, man			
[0.0114 mm]	39.6	taken in	U. Sh	ear	Remold	U. Shear	Remo	old	Conte	ent, D	escriptio	n of Materia	al Sa	ampled at the
[0.0081 mm]	37.1	tube, ft	tons/	/ft²	tons/ft ²	tons/ft ²	tons/	ft²	%		v	arious Tube	e De	ptris
[0.0059 mm]	32.1	0.0-0.5	0 11	15	0	0 084	0		26	Alte	rnating la	yers of light 1	to da	ark grey clay, silt
[0.0030 mm]	22.2	0.0 0.0	0.11	3.75" on left to 4.5" on						on right.				
[0.0014 mm]	12.4	0.75-1.25	0.08	34	0	0.094	0		32.	7 blad	ternating l ck line run	ayers of ligh s from 9" on	left	dark grey clay, to 10.5" on right.
)5	0	0.136	0.0	1	32.	Alte	rnating la	vers of light line at 17	to da .25".	ark grey clay, silt			

Comments:

Tube labeled 12-14'. Maine Sensitive loading sequence.

1.75-2.0

0.167

AUTHORIZATION AND DISTRIBUTION

0.031

Reported by: GREGORY LIDSTONE

Date Reported: 1/25/2023

32.3

Alternating layers of light to dark grey clay.

TOWN	Vassalboro	Reference No.	303226
WIN	026442.00	Water Content, %	23.5
Sampled	11/15/2022	Liquid Limit @ 25 blows (T 89), %	21
Boring No./Sample No.	BB-VMB-101/1U	Plastic Limit (T 90), %	15
Station	103+66.2	Plasticity Index (T 90), %	6
Depth	5.0-7.0	Tested By	BBURR



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GEOTECHNICAL TEST REPORT

🏥 MaineD01	-	GE		CHNIC Central	AL TE	ST R	EPOF /	RT			
		S A	ΜP	LE I	NFO	RMA	ΥΤΙΟ) N			
Reference No.	Boring	No./Sampl	e No.		S	ample Des	scription			Sampled	Received
303228	BB-\	/MB-101	/3D		GEOTE	HNICAL)	11/15/2022	12/7/2022
Sample Type: GEO	TECHNIC	AL Loca	ation:		Station	103+66.	2 Offse	et, ft:	5.6 R [.]	T Dbfg, ft:	7.0-9.0
WIN/Town 026442.0	0 - VASS	ALBORO					Sa	ampler	r: JAME	S MANAH	AN
			т	сет	DEC	н т	6				
				ESI	K E J	ULI	3				
Sieve Analysis (T 88)				M	scellan	eous T	ests			
	,		Li	iquid Limit @	25 blows (T	89), %				23	
Wash Metho	d		Ρ	lastic Limit (T	90), %					19	
			Ρ	lasticity Index	: (T 90), %					4	
SIEVE SIZE	%		S	pecific Gravit	y, Corrected	to 20°C (T	100)		2	.72	
U.S. [SI]	Passing		L	oss on Ignitio	n, % (T 267)						
3 in. [75.0 mm]			Water Content (T 265), % 26.3								
1 in. [25.0 mm]											
³ / ₄ in. [19.0 mm]											
¹ / ₂ in. [12.5 mm]					Co	nsolida	tion (T	216)			
% IN. [9.5 mm]					Trimmings	Water Cont	ent %	- /			
74 In. [0.3 mm]	100.0				Thinning3,					0/	
No. 10 [2 00 mm]	00.0 00 0					Initial	Final		Ratio	% Strain	
No. 20 [0 850 mm]	33.5		١	Nater Conten	t, %		P	min			
No. 40 [0.425 mm]	99.6		[Dry Density, It	os/ft³		P	р			
No. 60 [0.250 mm]			١	Void Ratio			Р	max			
No. 100 [0.150 mm]			S	Saturation, %			С	c/C'c			
No. 200 [0.075 mm]	98.9						· · · · ·			·	
[0.0272 mm]	66.0			Vane Sh	ear Tes	t on Sh	elby Tı	ibes	(Maine	DOT)	
[0.0181 mm]	59.2	Depth		3 In.	(iln.	Water	De	escription	of Material S	ampled at the
[0.0114 mm]	45.6	taken in tube, ft	U. She	ar Remold	U. Shear	tons/ft ²	Content	,	Var	ious Tube D	epths
[0.0083 mm]	38.8		10113/1		10113/11	tonant					
[0.0061 mm]	31.9										
[0.0031 mm]	22.8										
	16.0										

Comments:

AND A U T H O R I Z A T I O N DISTRIBUTION

Reported by: **GREGORY LIDSTONE**

Date Reported: 1/4/2023

TOWN	Vassalboro	Reference No.	303228
WIN	026442.00	Water Content, %	26.3
Sampled	11/15/2022	Liquid Limit @ 25 blows (T 89), %	23
Boring No./Sample No.	BB-VMB-101/3D	Plastic Limit (T 90), %	19
Station	103+66.2	Plasticity Index (T 90), %	4
Depth	7.0-9.0	Tested By	BBURR



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GEOTECHNICAL TEST REPORT Central Laboratory

Central Laboratory										
		SAMF	PLE I	NFO	D R M	ΑΤ	ION			
Reference No.	Boring	No./Sample No.		ę	Sample D	Descript	tion		Sampled	Received
303229	BB-\	/MB-102/1D		<u>GEOTE</u>		L (DIS	TURBED	<u>))</u>	11/14/2022	2 12/7/2022
Sample Type: GEO	TECHNIC	AL Location:		Statio	n: 103+8	9.9 (Offset, ft:	9.7 L	_T Dbfg, ft:	5.0-7.0
WIN/Town 026442.0	00 - VASS	ALBORO					Sample	er: JAM	ES MANAH	AN
		-	EST	RES	SUL	ΤS				
							- T4]
Sieve Analysis (T 2	27, T 11)			IV		neou	s lests	5		
			Liquid Limit @	25 blows (T 89), %					-
Wash Metho	d									-
Procedure A	4		Plasticity Index	(T 90), %						-
SIEVE SIZE	_ %		Specific Gravity	y, Correcte	d to 20°C ((T 100)				
0.8. [SI]	Passing		Loss on Ignition	n, % (T 26	7)					
3 in. [75.0 mm]			Water Content	(T 265), %	1				20.0	
1 in. [25.0 mm]										-
³ ⁄ ₄ in. [19.0 mm]	100.0									
½ in. [12.5 mm]	96.3			C	onoolia	lation	(T 246	•		
¾ in. [9.5 mm]	94.2				onsond	ation	1 (1 210	·)		
1⁄4 in. [6.3 mm]	90.4			Trimmings	s, Water Co	ontent, %	, D			
No. 4 [4.75 mm]	87.7				Initial	Final		Void	%	
No. 10 [2.00 mm]	80.1				Initial	Final		Ratio	Strain	
No. 20 [0.850 mm]	73.2		Water Conten	t, %			Pmin			
No. 40 [0.425 mm]	68.7		Dry Density, Ib	os/ft³			Рр			
No. 60 [0.250 mm]	65.5		Void Ratio				Pmax			

Saturation, %

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth	3	n.	6	n.	Water	
taken in	U. Shear	Remold	U. Shear	Remold	Content,	Description of Material Sampled at the
tube, ft	tons/ft ²	tons/ft ²	tons/ft ²	tons/ft ²	%	Valious Tube Deptils

Cc/C'c

Comments:

No. 100 [0.150 mm]

No. 200 [0.075 mm]

AUTHORIZATION AND DISTRIBUTION

Reported by: GREGORY LIDSTONE

Date Reported: 12/13/2022

Paper Copy: Lab File; Project File; Geotech File

62.4

55.3

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MaineDOT TESTING LABORATORIES

GEOTECHNICAL TEST REPORT Central Laboratory

S A M P L E IN F O R M A T I O N Reference No. Boring No./Sample No. Sample Description Sampled Received 303230 BB-VMB-102/2D GEOTECHNICAL (DISTURBED) 11/14/2022 12/7/2022 Sample Type: GEOTECHNICAL Location: Station: 103+89.9 Offset, ft: 9.7 LT Dbfg, ft: 10.0-12.0 WIN/Town 026442.00 - VASSALBORO Sample Type: GEOTECHNICAL Location: Station: 103+89.9 Offset, ft: 9.7 LT Dbfg, ft: 10.0-12.0 WIN/Town 026442.00 - VASSALBORO Sample Type: GEOTECHNICAL Location: Station: 103+89.9 Offset, ft: 9.7 LT Dbfg, ft: 10.0-12.0 WIN/Town 026442.00 - VASSALBORO Sample Type: GEOTECHNICAL Location: TE ST RESULTS Miscellaneous Tests Liquid Limit @ 25 blows (T 89), % 34 Plasticity Index (T 90), % 19 Blacking Index (T 90), % 19 Sieve Analysis (T 88) Miscellaneous Tests Liquid Limit @ 25 blows (T 89), % 34					ential	Labu	alor	y				
Reference No. Boring No./Sample No. Sample Description Sampled Received 303230 BB-VMB-102/2D GEOTECHNICAL (DISTURBED) 11/14/2022 12/7/2022 Sample Type: GEOTECHNICAL Location: Station: 103+89.9 Offset, ft: 9.7 LT Dbfg, ft: 10.0-12.0 WIN/Town 026442.00 - VASSALBORO Sampler: JAMES MANAHAN Sample: JAMES MANAHAN TEST RESULTS Miscellaneous Tests UN/Town 026442.00 - VASSALBORO Sample Type: JAMES MANAHAN TEST RESULTS Miscellaneous Tests Uiquid Limit (2 90), % 34 Plastic Limit (7 90), % 15 Specific Gravity Corrected to 20°C (T 100) 2.79 Loss on Ignition, % (T 267) Uses on Ignition, % (T 267) 3 in. [25.0 mm] Mater Content, % Pinings. Water Content, % No. 40 [0.425 mm] 99.6 Initial Final Void % Strain No. 40 [0.425 mm] 99.6 Pinings. Water Content, % Pinings. No. 40 [0.425 mm] 99.6 Initial Final Void % <td></td> <td></td> <td>S A</td> <td>MPL</td> <td>LEI</td> <td>NFO</td> <td>RM</td> <td>ΑΤΙ</td> <td>ΟΝ</td> <td></td> <td></td> <td></td>			S A	MPL	LEI	NFO	RM	ΑΤΙ	ΟΝ			
303230 BB-VMB-102/2D GEOTECHNICAL (DISTURBED) 11/14/202 12/7/2022 Sample Type: GEOTECHNICAL Location: Station: 103+89.9 Offset, ft: 9.7 LT Dbfg, ft: 10.0-12.0 Sampler: JAMES MANAHAN WIN/Town 026442.00 - VASSALBORO Sampler: JAMES MANAHAN Sampler: JAMES MANAHAN WIN/Town 026442.00 - VASSALBORO Sampler: JAMES MANAHAN Sampler: JAMES MANAHAN Sieve Analysis (T 88) Wash Method Image: Sampler Type: Sampl	Reference No.	Boring	No./Sample	e No.	Sample Description						Sampled	Received
Sample Type: GEOTECHNICAL Location: Station: 103+89.9 Offset, ft: 9.7 LT Dbfg, ft: 10.0-12.0 WIN/Town 026442.00 - VASSALBORO Sampler: JAMES MANAHAN TEST RESULTS Sieve Analysis (T 88) Wash Method Image: Colspan="2">Miscellaneous Tests SiEVE SIZE % 19 U.S. (SI) Passing 15 Sieve Analysis (T 89) 15 Sieve Size % 15 Vus. (SI) Passing 15 Sieve Content (T 90), % 15 Sieve Content, % 29.8 Vin (12.50 mm) Vater Content (T 266), % Vain (12.5 mm) Water Content (T 266), % Vin (12.60 mm) 100.0 No. 4 (4.75 mm) Modulo (0.00 No. 20 (0.850 mm) 100.0 No. 40 (0.425 mm) 99.6 No. 40 (0.250 mm) No. 100 (0.150 mm) No. 20 (0.755 mm) 99.2 [0.0220 mm] 88.9 [0.0147 mm] 86.3 [0.0070 mm] 59.3 Vane Shear Test on Shelby Tubes (Maine DOT)<	303230	BB-V	/MB-102	/2D						D)	11/14/2022	12/7/2022
Sender: JMESMANAHAN Wash Method Miscellaneous Tests Liquid Limit @ 25 blows (T 89), % 34 Neastor JMESMANAHAN Sieve Analysis (T 88) Miscellaneous Tests Liquid Limit @ 25 blows (T 89), % 34 Neastor JMESMANAHAN Sieve Analysis (T 88) Miscellaneous Tests Juit (J 100, % 15 Sieve Size % Name Consolidation (T 216) Misce Content, % Timmings, Water Content, % No. 20 [0.250 mm] No. 20 [0.250 mm] No. 20 [0.075 mm] 99.2 Operation (S 200) Net Content, % Pinate in the fin	Sample Type: GEO	TECHNIC	AL Loca	tion:		Station:	103+89	. 9 Of	fset, ft:		LT Dbfg, ft:	10.0-12.0
TEST RESULTS Sieve Analysis (T 88) Wash Method Miscellaneous Tests U.S. [SI] Passing 3 in. [75.0 mm] 19 1 in. [25.0 mm] Plastic limit (T 90), % 19 ½ in. [19.0 mm] Use [SI] Passing ½ in. [19.0 mm] Use [SI] Vash Method ½ in. [12.5 mm] Water Content (T 265), % 29.8 No. 4 [4.75 mm] Miscellaneous Tests Use [SI] ½ in. [12.5 mm] Water Content (T 265), % 29.8 No. 4 [0.425 mm] Miscellaneous (T 265), % 29.8 No. 4 [0.425 mm] No. 40 [0.425 mm] No. 40 [0.425 mm] No. 40 [0.425 mm] No. 20 [0.850 mm] No. 200 [0.075 mm] 99.6 No. 60 [0.250 mm] No. 200 [0.075 mm] No. 200 [0.075 mm] 99.2 Outed Ratio Presson CarCco [0.00220 mm] 88.9 3 ln. 6 ln. Water [0.0070 mm] 59.3 0.0052 mm] 51.3 0.0561 dustion ft ² tons/ft ²	WIN/Town 026442.0	0 - VASS	ALBORO		Sampler: JAMES MANAHAN							
Sieve Analysis (T 88) Miscellaneous Tests Wash Method 1 Sieve SiZE % U.S. [SI] Passing 3 in. [75.0 mm] 15 Specific Gravity, Corrected to 20°C (T 100) 2.79 Loss on Ignition, % (T 267) User Content, (T 265), % ½ in. [12.5 mm] 1 ½ in. [2.0 mm] 100.0 No. 10 [2.00 mm] 100.0 No. 20 [0.850 mm] 100.0 No. 20 [0.250 mm] 100.0 No. 40 [0.425 mm] 99.6 No. 200 [0.075 mm] 99.2 [0.0023 mm] 10.5 [0.0023 mm] 15.5 [0.0023 mm] 15.5 [0.0023 mm] 15.3 [0.0003 mm] 15.3 <t< td=""><td></td><td colspan="8"></td></t<>												
Sieve Analysis (T 88) Miscellaneous Tests Wash Method 1 SiEvE SiZE % U.S. (SI) Passing 3 in. [75.0 mm] 15 Specific Gravity. Corrected to 20°C (T 100) 2.79 Loss on Ignition. % (T 267) Water Content (T 265), % Vi.n. [12.5 mm] 1 % in. [9.5 mm] 1 No. 4 [4.75 mm] 1 No. 10 [2.00 mm] 100.0 No. 40 [0.425 mm] 99.6 No. 40 [0.425 mm] 99.6 No. 200 [0.075 mm] 99.2 [0.00220 mm] 88.9 [0.0147 mm] 81.5 [0.0023 mm] 0.51.9 [0.0033 mm] 1 [0.0047 mm] 15.9 [0.0023 mm] 51.9 [0.0023 mm] 15.9 [0.0023 mm] 51.9 [0.0023 mm] 51.9 [0.0070 mm]												
Liquid Limit @ 25 blows (T 89). % 34 Wash Method Plastic Limit (T 90). % 19 SIEVE SIZE % Siever Size % U.S. [SI] Passing Siever Size % 15 Siever Size % Plastic Limit (T 90). % 15 Siever Size % Plastic Limit (T 90). % 15 Siever Size Passing Siever Size % 29.8 3 in. [19.0 mm] Mater Content (T 265). % 29.8 29.8 ½ in. [12.5 mm] Mater Content (T 265). % 29.8 29.8 ½ in. [12.5 mm] Mater Content, % Initial Final Void % ½ in. [12.5 mm] Mater Content, % Initial Final Ratio Strain № 0. 10 [2.00 mm] 100.0 No. 20 [0.425 mm] 99.6 No. 100 [0.150 mm] Dry Density, Ibs/ft ³ Pp Initial Final Void % Strain No. 200 [0.075 mm] 99.2 Void Ratio Pmax Initial Strain Sturation, % Cc/C'c Initial Staturation, % Cc/C'c Initial Staturation, % Staturation, % Staturation, % Staturation, % Destription of	Sieve Analysis (T 88)				Mi	scellar	neous	Tests	5		
Wash Method 19 Wash Method Plastic Limit (T 90), % 15 SIEVE SIZE % Passing 3 in. [75.0 mm] 1 SiEVE Size 1 in. [25.0 mm] 4 1 ½ in. [19.0 mm] 4 1 ½ in. [19.0 mm] 1 1 ½ in. [12.5 mm] 4 1 ½ in. [12.5 mm] 1 1 ½ in. [2.5 mm] 1 1 No. 10 [2.00 mm] 100.0 No. 200 [0.850 mm] No. 200 [0.75 mm] 99.6 No. 100 [0.150 mm] 1 No. 200 [0.75 mm] 99.2 [0.0220 mm] 88.9 [0.0033 mm] 69.1 [0.0047 mm] </td <td></td> <td>,</td> <td></td> <td>Liq</td> <td>uid Limit @ 2</td> <td>5 blows (T</td> <td>39), %</td> <td></td> <td></td> <td></td> <td>34</td> <td></td>		,		Liq	uid Limit @ 2	5 blows (T	39), %				34	
SIEVE SIZE U.S. [SI] % Passing 3 in. [75.0 mm] 15 3 in. [75.0 mm] Loss on Ignition, % (T 267) 1 in. [25.0 mm] Water Content (T 265), % 2 in. [12.5 mm] % ½ in. [12.5 mm] Main [19.0 mm] ½ in. [12.5 mm] Main [19.0 mm] ½ in. [12.5 mm] Main [19.0 mm] ½ in. [12.5 mm] Main [10.0 mm] No. 4 [4.75 mm] Main [10.0 mm] No. 4 [4.75 mm] Main [10.0 mm] No. 40 [0.425 mm] 99.6 No. 60 [0.250 mm] 99.6 No. 100 [0.150 mm] Dry Density, Ibs/ft ² Pp Void Ratio Pmax J0.0220 mm] 88.9 [0.0147 mm] 81.5 [0.0093 mm] 69.1 [0.0070 mm] 59.3 [0.0052 mm] 51.9	Wash Metho	d		Pla	astic Limit (T 9	90), %					19	
SIEVE SIZE U.S. [SI] % Passing 3 in. [75.0 mm] 1 1 in. [25.0 mm] 29.8 1 in. [25.0 mm] 29.8 ½ in. [19.0 mm] 29.8 ½ in. [12.5 mm] 29.8 ½ in. [12.5 mm] 1 ½ in. [12.0 mm] 1 No. 4 [4.75 mm] 1 No. 40 [0.425 mm] 99.6 No. 40 [0.425 mm] 99.6 No. 200 [0.75 mm] 99.2 [0.0220 mm] 88.9 [0.0147 mm] 81.5 [0.0093 mm] 69.1 [0.0093 mm] 69.1 [0.0052 mm] 51.9 1 1 10.0052 mm] 51.9				Pla	asticity Index (T 90), %					15	
U.S. [SI] Passing 3 in. [75.0 mm] Loss on Ignition, % (T 267) 4 in. [25.0 mm] Water Content (T 265), % 29.8 1 in. [25.0 mm] ½ in. [12.5 mm] № (11.6 mm]	SIEVE SIZE	%		Spe	ecific Gravity,	Corrected	to 20°C (T	100)			2.79	
3 in. [75.0 mm] Image: marked state in the state i	U.S. [SI]	Passing		Loss on Ignition, % (T 267)								
1 in. [25.0 mm] ¾ in. [19.0 mm] ¼ in. [12.5 mm] ⅓ in. [9.5 mm] ¼ in. [6.3 mm] № 14 [4.75 mm] № 10 [2.00 mm] 100.0 № 20 [0.850 mm] № 10 [2.00 mm] 100.0 № 20 [0.850 mm] 100.0 № 40 [0.425 mm] 99.6 № 100 [0.150 mm] 0rg Density, lbs/ft ³ № 20 [0.075 mm] 99.2 [0.0220 mm] 88.9 [0.0147 mm] 81.5 [0.0093 mm] 69.1 [0.0070 mm] 59.3 [0.0052 mm] 51.9 14 for bert 10 soft/t ² 10.0052 mm] 51.9	3 in. [75.0 mm]			Water Content (T 265), %						29.8		
³ ⁄ ₄ in. [19.0 mm] ³ ⁄ ₄ in. [2.5 mm] ³ ⁄ ₄ in. [9.5 mm] ³ ⁄ ₄ in. [9.5 mm] ³ ⁄ ₄ in. [6.3 mm] No. 4 [4.75 mm] No. 10 [2.00 mm] 100.0 No. 10 [2.00 mm] 100.0 No. 20 [0.850 mm] Initial Final Void % No. 40 [0.425 mm] 99.6 No. 40 [0.425 mm] 99.6 No. 100 [0.150 mm] 99.2 Carl Color Pmax Dry Density, lbs/ft ³ Propering No. 200 [0.075 mm] 99.2 Description of Material Sampled at the U. Shear Saturation, % Color Consolidation theorem of table theorem of tables theorem of table theorem of tables theorem of table	1 in. [25.0 mm]											
½ in. [12.5 mm]	³ ⁄ ₄ in. [19.0 mm]											
3% in. [9.5 mm] Trimmings, Water Content, % 14 in. [6.3 mm] Trimmings, Water Content, % No. 4 [4.75 mm] Initial Final Void % No. 10 [2.00 mm] 100.0 Water Content, % Pmin Pmin No. 20 [0.850 mm] 99.6 No. 40 [0.425 mm] 99.6 Pry Density, lbs/ft³ Pp Imitial Pmax Imitial Pmax Imitial Pinal District Content, % Provide Ratio Strain No. 40 [0.425 mm] 99.6 Void Ratio Pmin Pp Imitial Pinal Imitial Pinal Imitial Pinal Imitial Pinal Imitial Strain Imitial Pinal Imitial Imitial Imitial Imitial Pinal Imitial Imiti	½ in. [12.5 mm]					Co	hiloan	ation	(T 216	3		
1/4 in. [6.3 mm] Trimmings, Water Content, % No. 4 [4.75 mm] Initial Final Void % No. 10 [2.00 mm] 100.0 Water Content, % Pmin No. 40 [0.425 mm] 99.6 No. 40 [0.425 mm] 99.6 Origonal Strain Product Strain Product Strain No. 40 [0.425 mm] 99.6 Origonal Strain Product Strain Product Strain No. 40 [0.425 mm] 99.6 Origonal Strain Product Strain Product Strain No. 100 [0.150 mm] 99.2 Origonal Strain Product Strain Product Strain No. 200 [0.075 mm] 99.2 Origonal Strain Saturation, % Cc/C'c Depth Initial Final Water Content, % Product Strain Product Strain No. 200 [0.075 mm] 99.2 Origonal Strain Saturation, % Cc/C'c Depth [0.0147 mm] 81.5 Depth 3 In. 6 In. Water Description of Material Sampled at the tons/ft² [0.0052 mm] 51.9 Strain Description of Material Sampled at the tons/ft² Description Strain Description Strain [0.0052 mm]	¾ in. [9.5 mm]						1301146			')		
No. 4 [4.75 mm] Initial Final Void % No. 10 [2.00 mm] 100.0 Water Content, % Pinitial Pinitial Pinitial Ratio Strain No. 20 [0.850 mm] 0.425 mm] 99.6 Dry Density, lbs/ft ³ Pp Imitial Pinitial Pinitial Pinitial Pinitial % No. 40 [0.425 mm] 99.6 Order Content, % Imitial Pinitial Pinitial Pinitial Pinitial Pinitial Pinitial Pinitial % No. 40 [0.425 mm] 99.6 Order Content, % Imitial Pinitial	¹ / ₄ in. [6.3 mm]				Т	rimmings,	Nater Con	itent, %				
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No. 20 [0.850 mm] Water Content, % Pmin Pmin No. 40 [0.425 mm] 99.6 No. 60 [0.250 mm] Pp No. 100 [0.150 mm] Void Ratio Pmax No. 200 [0.075 mm] 99.2 [0.0220 mm] 88.9 [0.0147 mm] 81.5 [0.0093 mm] 69.1 [0.0070 mm] 59.3 [0.0052 mm] 51.9	No. 10 [2.00 mm]	100.0				A (D ·	Rati	o Strain	
No. 40 [0.425 mm] 99.6 No. 60 [0.250 mm] Pp No. 100 [0.150 mm] Void Ratio No. 200 [0.075 mm] 99.2 [0.0220 mm] 88.9 [0.0147 mm] 81.5 [0.0093 mm] 69.1 [0.0070 mm] 59.3 [0.0052 mm] 51.9	No. 20 [0.850 mm]			VV	ater Content,	%			Pmin	_		
No. 60 [0.250 mm] Void Ratio Pmax No. 100 [0.150 mm] Saturation, % Cc/C'c No. 200 [0.075 mm] 99.2 [0.0220 mm] 88.9 [0.0147 mm] 81.5 [0.0093 mm] 69.1 [0.0070 mm] 59.3 [0.0052 mm] 51.9	No. 40 [0.425 mm]	99.6		Dr	ry Density, Ibs	s/ft ³			Pp -			
No. 100 [0.150 mm] Saturation, % Cc/Cc No. 200 [0.075 mm] 99.2 [0.0220 mm] 88.9 [0.0147 mm] 81.5 [0.0093 mm] 69.1 [0.0070 mm] 59.3 [0.0052 mm] 51.9	No. 60 [0.250 mm]			Vc	bid Ratio				Pmax	_		
No. 200 [0.075 mm]99.2[0.0220 mm]88.9[0.0147 mm]81.5[0.0093 mm]69.1[0.0070 mm]59.3[0.0052 mm]51.9	No. 100 [0.150 mm]			Sa	aturation, %				Cc/C'c			
[0.0220 mm]88.9Varie Sitear Test on Siterby Tubes (Warie DOT)[0.0147 mm]81.5[0.0093 mm]69.1[0.0070 mm]59.3[0.0052 mm]51.9	No. 200 [0.075 mm]	99.2		١	Jana Sha	or Too	ton Sh	alby	Tubos	Mai		
Depth S fill O beth [0.0093 mm] 69.1 [0.0070 mm] 59.3 [0.0052 mm] 51.9	[0.0220 mm]	00.9 04 E							Tubes	(Iviali	lie DOT)	
[0.0093 mm] 69.1 Constrained Constrained <thc< td=""><td>[0.0147 mm]</td><td>81.5</td><td colspan="6">Depth 3 IN. 6 IN. Water taken in U. Shear Remold U. Shear Remold Content Description of Material St</td><td>ampled at the</td></thc<>	[0.0147 mm]	81.5	Depth 3 IN. 6 IN. Water taken in U. Shear Remold U. Shear Remold Content Description of Material St						ampled at the			
[0.0052 mm] 51.9	[0.0093 mm]	09.1 50.2	tube, ft	tons/ft ²	tons/ft ²	t^2 tons/ft ² tons/ft ² %			Various Tube Depths			
	[0.0070 mm]	55.5										
[0 0027 mm] 37 0	[0.0032 mm]	37.0										
[0.0027 mm] 37.0	[0.0027 mm]	27.2										

Comments:

AUTHORIZATION AND DISTRIBUTION

Reported by: GREGORY LIDSTONE

TOWN	Vassalboro	Reference No.	303230
WIN	026442.00	Water Content, %	29.8
Sampled	11/14/2022	Liquid Limit @ 25 blows (T 89), %	34
Boring No./Sample No.	BB-VMB-102/2D	Plastic Limit (T 90), %	19
Station	103+89.9	Plasticity Index (T 90), %	15
Depth	10.0-12.0	Tested By	BBURR



🟥 MaineDOT

MaineDOT TESTING LABORATORIES

GEOTECHNICAL TEST REPORT Central Laboratory

		S A	ΜP	LE		NFO	RM	ΑΤ	10	N			
Reference No.	ference No. Boring No./Sample No.			Sample Description							Sampled	Received	
303231	BB-\	/MB-102	/MB-102/3D			GEOTECHNICAL (DISTURBED)						11/14/2022	12/7/2022
Sample Type: GEO	TECHNIC	AL Loca	ation:		J	Station:	103+8	9.9 C	Offset,	ft: 9.7	7 L1	Dbfg, ft:	15.0-15.5
WIN/Town 026442.0	0 - VASS	ALBORO							Sam	pler: J		S MANAH	AN
			т	EG	с т	DES	11.1	те				-	
Sieve Analysis (T 88)					Mi	scella	neou	s Tes	sts			
	,		Liquid Limit @ 25 blows (T 89), %										
Wash Metho	d		F	Plastic	Limit (T 9	90), %							
			F	Plastici	ity Index (T 90), %							
SIEVE SIZE	%		\$	Specifi	c Gravity,	Corrected	to 20°C (T 100)			2	.77	
U.S. [SI]	Passing		Loss or	oss on Ignition, % (T 267)									
3 in. [75.0 mm]			Water Content (T 265), %						2	3.9			
1 in. [25.0 mm]													
¾ in. [19.0 mm]													
½ in. [12.5 mm]			Γ			Co	neolic	lation	(T 2 [,]	16)			
¾ in. [9.5 mm]			_										
¼ in. [6.3 mm]					Т	rimmings,	Water Co	ontent, %)				
No. 4 [4.75 mm]							Initial	Final		<u>\</u>	Void	%	
No. 10 [2.00 mm]	100.0		-		<u> </u>	21				F	Ratio	Strain	
No. 20 [0.850 mm]			-	Water	Content,	%			Pmir	1			
No. 40 [0.425 mm]	99.8		-	Dry De	ensity, lbs	s/ft ³			Pp				
No. 60 [0.250 mm]			-	Void F	Ratio				Pma	IX No.			
No. 100 [0.150 mm]				Satura	ation, %				CC/C	C			
NO. 200 [0.075 mm]	98.8			Var	no Sha	ar Toe	t on S	holby	/ Tub	06 (M	aino		
[0.027 mm]	52.4		vane Snear Test on Sneiby Tubes (Maine DOT)										
[0.0179 mm]	55.T	Depth 3 In. taken in U. Shear Remold U. Sh			U. Shear	Remo	Id Con	ater	Descri	iption	of Material S	ampled at the	
[0.0110 mm]	40.4 22.8	tube, ft	tons/	ft²	tons/ft ²	tons/ft ²	tons/f	ťt²	%		Var	ious Tube D	epths
[0.0001 mm]	28.9												
[0.0030 mm]	19.3												
[0.0000 mm]	12.1												
	12.1												

Comments:

Insufficient material for Atterburg Limits.

AUTHORIZATION AND DISTRIBUTION

Reported by: GREGORY LIDSTONE

Date Reported: 1/4/2023

🙆 MaineDOT

MaineDOT TESTING LABORATORIES

GEOTECHNICAL TEST REPORT Central Laboratory

	S A	MPLE	INFORMA	ΤΙΟΝ			
Reference No.	Boring No./Samp	ole No.	Sample Descr	ription	Sampled	Received	
303232	BB-VMB-10	2/4D	<u>GEOTECHNICAL (D</u>	ISTURBED)	11/14/2022	12/7/2022	
Sample Type: G	EOTECHNICAL Loc	cation:	Station: 103+89.9	Offset, ft: 9.7	LT Dbfg, ft:	20.0-21.8	
WIN/Town 02644	12.00 - VASSALBORO			Sampler: J A	MES MANAH	AN	
		TEST	RESULTS	5			
Sieve Analysis	(T 27, T 11)	27. T 11)		Miscellaneous Tests			
		Liquid Limit @) 25 blows (T 89), %				

Wash Method						
Procedure A	L .					
SIEVE SIZE U.S. [SI]	% Passing					
3 in. [75.0 mm]						
1 in. [25.0 mm]	100.0					
¾ in. [19.0 mm]	96.7					
½ in. [12.5 mm]	95.4					
¾ in. [9.5 mm]	94.9					
¼ in. [6.3 mm]	93.8					
No. 4 [4.75 mm]	93.2					
No. 10 [2.00 mm]	90.9					
No. 20 [0.850 mm]	88.6					
No. 40 [0.425 mm]	86.8					
No. 60 [0.250 mm]	84.6					
No. 100 [0.150 mm]	79.9					
No. 200 [0.075 mm]	62.9					

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), % 16.7

Consolidation (T 216)							
Trimmings, Water Content, %							
	Initial	Final		Void Ratio	% Strain		
Water Content, %			Pmin				
Dry Density, lbs/ft ³			Рр				
Void Ratio			Pmax				
Saturation, %			Cc/C'c				

Vane Shear Test on Shelby Tubes (Maine DOT)

Depth	3	3 In.		6 In.		
taken in	U. Shear	Remold	U. Shear	Remold	Content,	Description of Material Sampled at the
tube, ft	tons/ft ²	tons/ft ²	tons/ft ²	tons/ft ²	%	various Tube Depths

Comments:

AUTHORIZATION A N D DISTRIBUTION

Reported by: GREGORY LIDSTONE

One-Dimensional Consolidation by ASTM D2435 - Method B





					Before Test	After Test
Current Vertical Effect	ive Stress:			Water Content, %	33.71	22.18
Preconsolidation Stres	SS:			Dry Unit Weight, pcf	89.583	105.66
Compression Ratio:			Saturation, %	102.81	100.00	
Diameter: 2.495 in Height: 1.002 in			Void Ratio	0.89	0.60	
LL: 21	PL: 15	PI: 6	GS: 2.71			

	Project: Vassalboro	Location:	Project No.: 26442.00				
	Boring No.: BB-VMB-101	Tested By: GSL	Checked By:				
	Sample No.: 1U	Test Date: 1/5/2023	Test No.: 303226				
	Depth: 5.0-7.0 FT	Sample Type: Intact	Elevation:				
	Description: Grey Clay						
	Remarks: Maine Sensitive Loading/Unloading Sequence						
	Displacement at End of Increment						

One-Dimensional Consolidation by ASTM D2435 - Method B





					Before Test	After Test
Current Vertical Effect	ive Stress:			Water Content, %	33.71	22.18
Preconsolidation Stres	SS:			Dry Unit Weight, pcf	89.583	105.66
Compression Ratio:			Saturation, %	102.81	100.00	
Diameter: 2.495 in Height: 1.002 in			Void Ratio	0.89	0.60	
LL: 21	PL: 15	PI: 6	GS: 2.71			

	Project: Vassalboro	Location:	Project No.: 26442.00				
	Boring No.: BB-VMB-101	Tested By: GSL	Checked By:				
	Sample No.: 1U	Test Date: 1/5/2023	Test No.: 303226				
	Depth: 5.0-7.0 FT	Sample Type: Intact	Elevation:				
	Description: Grey Clay						
	Remarks: Maine Sensitive Loading/Unloading Sequence						
	Displacement at End of Increment						

Project: Vassalboro Boring No.: BB-VMB-101 Sample No.: 1U Test No.: 303226

Location: --Tested By: GSL Test Date: 1/5/2023 Sample Type: Intact

Soil Description: Grey Clay Remarks: Maine Sensitive Loading/Unloading Sequence

Measured Specific Gravity: 2.71 Initial Void Ratio: 0.889 Final Void Ratio: 0.601	Liquid Limit: Plastic Limit: Plasticity Ind	21 15 ex: 6	Specimen Diameter Initial Height: 1 Final Height: 0.8	: 2.50 in .00 in 5 in
	Before C	onsolidation	After Conso	lidation
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
Container ID	173	RING	RING & BASE	208
Wt. Container + Wet Soil, gm	104.51	416.06	402.78	204.12
Wt. Container + Dry Soil, gm	92.600	377.23	377.23	178.81
Wt. Container, gm	52.290	262.03	262.03	64.700
Wt. Dry Soil, gm	40.310	115.20	115.20	114.11
Water Content, %	29.55	33.71	22.18	22.18
Void Ratio		0.889	0.601	
Degree of Saturation, %		102.81	100.00	
Dry Unit Weight, pcf		89.583	105.66	

Project: Vas	salboro
Boring No.:	BB-VMB-101
Sample No.:	1U
Test No.: 30)3226

Location: --Tested By: GSL Test Date: 1/5/2023 Sample Type: Intact Project No.: 26442.00 Checked By: --Depth: 5.0-7.0 FT Elevation: --

Soil Description: Grey Clay Remarks: Maine Sensitive Loading/Unloading Sequence

Displacement at End of Increment

	Applied	Final	Void	Strain	Sq.Rt				
	Stress	Displacement	Ratio	at End	Т90	Cv	Mv	k	
	tsf	in		8	min	ft²/sec	1/tsf	ft/day	
1	0.0676	0.04485	0.804	4.48	17.847	1.32e-006	6.62e-001	2.36e-003	
2	0.125	0.05486	0.785	5.48	6.989	3.18e-006	1.74e-001	1.49e-003	
3	0 250	0 06617	0 764	6 60	7 943	2 740-006	9 030-002	6 67e-004	
1	0.200	0 09291	0.732	9.26	7 511	2.910-006	6.640-002	5.030-004	
4	1 00	0.00201	0.752	10 0	7.511	2.010-000	5 20c 002	2 020 004	
Ś	1.00	0.1095	0.002	10.9	/.JIZ	2.000-000	2.20- 002	3.630-004	
0	2.00	0.1414	0.022	14.1	0.410	2.940-000	3.200-002	2.340-004	
/	4.00	0.1/30	0.562	17.3	3.343	5.240-006	1.58e-002	2.23e-004	
8	8.00	0.2049	0.502	20.4	2.080	7.80e-006	7.94e-003	1.6/e-004	
9	4.00	0.2007	0.510	20.0	0.204	7.69e-005	1.03e-003	2.15e-004	
10	2.00	0.1962	0.519	19.6	0.422	3.75e-005	2.23e-003	2.26e-004	
11	1.00	0.1917	0.527	19.1	0.780	2.05e-005	4.51e-003	2.50e-004	
12	0.500	0.1874	0.535	18.7	2.643	6.13e-006	8.70e-003	1.44e-004	
13	1.00	0.1900	0.530	19.0	1.653	9.82e-006	5.27e-003	1.39e-004	
14	2.00	0.1941	0.523	19.4	0.596	2.70e-005	4.14e-003	3.02e-004	
15	4.00	0.1999	0.512	20.0	0.495	3.21e-005	2.87e-003	2.49e-004	
16	8.00	0.2118	0.489	21.1	1.920	8.10e-006	2.97e-003	6.49e-005	
17	16.0	0.2400	0.436	23.9	1.357	1.09e-005	3.51e-003	1.03e-004	
18	4.00	0.2284	0.458	22.8	1.344	1.08e-005	9.63e-004	2.79e-005	
19	1.00	0.2181	0.478	21.8	0.769	1.93e-005	3.44e-003	1.79e-004	
20	0.250	0.2075	0.497	20.7	3.168	4.82e-006	1.40e-002	1.83e-004	
21	0.0625	0.1973	0.517	19.7	10.276	1.53e-006	5.42e-002	2.23e-004	
	Applied	Final	Void	Strain	Log				
	Stress	Displacement	Ratio	at End	T50	Cv	Mtz	k	Ca
	tsf	in	10020	40 <u>2</u> .1.4	min	ft²/sec	1/tsf	ft/dav	8
	001	±		0		20 ,000	1,001	20,001	0
1	0.0676	0.04485	0.804	4.48	2.291	2.39e-006	6.62e-001	4.26e-003	0.00e+000
2	0.125	0.05486	0.785	5.48	1.897	2.72e-006	1.74e-001	1.28e-003	0.00e+000
3	0.250	0.06617	0.764	6.60	1.975	2.56e-006	9.03e-002	6.23e-004	0.00e+000
4	0.500	0.08281	0.732	8.26	1.889	2.60e-006	6.64e-002	4.65e-004	0.00e+000
5	1.00	0.1093	0.682	10.9	1.985	2.36e-006	5.30e-002	3.37e-004	0.00e+000
6	2.00	0.1414	0.622	14.1	1.207	3.63e-006	3.20e-002	3.13e-004	0.00e+000
7	4.00	0.1730	0.562	17.3	0.698	5.83e-006	1.58e-002	2.48e-004	0.00e+000
8	8.00	0.2049	0.502	20.4	0.448	8.40e-006	7.94e-003	1.80e-004	0.00e+000
9	4.00	0.2007	0.510	20.0	0.000	0.00e+000	1.03e-003	0.00e+000	0.00e+000
10	2.00	0.1962	0.519	19.6	0.000	0.00e+000	2.23e-003	0.00e+000	0.00e+000
11	1.00	0.1917	0.527	19.1	0.198	1.88e-005	4.51e-003	2.29e-004	0.00e+000
12	0 500	0 1874	0 535	18 7	0 484	7 770-006	8 70e-003	1 82e-004	0 000+000
13	1 00	0 1900	0.530	19.0	0 000	0 000+000	5 270-003	0 00e+000	0 000+000
1 /	2 00	0.1941	0.523	19.0	0.000	2 880-005	4 140-003	3 220-004	0.000+000
15	2.00	0.1994	0.525	20 0	0.120	3 080-005	2 876-003	2 396-004	0 000+000
16	4.00	0.1399	0.012	20.0	0.120	2 040-005	2 970-003	1 630-004	0.000+000
17	0.00	0.2118	0.409	22.1	0.1//	2.040-005	2.9/0-003	1 530-004	0.00000000
1 0	10.0	0.2400	0.430	23.9	0.213	T.016-002	0.620.004	1.330-004	0.00000000
10	4.00	0.2284	0.438	22.0	0.000	1 640 005	2 440 002	1 520 004	0.00000000
13	1.00	0.2181	0.4/8	21.8	U.ZII 1 002	1.040-005	3.44e-003	1.04-004	0.000+000
20	0.250	0.20/5	0.49/	20.7	1.083	3.28e-006	1.40e-002	1.24e-004	0.00e+000
21	0.0625	0.1973	0.517	19.7	4.134	8.82e-007	5.42e-002	1.29e-004	U.UUe+000

11/18/2024 MAINE DEPARTMENT OF TRANSPORTATION MEADOW BROOK BRIDGE NO. 5856 CULVERT REPLACEMENT 09.0026222.00



APPENDIX E – CALCULATIONS

	ULI I	Engineers and	JOB Meadow Brook Bridge No. 5856				
	GeoEnvironmental, Inc.	Scientists	SHEET NO	,			
	South Portland, ME 04106		Calculated By B.Cardali	Date October 24, 202			
	http://www.gza.com		Checked By C.Snow	Date October X, 2024			
			Scale				
Objective: C	alculate the net pressure from the e	xisting culverts and the proposed cul	lvert at the elevation of the bottor	n of the proposed			
bearing pad.							
Existing Brid	ge Sketch and Pressure Calculat	ion:					
	<u> </u>						
	\rightarrow	Existing Bridge		El. 168' Approx			
				164			
				El. 160' Approx			
			2'-7"				
	4 ⁻ 5 ⁻	Marine Clay					
	<u> </u>						
bearing stratu structure span stress at the b Average effec	The matter is the recent boring drille m. However, the recent boring drille s the marine clay, whereas the prop earing elevation is based on the so tive stress in channel = (120 pcf - 62	d through the bridge and in the streat bosed structure will partially bear dire is between the existing abutments. 2.4 pcf) x 4.5') = 260 psf	The plans do not indicate the as- m indicates Marine clay is prese ectly on the clay. Therefore the ex	-built elevations or nt. The existing kisting effective			
bearing stratu structure spar stress at the b Average effec Proposed Box	cale that the footings should be exit m. However, the recent boring drille is the marine clay, whereas the prop earing elevation is based on the soi tive stress in channel = (120 pcf - 62 culvert Sketch and Pressure Ca	d through the bridge and in the streat posed structure will partially bear dire ils between the existing abutments. 2.4 pcf) x 4.5') = 260 psf	The plans do not indicate the as im indicates Marine clay is presen actly on the clay. Therefore the ex	-built elevations or nt. The existing fisting effective			
bearing stratu structure spar stress at the b Average effec ' <u>roposed Box</u>	cale that the recent boring drille m. However, the recent boring drille is the marine clay, whereas the prop earing elevation is based on the soi tive stress in channel = (120 pcf - 62 <u>culvert Sketch and Pressure Ca</u>	d through the bridge and in the strea bosed structure will partially bear dire is between the existing abutments. 2.4 pcf) x 4.5') = 260 psf Iculation:	The plans do not indicate the as im indicates Marine clay is presel actly on the clay. Therefore the ex	-built elevations or nt. The existing isting effective			
bearing stratu structure spar stress at the b Average effec roposed Box	cale that the footings should be exit m. However, the recent boring drille s the marine clay, whereas the prop earing elevation is based on the soi tive stress in channel = (120 pcf - 62 Culvert Sketch and Pressure Ca	Induction of the bridge and in the streat posed structure will partially bear dire is between the existing abutments. 2.4 pcf) x 4.5') = 260 psf Iculation: 19'-0" Fill	The plans do not indicate the as im indicates Marine clay is presen ectly on the clay. Therefore the ex El. 168	-built elevations or nt. The existing isting effective			
bearing stratu structure spar stress at the b Average effec roposed Box	cale that the footings should be exit m. However, the recent boring drille is the marine clay, whereas the prop earing elevation is based on the soi tive stress in channel = (120 pcf - 62 <u>culvert Sketch and Pressure Ca</u>	Induction of the bridge and in the streat posed structure will partially bear dire ils between the existing abutments. 2.4 pcf) x 4.5') = 260 psf Iculation: 19-0" Fill	The plans do not indicate the as im indicates Marine clay is presel ectly on the clay. Therefore the ex 	^b Ull elevations or nt. The existing fisting effective			
earing stratu tructure spar tress at the b Average effec	cale that the footings should be exit m. However, the recent boring drille is the marine clay, whereas the prop earing elevation is based on the sol tive stress in channel = (120 pcf - 62 <u>culvert Sketch and Pressure Ca</u>	Induction and the bridge and in the streat posed structure will partially bear dire is between the existing abutments. 2.4 pcf) x 4.5') = 260 psf Iculation: 19'-0" Fill	The plans do not indicate the as im indicates Marine clay is presen ectly on the clay. Therefore the ex El. 168	^b Ull elevations or nt. The existing isting effective			
bearing stratu structure spar stress at the b Average effec roposed Box	cale that the footings should be exit m. However, the recent boring drille is the marine clay, whereas the prop earing elevation is based on the soi tive stress in channel = (120 pcf - 62 culvert Sketch and Pressure Ca	Include to a strain of the bridge and in the streat posed structure will partially bear dire is between the existing abutments. 2.4 pcf) x 4.5') = 260 psf Iculation:	The plans do not indicate the as im indicates Marine clay is presen ectly on the clay. Therefore the ex El. 168	-Duilt elevations or nt. The existing risting effective			
earing stratu tructure spar tress at the b verage effec roposed Box	cale that the recent boring drille m. However, the recent boring drille is the marine clay, whereas the prop earing elevation is based on the sol tive stress in channel = (120 pcf - 62 <u>culvert Sketch and Pressure Ca</u>	Include to a stratule bridge and in the streat posed structure will partially bear dire lis between the existing abutments. 2.4 pcf) x 4.5') = 260 psf Iculation: 19'-0" Fill 1'-0" 17.0 ft	The plans do not indicate the as im indicates Marine clay is presel ectly on the clay. Therefore the ex 	^b Ull elevations or nt. The existing isting effective			
bearing stratu structure span stress at the b Average effec roposed Box	cale that the rocent boring drille m. However, the recent boring drille s the marine clay, whereas the prop earing elevation is based on the soi tive stress in channel = (120 pcf - 62 Culvert Sketch and Pressure Ca	Induction and the bridge and in the streat posed structure will partially bear dire is between the existing abutments. 2.4 pcf) x 4.5') = 260 psf Iculation: 19'-0" Fill 11'-0" 17.0 ft	The plans do not indicate the as im indicates Marine clay is presen- ectly on the clay. Therefore the ex- El. 168	Pull elevations or nt. The existing disting effective			
bearing stratu structure spar stress at the b Average effec roposed Box	cale that the recent boring drille m. However, the recent boring drille is the marine clay, whereas the prop earing elevation is based on the sol tive stress in channel = (120 pcf - 62 culvert Sketch and Pressure Ca	Include to a stratule bridge and in the streat posed structure will partially bear dire lis between the existing abutments. 2.4 pcf) x 4.5') = 260 psf Iculation: Inculation: Inc	The plans do not indicate the as im indicates Marine clay is presen- ectly on the clay. Therefore the ex- ectly on the cla	Pull elevations or nt. The existing risting effective			
bearing stratu structure spar stress at the b Average effec	cale that the footings should be exit m. However, the recent boring drille is the marine clay, whereas the prop earing elevation is based on the sol tive stress in channel = (120 pcf - 62 Culvert Sketch and Pressure Ca	Ended to a sinable bridge and in the streat posed structure will partially bear dire lis between the existing abutments. 2.4 pcf) x 4.5') = 260 psf Iculation: 19'-0" Fill 11'-0" 17.0 ft 5 Fill	The plans do not indicate the as im indicates Marine clay is presen- ectly on the clay. Therefore the ex- El. 168	^b Ull felevations or nt. The existing sisting effective			
bearing stratu structure spar stress at the b Average effec roposed Boy	cale that the roburngs should be exit m. However, the recent boring drille is the marine clay, whereas the prop earing elevation is based on the soil tive stress in channel = (120 pcf - 62 Culvert Sketch and Pressure Ca	Include to a solution of the stream of the bridge and in the stream opsed structure will partially bear direly bear dir	The plans do not indicate the as im indicates Marine clay is presen- ectly on the clay. Therefore the ex- El. 168	-built elevations or nt. The existing sisting effective			
pearing stratu structure spar stress at the b Average effec roposed Box	Cale that the lookings should be exit m. However, the recent boring drille is the marine clay, whereas the properties earing elevation is based on the solution tive stress in channel = (120 pcf - 62 Culvert Sketch and Pressure Ca	Ended to a solution rayer. In the bridge and in the streat posed structure will partially bear direly bear di	The plans do not indicate the as im indicates Marine clay is presen- setly on the clay. Therefore the ex- El. 168	2' Apprx.			
Average effector Troposed Box Troposed Box Troposed Box Troposed Box Troposed Box Troposed Box Troposed Box Troposed Box	cale that the footings should be exit m. However, the recent boring drille is the marine clay, whereas the prop earing elevation is based on the sol tive stress in channel = (120 pcf - 62 Culvert Sketch and Pressure Ca Culvert Sketch and Pressure Ca $1^{-}0^{-}$	Ended to a suitable bridge and in the streat posed structure will partially bear dire is between the existing abutments. 2.4 pcf) x 4.5') = 260 psf Iculation: 19'-0" Fill 1'-0" Fill Crushed Stone Base	The plans do not indicate the as im indicates Marine clay is presen- ectly on the clay. Therefore the ex- El. 168	-built elevations or ht. The existing sisting effective P Apprx. -2' Apprx.			
Average effector Troposed Box Troposed Bo	cale that the lookings should be exit m. However, the recent boring drille is the marine clay, whereas the properties arring elevation is based on the solution tive stress in channel = (120 pcf - 62 Culvert Sketch and Pressure Ca Culvert Sketch and Pressure Ca $\frac{1}{2}$ \frac	feet = 411 psf	The plans do not indicate the as im indicates Marine clay is presen- ectly on the clay. Therefore the ex- ectly on the cla	-Duilt elevations or nt. The existing isting effective 3' Apprx. .2' Apprx.			
Average effector Troposed Box Troposed Bo	cale that the footings should be exit m. However, the recent boring drille is the marine clay, whereas the prop earing elevation is based on the sol tive stress in channel = (120 pcf - 62 Culvert Sketch and Pressure Ca Culvert Sketch and Pressure Ca $1^{-0^{-1}}$ $1^{-0^{-1}}$ $1^{-0^{-1}}$ to x culvert = 7' x 17' = 119 sf crete = [(2(18+8)) x 1 x150 pcf]/ 19 theore, Fill in (2'), and Crushed Store	feet = 411 psf e below box = (2.8' x 125 pcf) + (2' x	The plans do not indicate the as im indicates Marine clay is presen- ectly on the clay. Therefore the ex- El. 168 160.4' El. 156 El. 156 El. 156	 built elevations or nt. The existing isting effective 8' Apprx. .2' Apprx. .2' Apprx. .5) = 653 psf 			
Area of open b Neight of Con Neight of Con	cale that the lookings should be exit m. However, the recent boring drille is the marine clay, whereas the properties arring elevation is based on the solution tive stress in channel = (120 pcf - 62 Culvert Sketch and Pressure Ca Culvert Sketch and Pressure Ca Culvert Sketch and Pressure Ca $1^{-0^{-1}}$ $1^{-0^{-1}}$ $1^{-0^{-1}}$ $1^{-0^{-1}}$ $1^{-0^{-1}}$ $1^{-0^{-1}}$ 1^{-1} $1^{-0^{-1}}$ 1^{-1} $1^{$	feet = 411 psf e below box = (2.8' x 125 pcf) + (2' x 1064 psf	The plans do not indicate the as im indicates Marine clay is presen- ectly on the clay. Therefore the ex- El. 168 El. 168 El. 168 El. 168 El. 156 El. 156 El. 156	-built elevations or ht. The existing isting effective b' Apprx. -2' Apprx. f()) = 653 psf			
bearing stratu structure spar stress at the b Average effec Proposed Box Proposed Box Veight of Con Veight of Con Veight of Fill a Veight of Con Sonclusion:	cale that the footings should be exit m. However, the recent boring drille is the marine clay, whereas the proj- earing elevation is based on the solution tive stress in channel = (120 pcf - 62 Culvert Sketch and Pressure Ca Culvert Sketch and Pressure Ca Culvert Sketch and Pressure Ca 1'-0"	feet = 411 psf e below box = (2.8' x 125 pcf) + (2' x 1064 psf	The plans do not indicate the as im indicates Marine clay is presen- ectly on the clay. Therefore the ex- El. 168 El.	-built elevations or ht. The existing isting effective s' Apprx. .2' Apprx. f)) = 653 psf			
Area of open b Veight of Con Veight of Con Veight of Con Conclusion:	cale that the lootings should be exit m. However, the recent boring drille is the marine clay, whereas the properties arring elevation is based on the solution tive stress in channel = (120 pcf - 62 Culvert Sketch and Pressure Ca Culvert Sketch and Pressure Ca Culvert Sketch and Pressure Ca $1^{-0^{-1}}$ $1^{-0^{-1}}$ $1^{-0^{-1}}$ $1^{-0^{-1}}$ $1^{-0^{-1}}$ $1^{-0^{-1}}$ 1^{-1} $1^{-0^{-1}}$ 1^{-1} $1^{$	feet = 411 psf e below box = (2.8' x 125 pcf) + (2' x 1064 psf e below the proposed culvert is ap	The plans do not indicate the as im indicates Marine clay is presen- ectly on the clay. Therefore the ex- ectly on the cla	 built elevations or nt. The existing siting effective 3' Apprx. .2' Apprx. (f)) = 653 psf an the existing, 			
vrea of open b Veight of Con Veight of Con	cale that the footings should be exit m. However, the recent boring drille is the marine clay, whereas the proj- earing elevation is based on the sol- tive stress in channel = (120 pcf - 62 Culvert Sketch and Pressure Ca Culvert Sketch and Pressure Ca Culver Ca Culve	feet = 411 psf e below box = (2.8' x 125 pcf) + (2' x 1064 psf d below the proposed culvert is ap lerlying clay should be checked.	The plans do not indicate the as im indicates Marine clay is presen- ectly on the clay. Therefore the ex- El. 168 El.	-built elevations or ht. The existing isting effective g' Apprx. (f)) = 653 psf an the existing,			

and the second	Meadow Brook Bridge -	Vassalboro	
	SETTLEMENT due to p	roposed Fill/cu	lvert
	Vassalboro, ME		
	GZA File No. 09.002622		
_ /	Calc By:	B.Cardali	10/28/2024
	Check By:	C. Snow	11/13/2024

	raccaisere, in																			
$- \mathbf{Q}_{\mathbf{X}}$	GZA File No. 09.002	26222.00															Secondary			
_ /	Calc By:	B.Cardali	10/28/2024												First pa	ving cycle 15 yrs	Post construction	n t2 (days) :	5475	
	Check By:	C. Snow	11/13/2024															t	0.848	
																		U	0.90	
	Depth (ft)	Thick.	Original Embankment	In-Situ	Final	Max.			RECOMPRESSION	VIRGIN COMPR.	TOTAL CONSOL.	Stress	Calpha	Second	thickness		t90	t2/t1	log(t2/t1)	Ss
laver	top/mid/bot	(ft)	Stress Influence	Stress	Stress	Prev.	RR	CR	SETTLEMENT	SETTLEMENT	SETTLEMENT	Ratio		Settlement		Cv (ft^2/day)	(primary)		(cycles)	(in)
Layer	(below bot		(psf)	(psf)	(psf)	Stress			RR H log(Po+dP/Po)	CR H log(Po+dP/Pmax)	(in)			(in)	(ft)		(days)		15 yr	
	of load)					(psf)			(in)	(in)				Per cycle						
	0																			
Clay	1.65	3.3	0	260	1064	1180	0.017	0.13	0.41	0.00	0.41	0.90	0.004	0.16	3.3	0.7	3	1660.04	3.22	0.51
	3.3			(See Net P	ressure Calc)															
Total Clay Thickness	3.3																			
TOTAL		3.3							0.00	0.00	0.41			0.16						0.51

Notes 1. Use Bousinessq stress bulb to apply influence factor at the midpoint of each cohesive layer for the footing load. Apply full fill surcharge from fill (no stress re **Reference Ladd Figure 4-2, Portsmouth NH Sensitive Clay (below)** 2. Initial and Final stress calculated in net pressure calculation, (see Appendix E) and are directly input into the calculation. Use the Stress Ratio for LADD Fig

		Settlement (in)
Primary (Sc)		0.41
Secondary	15 yr	0.51
Total		0.92

Primary is anticipated to occur prior to final paving, therefore post construction settlement is anticipated to be 0.5 inches or less.



Engineers and Scientists JOB: <u>09.0026222.00 Vassalboro- Meadow</u> Brk Bridge SUBJECT: Footings Bearing on Marine Clay SHEET: <u>1 OF 6</u> CALCULATED BY <u>B. Cardali 10/28/2024</u> CHECKED BY <u>C. Snow 10/28/2024</u>

Objective

Calculate soil bearing resistance for a culvert bearing on naturally deposited marine clay over glacial outwas h Evaluate strength and service bearing resistance at the top of 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

$\phi_{f} := 0 \text{deg}$	Internal friction angle
$\phi_b := .5$	Bearing resistance factor as specified in Table 10.5.5.2.2-1 (Theoretical Method, SPT Data, Strength Limit, Spread Footing)
c∷= .6ksf	Cohesion of the Marine Clay (base), taken as undrained shear strength
$\gamma := 118 \text{pcf}$	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 _{wγ} :=	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) $C_{wq} := 0.5$ $C_{w\gamma} := 0.5$

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1

0.91

0.89

0.88

1.05

1.05

1.06



Bearing Capacity Factors

$$\begin{split} \mathbf{N}_{cm} \begin{pmatrix} \mathbf{B}_1 \end{pmatrix} &:= \mathbf{N}_c \cdot \mathbf{s}_c \begin{pmatrix} \mathbf{B}_1 \end{pmatrix} & \mathbf{N}_{cm} \begin{pmatrix} \mathbf{B}_1 \end{pmatrix} = \\ \hline \mathbf{5.37} \\ \hline \mathbf{5.41} \\ \hline \mathbf{5.44} \\ \end{split}$$
$$\mathbf{N}_{\gamma m} \begin{pmatrix} \mathbf{B}_1 \end{pmatrix} &:= \mathbf{N}_{\gamma} \cdot \mathbf{s}_{\gamma} \begin{pmatrix} \mathbf{B}_1 \end{pmatrix} & \mathbf{N}_{\gamma m} \begin{pmatrix} \mathbf{B}_1 \end{pmatrix} = \end{split}$$

$$B_{1} := N_{\gamma} \cdot s_{\gamma} (B_{1}) \qquad N_{\gamma m} (B_{1}) = \frac{0}{0}$$

Nominal Bearing Resistance

$$q_{n}(B_{1}) \coloneqq \overline{\left(c \cdot N_{cm}(B_{1}) + \gamma \cdot D_{f} \cdot N_{qm}(B_{1}) \cdot C_{wq} + 0.5 \cdot \gamma \cdot B_{1} \cdot N_{\gamma m}(B_{1}) \cdot C_{w\gamma}\right)} \qquad \qquad q_{n}(B_{1}) = q_{n}(B_{1}) = q_{n}(B_{1}) + q_{n}(B_{1}) \cdot C_{wq} + 0.5 \cdot \gamma \cdot B_{1} \cdot N_{\gamma m}(B_{1}) \cdot C_{w\gamma}\right)$$

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Factored Bearing Resistance - Strength Limit State

$$q_{\mathbf{D}}(\mathbf{B}_{1}) \coloneqq \phi_{\mathbf{b}} \cdot q_{\mathbf{n}}(\mathbf{B}_{1})$$



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



Service Limit Design

GZA calculated the proposed and existing effective stress at the proposed culvert base elevation (see calculation in Appendix E). The proposed construction will result in an increase in pressure. GZA's settlement calculation estimates up to 1 inch of post-construction settlement.

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. Considering GZA's experience with the underlying Presumpscot formation clay, GZA recommends utilizing a service bearing resistance of 2 ksf, based on a homogeneous inorganic clay, sandy or silty clay (CL,CH) that is medium stiff.

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

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 $N_{qm}(B_1) =$

1

1

·ksf

4



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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)

		Bearing Res	istance (ksf)
Type of Bearing Material	Consistency in Place	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	Very dense	12-20	14
mixtures (GW, GP, SW, SP)	Medium dense to dense	8-14	10
	Loose	4-12	6
Coarse to medium sand, and with little gravel (SW,	Very dense	8-12	8
SP)	Medium dense to dense	4-8	6
	Loose	2-6	3
Fine to medium sand, silty or clayey medium to	Very dense	6-10	6
coarse sand (SW, SM, SC)	Medium dense to dense	4-8	5
	Loose	2-4	3
Fine sand, silty or clayey medium to fine sand (SP,	Very dense	6-10	6
SM, SC)	Medium dense to dense	4-8	5
	Loose	2–4	3
Homogeneous inorganic clay, sandy or silty clay	Very dense	6-12	8
(CL, CH)	Medium dense to dense	2–6	4
	Loose	1–2	1
Inorganic silt, sandy or clayey silt, varved silt-clay-	Very stiff to hard	4-8	6
fine sand (ML, MH)	Medium stiff to stiff	2–6	3
	Soft	1-2	1



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φ _f	N _c	N_q	N_{γ}	ϕ_f	N _c	N _q	N
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, 1. Bearing Canacity Factors N (Prendtl 1021) N (Deisener 1024) and N (Vecia 1075)

Table 10.6.3.1.2a-2-Coefficients Cwg and Cwy for Various **Groundwater Depths**

D_w	C_{wq}	C _{wy}
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.

Table 10.6.3.1.2a-3-Shape Correction Factors sc, sr, sg

Friction Angle

Cohesion Term (s.)

Vassalboro - LRFD Soil Bearing resistance Culvert

Factor

Surcharge Term (s_) Unit Weight Term (s_{γ})



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Shape Factors s_c, s_{γ}, s_q	$\phi_f = 0$	$1 + \left(\frac{B}{5L}\right)$	1.0	1.0
	$\phi_f > 0$	$1 + \left(\frac{B}{L}\right) \left(\frac{N_q}{N_c}\right)$	$1 - 0.4 \left(\frac{B}{L}\right)$	$1 + \left(\frac{B}{L}\tan\phi_f\right)$

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Table 10.6.3.1.2a-4-Depth Correction Factor d

Friction Angle, ϕ_f (degrees)	D_f/B	d_q
	1	1.20
22	2	1.30
52	4	1.35
	8	1.40
	1	1.20
27	2	1.25
37	4	1.30
	8	1.35
	1	1.15
12	2	1.20
42	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.



Engineers and Scientists JOB: 09.0026222.00 Vassalboro -<u>Meadow Brook Bridge</u> SUBJECT: Lateral Earth Pressures SHEET: 1 OF 1 CALCULATED BY <u>B.Cardali 10/28/24</u> CHECKED BY <u>S.Snow 10/28/24</u>

Subject:	Eval uate lateral earth pressure coefficients for a precast box culvert walls, inlet and outlet walls.		
References:	 MaineDOT Bridge Design Guide, Chapter 3 AASHTO LRFD Bridge Design Specifications, 9th Edition (2020) U.S. ArmyCorps of Engineers Engineer Manual 1110-2-2502, Retaining and Flood Walls 		
Input Parameters:			
$\phi := 32 \text{deg}$	Effective angle of internal friction (<i>Granular borrow, Soil Type 4, BDG</i> Table 3-3)		
$\delta_{f} \coloneqq 19.5 \text{deg}$	Average value, precast concrete against clean s and/silty sand-gravel mixture (AASHTO LRFD Table 3.11.5.3-1)		
$\beta := 26.6 \text{deg}$	Angle of backfill to the horizontal (Sheets 23 & 24, PIC Plans 2022-10-12)		
$\theta := 90 \cdot \deg$	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.

 $K_0 \coloneqq 1 - \sin(\phi) = 0.47$

At-rest Earth Pressure Coefficient, Level Ground

Outlet Walls free to rotate:

The earth pressure is applied to a plane extedning vertically up from the heel of the wall base, and the weight of the soil on the inside of the vertical plane is considereed 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:

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

For a sloped 2H:1V backfill:

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

$$K_{ar} = 0.31$$

March 2014

BIG TWENTY TWP. T19-R12 WELS TISRI WELS GRAND T18-R12 WELS THUR11 FORT T18 R13 WELS T18 R10 WELS WAN BUREN ST. JOHN PLT. T1743 WELS T174R4 Wels T17465 WELS NEW T174R13 WELS T17-R12 WELS T174R14 WELS T16 R14 WELS T16 R13 WELS T16 RB WELS T16,R5 WELS T16,R4 Wels TIS R12 T16-R9 WELS EAQLE LAKE TIS-RE WELS CONNOF TWP. TIS RIS NEW T15,R16 WELS T15-R14 WELS T15 R11 WELS T15 R10 WELS T15-R5 WELS T15-R12 WELS T15-R9 WELS WELS T16-R8 WELS PLT. 268¢ T14 E13 WELS T14 R11 WELS T14 R12 WELS T14,R8 WELS T14R18 WELS T144R15 WELS T14 R54 WECS T14 R10 WELS T14 CH WEAS T14,R7 WELS T14,R8 WELS T14,R5 WELS CARIBOU T13,R14 WELS T13 R18 WELS VIS RIS WELS T13-R13 WELS T13 B12 WELS T13 R11 WELS T13 R1 WELS T13,R9 Wels T13.R8 WELS T13.R7 WELS T134R5 WELS WADE PORTAGE LAKE FORT T12 R17 WELS T12-R16 WEL8 T12 E15 WELS T12 B10 WELS T12,R8 WELS T124R14 WELS T12 RU1 WELS T12,R9 WELS T 12,87 WELS T12 R18 WELS T12 R 12 WELS PLT. ASTEE PRESQUE T11 R17 WELS T114R16 WELS T11 R15 WELS T11 B11 WELS T11 R4 WELS T11 R14 WELS 2600 T11,R10 WELS TI1 R12 WELS T11,R9 WELS WELS T1147 WELS GARRIELI PLT. 600 HILL TIO B11 WELS T10 R8 WELS BIG JEN TWP T10-R15 WELS T10 R10 WELS T10 R13 WELS T10 B10 WELS T10 R9 WELS T10 Pri TIO RIZ WELS SCILAPAN TWP. TIO R3 WELS T10.R7 WELS T10,R6 WELS BLAIN т¥Р. T9 R17 Wels TS R16 WELS T9 B16 WELS T9 814 WEL8 WELS T9 B12 WELS T9 B11 WELS T9 R10 WELS T9,R8 WELS TO PO WELS T9-R18 WELS TO R7 WELS OXBOW PLT. TS R5 WELS T9 B4 WELS T9 R3 WELS - TH BAS 2400 ST. CROIX TWP. SOPER MIN TWP EAGLE LARE TWP T8 88 WELS TA R18 Wels NELS T8 R18 WELS T8 R16 WELS T8 RM4 WELS WELS T8 R10 WELS T8 89 WELS T& R7 WELS TS R3 WELS T8 819 WELS T8 88 WELS TT R12 WELS 17 R15 WELS TZ R14 WECS T7 B8 WELS 17 818 WELS 17 817 WELS T7 B16 WEAS 17 B13 WELS 17 811 WELS 17 810 WELS T7 89 WELS WELS T7 86 WELS 78 17 PS WELS TWP BIG,SIX TWP TS RB WELS LUDLOW NEW LIMERICK TO B18 Wels TRAIT MELS T8-R13 WELS TE R11 WELS T8 E10 WELS TO RZ WELS T& RA WELS T6 R15 WELS TO RIA WELS T6 R12 WELS OUT BI ST. JOHN TWP. NORO PLT. ERRAL HOUNTON 22/2 PLAN TS B17 WELS RUSSEL POND TWP. TS R14 WELS TS R8 WELS MOUNT DYER BROOK 15 E18 WELS TS B15 WELS TS R12 WELS TS R11 WELS TS R8 WELS TS R7 WELS ESUN OAKFIE HERGE TS R20 IA RIO V T4 R15 WELS T4 B17 WELS I STRE T4 R14 WELS T4 R13 WELG T4 R9 WELS T4 R8 WELS T4,R7 WELS T4 R12 WELS T4 B11 WELS ISLAND FALLS T4-R3 WELS DOLE BROOK TWP TA 82 WELS CARY PLT SCALE 2200 WELS лат T3 RA Wates KSTO T3 B10 WEL4 KATA T3 B4 WELS T3 83 WELS T3 R12 WELS SHERMAN ACADEMY GRANT TLATIS WELS T3 B11 WELS 백 OBSTE T2 B12 WELS RIA T2 B13 WELS T2,R'0 WELS TAN MELS T2 R8 WELS T2 R4 WELS PLT. WNDO SILVER RIDGE TWP. EAST MIDDLESEX CANAL GRANT UPPER DLUNK TWP. TI BIJ WELS T1 B12 WELS T1 R9 WELS TLOB WESS T1 B11 Wels UNDSTOP T1 R8 WELS SPENCER TWP T1 240 Walls RIVER TUNDAN BURCHASE 2013 ET HERE LILY BAY ACWAHO PLT. 1198 88 TA RID WELS TARII WELS State of NCH TB R4 NBPP VEAZ NS ACADI INCA HISER TWP. LONG TB P11 WELS ROOK WELS DSTRI TWP. T&R3 NBPP T5 R T2,R9 NWP ANT EAU TWP 1909 PRENTISS TWP. TWP. CHASE STREAM TWP. TSJRS NWP WEBSTE PLT. JOHNSON MOUNTAIN TWP. T4,R9 NWP UPPER NCHANTS KATAHDIN Ion Worki Twp. USSU TWP WP. CARROL PLT. OTTSN TWP. LOWER ICHANTE TWP. EBQE PLT. T3 R5 BKP WKR KING & BARTALETT TWP. писор T&R1 T5-R1 NBPP JIM PON TWP. T3 R1 NBPP ALDER STREAM PLT. T3 R4 BKP WKF RCE LAGSTAFI TWP. ANCH GRAND LAKE D MQUNTA TELND BPP BIGELOW TWP. TEND BPP ABBOT RNEVIL TWP. DEAD RI DÖVER-NGSU WYNAN DWF. T43 MD BPP T2%ED BPP LOWER IPSUPT PLT BPP T20 ED BPP MOUNT ABRAM TWP. ~^{KIK} LINCOL PLT. EAT 1800 172 N882TT ANDOV 1651 ж RILEY MILTON. TWP. MOUNT TWP. 1885 UTCHFIEL 7390

Figure 5-1 Maine Design Freezing Index Map



State of MAINE Design Freezing Index

Frost Penetration Calculation

GZA File No. 09.0026222.00

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Meadow Brook Bridge Replacement

Extrapolations based on -I.Coldest year in 10 ,1958-1967 fig.7 2Fort Kent, data, coldest year in 21 3Plant hardiness zone map, USDA miscellaneous publication no. 814

Frost Penetration Calculation Meadow Brook Bridge Replacement GZA File No. 09.0026222.00 Page 2 of 2

Desian	Frost Penetration (in)						
Freezing	Co	Coarse Grained		F	Fine Grained		
Index	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	62.2	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	49.4" = 4.1'	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	

Table 5-1 Depth of Frost Penetration

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.

Marine Clay is anticipated near the culvert bearing elevation and have an average water content of 20 to 30 percent. Based on the MaineDOT BDG, Section 5.2.1 and a Freezing index of 1,600 the estimated depth of frost penetration is 4.1 feet.