SCHONEWALD ENGINEERING ASSOCIATES, INC.
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GEOTECHNICAL DESIGN REPORT
NOYES BRIDGE #5932 REPLACEMENT
ROUTE 9 OVER MILL BROOK
CUMBERLAND, MAINE
MAINEDOT WIN 26180.00

PREPARED FOR:

T.Y. Lin International
Falmouth, Maine

PREPARED BY:

Isabel V. Schonewald, P.E.
Schonewald Engineering Associates, Inc. (SchonewaldEA)
Cumberland, Maine

October 2025

SchonewaldEA Project No. 25-112

SCHONEWALD ENGINEERING ASSOCIATES, INC.

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Schonewald Engineering Associates, Inc.
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129 Middle Road, Cumberland, Maine 04021
phone 207/829-5226
cell 207/272-9879

VIA EMAIL

October 26, 2025
Project No. 25-112

Daniel Myers, P.E.
Shawn Davis, P.E.
T.Y. Lin International, Inc.
12 Northbrook Drive
Building A, Suite One
Falmouth, ME 04105

Re: Geotechnical Design Report
Noyes Bridge #5932 Replacement
Route 9 over Mill Brook
Cumberland, Maine
MaineDOT WIN 26180.00

Dear Daniel and Shawn:

Schonewald Engineering Associates, Inc. (SchonewaldEA) has prepared this geotechnical design report for T.Y. Lin International, Inc. (TYLin) to support your design of the replacement structure for Noyes Bridge that carries Route 9 over Mill Brook in Cumberland, Maine (MaineDOT WIN 26180.00). This report includes a summary of the geotechnical field and laboratory programs completed, an interpretation of the subsurface conditions and their impact on the proposed design and construction, and recommendations for the design and construction of the replacement structure. SchonewaldEA's work included assessing subsurface conditions, evaluating the geotechnical engineering implications of the subsurface conditions, and preparing this report that summarizes the findings of the work and provides geotechnical recommendations.

SchonewaldEA's work on this project has been completed under a Subconsultant Agreement for Professional Services with TYLin that is dated April 4, 2025. This report is subject to the limitations contained in the closure section of the report. A quality control/ quality assurance review of the geotechnical work completed by SchonewaldEA for this project was completed by Stephen J. Rabasca, P.E. of SoilMetrics, LLC located in Cape Elizabeth, Maine. Mr. Rabasca's review included evaluating whether the interpretation of subsurface conditions and the recommendations provided are appropriate, as well as assessing whether the work and this memorandum adequately and appropriately address the project objectives. Mr. Rabasca's comments and suggestions have been addressed.

PROJECT DESCRIPTION

TYLin is designing the replacement for an existing bridge (culvert) that carries Route 9 over Mill Brook in Cumberland. Mill Brook crosses Route 9 between Winn and Range (Cross) Roads; approximately 1.3 miles south of Cumberland Center. Route 9 is a commuter route into Greater Portland and is designated as a rural, major collector road. The existing culvert has an approximate 24 degree skew to Route 9 and crosses under a superelevated section of the roadway.

The existing bridge was constructed in 1963 and consists of a corrugated metal arch pipe structure having a span of 13 feet, 5 inches and height of 8 feet, 5 inches. The design invert elevation of the existing culvert is approximately 42.5 feet (unknown vertical datum) along the entire length of the pipe arch, based on design drawings dated 1962. The approximate elevation of the Route 9 centerline where it crosses the existing culvert is currently 52.5 feet (NAVD88). The existing pipe arch was bedded on a 1-foot thickness of granular borrow according to the 1962 design plans.

Prior to construction of the existing culvert, a single span bridge carried the road over Mill Brook. The bridge had stacked stone abutments. According to the 1962 design drawings, the existing culvert was constructed just behind and parallel to the southerly abutment of the former bridge. We suspect that at least a portion of the southerly abutment formed the temporary earth support for the northerly excavation face and that material (stone blocks) from the southerly abutment and its wing walls was used to backfill the then existing stream channel.

We understand that the proposed replacement structure is a 22-foot span by 10-foot rise precast concrete box culvert. The design shows that the centerline of the proposed box is located approximately 15 feet southerly of the current culvert's centerline and the skew has increased from approximately 24 to 30 degrees. The box culvert will be embedded into the stream bed and the current design calls for placing two feet of riprap inside of the box such that the existing "flow line" is maintained. As proposed, the invert elevation of the concrete box structure varies from 37.75 feet at the inlet to 37.00 feet at the outlet; the invert elevation of the concrete box structure is 37.39 feet at the centerline of Route 9. No change in the roadway's horizontal alignment or width is anticipated, however, the roadway will be raised between approximately 6 and 12 inches over the proposed structure. We further understand that Route 9 can be closed during construction, which will greatly simplify construction phasing/ excavation support.

The proposed culvert's bearing surface is approximately 3 feet below the culvert structure invert to accommodate the thickness of the culvert's base slab and the needed bearing pad. This results in an approximately 17- to 19-foot deep excavation for construction; the excavation is expected to extend to around 8 feet below the observed groundwater level. Key geotechnical design issues are the character of the bearing soil (saturated recent alluvium) and the relative elevations of the bottom of the excavation, the top of soft marine silt-clay, and groundwater.

GEOLOGIC SETTING

Surficial geology along Mill Brook, including the project site, is mapped as recent stream alluvium along the stream channel surrounded by marine silt-clay of the Presumpscot Formation (Surficial Geology of the Cumberland Center, Maine Quadrangle; Maine Geological Survey Open File 99-81). Recent stream alluvium typically consists of saturated, loose (organic) silty fine to medium sand. The Presumpscot Formation marine silt-clay is encountered throughout coastal Maine. It is typically sensitive and very soft in nature and is characterized as having both low shear strength and bearing resistance, and undergoing significant strength loss when disturbed. The Presumpscot Formation is characteristically compressible and would be expected to consolidate if a load greater than the existing load is applied.

Bedrock in the project area is mapped as the Hutchins Corner Formation of the Central Maine Sequence (Bedrock Geology of the Portland 1:100,000 Quadrangle, Maine and New Hampshire; Maine Geological Survey Open File 98-1). The bedrock core obtained in the test boring consisted of aphanitic to fine grained Hornfels, a very hard, massive, polymineralic rock formed by contact metamorphism. The protolith rock (interbedded sandstone and mudstone (Vassalboro Formation)) underwent alteration likely as a result of the large granitic intrusion that is mapped in close proximity to the project site.

SUBSURFACE EXPLORATION PROGRAMS

SchonewaldEA retained New England Boring Contractors of Hermon, Maine to provide drilling and traffic control services for preliminary and final subsurface exploration programs.

The preliminary (100-series) program consisted of drilling two test borings and three shallow attempts (probes) at the bridge site to evaluate subsurface conditions. The preliminary test borings were designated BB-CMB-101 and -102C and were located in opposite quadrants of the existing culvert. The three shallow attempts were designated BB-CMB-102, -102A, and -102B. The preliminary test borings were drilled between October 3 and 5, 2022. The objectives of the preliminary test boring program included:

- Identifying the bearing soil for the proposed structure and assessing its engineering characteristics;
- Assessing the depth to the top of soft marine silt-clay relative to the proposed bottom of excavation, the characteristics of the marine silt-clay, and the thickness of the stratum; and
- Confirming the depth to the top of bedrock and the character of the bedrock.

The final (200-series) program consisted of drilling one test boring within the footprint of the proposed box culvert to confirm the type and character of the bearing soil and the separation between the bottom of excavation and top of soft marine silt-clay. The 200-series test boring was designated BB-CMB-201 and was drilled on June 23, 2025.

For both programs, SchonewaldEA selected the final test boring locations in the field and drilling methods, designated the type and depth of sampling and in-situ testing as work progressed, and observed and logged the test borings on a full-time basis.

The approximate locations of the test borings are depicted on the Boring Location Plan that is included in Appendix A. The borings were located in the field by taping from prominent site features depicted on the survey base plan; the locations should be considered only as accurate as the method implies. The ground surface elevation at each borehole that is noted on the boring log was approximated from the ground surface topography depicted on the base plan.

The test borings were advanced using standard cased wash boring techniques. One of the two deeper preliminary test borings (BB-CMB-102C) was extended through overburden to refusal and approximately 10 feet of NQ2 (N-size, double-barrel core barrel) bedrock core was obtained. The other deeper test borings (BB-CMB-101 and -201) were terminated in overburden soils. MaineDOT's key to soil and rock descriptions and the logs of the test borings are included as Appendix B. Photographs of the bedrock core obtained in test boring BB-CMB-102C are included as Appendix C.

Standard Penetration Tests (SPTs) were completed and split-spoon soil samples were obtained near the ground surface and then typically at five-foot intervals to the bottom of each boring, except as follows. With the intent of better defining the bearing stratum and the depth of the top of the soft marine silt-clay stratum, SPTs / split-spoon sampling was completed continuously (every 2 feet) over a 10- to 16-foot depth in each of the three deeper test borings. Specifically, from 14 and 24 feet Below the Ground Surface (BGS) in BB-CMB-101, from 10 to 26 feet BGS in BB-CMB-102C, and from 14 to 30 feet BGS in BB-CMB-201. SPTs were performed using an auto hammer that had been calibrated in general conformance with MaineDOT policy. The hammer efficiency factors are recorded on the boring logs.

In lieu of SPTs / split-spoon sampling, vane shear tests were completed in soft marine silt-clay soils where encountered in the test borings. Vane shear tests were completed using MaineDOT's Geonor vane (65 mm by 130 mm) and the associated soil shear strength was determined using a vane constant developed by MaineDOT. Vane shear testing was completed in accordance with MaineDOT's standard field procedures that conform to the ASTM standard. Thin-walled undisturbed tube samples of the soft marine silt-clay were obtained in the preliminary test borings using a fixed-piston sampler and were obtained, packed/ sealed, and handled/ transported in accordance with generally accepted best field practices.

Groundwater levels observed within the borings are noted on the boring logs, along with the conditions (e.g., stabilization times) under which the groundwater measurements were obtained. The boreholes were backfilled using drill cuttings, supplemented by manufactured sand and gravel, and the pavement patched.

GEOTECHNICAL LABORATORY TESTING PROGRAMS

Representative soil samples obtained in the preliminary and final test borings were submitted to the R. W. Gillespie & Associates, Inc. (RWG&A) geotechnical laboratory in Biddeford, Maine for soil testing programs. The testing programs were developed by SchonewaldEA based on the subsurface conditions encountered in the test borings with the objectives of 1) corroborating the interpreted top of the soft marine silt-clay, 2) confirming field classifications, and 3) obtaining project-specific consolidation characteristics of the marine silt-clay. The laboratory testing programs are summarized in the following table.

Boring No.	Sample No.	Sample Depth (ft, BGS)	Soil Material Type	Tests Performed
UNDISTURBED TUBE SAMPLES				
BB-CMB-101	U1	42-44	marine silt-clay	tube opening, Atterberg limits, consolidation (**square root time** w/ unload-reload)
BB-CMB-102C	U1	35-37	marine silt-clay	tube opening, Atterberg limits, consolidation (**log time for C-alpha** w/ unload-reload)
BB-CMB-102C	U2	50-52	marine silt-clay	tube opening, Atterberg limits, consolidation (**square root time** w/ unload-reload)
SPLIT-SPOON JAR SAMPLES				
BB-CMB-101	6D	18-20	silt-clay crust	wash gradation with hydrometer
BB-CMB-101	7D	20-22	silt-clay crust	Atterberg Limits, wash gradation with hydrometer, moisture content
BB-CMB-101	8D	22-24	silt-clay crust	Atterberg limits, moisture content
BB-CMB-102C	6D	16-18	recent alluvium	wash gradation with hydrometer, organic content
BB-CMB-102C	7D	18-20	recent alluvium	wash gradation with hydrometer, organic content
BB-CMB-102C	8D	20-22	recent alluvium	wash gradation with hydrometer, organic content
BB-CMB-102C	9D	22-24	marine silt-clay	Atterberg Limits, wash gradation with hydrometer, moisture content
BB-CMB-102C	10D	24-26	marine silt-clay	Atterberg limits, moisture content
BB-CMB-201	3D	9-11	recent alluvium	wash gradation with hydrometer, moisture content
BB-CMB-201	4D	14-16	recent alluvium	wash gradation with hydrometer, moisture content
BB-CMB-201	5D	16-18	recent alluvium	wash gradation with hydrometer, moisture content
BB-CMB-201	6D	18-20	recent alluvium	wash gradation with hydrometer, moisture content
BB-CMB-201	7D	20-22	recent alluvium	wash gradation with hydrometer, moisture content
BB-CMB-201	8D	22-24	marine silt-clay	Atterberg Limits, wash gradation with hydrometer, moisture content
BB-CMB-201	9D	24-26	marine silt-clay	Atterberg Limits, wash gradation with hydrometer, moisture content
BB-CMB-201	10D	26-28	marine silt-clay	Atterberg Limits, wash gradation with hydrometer, moisture content
BB-CMB-201	11D	28-30	marine silt-clay	Atterberg Limits, wash gradation with hydrometer, moisture content
BB-CMB-201	12D	34-36	marine silt-clay	Atterberg Limits, wash gradation with hydrometer, moisture content

Laboratory test results are summarized on the test boring logs included as Appendix B. The laboratory test reports that include methodology/ test standards are included as Appendix D.

SUBSURFACE CONDITIONS

Subsurface conditions encountered in the test borings completed at the project site consisted of approximately 10 feet of Embankment (Granular) Fill over an approximately 7- to 13-foot thickness of fine to medium sand with organic silt that contains organics and wood (Recent Alluvium). The recent alluvium was underlain by 38 to up to 57 feet of very soft, sensitive silt and clay of low plasticity (Marine Silt-Clay). In test boring BB-CMB-102C, that extended to bedrock, the marine silt-clay deposit was underlain by a 6-foot thickness of interbedded marine sands and silt and a 7-foot thick layer of glacial till over bedrock.

SchonewaldEA's interpretation of the subsurface conditions underlying the site is depicted on the Interpretive Subsurface Profile that is included in Appendix A.

Rubble Fill: Rubble fill was encountered near the ground surface in the northwest quadrant of the existing culvert. Three attempts (test probes BB-CMB-102, -102A, and -102B) were made to penetrate the rubble fill, but obstructions were encountered between 4.8 and 7.9 feet BGS. In the interest of time, the fourth attempt (test boring BB-CMB-102C) was relocated to the southerly side (southwest quadrant) of the existing culvert. The rubble fill is believed to be associated with the stacked stone abutments and wing walls of the original single-span bridge.

Embankment (Granular) Fill: The three 100- and 200-series test borings (BB-CMB-101, -102C, and -201) encountered approximately 10 feet of embankment (granular) fill. The relative density of the fill varied from very loose to dense. The fill consisted of fine to coarse sand, with varying amounts of silt and gravel.

Recent Alluvium: The three 100- and 200-series test borings (BB-CMB-101, -102C, and -201) encountered recent alluvium below the embankment fill. The recent alluvium was typically non-plastic, saturated, very loose to loose, silt and fine to medium sand in varying proportions, with organics and wood. The organic content of three samples of recent alluvium collected from BB-CMB-102C was determined as part of the laboratory testing program; the organic content varied from 0.6 to 4.8 percent. The bottom of the recent alluvium was observed to range from 22 feet BGS (Elev. 31 feet) in test boring BB-CMB-201 to 23.5 feet BGS (Elev. 28 feet) in test boring BB-CMB-102C, both located within the footprint of the proposed culvert.

Soft Marine Silt-Clay: The three 100- and 200-series test borings encountered soft marine silt-clay (Presumpscot Formation) below the recent alluvium. The soft marine silt-clay is characterized as a very soft, sensitive, silt and clay of low plasticity. The soft marine silt-clay was overlain by a 3-foot layer of stiffer crust in test boring BB-CMB-101; the stiffer crust was absent in test borings BB-CMB-102C and -201 that are located closer to the Mill Brook channel. The results of in-situ vane shear tests conducted in the marine silt-clay indicated the soil has an undrained shear strength that was typically 400 to 450 pounds per square foot (psf) in the upper 23 feet of the deposit and increased up to approximately 850 to 900 psf at depth. The total thickness of the soft marine silt-clay ranged from 38 to 57 feet. The elevation of the top of the soft marine silt-clay increased from south to north.

Interbedded Marine Sands and Silt: A 6-foot thick layer of interbedded marine sands and silt was encountered below the marine silt-clay in test boring BB-CMB-102C. The interbedded marine sands and silt is characteristically a non-plastic soil and consists of thin layers having varying amounts of fine sand, silt, and clay. It is indicative of a higher energy depositional environment than the marine silt-clay. The bottom of the interbedded marine sands and silt was encountered at 67 feet BGS.

Glacial Till: A 7-foot thick layer of glacial till was encountered below the interbedded marine sands and silt in test boring BB-CMB-102C. The glacial till was typically medium dense, fine to medium sand, with varying amounts of gravel and silt. The bottom of the glacial till layer was encountered at 73.5 feet BGS.

Bedrock: Bedrock was encountered in BB-CMB-102C at 73.5 feet BGS (Elev. -22 feet). Ten feet of rock core was obtained. The bedrock consists of a very hard, typically fresh, aphanitic to fine grained Hornfels. The Rock Quality Designation (RQD) of the two core runs were 45 and 75 percent indicating the rock quality is poor to fair.

Detailed descriptions of the soils and bedrock encountered in the test borings are provided on the logs included in Appendix B.

Groundwater: Groundwater was observed near the base of the fill, at Elev. 45.5 feet and Elev. 42 feet in test borings BB-CMB-101 and BB-CMB-102C, respectively. Groundwater observations were made during the exploration program and are noted on the logs included in Appendix B. Groundwater fluctuations would be expected to vary over time due to a number of factors, most notably weather and seasonal fluctuations.

IMPLICATIONS OF SUBSURFACE CONDITIONS

Structure Option: A precast concrete box culvert installed on a robust bearing pad constructed on undisturbed recent alluvium appears feasible.

Settlement and Bearing Resistance: Installing the proposed concrete box culvert will result in a small net reduction in stress at the bearing elevation due to the removal of existing soil, increase in the culvert opening, and distribution of the imposed loads over the larger base slab of the box. Refer to the supporting evaluation provided at the end of Appendix E. We anticipate, therefore, the concrete box culvert will not undergo detrimental post-construction settlement.

The recent alluvium has low, but sufficient bearing resistance to support the concrete box culvert, noting that a robust bearing pad will be necessary and care will be needed to not disturb the subgrade / bearing soil.

Primary Constructability Challenges: The primary construction considerations for the box culvert include the ability to excavate to the required subgrade elevation without disturbing the bearing soil and maintaining a stable excavation base while constructing the bearing pad and installing the box culvert.

We anticipate the excavation needed to construct the bearing pad will extend to between approximately elevations 33.5 to 34.5 feet. This is within the saturated silty fine sand (recent alluvium) and only approximately 3 to 5 feet above the top of the soft, sensitive marine silt-clay, based on test borings BB-CMB-102C and -201, both located within the footprint of the proposed culvert.

An approximately 17- to 19-foot deep excavation will be required for construction; the excavation is expected to extend to up to approximately 8 feet below the observed groundwater level. An active dewatering system should be required and strict grade control will be necessary while excavating to the bearing elevation. Once the bearing elevation is achieved, a geogrid should be placed across the bottom of the excavation to aid construction of the bearing pad. This is in addition to the geogrid embedded in the geotextile-wrapped crushed stone bearing pad discussed below.

DESIGN RECOMMENDATIONS

SchonewaldEA provides the following recommendations for the design and construction of the proposed 22-foot span by 10-foot rise concrete box culvert. SchonewaldEA understands that the structural design of the box culvert and the design of the excavation support/ dewatering system are the responsibility of the contractor.

Design Elements

A robust bearing pad will be needed to found the box culvert on recent alluvium soil. The bearing pad should consist of a minimum 2-foot thickness of crushed stone (Culvert Bedding Stone) that is wrapped in non-woven geotextile fabric. To engage the strength of the crushed stone, a geogrid should be embedded at the midpoint of the geotextile-wrapped, 2-foot thick crushed stone layer.

A concrete cutoff (toe) wall should be constructed at the inlet and outlet of the box culvert to cutoff stream flow through the bearing pad. Per the project details, the bearing pad material should not extend under the toe walls. The toe wall at the outlet end will also provide some protection against piping.

Both the inlet and outlet of the culvert should be armored with riprap that is underlain by a non-woven geotextile fabric. The toe of the riprap sections should be constructed 1 foot below the streambed elevation to serve as a key.

Excavation, Bearing Pad, and Structure Backfill

Construction of the proposed culvert will require soil excavation. We anticipate the excavation needed to construct the bearing pad for the box culvert will extend to between approximately 17 to 19 feet below the existing road surface; the excavation is expected to extend to up to approximately 8 feet below the observed groundwater level. The bearing surface is anticipated to be within the saturated recent alluvium and only a few feet above the soft marine silt-clay. The full nature of the bearing surface will not be evident until the culvert excavation is made.

An earth support system will be required since laying back slopes does not appear feasible. The contractor’s earth support system design will need to address the relative positions of the proposed culvert and the existing culvert and the rubble fill encountered to the north of the existing culvert. The contractor’s earth support system design should include provisions for continuous dewatering. Bottom heave should be checked as part of sheeting design. Phasing shut down of the dewatering system should avoid a condition under which the culvert could float. Regardless of the method of excavation, all excavations and earth support systems shall meet all applicable OSHA regulations.

Use of proper excavation phasing, a smooth-edged bucket, and careful grade control will be required to avoid overexcavating and/or disturbing the bearing pad subgrade. Geogrid should be placed across the base of the excavation prior to construction of the bearing pad to enhance the stability of the subgrade and to aid construction of the bearing pad and installation of the culvert.

The bearing pad should consist of a minimum 2-foot thickness of crushed stone (Culvert Bedding Stone) that is wrapped in non-woven geotextile fabric. To engage the strength of the crushed stone, a geogrid should be embedded at the midpoint of the geotextile-wrapped, 2-foot thick crushed stone layer.

The Culvert Bedding Stone shall meet the criteria for MaineDOT Standard Specification 703.13 – Crushed Stone ¾-Inch, as specified in Special Provision 203 (culvert bedding stone).

The geotextile fabric used to envelope the Culvert Bedding Stone and under riprap shall meet the criteria for MaineDOT Standard Specification 722.01 – Stabilization/ Reinforcement Geotextile.

Requirements for the geogrid placed over the excavation subgrade and embedded in the 2-foot thick bearing pad are provided in Special Provision 620 (reinforcement geogrid).

The soil envelope and backfill should consist of MaineDOT's Granular Borrow Material for Underwater Backfill with a maximum particle size of 4 inches. The granular borrow backfill should be placed in lifts of 8 to 12 inches loose measure and compacted to the box culvert manufacturer's specifications or, in the absence of manufacturer's specifications, to at least 92 percent of the AASHTO T-180 maximum dry density. In no case should the backfill soil be compacted to less than 92 percent of the AASHTO T-180 maximum dry density.

Box Culvert Structural Design

The following geotechnical design parameters should be used for the structural design of the 22-foot span (22-foot wide base slab) box culvert. Supporting calculations that include methodology/ references are included in Appendix E.

- Parameters assigned to bedding and backfill materials should be as indicated for Soil Type 4 in Table 3-3 (Material Classification) in the MaineDOT Bridge Design Guide, specifically:
  - Internal friction angle (φ) equal to 32 degrees; and
  - Total unit weight (γ_t) equal to 0.125 kips per cubic foot (kcf).
- For service limit state analyses, the factored bearing resistance of a minimum 2-foot thick bearing pad overlying undisturbed native alluvium soils should not exceed 2 kips per square foot (ksf).
- For strength limit state analyses, the factored bearing resistance of a minimum 2-foot thick bearing pad overlying undisturbed native alluvium soils should not exceed 2 ksf, given the proximity of the marine silt-clay soils to the bearing pad subgrade.
- The modulus of subgrade reaction for the bearing pad overlying undisturbed native alluvium soils should not exceed 4 pounds per cubic inch (for the 22-foot wide culvert base slab).
- For evaluation of sliding on the base of the precast concrete box, the friction angle between the precast concrete structure and the underlying geotextile-wrapped bearing pad should be taken as 26 degrees.
- A restrained condition should be assumed and, therefore, an at-rest coefficient of lateral earth pressure, K_o, equal to 0.47 should be used for the determination of lateral earth pressure acting on the walls of the box culvert.

Construction Considerations

- Saturated, Loose Silty Fine Sands (Recent Alluvium): As noted above, the recent alluvium poses constructability challenges. The loose silty fine sand is saturated (is below the groundwater level) and will easily become disturbed by construction activities. As great a thickness as possible of recent alluvium needs to remain in place and undisturbed between the box culvert bearing pad and the underlying soft marine silt-clay. The excavation to install the box culvert and/or remove the existing culvert will require care to maintain bottom stability and bearing resistance. The following items will need to be considered to maintain a stable excavation and bearing surface:
  - Use of temporary sheeting will be necessary to achieve the necessary depth (17 to 19 feet) of the bearing pad subgrade. Sloping the sides of the excavation should not be considered feasible below groundwater.

  - Adequate embedment of the sheeting into the marine silt-clay will be necessary to allow excavation into the saturated recent alluvium and maintenance of a stable excavation bottom.

  - Construction-phase dewatering will be needed to limit vibration-induced disturbance and associated immediate settlement of the recent alluvium during excavating, limit the risk of excavation bottom heave, and allow bearing pad construction in the relative dry.

  - Actively dewatering the recent alluvium could also mitigate construction-phase settlement of the bearing pad, thereby reducing the potential for differential settlement of the subgrade along the length of the culvert.

  - Use of watertight dump trucks to contain the excavated saturated material for transportation to the disposal area may be necessary.

  - Phasing the shut down of the dewatering system should be addressed by the contractor to avoid a condition under which the culvert could "float."

  - Final shimming and repair of the new roadway to address subsidence associated with withdrawal of temporary sheeting and shoring materials will likely be needed.

- Sensitive, Soft Silt and Clay (Marine Silt-Clay): The marine silt-clay encountered in the test borings is sensitive and very soft in nature and is characterized as having both low shear strength and bearing resistance, and undergoing significant strength loss when disturbed.

  - The excavation needed to construct the bearing pad will extend to between approximately elevations 33.5 to 34.5 feet. This is only approximately 3 to 5 feet above the top of the soft marine silt-clay based on test borings BB-CMB-102C and -201. It will be necessary to maintain this separation.

  - No change in the roadway's horizontal alignment or width is anticipated, however, the roadway will be raised between approximately 6 and 12 inches over the proposed structure. Given the relatively minor change in grade of the roadway and presuming the existing roadway embankment has an adequate factor of safety against global instability, the approach fills for the box culvert should also be stable. Considering the anticipated net decrease in overburden pressure acting on the compressible marine silt-clay relative to the existing culvert configuration, post-construction consolidation settlement should be limited. Refer to the supporting evaluation provided at the end of Appendix E. This recognizes that fill was in place for an extended period of time where the existing culvert is located, but where it is outside the footprint of the proposed culvert.

CLOSURE

This report has been prepared for the use of T.Y. Lin International, Inc. for specific application to the design of a replacement of Noyes Bridge that carries Route 9 over Mill Brook in Cumberland, Maine in accordance with generally accepted geotechnical and foundation engineering practices. No other intended use or warranty is expressed or implied.

In the event that any changes in the nature, design, or location of the proposed project are planned, this report should be reviewed by a geotechnical engineer to assess the appropriateness of the conclusions and recommendations and to modify the recommendations as appropriate to reflect the changes in design.

These analyses and recommendations are based in part upon a limited subsurface investigation at discrete exploratory locations completed at the site. If variations from the conditions encountered during the investigation appear evident during construction, it may also become necessary to re-evaluate the recommendations made in this report.

It is recommended that a geotechnical engineer be provided the opportunity to review the design documents in order that the design recommendations and construction considerations presented in this report are properly interpreted and implemented in the design and specifications. It is also recommended that a geotechnical engineer be on site to observe excavation and subgrade preparation operations for the box culvert construction.

SchonewaldEA appreciates the opportunity to be of service to TYLin and MaineDOT. If you have any questions regarding the work completed by SchonewaldEA or the information provided in this geotechnical design report, please call/reply at your convenience.

Sincerely,
Schonewald Engineering Associates, Inc.

STATE OF MAINE
ISABEL V. SCHONEWALD
No. 7528
LICENSED
PROFESSIONAL ENGINEER
10/26/25

Isabel V. (Be) Schonewald, P.E.
President

Enclosures

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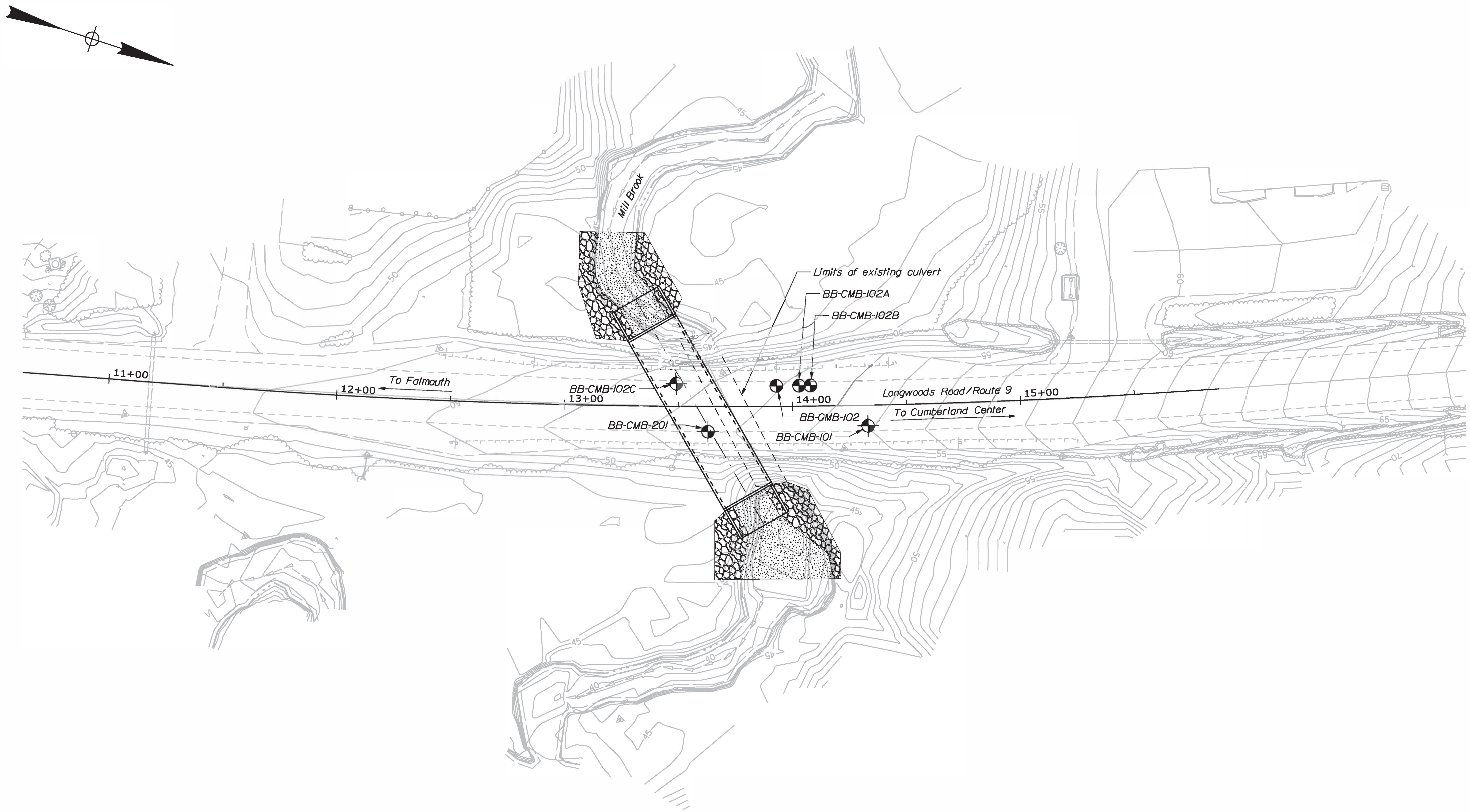
GEOTECHNICAL DESIGN REPORT
NOYES BRIDGE #5932 REPLACEMENT
ROUTE 9 OVER MILL BROOK
CUMBERLAND, MAINE
MAINEDOT WIN 26180.00

APPENDICES

APPENDIX A

FIGURES



PLAN

25 0 25 50
Scale of Feet

LEGEND:

Cased Wash Boring

Probe

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

Fed. #2618000

WIN
26180.00

BRIDGE PLANS

BRIDGE #5932

	BY	DATE
PROJ. MANAGER JERRY DOSTIE		
DESIGN-DETAILED	I. SCHONEWALD	12/2022
CHECKED-REVIEWED	S. MORGAN	
DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

NOYES BRIDGE
OVER MILL BROOK
CUMBERLAND CUMBERLAND COUNTY

BORING LOCATION PLAN

FIGURE

1

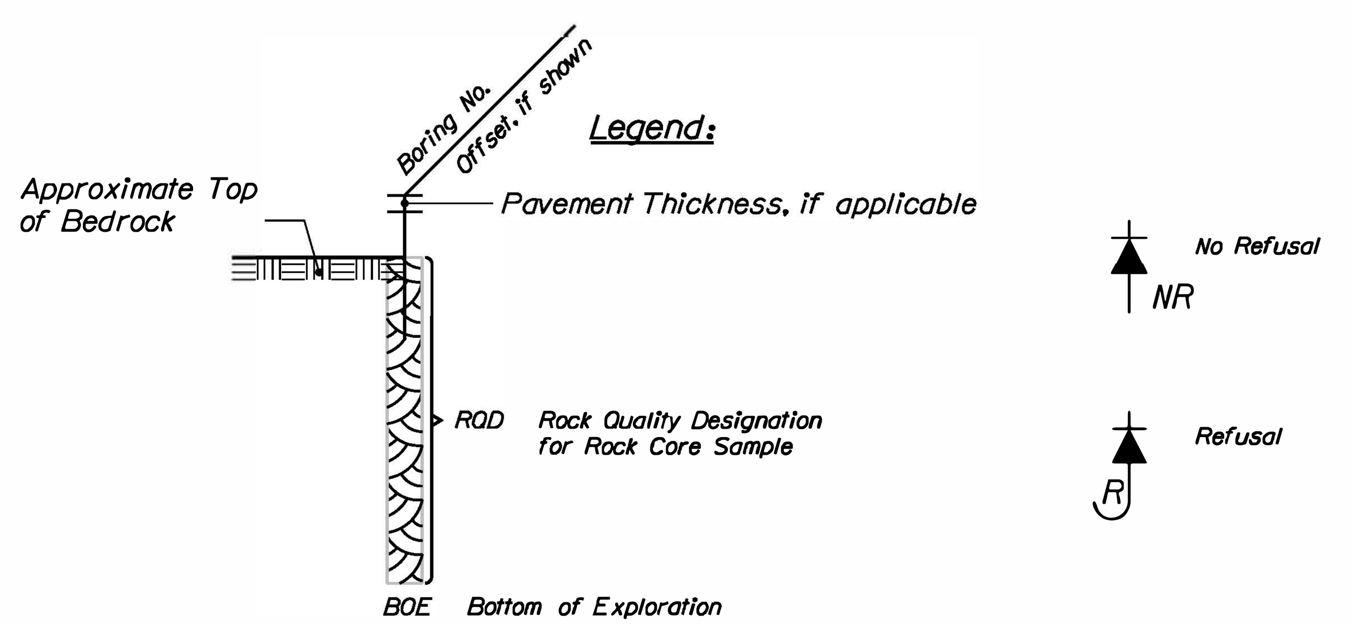
OF 2

SCHONEWALD ENGINEERING ASSOCIATES, INC.

TYLin

Filename: ...\xxx_Boring_Location_Plan.dgn Division: HIGHWAY Username: Date:8/28/2025

Date:10/24/2025 Username: Division: HIGHWAY Filename: ...\MSTA\006_Soil Profile.dgn

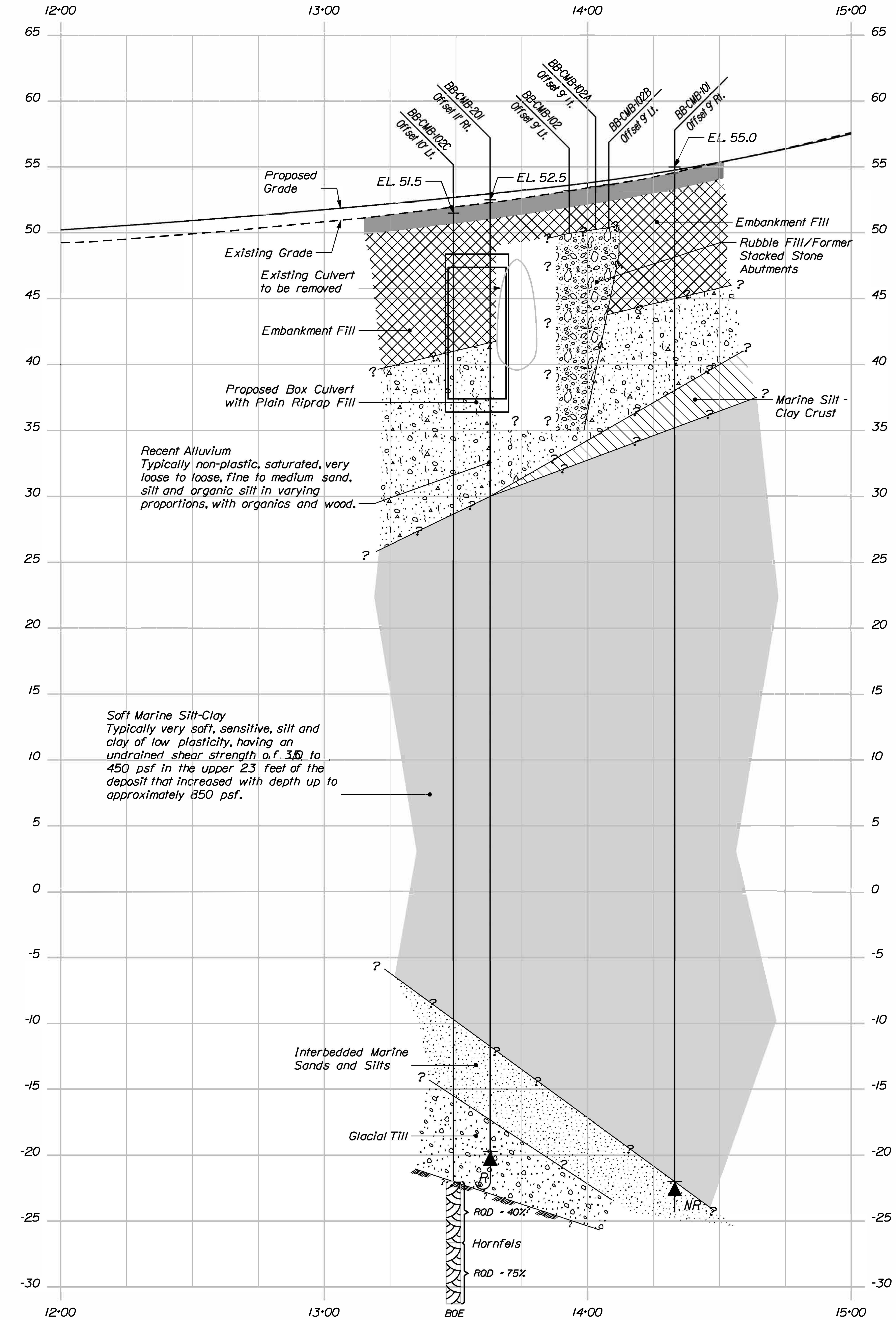


PROFILE - ROUTE 9

Horiz. 25 0 25 50
Vert. 5 0 5 10
Scale of Feet

NOTE:

This generalized interpretive soil profile is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and have been developed by interpretations of widely spaced explorations and samples. Actual soil transitions may vary and are probably more erratic. For more specific information refer to the exploration logs.



Schonewald Engineering Associates, Inc.

TYLin

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

Fed. #2618000

WIN 26180.00

BRIDGE PLANS

BRIDGE #5932

PROJ. MANAGER	JERRY DOSTIE	
	BY	DATE
DESIGN-DETAILED	L. SCHONEWALD	
CHECKED-REVIEWED	S. MORGAN	12/2022
DESIGN2-DETAILED2		
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NOYES BRIDGE
OVER MILL BROOK
CUMBERLAND CUMBERLAND COUNTY

INTERPRETIVE SUBSURFACE PROFILE

FIGURE

2

OF 2

APPENDIX B

MAINEDOT KEY TO SOIL AND ROCK DESCRIPTIONS AND BORING LOGS

UNIFIED SOIL CLASSIFICATION SYSTEM

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

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

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

MODIFIED BURMISTER SYSTEM

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

TERMS DESCRIBING DENSITY/CONSISTENCY

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

Density of Cohesionless Soils	Standard Penetration Resistance N_{60}-Value (blows per foot)
Very loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

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

Consistency of Cohesive soils	SPT N_{60}-Value (blows per foot)	Approximate Undrained Shear Strength (psf)	Field Guidelines
Very Soft	WOH, WOR, WOP, <2	0 - 250	Fist easily penetrates
Soft	2 - 4	250 - 500	Thumb easily penetrates
Medium Stiff	5 - 8	500 - 1000	Thumb penetrates with moderate effort
Stiff	9 - 15	1000 - 2000	Indented by thumb with great effort
Very Stiff	16 - 30	2000 - 4000	Indented by thumbnail
Hard	>30	over 4000	Indented by thumbnail with difficulty

Rock Quality Designation (RQD):

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

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

Rock Quality Based on RQD

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

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

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

Sample Container Labeling Requirements:

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

May 2024

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Noyes Bridge #5932
Route 9 over Mill Brook
Location: Cumberland, ME

Boring No.: BB-CMB-101

WIN: 26180.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	55	**Auger ID/OD:**	SSA (4.5") to 10'
Operator:	McDougal/ Share/ Schaefer	**Datum:**	NAVD88	**Sampler:**	standard split-spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-53 track (NEBC-28)	**Hammer Wt./Fall:**	140 lbs/30 inches
Date Start/Finish:	10/5/22; 0750-1300	**Drilling Method:**	cased wash boring	**Core Barrel:**	not applicable
Boring Location:	Sta. 14+33, 9' RT	**Casing ID/OD:**	HW (4.0/4.5") to 14'	**Water Level*:**	9.6 ft (open, 0 hrs stab)
Hammer Efficiency Factor:	0.923	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA			15 inches HMA	
								53.7		1.3	
	1D	24/15	2.0 - 4.0	15-18-13-5	31	48				Layered, brown and tan, damp, dense, fine to coarse SAND, some gravel, little silt, (Fill).	
5	2D	24/19	5.0 - 7.0	1-2-1-2	3	5				Brown, moist, loose, Silty fine to medium SAND, trace to little fine gravel, trace coarse sand, with minor chips brick and one root, (Fill).	
10								45.0		10.0	
	3D	24/24	10.0 - 12.0	WOH/24"	0	0	HW PUSH			Transition from sandy material at top of sample to: 2-inch layer ORGANIC SILT/ PEAT underlain by: 3D Brown grey, wet/saturated, very loose, ORGANIC SILT, some fine sand, trace clay, trace medium sand, with roots throughout, (Recent Alluvium).	
	4D	24/18	14.0 - 16.0	3-4-2-4	6	9	OPEN			Brown, ORGANIC SILT, some fine sand; changing at 14.5 ft to: 4D: Grey, loose, fine to medium SAND, little silt, with pockets of wood and organic bits throughout; strong organic odor, (Recent Alluvium).	
15											
	5D	24/17	16.0 - 18.0	2-2-2-2	4	6				Brown grey, fine to coarse SAND, little silt; changing at 17.0 ft to:	
								38.0		17.0	
										5D: Olive grey, Clayey SILT, trace very fine sand, with numerous partings and seams of Silty fine SAND, (Marine Silt-Clay Crust).	
	6D	24/24	18.0 - 20.0	1-1-2-1	3	5				Olive grey, medium stiff, Clayey SILT, trace very fine sand, with numerous seams and layers of Silty fine SAND, (Marine Silt-Clay Crust).	RWGA#17265 G=A-4(0) WC=29.6%
20								35.0		20.0	
	7D	24/21	20.0 - 22.0	WOR/12"-WOH/12"	0	0				Olive grey, very soft, Clayey SILT, with occasional partings of Silty fine SAND, (Marine Silt-Clay).	RWGA#17266 G=A-6(15) WC=33.5% LL=35.8 PL=21.9 PI=13.9
	8D	24/24	22.0 - 24.0	WOR-WOH/18"	0	0				Olive grey, very soft, Clayey SILT, with occasional partings of Silty fine SAND, (Marine Silt-Clay).	RWGA#17267 WC=37.6% LL=33.7 PL=22.9 PI=10.8
25											

Remarks:

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

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Noyes Bridge #5932
Route 9 over Mill Brook
Location: Cumberland, ME

Boring No.: BB-CMB-101

WIN: 26180.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	55	**Auger ID/OD:**	SSA (4.5") to 10'
Operator:	McDougal/ Share/ Schaefer	**Datum:**	NAVD88	**Sampler:**	standard split-spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-53 track (NEBC-28)	**Hammer Wt./Fall:**	140 lbs/30 inches
Date Start/Finish:	10/5/22; 0750-1300	**Drilling Method:**	cased wash boring	**Core Barrel:**	not applicable
Boring Location:	Sta. 14+33, 9' RT	**Casing ID/OD:**	HW (4.0/4.5") to 14'	**Water Level*:**	9.6 ft (open, 0 hrs stab)
Hammer Efficiency Factor:	0.923	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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RC = Roller Cone
WOH = Weight of 140 lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
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C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	9D MV	24/24	25.0 - 27.0	WOR/24"	0	0				Grey with black streaks, very soft, CLAY, some silt, with few partings of Silty fine SAND, (Marine Silt-Clay). 25.3 ft: Unable to push vane past 25.3 ft.	
30	10D V1	24/24	30.0 - 32.0 30.6 - 31.0	PUSH THRU VANE Su=385 /0 psf	--					Dark grey with black streaks, soft, CLAY, some silt, with immature concretions, (Marine Silt-Clay). V1: 14 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	V2		31.6 - 32.0	Su=467 /0 psf						V2: 17 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
35	11D V3	24/24	35.0 - 37.0 35.6 - 36.0	PUSH THRU VANE Su=412 /0 psf	--					Dark grey with black streaks, soft, CLAY, some silt, with immature concretions, (Marine Silt-Clay). V3: 15 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	V4		36.6 - 37.0	Su=330 /0 psf						V4: 12 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
40	12D V5	24/24	40.0 - 42.0 40.6 - 41.0	PUSH THRU VANE Su=549 /0 psf	--					Dark grey with black streaks, medium stiff, CLAY, some silt, with immature concretions, (Marine Silt-Clay). V5: 20 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	V6		41.6 - 42.0	Su=604 /0 psf						V6: 22 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	U1	24/22	42.0 - 44.0	PISTON SAMPLER	--					Dark grey with black streaks, CLAY, some silt, (Marine Silt- Clay).	RWGA#17262 WC=43.4% LL=44.2 PL=22.9 PI=21.3 CONSOL
45	13D V7	24/24	45.0 - 47.0 45.6 - 46.0	PUSH THRU VANE Su=742 /0 psf	--					Dark grey with black streaks, medium stiff, CLAY, some silt, with immature concretions, (Marine Silt-Clay). V7: 27 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	V8		46.6 - 47.0	Su=632 /0 psf						V8: 23 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
50											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

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Location: Cumberland, ME

Boring No.: BB-CMB-101
WIN: 26180.00

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Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-53 track (NEBC-28)	**Hammer Wt./Fall:**	140 lbs/30 inches
Date Start/Finish:	10/5/22; 0750-1300	**Drilling Method:**	cased wash boring	**Core Barrel:**	not applicable
Boring Location:	Sta. 14+33, 9' RT	**Casing ID/OD:**	HW (4.0/4.5") to 14'	**Water Level*:**	9.6 ft (open, 0 hrs stab)
Hammer Efficiency Factor:	0.923	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50	14D	24/24	50.0 - 52.0	PUSH THRU VANE	--					Dark grey with black streaks, medium stiff, CLAY, some silt, with immature concretions, (Marine Silt-Clay).	
	V9		50.6 - 51.0	Su=714 /0 psf						V9: 26 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	V10		51.6 - 52.0	Su=687 /0 psf						V10: 25 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
55	15D	24/24	55.0 - 57.0	PUSH THRU VANE	--					Dark grey with black streaks, medium stiff, CLAY, some silt, with immature concretions, (Marine Silt-Clay).	
	V11		55.6 - 56.0	Su=659 /0 psf						V11: 24 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	V12		56.4 - 56.8	Su=852 /55 psf						V12: 31 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
										57 ft: Push rods to refusal to gauge thickness of marine silt-clay stratum.	
60											
65											
70											
75											

Remarks:

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Maine Department of Transportation

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US CUSTOMARY UNITS

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Route 9 over Mill Brook
Location: Cumberland, ME

Boring No.: BB-CMB-101

WIN: 26180.00

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Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-53 track (NEBC-28)	**Hammer Wt./Fall:**	140 lbs/30 inches
Date Start/Finish:	10/5/22; 0750-1300	**Drilling Method:**	cased wash boring	**Core Barrel:**	not applicable
Boring Location:	Sta. 14+33, 9' RT	**Casing ID/OD:**	HW (4.0/4.5") to 14'	**Water Level*:**	9.6 ft (open, 0 hrs stab)
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Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
75											
								-21.9		76.9 **Bottom of Exploration at 76.9 feet below ground surface.** Rod refusal; suggesting bottom of marine silt-clay stratum.	
80											
85											
90											
95											
100											

Remarks:

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

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Noyes Bridge #5932, Route 9 over Mill Brook
Location: Cumberland, ME

Boring No.: BB-CMB-102*
WIN: 26180.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	varies - multiple attempts	**Auger ID/OD:**	SSA (4.5")
Operator:	McDougal/ Share/ Schaefer	**Datum:**	NAVD88	**Sampler:**	standard split-spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-53 track (NEBC-28)	**Hammer Wt./Fall:**	140 lbs/30 inches
Date Start/Finish:	10/3/22; 1000-1230	**Drilling Method:**	cased wash boring - attempts	**Core Barrel:**	not applicable
Boring Location:	refer to remarks - multiple attempts	**Casing ID/OD:**	HW (4.0/4.5")	**Water Level*:**	--
Hammer Efficiency Factor:	0.923	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA			16 inches HMA	
										1.4	
	1D	24/16	2.0 - 4.0	10-15-19-17	34	52				Tan brown, damp, very dense, fine to coarse SAND, some gravel, little silt, ((Granular) Fill).	
										4.2	
										4.2 ft: Very boney material based on drilling behavior; augers walking; auger cuttings change color.	
5	2D	24/9	5.0 - 7.0	7-2-5-4	7	11	21			Brown, damp to moist, medium dense, fine to coarse SAND, little to some gravel, little silt, (Fill).	
							27				
							155+ RC			Obstruction at 7.8 ft; attempt to penetrate with roller cone; unsuccessful.	
										7.9	
										Bottom of Exploration at 7.9 feet below ground surface. Roller cone refusal.	
10											
15											
20											
25											

Remarks:

* Total of three attempts to penetrate rubble fill encountered in northwest quadrant of culvert crossing.
BB-CMB-102 at Station 13+93, 9' LT; SSA refusal at 7.9' BGS
BB-CMB 102A at Station 14+03, 9' LT; RC refusal at 6.7' BGS
BB-CMB-102B at Station 14+08, 9' LT; SSA refusal at 4.8" BGS.
Believed to be in rubble fill associated with former block abutments.

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Noyes Bridge #5932
Route 9 over Mill Brook
Location: Cumberland, ME

Boring No.: BB-CMB-102C

WIN: 26180.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	51.5	**Auger ID/OD:**	SSA (4.5") to 10'
Operator:	McDougal/ Share/ Schaefer	**Datum:**	NAVD88	**Sampler:**	standard split-spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-53 track (NEBC-28)	**Hammer Wt./Fall:**	140 lbs/30 inches
Date Start/Finish:	10/3/22; 1250 - 10/4/22;	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta. 13+49, 10' LT	**Casing ID/OD:**	HW (4.0/4.5") 14'/NW (3.0/3.5") 73.5'	**Water Level*:**	9.7' (cased; 16 hrs stab)
Hammer Efficiency Factor:	0.923	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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WOH = Weight of 140lb. Hammer
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WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index
G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA			15 inches HMA	
								50.2		1.3	
	1D	24/24	2.0 - 4.0	5-16-13-7	29	45				Brown, damp, fine to coarse SAND, little gravel, little silt, ((Granular) Fill). Changing at 2.8 ft to: 1D: Tan, damp, fine to medium SAND, trace to little silt, (Fill).	
5	2D	24/5	5.0 - 7.0	2-2-2-2	4	6				Brown, moist, loose, fine to coarse SAND, some silt, little gravel, (Fill).	
							HW				
10	3D	24/19	10.0 - 12.0	1-1-2-2	3	5	PUSH	41.0		Fill changing at 10.5 ft to: 10.5 3D: Brown grey, wet, loose, fine to medium SAND, trace to little organic silt, with organic bits in lower 8 in of sample; strong organic odor, (Recent Alluvium).	
	4D	24/10	12.0 - 14.0	2-2-1-2	3	5				Brown grey, loose, fine to medium SAND, trace to little organic silt, trace coarse sand, with pieces wood throughout, (Recent Alluvium).	
15	5D	24/10	14.0 - 16.0	3-2-1-1	3	5				Brown grey, loose, fine to coarse SAND, trace organic silt, with one 1-in seam of grey, Silty fine SAND over 1-in piece wood in bottom of sample, (Recent Alluvium).	
	6D	24/11	16.0 - 18.0	1-1-2-2	3	5				Top 7": Grey brown, Organic Silty fine to medium SAND, trace coarse sand, with pieces of wood. Bottom 4": Brown grey, fine to medium SAND, trace organic silt, with abundant wood, (Recent Alluvium).	RWGA#17268 G=A-2-4(0) WC=47.5% ORGANIC 4.5%
	7D	24/9	18.0 - 20.0	2-2-2-2	4	6				Dark grey, loose, fine to coarse SAND, little silt, trace coarse sand, with abundant wood throughout, (Recent Alluvium).	RWGA#17269 G=A-1-b WC=77.8% ORGANIC 4.8%
20	8D	24/10	20.0 - 22.0	2-2-5-3	7	11				Dark grey, medium dense, fine to coarse SAND, trace to little silt, with one 2-in seam Organic Silty fine to medium SAND, with organic bits, (Recent Alluvium).	RWGA#17270 G=A-2-4(0) WC=25.8% ORGANIC 0.6%
	9D	24/16	22.0 - 24.0	3-3-1-1	4	6		28.2		Dark grey, fine to coarse SAND, trace to little silt, (Recent Alluvium). Changing at 23.3 ft to: 23.3 9D: Grey with occasional black streaks, Silty CLAY, trace very fine sand, (Marine Silt-Clay).	RWGA#17271 G=A-7-6(21) WC=38.2% LL=40.9
25	10D	24/21	24.0 - 26.0	WOR/18"-WOH	0	0				Dark grey with occasional black streaks, very soft, CLAY, some silt,	

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Noyes Bridge #5932
Route 9 over Mill Brook
Location: Cumberland, ME

Boring No.: BB-CMB-102C

WIN: 26180.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	51.5	**Auger ID/OD:**	SSA (4.5") to 10'
Operator:	McDougal/ Share/ Schaefer	**Datum:**	NAVD88	**Sampler:**	standard split-spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-53 track (NEBC-28)	**Hammer Wt./Fall:**	140 lbs/30 inches
Date Start/Finish:	10/3/22; 1250 - 10/4/22;	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta. 13+49, 10' LT	**Casing ID/OD:**	HW (4.0/4.5") 14'/NW (3.0/3.5") 73.5'	**Water Level*:**	9.7' (cased; 16 hrs stab)
Hammer Efficiency Factor:	0.923	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25										(Marine Silt- Clay).	PL=20.8 PI=20.1 RWGA#17272 WC=41.2% LL=39.9 PL=22.3 PI=17.6
30	11D	24/24	30.0 - 32.0	PUSH THRU VANE	--					Dark grey with occasional black streaks, soft, CLAY, some silt, (Marine Silt-Clay).	
	V1		30.6 - 31.0	Su= -- /0 psf						V1: -- / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	V2		31.6 - 32.0	Su=453 /0 psf						V2: 16.5 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
35	U1	24/22	35.0 - 37.0	PISTON SAMPLER	--					Dark grey, CLAY, some silt, (Marine Silt-Clay).	RWGA#17263 WC=47.1% LL=48.9 PL=25.6 PI=23.3 CONSOL
40											
	12D	24/24	41.0 - 43.0	PUSH THRU VANE	--		OPEN			Dark grey, soft, CLAY, some silt, (Marine Silt-Clay).	
	V3		41.6 - 42.0	Su=440 /55 psf						V3: 16 / 2 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	V4		42.6 - 43.0	Su=467 /137 psf						V4: 17 / 5 ft-lbs (65 mm x 130 mm vane raw torque readings)	
45	13D	24/24	45.0 - 47.0	PUSH THRU VANE	--					Dark grey, soft to medium stiff, CLAY, some silt, (Marine Silt-Clay).	
	V5		45.6 - 46.0	Su=481 /0 psf						V5: 17.5 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	V6		46.6 - 47.0	Su=549 /0 psf						V6: 20 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
50											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Noyes Bridge #5932
Route 9 over Mill Brook
Location: Cumberland, ME

Boring No.: BB-CMB-102C

WIN: 26180.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	51.5	**Auger ID/OD:**	SSA (4.5") to 10'
Operator:	McDougal/ Share/ Schaefer	**Datum:**	NAVD88	**Sampler:**	standard split-spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-53 track (NEBC-28)	**Hammer Wt./Fall:**	140 lbs/30 inches
Date Start/Finish:	10/3/22; 1250 - 10/4/22;	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta. 13+49, 10' LT	**Casing ID/OD:**	HW (4.0/4.5") 14'/NW (3.0/3.5") 73.5'	**Water Level*:**	9.7' (cased; 16 hrs stab)
Hammer Efficiency Factor:	0.923	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

Definitions:
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SSA = Solid Stem Auger
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WOH = Weight of 140 lb. Hammer
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WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
$S_{u(lab)}$ = Lab Vane Undrained Shear Strength (psf)
q_p = Unconfined Compressive Strength (ksf)
N-uncorrected = Raw Field SPT N-value
Hammer Efficiency Factor = Rig Specific Annual Calibration Value
N_{60} = SPT N-uncorrected Corrected for Hammer Efficiency
N_{60} = (Hammer Efficiency Factor/60%)*N-uncorrected
T_v = Pocket Torvane Shear Strength (psf)
WC = Water Content, percent
LL = Liquid Limit
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G = Grain Size Analysis
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Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50	U2	24/23	50.0 - 52.0	PISTON SAMPLER	--					Dark grey, CLAY, some silt, (Marine Silt-Clay).	RWGA#17264 WC=41.2% LL=44.4 PL=23.0 PI=21.4 CONSOL
55	14D	24/24	55.0 - 57.0	PUSH THRU VANE	--					Dark grey, medium stiff, CLAY, some silt, with concretions, (Marine Silt-Clay).	
	~~V7~~		~~55.6 - 56.0~~	~~Su=577 /0 psf~~						V7: 21 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	V8		56.6 - 57.0	Su=879 /55 psf						V8: 32 / 2 ft-lbs (65 mm x 130 mm vane raw torque readings)	
60	15D	24/24	60.0 - 62.0	VANE/12"-WOH-1	--					Dark grey, medium stiff, CLAY, some silt, with numerous 1/4- to 1/2-in seams of fine SAND, little silt and Silty fine SAND, (Marine Silt-Clay).	
	~~V9~~		~~60.6 - 61.0~~	~~Su=797 /0 psf~~				-9.7		V9: 29 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	MV									61.2 Unable to push vane past 61.2 ft.	
	MV						NW			Unable to push vane at 65 ft.	
65	16D	24/18	65.0 - 67.0	WOR-WOH-1-2	0	0	RC			Layered sample, dark grey, Silty fine to medium SAND, little clay; CLAY, little to some silt, some fine sand; and fine to medium SAND, some silt, (transition).	
								-15.5		67.0	
70	17D	24/16	70.0 - 72.0	3-7-6-7	13	20				Brown grading to grey brown, medium dense, fine to medium SAND, little silt, trace coarse sand grading to fine to coarse SAND, some silt. trace fine gravel, (Glacial Till).	
	R1	60/57	73.5 - 78.5	RQD = 40%			NQ2	-22.0		73.5 Top of bedrock at Elev. -22.0 ft. R1: Bedrock: Red-grey and green-grey, aphanitic to medium grained,	
75											

Remarks:

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Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS	**Project:** Noyes Bridge #5932 Route 9 over Mill Brook **Location:** Cumberland, ME	**Boring No.:** BB-CMB-102C **WIN:** 26180.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	51.5	**Auger ID/OD:**	SSA (4.5") to 10'
Operator:	McDougal/ Share/ Schaefer	**Datum:**	NAVD88	**Sampler:**	standard split-spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-53 track (NEBC-28)	**Hammer Wt./Fall:**	140 lbs/30 inches
Date Start/Finish:	10/3/22; 1250 - 10/4/22;	**Drilling Method:**	cased wash boring	**Core Barrel:**	NQ2
Boring Location:	Sta. 13+49, 10' LT	**Casing ID/OD:**	HW (4.0/4.5") 14'/NW (3.0/3.5") 73.5'	**Water Level*:**	9.7' (cased; 16 hrs stab)
Hammer Efficiency Factor:	0.923	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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G = Grain Size Analysis
C = Consolidation Test

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
75										HORNFELS, with occasional quartzite veins and inclusions; horizontal to low angle remnant bedding visible; very hard, typically fresh. Typically horizontal and low angle, closely spaced breaks; undulating, rough, typically fresh, and partially open to open. 77.5 to 78.5 ft highly broken. (HUTCHINS CORNER FORMATION) Core times: 1:30/ 1:55/ 1:50/ 2:25/ 2:55 min:sec/ft. ROCK QUALITY = POOR	
	R2	60/57	78.5 - 83.5	RQD = 75%						R2: Similar to R1, except close to moderately spaced breaks. Core times: 1:35/ 1:55/ 2:35/ 2:50/ 3:00 min:sec/ft ROCK QUALITY = FAIR	
80											
83.5								-32.0		**Bottom of Exploration at 83.5 feet below ground surface.**	
85											
90											
95											
100											

Remarks:

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Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project:	Noyes Bridge #5932 Route 9 over Mill Brook
Location:	Cumberland, ME
Boring No.:	BB-CMB-201
WIN:	26180.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	52.5	**Auger ID/OD:**	SSA (4.5") to 9 ft
Operator:	McDougal/ Turtlott	**Datum:**	NAVD88	**Sampler:**	standard split-spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-53 track	**Hammer Wt./Fall:**	140 lbs/30 inches
Date Start/Finish:	6/23/25; 1000-1630	**Drilling Method:**	cased wash boring	**Core Barrel:**	n/a
Boring Location:	Sta 13+63, 11' RT	**Casing ID/OD:**	HW (4") to 20 ft	**Water Level*:**	
Hammer Efficiency Factor:	0.786	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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WOH = Weight of 140lb. Hammer
WOR/C = Weight of Rods or Casing
WO1P = Weight of One Person
S_u = Peak/Remolded Field Vane Undrained Shear Strength (psf)
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WC = Water Content, percent
LL = Liquid Limit
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Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
0							SSA			11 inches HMA	
								51.6		0.9	
	1D	24/11	1.0 - 3.0	12-13-10-16	23	30				Brown, damp, dense, fine to coarse SAND, little silt, little gravel, (Fill).	
	2D	24/16	4.0 - 6.0	11-11-7-5	18	24				Light brown, damp, medium dense, fine to medium SAND, trace to little silt, trace coarse sand, (Fill).	
5											
	3D	24/10	9.0 - 11.0	1/12"-1/12"	1	1	HW PUSH			Light brown, damp to moist, very loose, fine to medium SAND, trace coarse sand, trace silt, (Fill).	#18606-01 G=A-3 WC=5.8%
10											
								41.7		10.8	
										Changing at 10.8 ft to: Grey, moist, Silty fine SAND, (Alluvium).	
	4D	24/8	14.0 - 16.0	2-3-3-4	6	8				Grey, loose, fine to medium SAND, trace silt, trace fine gravel, trace coarse sand, with pockets decomposed wood throughout; strong organic odor, (Alluvium).	#18606-02 G=A-3 WC=34.4%
15											
	5D	24/8	16.0 - 18.0	3-4-3-6	7	9				Grey, loose, fine to medium SAND, trace to little silt, trace coarse sand, with seams of wood throughout; somewhat layered, (Alluvium).	#18606-03 G=A-2-4(0) WC=33.6%
	6D	24/9	18.0 - 20.0	5-5-6-5	11	14				Grey, medium dense, fine to medium SAND, trace to little silt, trace coarse sand, with seams and pockets decomposed/black wood, (Alluvium).	#18606-04 G=A-1-b WC=22.6%
20											
	7D	24/13	20.0 - 22.0	3-2-3-2	5	7	OPEN			Grey, loose, fine to medium SAND, trace silt, trace coarse sand, with occasional pockets black organic staining, (Alluvium).	#18606-05 G=A-1-b WC=24.6%
								30.7		21.8	
	8D	24/24	22.0 - 24.0	WOR/24"	0	0				Changing at 21.8 ft to: Grey, Clayey SILT, (Marine Silt-Clay). Grey, (very soft), Clayey SILT, trace to little sand, (Marine Silt-Clay).	8D-#18606-06 G=A-6(17) WC=35.9% LL=40.0 PL=22.9 PI=17.1
	9D	24/24	24.0 - 26.0	PUSH THRU VANE	--					Grey, soft, Clayey SILT, (Marine Silt-Clay). V1: 16 / 2 ft-lbs (65 mm x 130 mm vane raw torque readings)	
25											

Remarks:

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

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Noyes Bridge #5932 Route 9 over Mill Brook
Location: Cumberland, ME

Boring No.: BB-CMB-201
WIN: 26180.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	52.5	**Auger ID/OD:**	SSA (4.5") to 9 ft
Operator:	McDougal/ Turtlott	**Datum:**	NAVD88	**Sampler:**	standard split-spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-53 track	**Hammer Wt./Fall:**	140 lbs/30 inches
Date Start/Finish:	6/23/25; 1000-1630	**Drilling Method:**	cased wash boring	**Core Barrel:**	n/a
Boring Location:	Sta 13+63, 11' RT	**Casing ID/OD:**	HW (4") to 20 ft	**Water Level*:**	
Hammer Efficiency Factor:	0.786	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
25	V1		24.6 - 25.0	Su=440 /55 psf							9D-#18606-07 G=A-6(19) WC=41.0% LL=39.6 PL=23.0 PI=16.6
	V2		25.6 - 26.0	Su=412 /27 psf						V2: 15 / 1 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	10D	24/24	26.0 - 28.0	PUSH THRU VANE	--					Dark grey, soft, Silty CLAY, trace sand, (Marine Silt-Clay).	
	V3		26.6 - 27.0	Su= 440 /0 psf						V3: 16 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	V4		27.6 - 28.0	Su=385 /0 psf						V4: 14 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	10D#18606-08 G=A-7-6(20) WC=43.1% LL=41.7 PL=23.7 PI=18.0
	11D	24/24	28.0 - 30.0	PUSH THRU VANE	--					Dark grey with black staining, soft, Silty CLAY, trace sand, (Marine Silt-Clay).	11D#18606-09 G=A-6(16) WC=48.4% LL=39.3 PL=23.9 PI=15.4
	MV		29.0 - 29.0	MV						MV: Missed vane interval.	
30	V5		29.6 - 30.0	Su=412 /0 psf						V5: 15 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	12D	24/24	34.0 - 36.0	PUSH THRU VANE	--					Dark grey with black staining, soft, Silty CLAY, trace sand, (Marine Silt-Clay).	12D#18606-10 G=A-6(16) WC=47.0% LL=37.8 PL=23.3 PI=14.5
35	V6		34.6 - 35.0	Su=494 /0 psf						V6: 18 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	V7		35.6 - 36.0	Su=467 /27 psf						V7: 17 / 1 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	13D	24/12	39.0 - 41.0	PUSH THRU VANE	--					Dark grey, soft, Silty CLAY, (Marine Silt-Clay).	
40	V8		39.6 - 40.0	Su=494 /0 psf						V8: 18 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	V9		40.6 - 41.0	Su=467 /0 psf						V9: 17 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	14D	24/24	44.0 - 46.0	PUSH THRU VANE	--					Dark grey with black staining, medium stiff, Silty CLAY, (Marine Silt-Clay).	
45	V10		44.6 - 45.0	Su=577 /55 psf						V10: 21 / 2 ft-lbs (65 mm x 130 mm vane raw torque readings)	
	V11		45.6 - 46.0	Su=632 /55 psf						V11: 23 / 2 ft-lbs (65 mm x 130 mm vane raw torque readings)	
50	15D	24/14	49.0 - 51.0	PUSH THRU VANE	--					Dark grey, medium stiff, Silty CLAY, (Marine Silt-Clay). V12: 21 / 1 ft-lbs (65 mm x 130 mm vane raw torque readings)	

Remarks:

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

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

Maine Department of Transportation

Soil/Rock Exploration Log
US CUSTOMARY UNITS

Project: Noyes Bridge #5932 Route 9 over Mill Brook
Location: Cumberland, ME

Boring No.: BB-CMB-201
WIN: 26180.00

Driller:	New England Boring Contractors	**Elevation (ft.)**	52.5	**Auger ID/OD:**	SSA (4.5") to 9 ft
Operator:	McDougal/ Turtlott	**Datum:**	NAVD88	**Sampler:**	standard split-spoon
Logged By:	Schonewald	**Rig Type:**	Mobile Drill B-53 track	**Hammer Wt./Fall:**	140 lbs/30 inches
Date Start/Finish:	6/23/25; 1000-1630	**Drilling Method:**	cased wash boring	**Core Barrel:**	n/a
Boring Location:	Sta 13+63, 11' RT	**Casing ID/OD:**	HW (4") to 20 ft	**Water Level*:**	
Hammer Efficiency Factor:	0.786	**Hammer Type:**	Automatic ☒ Hydraulic ☐ Rope & Cathead ☐		

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

Depth (ft.)	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (/6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N_{60}	Casing Blows	Elevation (ft.)	Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
50	V12 V13		49.6 - 50.0 50.6 - 51.0	Su=577 /27 psf Su=522 /0 psf						V13: 19 / 0 ft-lbs (65 mm x 130 mm vane raw torque readings)	
55											
60	MD ~~V14~~ V15		59.0 - 59.0 ~~59.6 - 60.0~~ 60.6 - 61.0	MD ~~Su=879 /55 psf~~ Su=934 /55 psf						MD: Missed spoon through vane interval. V14: 32 / 2 ft-lbs (65 mm x 130 mm vane raw torque readings) V15: 34 / 2 ft-lbs (65 mm x 130 mm vane raw torque readings)	
65											
70	MV							-17.5		70.0 70 ft: Possible transition to dense material based on drilling behavior. MV: Unable to push vane past 71.0 ft.	
	16D	13/13	71.0 - 72.1	8-10-50/1"	--					Grey, Silty GRAVEL, some fine to coarse sand; gravel typically angular, (Till).	
								-19.7		72.2 **Bottom of Exploration at 72.2 feet below ground surface.** at roller cone refusal.	
75											

Remarks:

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

* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.

APPENDIX C

BEDROCK CORE PHOTOGRAPHS

Core box containing wetted core from test boring BB-CMB-102C (Box 1 of 1); left side of core box (top portion of cores). Slots from top to bottom:
1) BB-CMB-102C, R1;
2) BB-CMB-102C, R2;
3) empty;
4) empty.

Core box containing wetted core from test boring BB-CMB-102C (Box 1 of 1); right side of core box (bottom portion of cores). Slots from top to bottom:
1) BB-CMB-102C, R1;
2) BB-CMB-102C, R2;
3) empty;
4) empty.

SCHONEWALD ENGINEERING ASSOCIATES, INC.

ROCK CORE PHOTOGRAPHS
NOYES BRIDGE #5932
ROUTE 9 OVER MILL BROOK
CUMBERLAND, MAINE
MAINEDOT WIN 26180.00

Sheet No.:

1 of 1

APPENDIX D

RESULTS OF LABORATORY TESTS ON SOIL SAMPLES

TABULATION OF SOIL TESTING (RWG&A PROJECT NOS. 1368-021 (100-series) and 1368-028 (200-series)) (listed in order of test report presentation)				
Boring No.	**Sample No.**	**Sample Depth (ft., BGS)**	**RWG&A Lab No.**	**Tests Completed**
UNDISTURBED TUBE SAMPLES				
BB-CMB-101	U1	42-44	17262	tube opening, Atterberg limits, consol (square root time w/ unload-reload)
BB-CMB-102C	U1	35-37	17263	tube opening, Atterberg limits, consol (log time for C-alpha w/ unload-reload)
BB-CMB-102C	U2	50-52	17264	tube opening, Atterberg limits, consol (square root time w/ unload-reload)
SPLIT-SPOON JAR SAMPLES				
BB-CMB-101	6D	18-20	17265	wash gradation with hydrometer
BB-CMB-101	7D	20-22	17266	wash gradation with hydrometer, Atterberg limits, moisture content
BB-CMB-101	8D	22-24	17267	Atterberg limits, moisture content
BB-CMB-102C	6D	16-18	17268	wash gradation with hydrometer, organic content
BB-CMB-102C	7D	18-20	17269	wash gradation with hydrometer, organic content
BB-CMB-102C	8D	20-22	17270	wash gradation with hydrometer, organic content
BB-CMB-102C	9D	22-24	17271	wash gradation with hydrometer, Atterberg limits, moisture content
BB-CMB-102C	10D	24-26	17272	Atterberg limits, moisture content
BB-CMB-201	3D	9-11	18606-1	wash gradation with hydrometer, moisture content
BB-CMB-201	4D	14-16	18606-2	wash gradation with hydrometer, moisture content
BB-CMB-201	5D	16-18	18606-3	wash gradation with hydrometer, moisture content
BB-CMB-201	6D	18-20	18606-4	wash gradation with hydrometer, moisture content
BB-CMB-201	7D	20-22	18606-5	wash gradation with hydrometer, moisture content
BB-CMB-201	8D	22-24	18606-6	Atterberg Limits, wash gradation with hydrometer, moisture content
BB-CMB-201	9D	24-26	18606-7	Atterberg Limits, wash gradation with hydrometer, moisture content
BB-CMB-201	10D	26-28	18606-8	Atterberg Limits, wash gradation with hydrometer, moisture content
BB-CMB-201	11D	28-30	18606-9	Atterberg Limits, wash gradation with hydrometer, moisture content
BB-CMB-201	12D	34-36	18606-10	Atterberg Limits, wash gradation with hydrometer, moisture content

Laboratory Vane Shear Test Results

ASTM D4648 Standard Test Method for Laboratory Miniature Vane Shear Test for Saturated Fine-Grained Clayey Soil

Project: Noyes Bridge, Cumberland (SEA #22-012, WIN 2618.00)
Client: Schonewald Engineering Associates, Inc.
Project No.: 1368-021

Location: Cumberland, ME
Date: 12/2/2022
Test Depth: 42.30 to 43.00

Boring/Sample No.	BB-CMB-101/ U1				Lab No.	17262	
Test No.	Test Depth (ft)	Vane Size	Max. Torque (Undisturbed) (kg-cm)	Max. Torque (Remolded) (kg-cm)	Undisturbed Undrained Shear Strength (psf)	Remolded Undrained Shear Strength (psf)	Moisture Content
1	42.3	M	13	0	272	0	47%
2	42.5	S	6	0	251	0	44%
3	42.6	S	7	0	292	0	44%
4	42.75	L	48	3	501	31	45%
5	43	L	51	4	532	42	45%

Vane Size	
	(mm)
S	16 x 32
M	20 x 40
L	24.5 x 50.8

Tested By: AGS

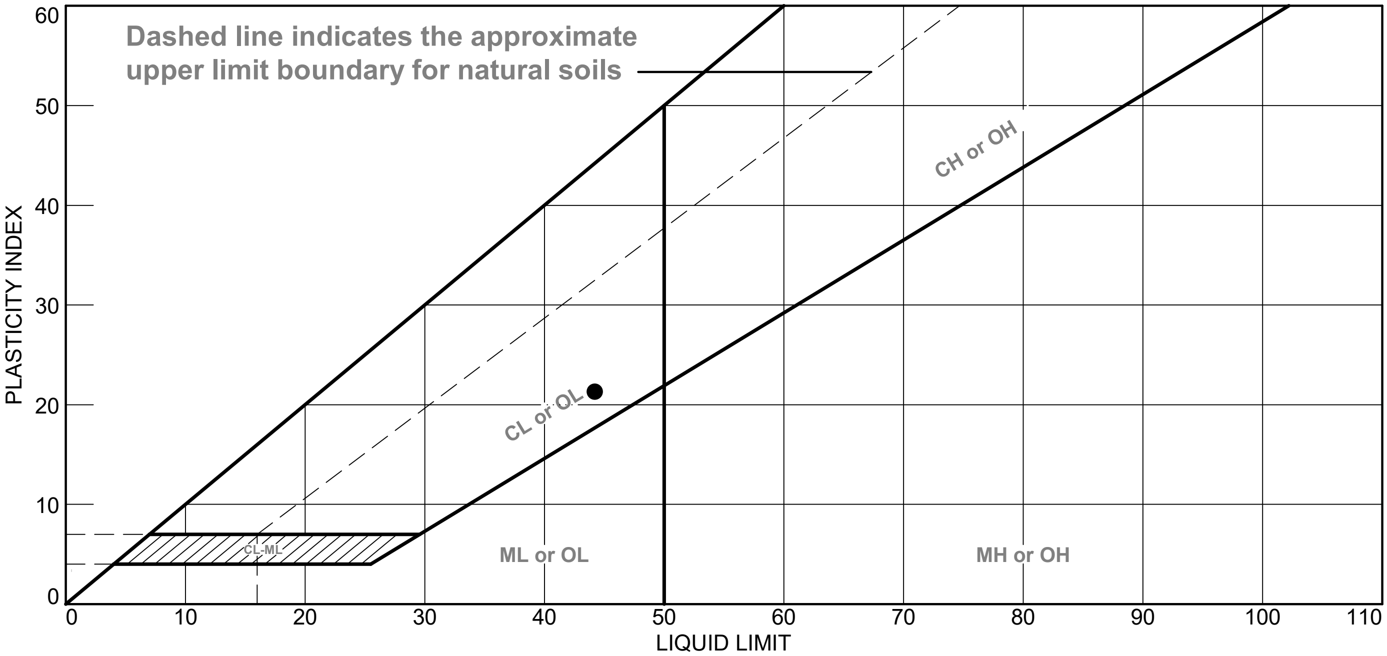
Checked By: MTG

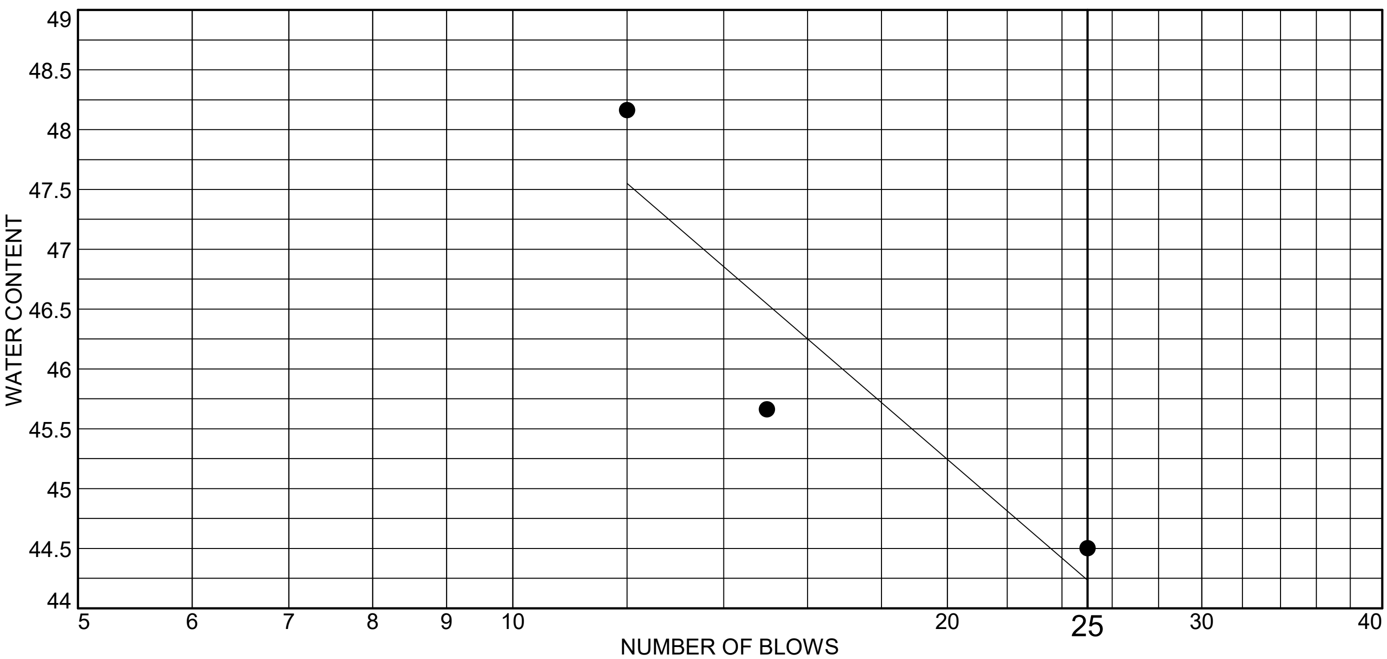
R.W. Gillespie & Associates

20 Pomerleau St., Suite 100, Biddeford ME 04005, 207-286-8008 / 177 Shattuck Way, Suite 1 West, Newington NH 03801, 603-427-0244

 MTG

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Lean Clay	44.2	22.9	21.3			

Project No. 1368-021 **Client:** Schonewald Engineering Associates, Inc

Project: Noyes Bridge SEA#22-012, WIN 2618.00

Cumberland, ME

Location: BB-CMB-101

Sample Number: U-1 **Depth:** 42.8

R.W. Gillespie & Associates, Inc.

Biddeford, Maine

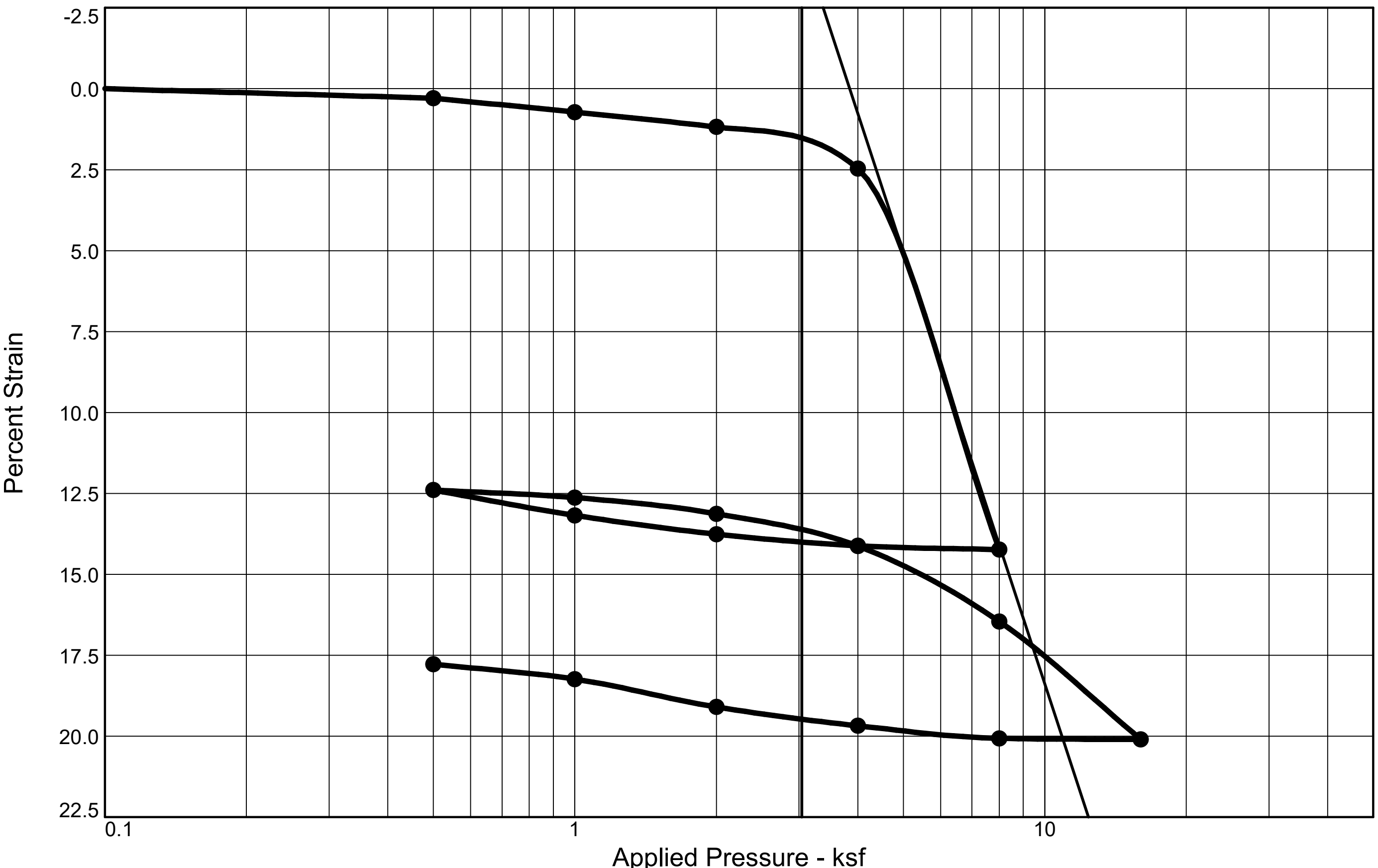
Remarks:

Lab No. 17262

Tested By: CAG **Checked By:** MTG

 MTG

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation

No.	Load (ksf)	C_v (ft.^{2}/day)	C_α	No.	Load (ksf)	C_v (ft.^{2}/day)	C_α	No.	Load (ksf)	C_v (ft.^{2}/day)	C_α
1	0.50	0.815		8	1.00	0.102		15	8.00	0.793	
2	1.00	0.304		9	0.50	0.037		16	4.00	0.428	
3	2.00	0.555		10	1.00	0.157		17	2.00	0.102	
4	4.00	0.364		11	2.00	0.151		18	1.00	0.042	
5	8.00	0.096		12	4.00	0.147		19	0.50	0.019	
6	4.00	0.997		13	8.00	0.094					
7	2.00	0.367		14	16.00	0.100					

Natural Saturation	Natural Moisture	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_r	Initial Void Ratio
89.7 %	43.4 %	77.0	44.2	21.3	2.75		4.1	1.03	0.08	1.331

MATERIAL DESCRIPTION	USCS	AASHTO
Lean Clay		

Project No. 1368-021 **Client:** Schonewald Engineering Associates, Inc

Project: Noyes Bridge SEA#22-012, WIN 2618.00
Cumberland, ME

Location: BB-CMB-101 **Depth:** 42.8 **Sample Number:** U-1

Remarks:

R.W. Gillespie & Associates, Inc.

Biddeford, Maine

Lab No. 17262

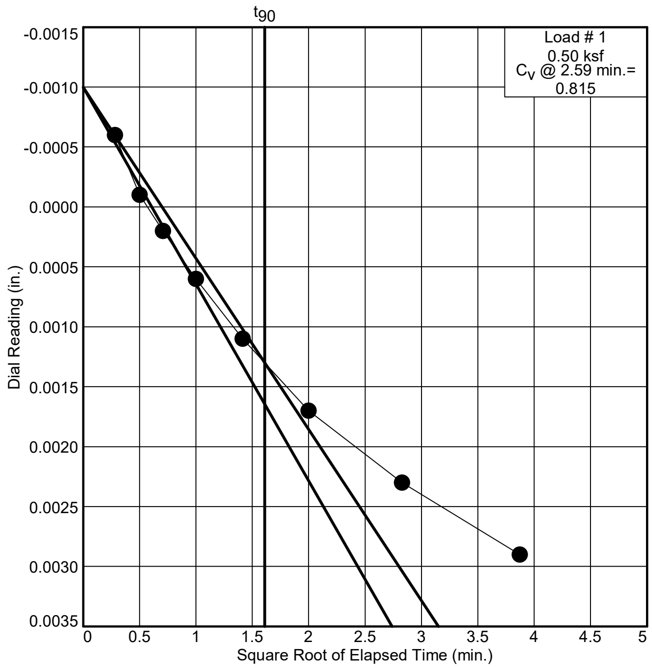
Tested By: AGS **Checked By:** MTG

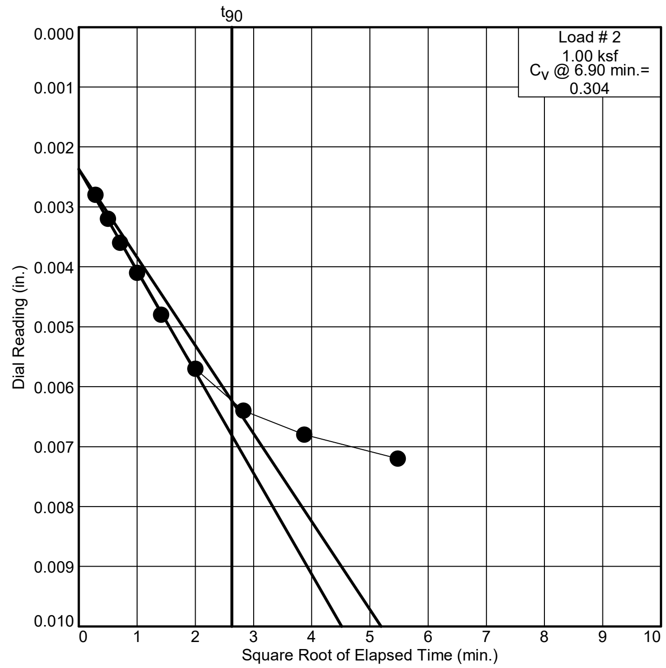
 MTG

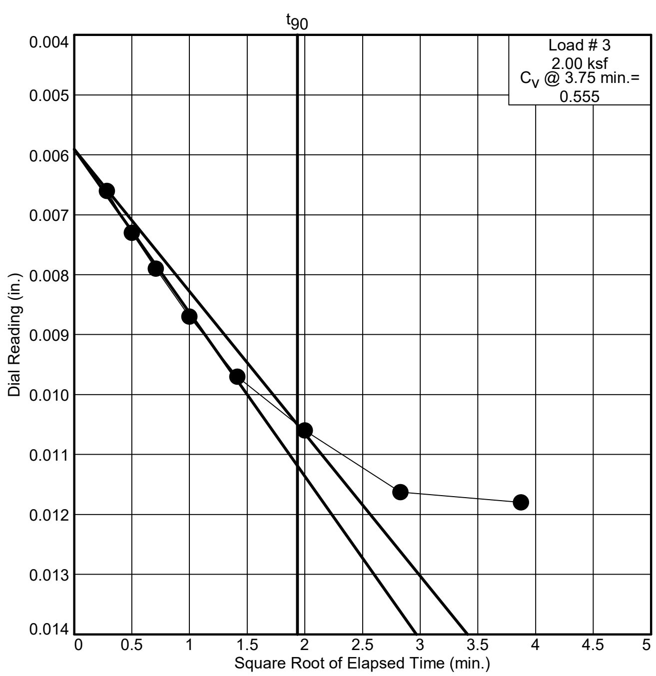
Dial Reading vs. Time

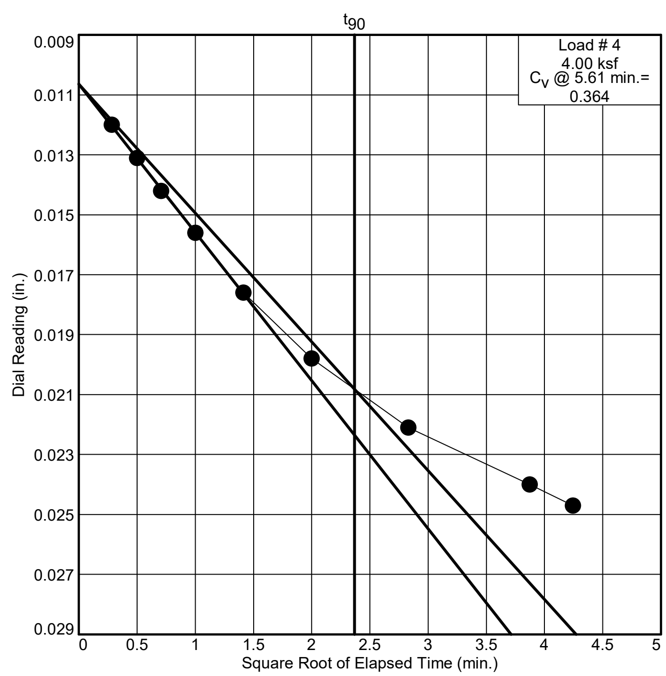
Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-101 Depth: 42.8 Sample Number: U-1









R.W. Gillespie & Associates, Inc.

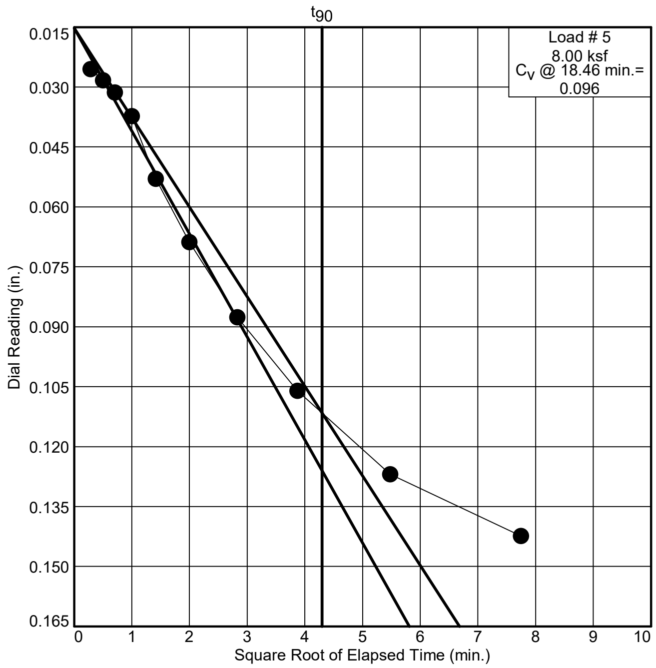
Biddeford, Maine

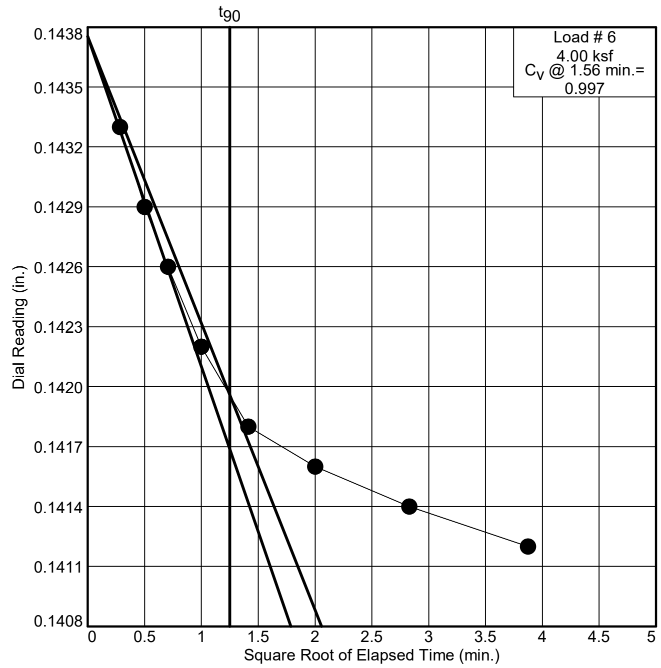
Lab No. 17262

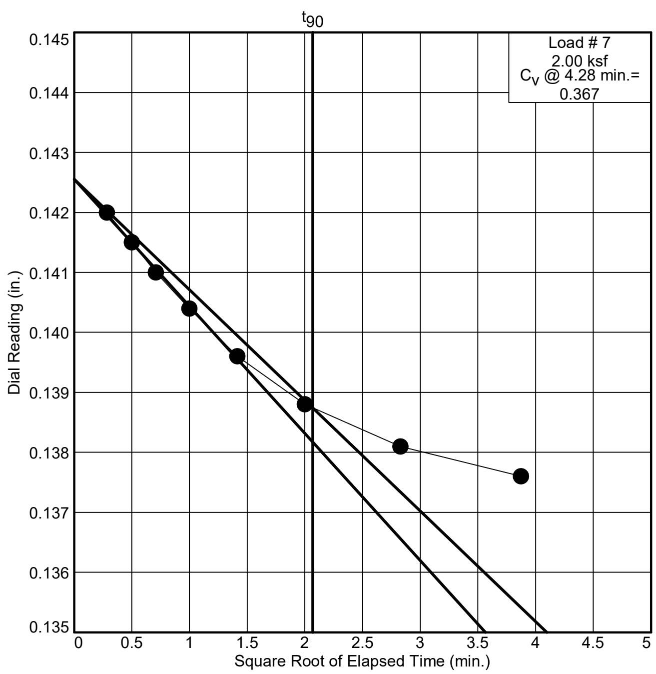
Dial Reading vs. Time

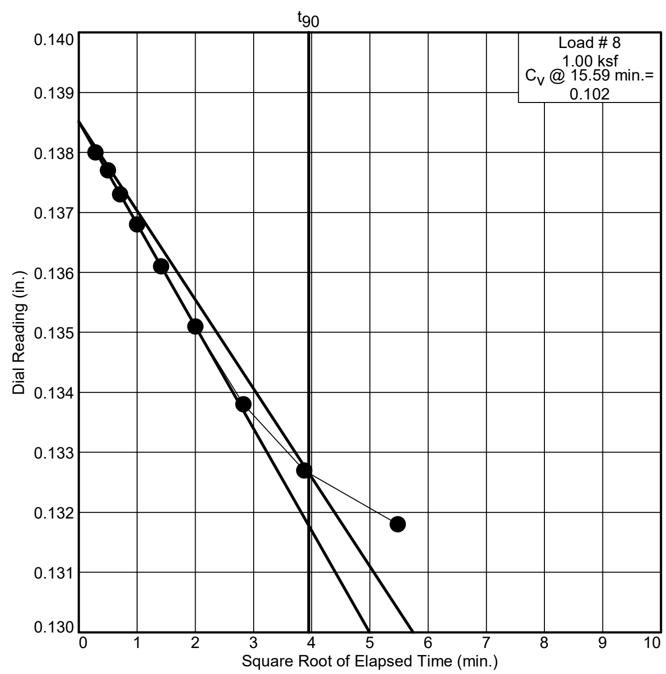
Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-101 Depth: 42.8 Sample Number: U-1









R.W. Gillespie & Associates, Inc.

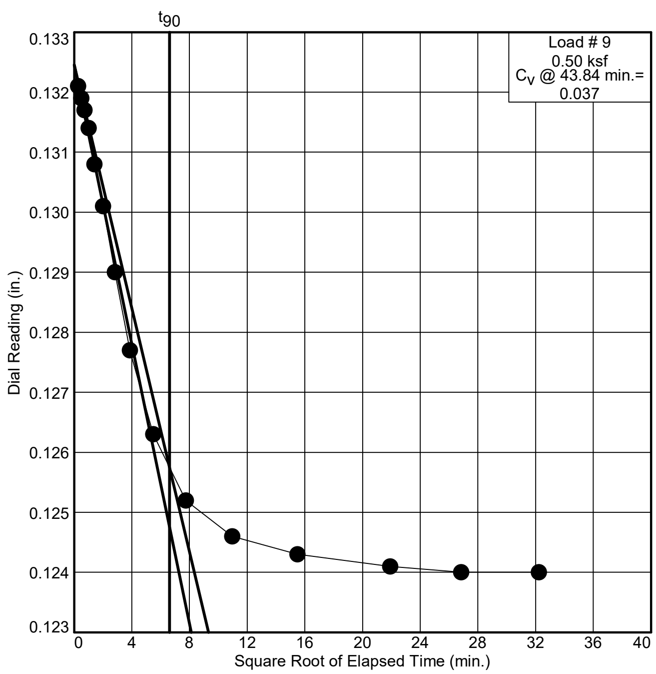
Biddeford, Maine

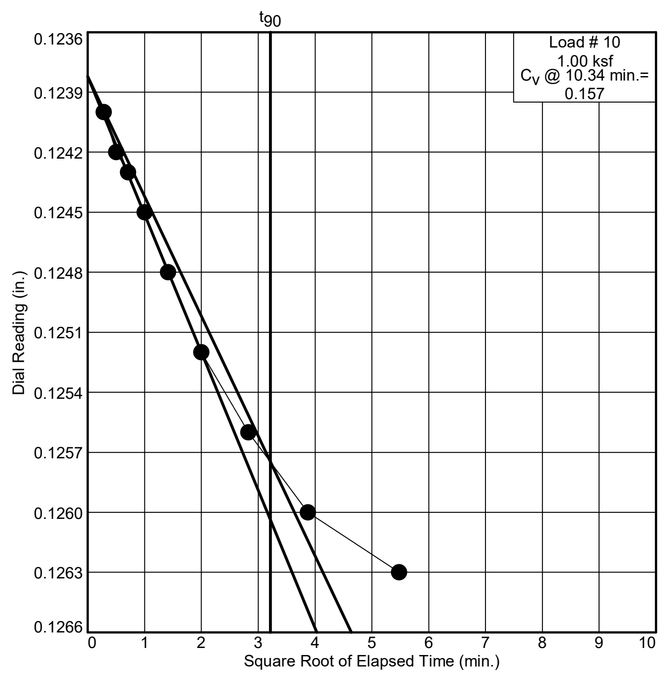
Lab No. 17262

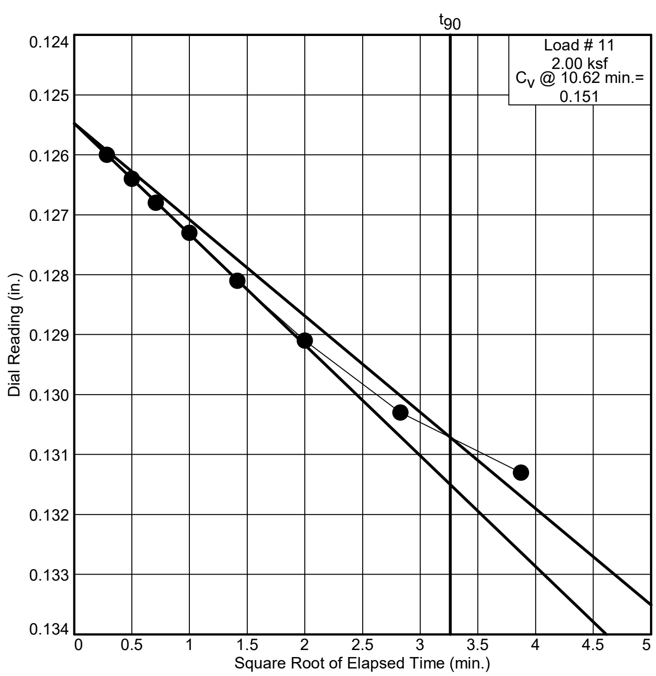
Dial Reading vs. Time

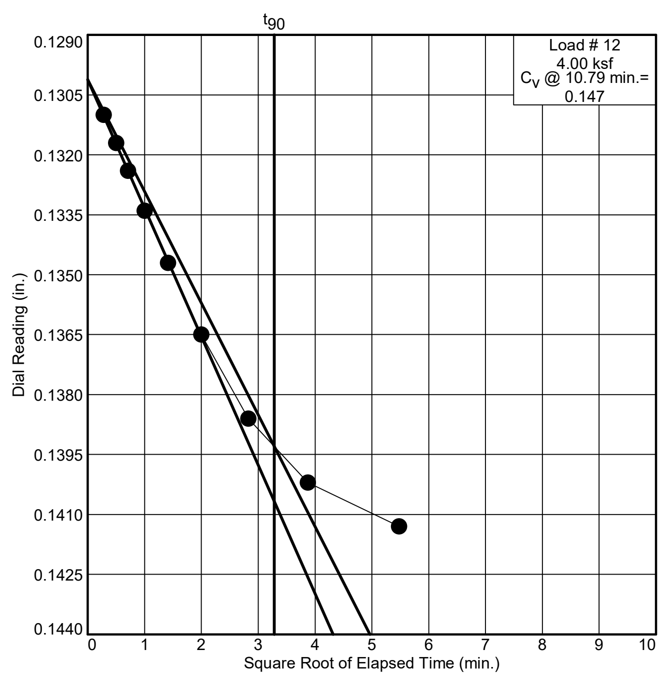
Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-101 Depth: 42.8 Sample Number: U-1









R.W. Gillespie & Associates, Inc.

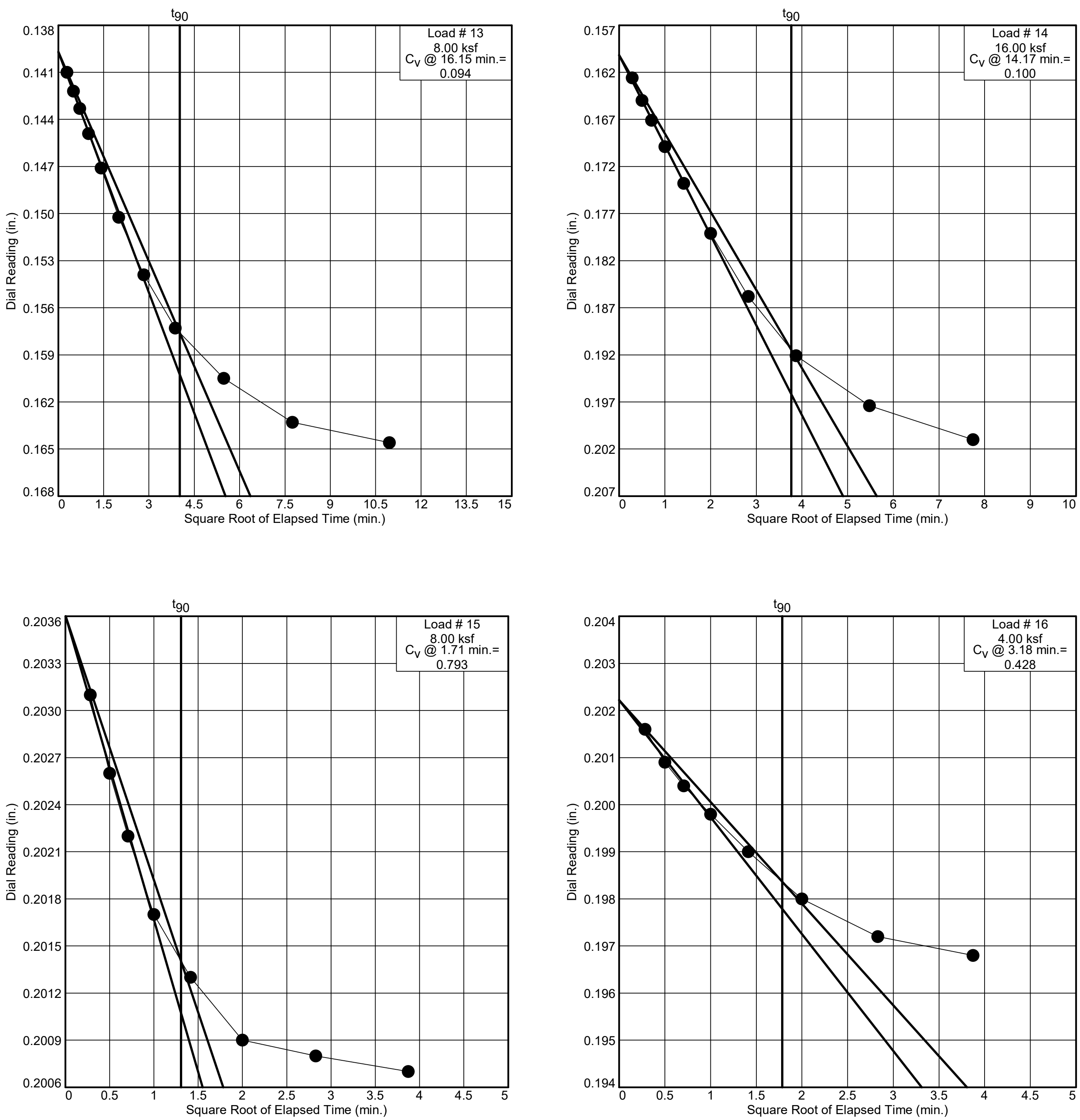
Biddeford, Maine

Lab No. 17262

Dial Reading vs. Time

Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-101 Depth: 42.8 Sample Number: U-1



R.W. Gillespie & Associates, Inc.

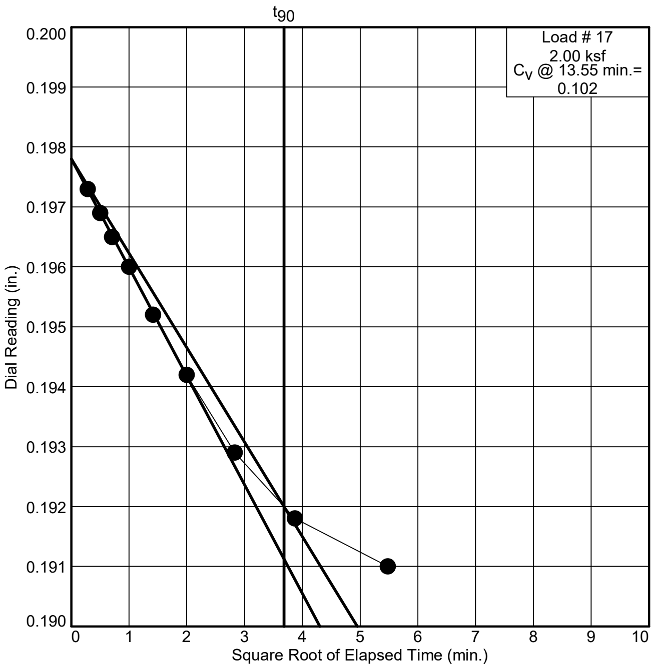
Biddeford, Maine

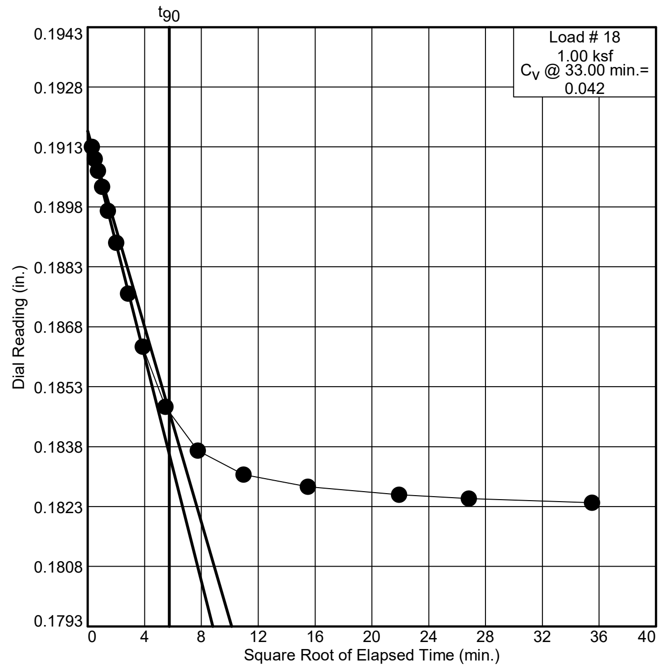
Lab No. 17262

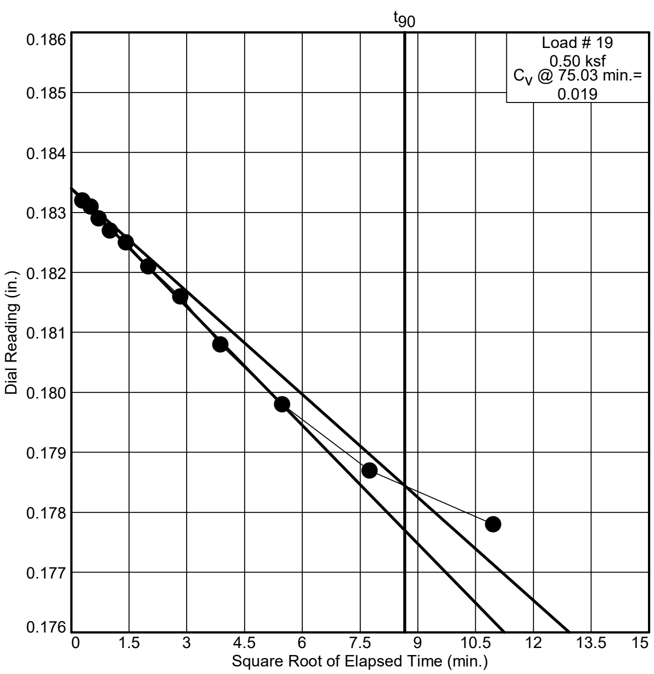
Dial Reading vs. Time

Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-101 Depth: 42.8 Sample Number: U-1







R.W. Gillespie & Associates, Inc.

Biddeford, Maine

Lab No. 17262

Laboratory Vane Shear Test Results

ASTM D4648 Standard Test Method for Laboratory Miniature Vane Shear Test for Saturated Fine-Grained Clayey Soil

Project: Noyes Bridge, Cumberland (SEA #22-012, WIN 2618.00)
Client: Schonewald Engineering Associates, Inc.
Project No.: 1368-021

Location: Cumberland, ME
Date: 12/2/2022
Test Depth: 35.00 to 35.40

Boring/Sample No.	BB-CMB-102C/ U1				Lab No.	17263	
Test No.	Test Depth (ft)	Vane Size	Max. Torque (Undisturbed) (kg-cm)	Max. Torque (Remolded) (kg-cm)	Undisturbed Undrained Shear Strength (psf)	Remolded Undrained Shear Strength (psf)	Moisture Content
1	35.2	L	50	2	522	21	47%
2	35.4	L	45	2	470	21	48%
3	35	L	49	4	512	42	47%

Vane Size	
	(mm)
S	16 x 32
M	20 x 40
L	24.5 x 50.8

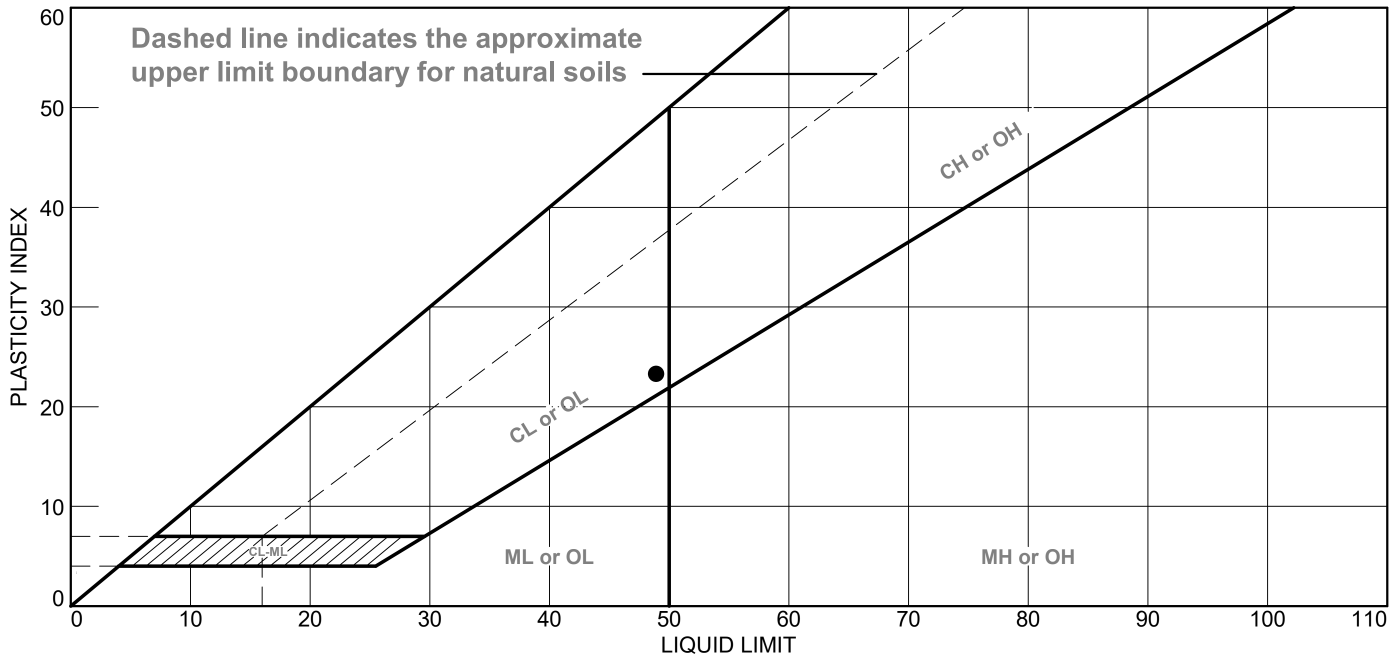
Tested By: AGS

Checked By: MTG

R.W. Gillespie & Associates

20 Pomerleau St., Suite 100, Biddeford ME 04005, 207-286-8008 / 177 Shattuck Way, Suite 1 West, Newington NH 03801, 603-427-0244

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Lean Clay	48.9	25.6	23.3			

Project No. 1368-021 **Client:** Schonewald Engineering Associates, Inc

Project: Noyes Bridge SEA#22-012, WIN 2618.00

Cumberland, ME

Location: BB-CMB-102C

Sample Number: U-1 **Depth:** 36'

Remarks:

R.W. Gillespie & Associates, Inc.

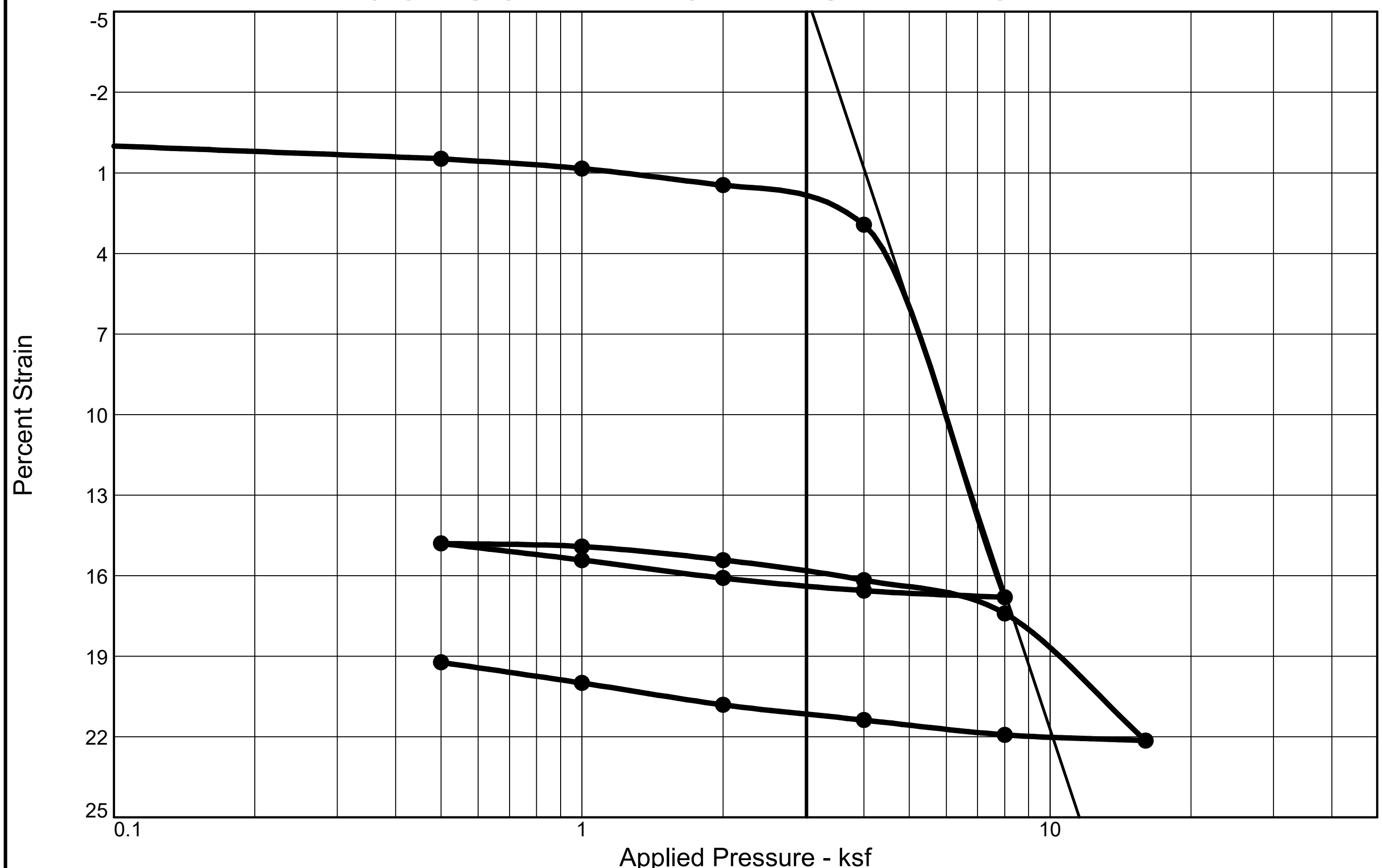
Biddeford, Maine

Lab No. 17263

Tested By: CAG **Checked By:** MTG

 MTG

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation											
No.	Load (ksf)	C_v (ft.²/day)	C_α	No.	Load (ksf)	C_v (ft.²/day)	C_α	No.	Load (ksf)	C_v (ft.²/day)	C_α
1	0.50	1.125		8	1.00	0.094		15	8.00	0.771	
2	1.00	0.704		9	0.50	0.046		16	4.00	0.303	
3	2.00	0.926		10	1.00	0.281		17	2.00	0.149	
4	4.00	0.683		11	2.00	0.222		18	1.00	0.054	
5	8.00	0.028	0.015	12	4.00	0.245					
6	4.00	0.788		13	8.00	0.259					
7	2.00	0.317		14	16.00	0.055	0.009				

Natural Saturation	Natural Moisture	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_r	Initial Void Ratio
99.8 %	47.1 %	74.8	48.9	23.3	2.75		4.1	1.20	0.05	1.296

MATERIAL DESCRIPTION	USCS	AASHTO
Lean Clay		

Project No. 1368-021 **Client:** Schonewald Engineering Associates, Inc

Project: Noyes Bridge SEA#22-012, WIN 2618.00
Cumberland, ME

Location: BB-CMB-102C **Depth:** 36' **Sample Number:** U-1

R.W. Gillespie & Associates, Inc.

Biddeford, Maine

Remarks:
Total Seating Displacement
0.0029"

Lab No. 17263

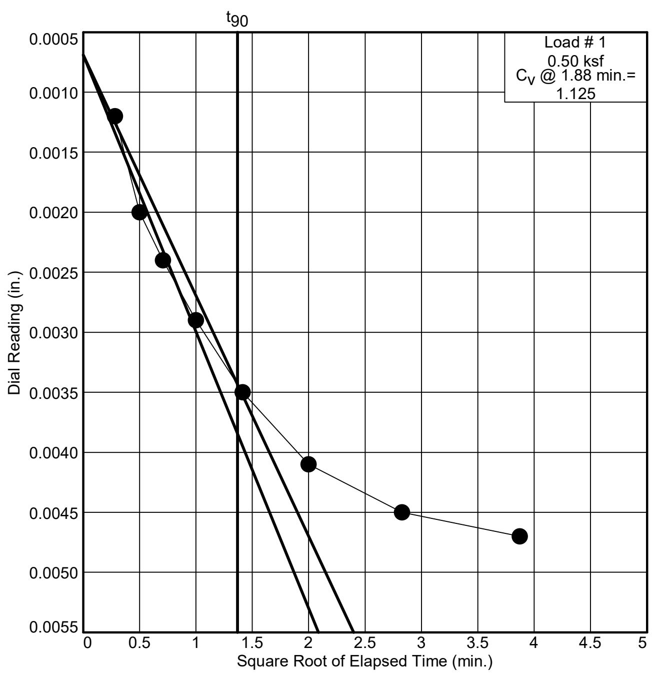
Tested By: AGS **Checked By:** MTG

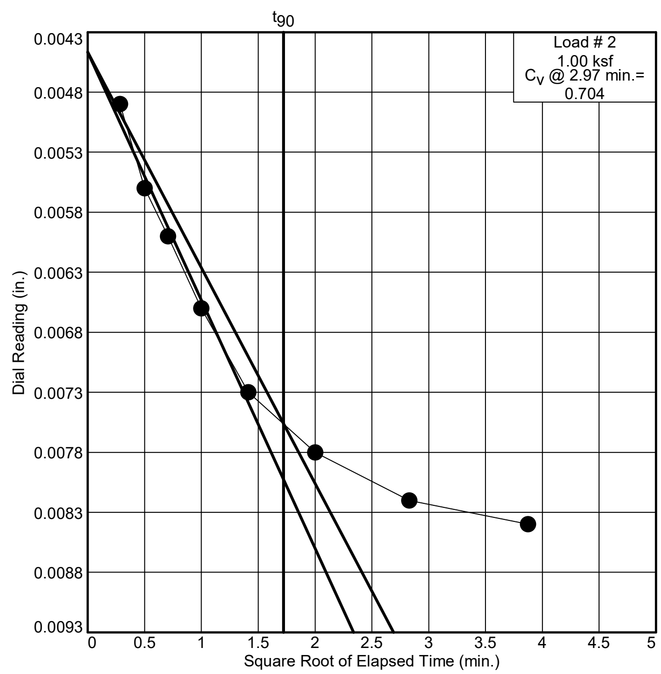
 MTG

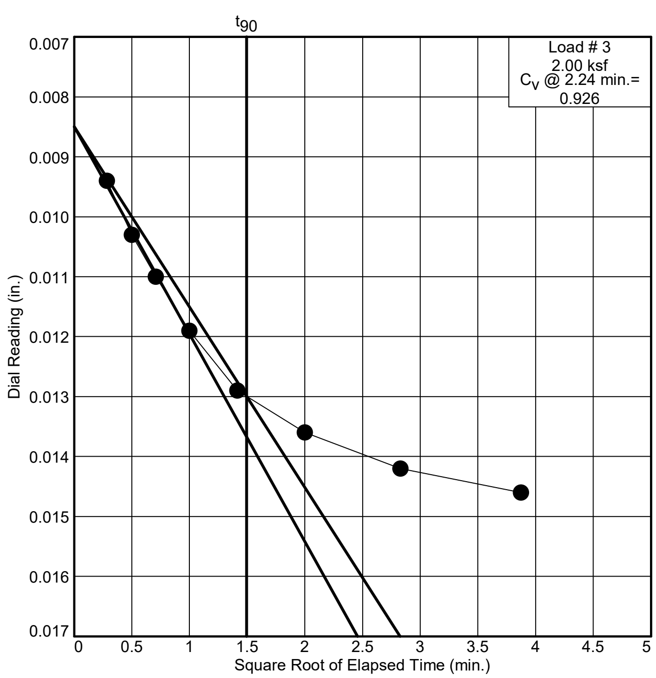
Dial Reading vs. Time

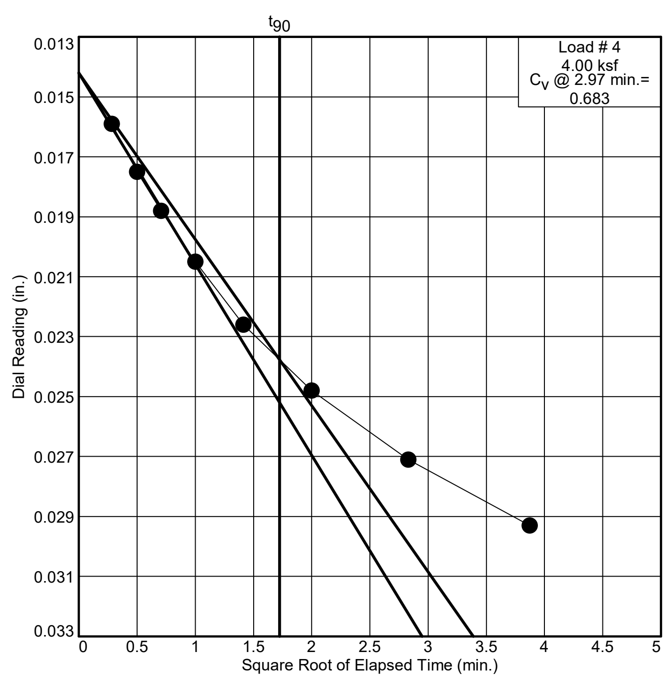
Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-102C Depth: 36' Sample Number: U-1









R.W. Gillespie & Associates, Inc.

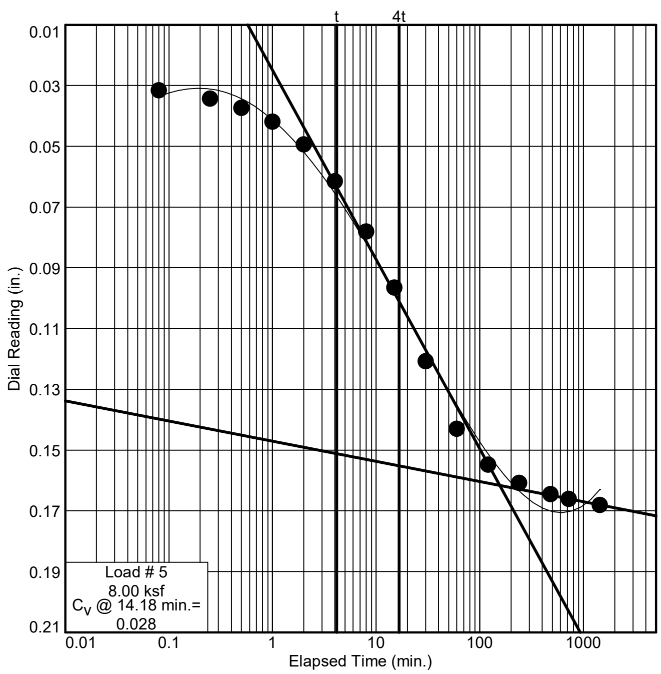
Biddeford, Maine

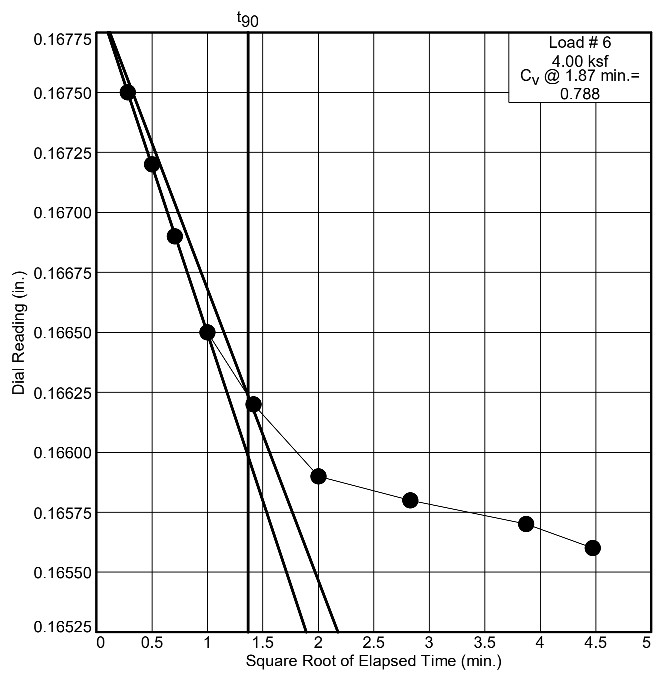
Lab No. 17263

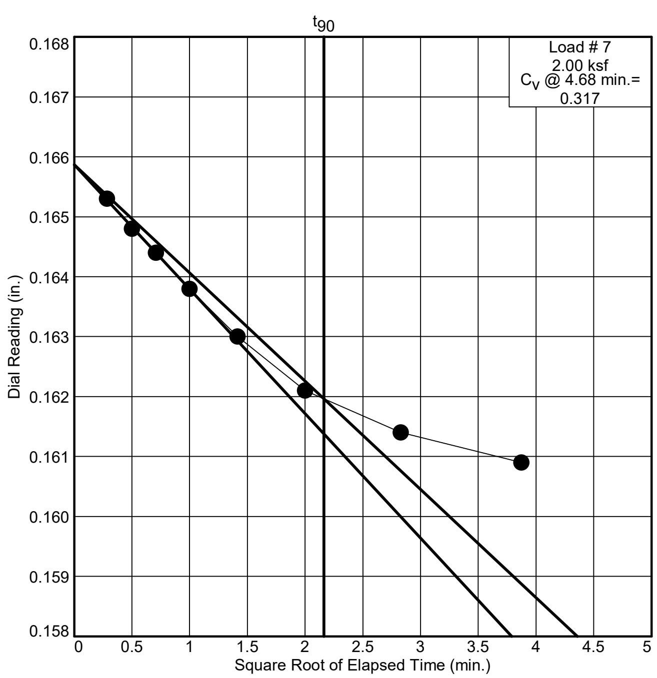
Dial Reading vs. Time

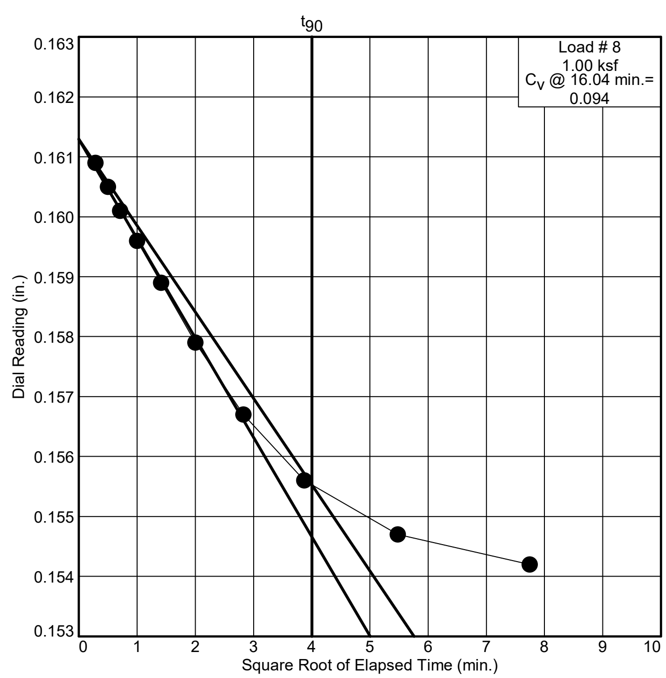
Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-102C   Depth: 36'   Sample Number: U-1









R.W. Gillespie & Associates, Inc.

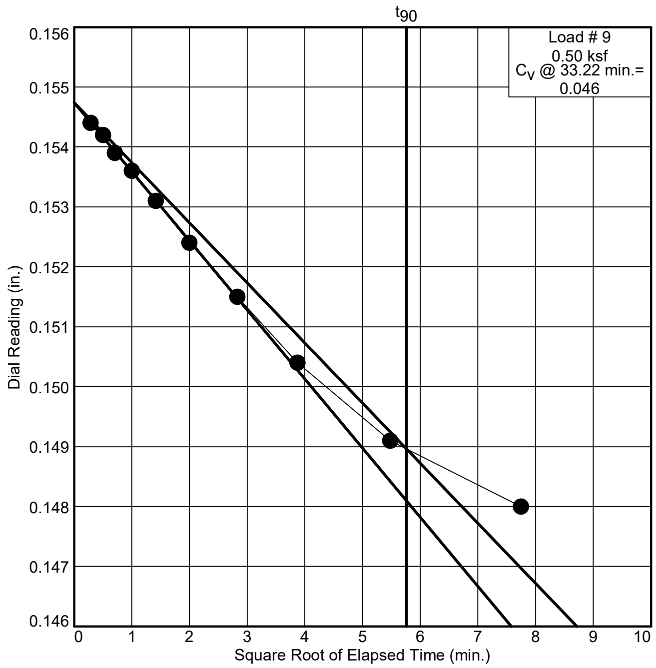
Biddeford, Maine

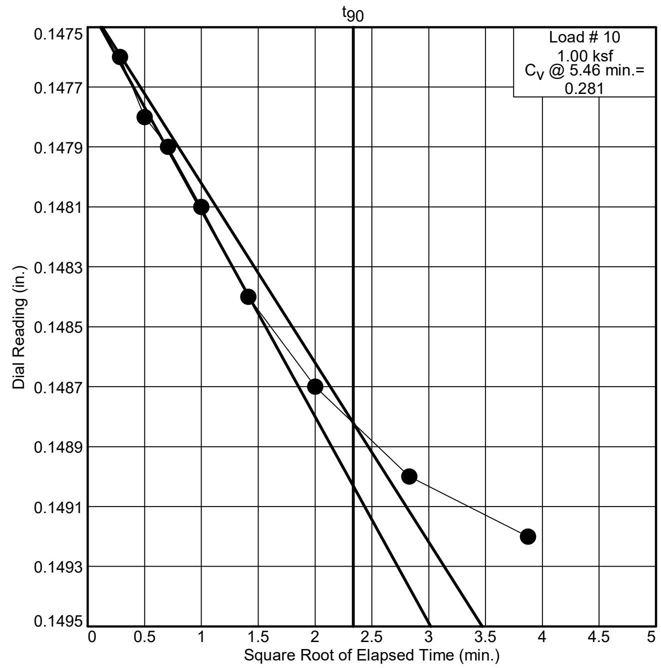
Lab No. 17263

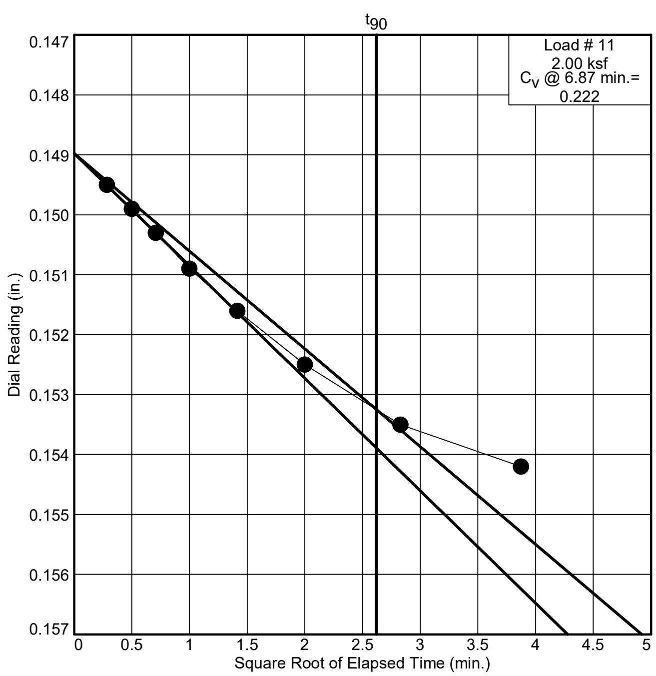
Dial Reading vs. Time

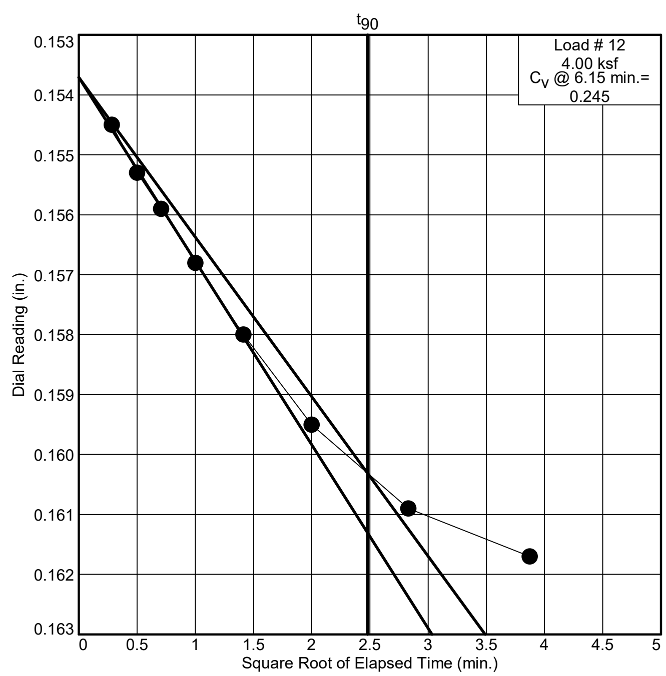
Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-102C Depth: 36' Sample Number: U-1









R.W. Gillespie & Associates, Inc.

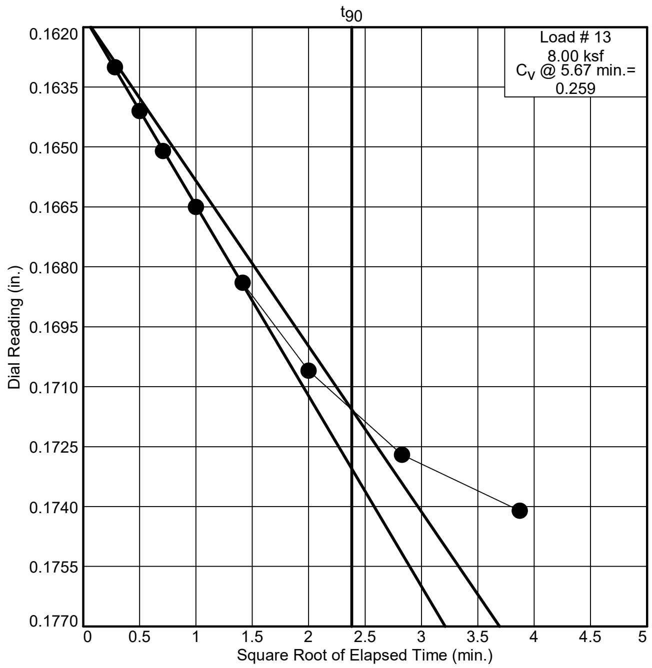
Biddeford, Maine

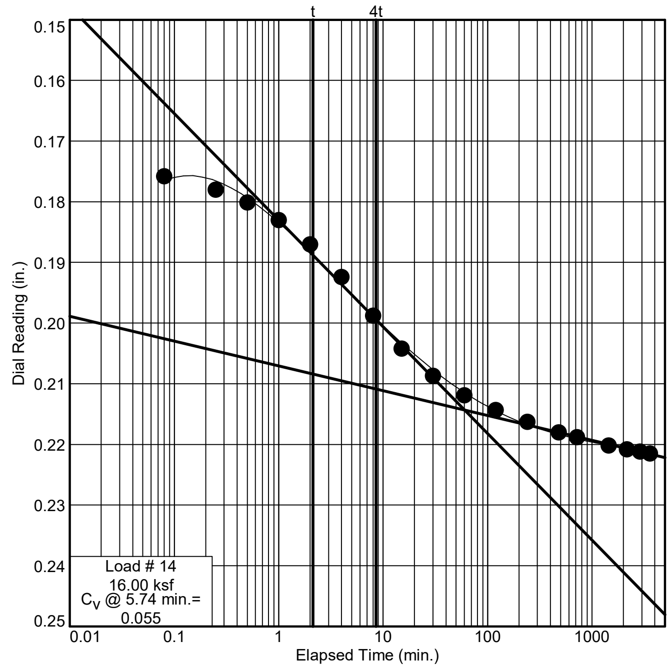
Lab No. 17263

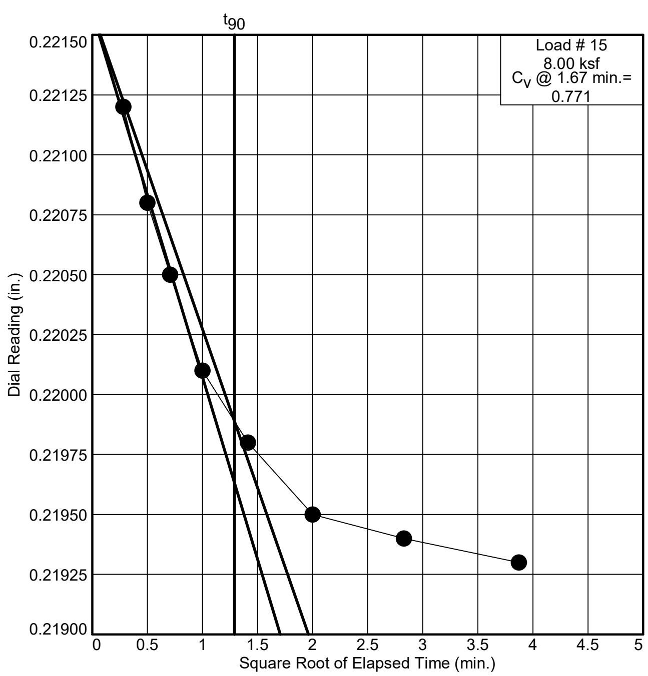
Dial Reading vs. Time

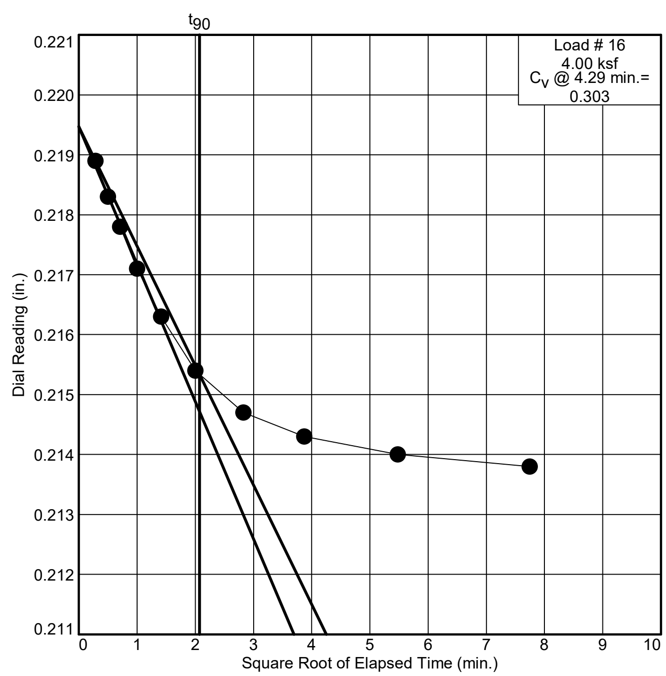
Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-102C Depth: 36' Sample Number: U-1









R.W. Gillespie & Associates, Inc.

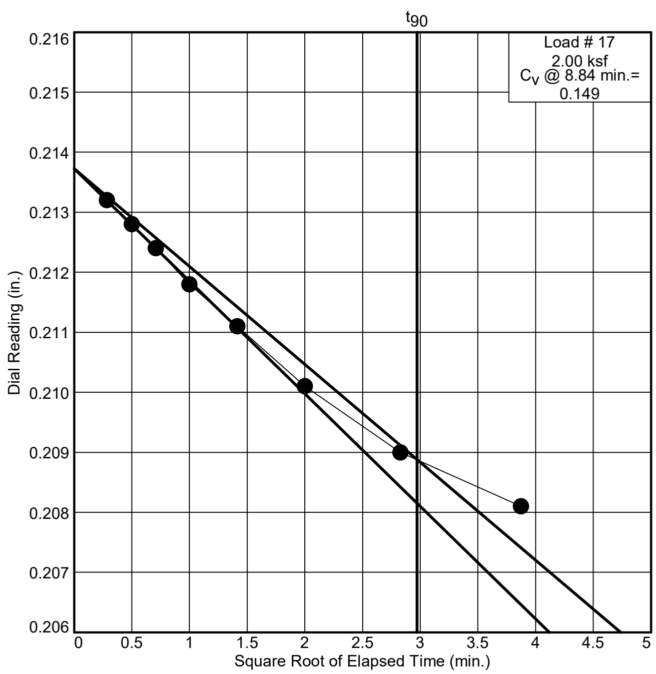
Biddeford, Maine

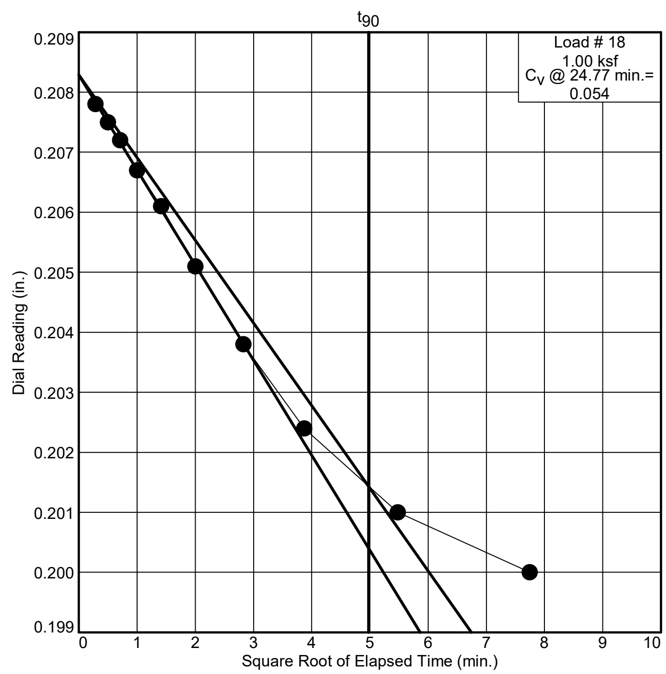
Lab No. 17263

Dial Reading vs. Time

Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-102C   Depth: 36'   Sample Number: U-1





R.W. Gillespie & Associates, Inc.

Biddeford, Maine

Lab No. 17263

Laboratory Vane Shear Test Results

ASTM D4648 Standard Test Method for Laboratory Miniature Vane Shear Test for Saturated Fine-Grained Clayey Soil

Project: Noyes Bridge, Cumberland (SEA #22-012, WIN 2618.00)
Client: Schonewald Engineering Associates, Inc.
Project No.: 1368-021

Location: Cumberland, ME
Date: 12/2/2022
Test Depth: 50.20 to 50.70

Boring/Sample No.	BB-CMB-102C/ U2				Lab No.	17264	
Test No.	Test Depth (ft)	Vane Size	Max. Torque (Undisturbed) (kg-cm)	Max. Torque (Remolded) (kg-cm)	Undisturbed Undrained Shear Strength (psf)	Remolded Undrained Shear Strength (psf)	Moisture Content
1	**50.2**	L	69	6	720	63	44%
2	**50.5**	L	65	5	679	52	42%
3	**50.7**	L	67	6	699	63	44%

Vane Size	
	(mm)
S	16 x 32
M	20 x 40
L	24.5 x 50.8

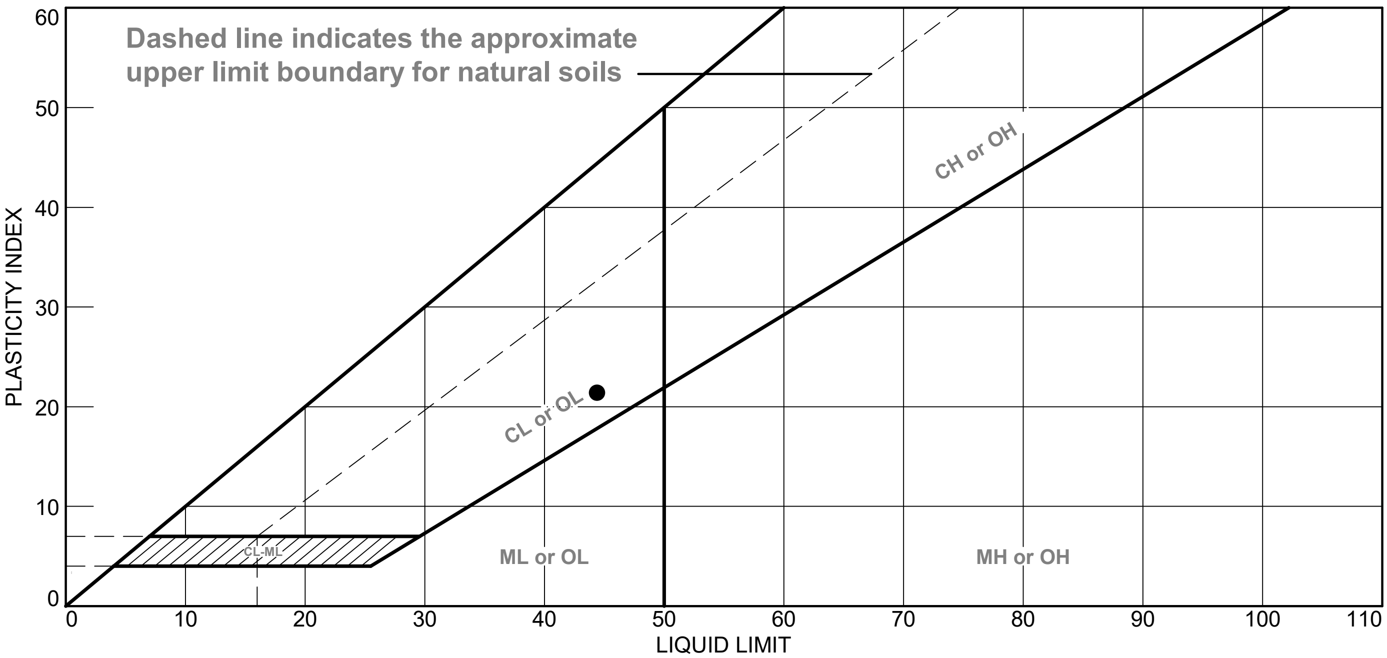
Tested By: AGS

Checked By: MTG

R.W. Gillespie & Associates

20 Pomerleau St., Suite 100, Biddeford ME 04005, 207-286-8008 / 177 Shattuck Way, Suite 1 West, Newington NH 03801, 603-427-0244

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Lean Clay	44.4	23.0	21.4			

Project No. 1368-021 **Client:** Schonewald Engineering Associates, Inc

Project: Noyes Bridge SEA#22-012, WIN 2618.00

Cumberland, ME

Location: BB-CMB-102C

Sample Number: U-2 **Depth:** 50.6

Remarks:

R.W. Gillespie & Associates, Inc.

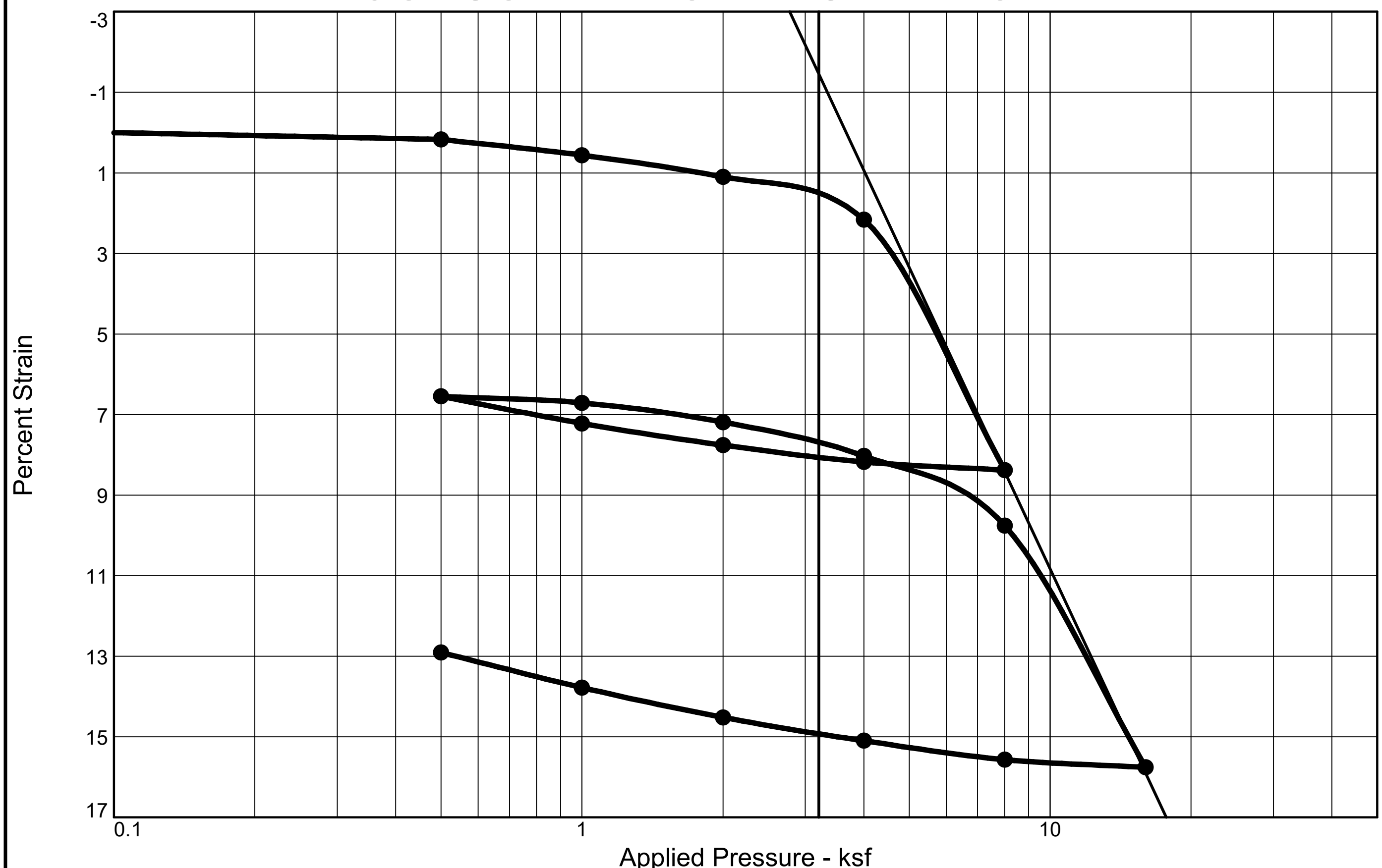
Biddeford, Maine

Lab No. 17264

Tested By: CAG **Checked By:** MTG

 MTG

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation											
No.	Load (ksf)	C_v (ft.^{2}/day)	C_α	No.	Load (ksf)	C_v (ft.^{2}/day)	C_α	No.	Load (ksf)	C_v (ft.^{2}/day)	C_α
1	0.50	0.413		8	1.00	0.230		15	8.00	1.632	
2	1.00	0.520		9	0.50	0.083		16	4.00	0.608	
3	2.00	0.917		10	1.00	0.832		17	2.00	0.195	
4	4.00	0.897		11	2.00	0.406		18	1.00	0.096	
5	8.00	0.071		12	4.00	0.383		19	0.50	0.046	
6	4.00	1.158		13	8.00	0.316					
7	2.00	0.719		14	16.00	0.154					

Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (ksf)	P_c (ksf)	C_c	C_r	Initial Void Ratio
Saturation	Moisture									
96.2 %	41.2 %	79.9	44.4	21.4	2.75		4.3	0.54	0.06	1.177

MATERIAL DESCRIPTION	USCS	AASHTO
Lean Clay		

Project No. 1368-021 **Client:** Schonewald Engineering Associates, Inc

Project: Noyes Bridge SEA#22-012, WIN 2618.00
Cumberland, ME

Location: BB-CMB-102C **Depth:** 50.6 **Sample Number:** U-2

R.W. Gillespie & Associates, Inc.

Biddeford, Maine

Remarks:

Lab No. 17264

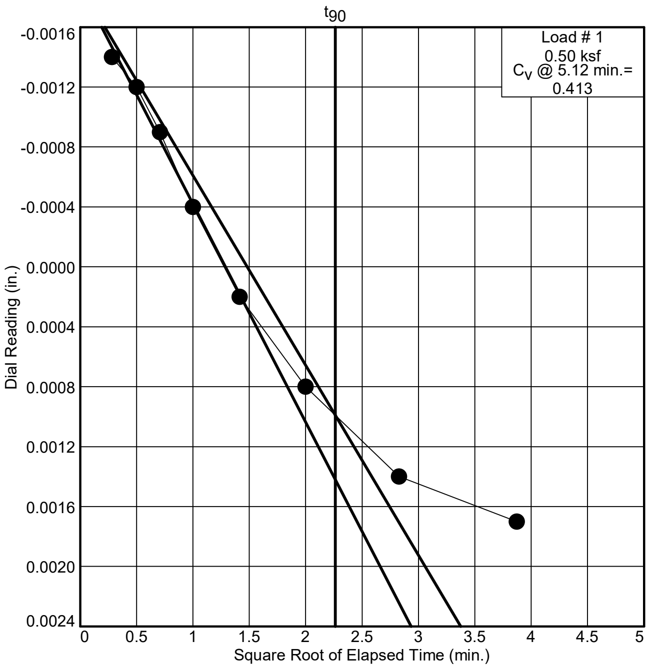
Tested By: AGS **Checked By:** MTG

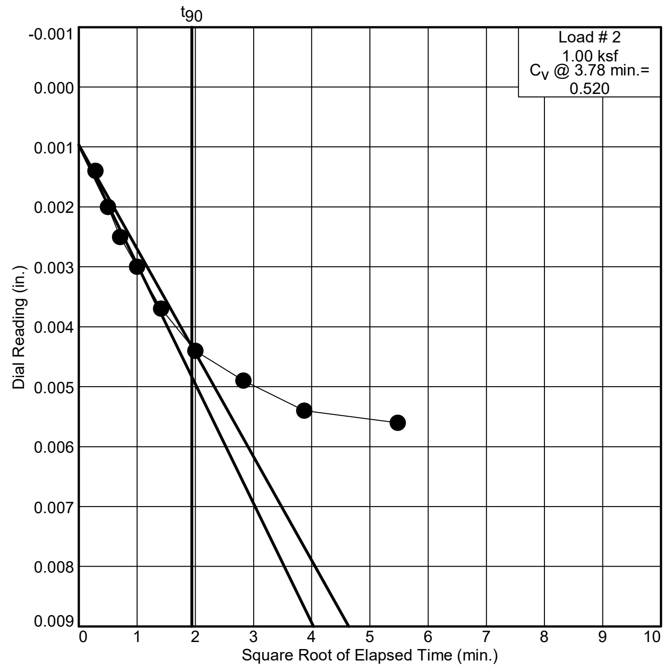
 MTG

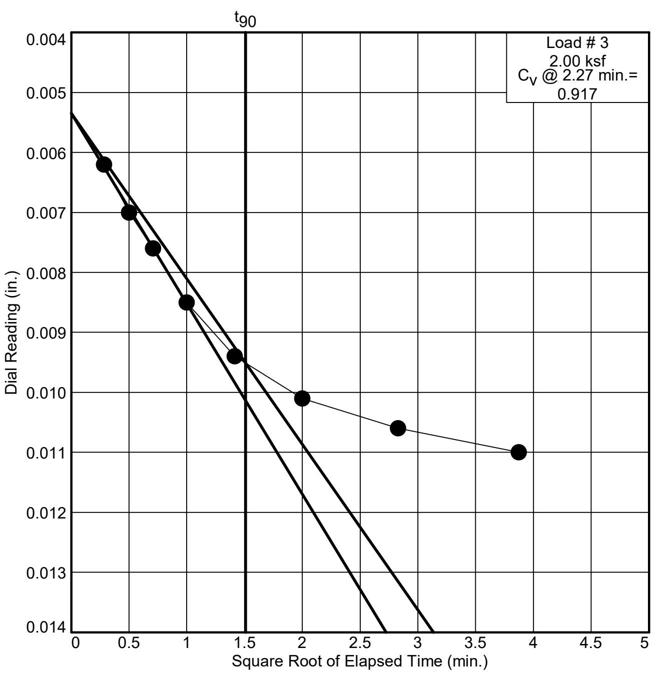
Dial Reading vs. Time

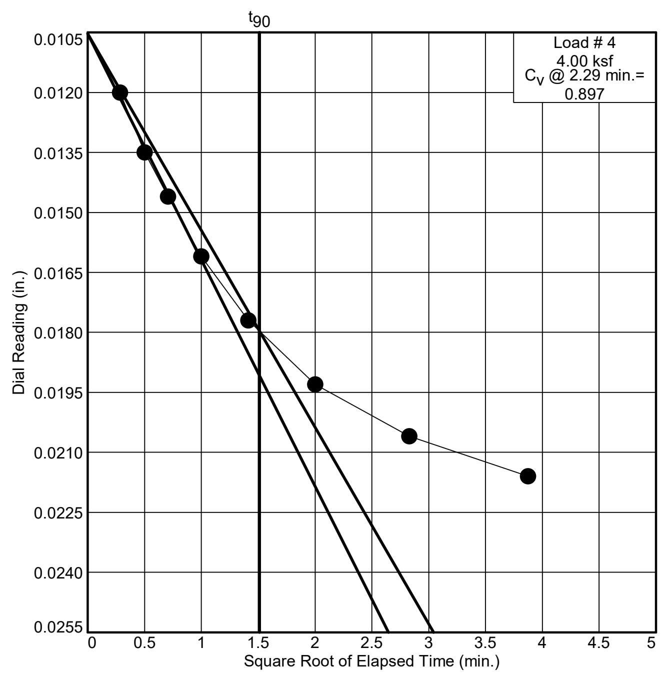
Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-102C Depth: 50.6 Sample Number: U-2









R.W. Gillespie & Associates, Inc.

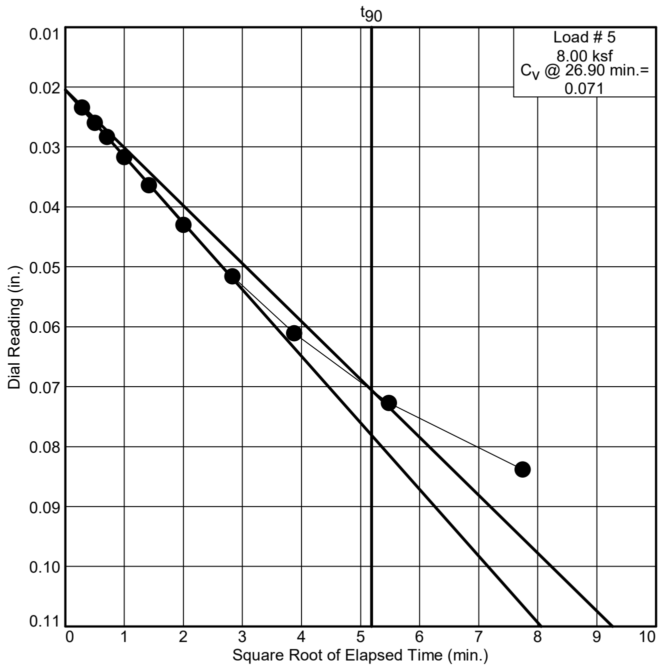
Biddeford, Maine

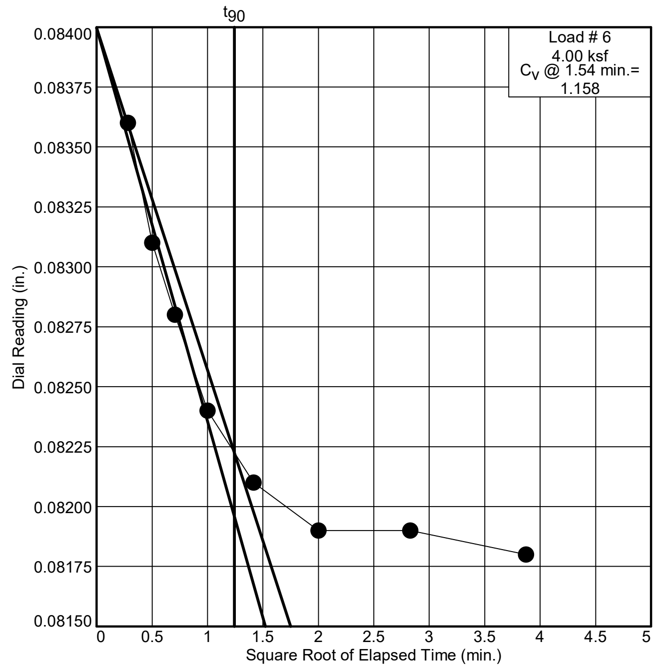
Lab No. 17264

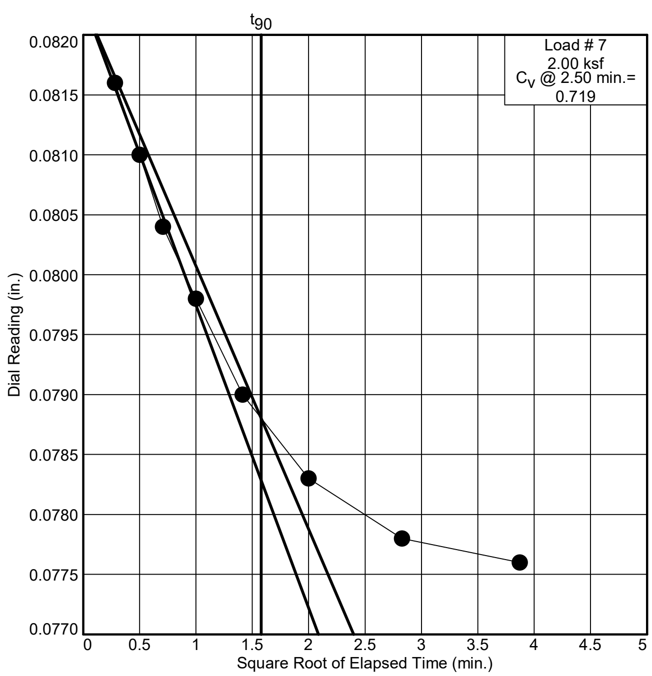
Dial Reading vs. Time

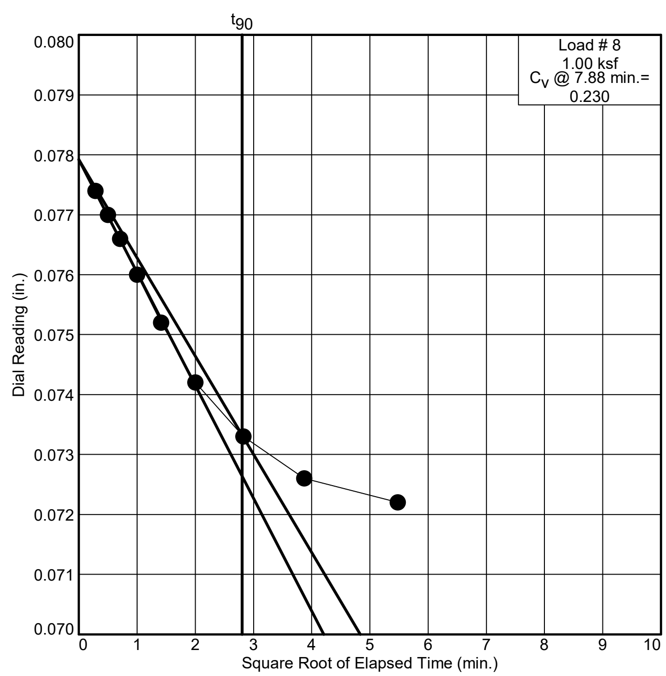
Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-102C   Depth: 50.6   Sample Number: U-2









R.W. Gillespie & Associates, Inc.

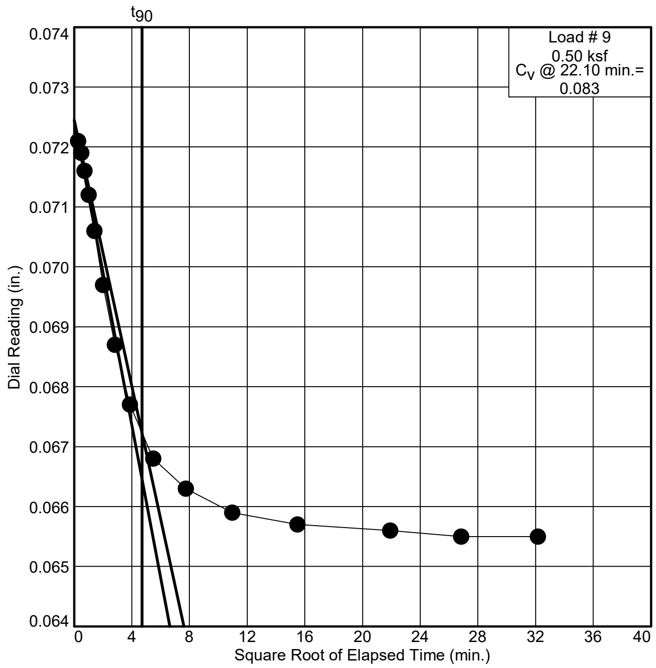
Biddeford, Maine

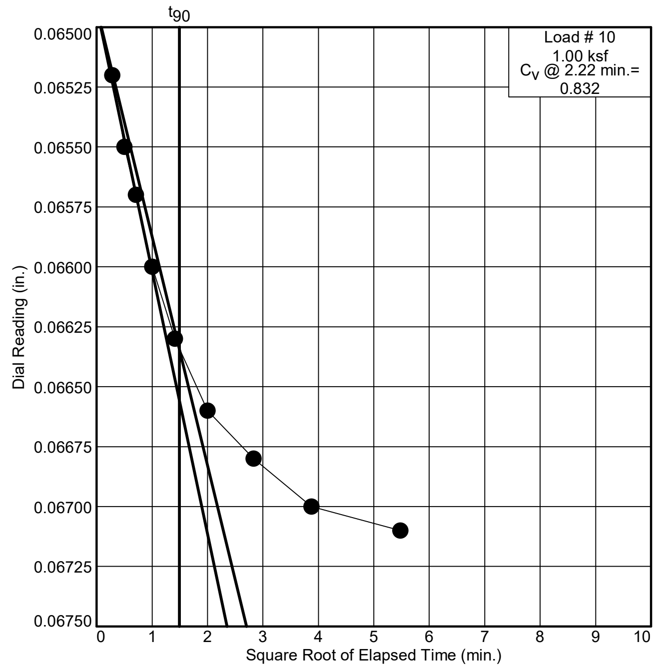
Lab No. 17264

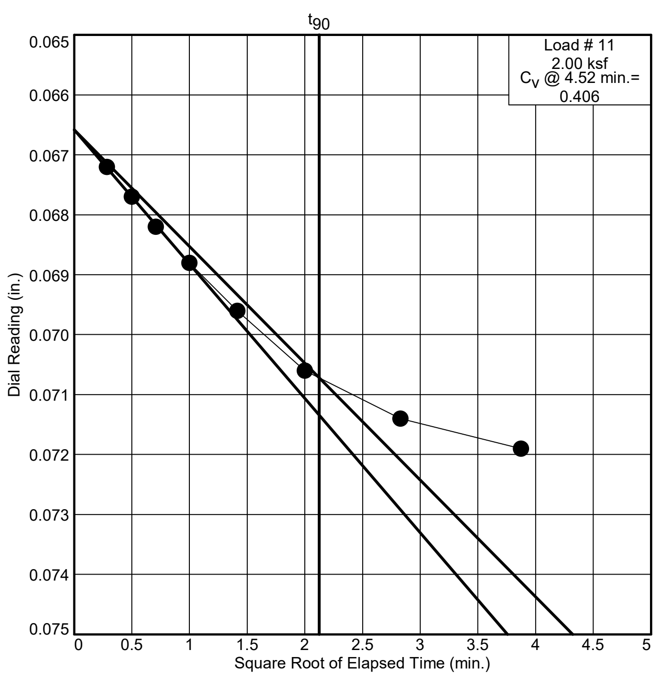
Dial Reading vs. Time

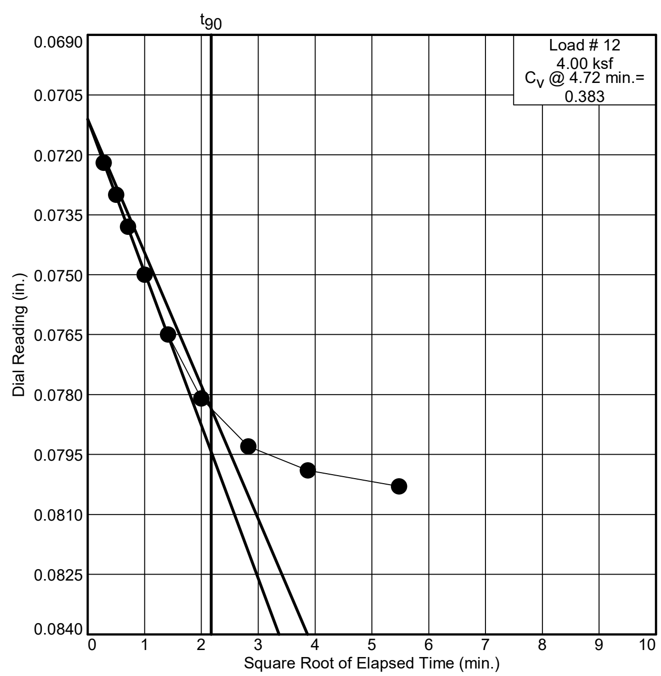
Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-102C Depth: 50.6 Sample Number: U-2









R.W. Gillespie & Associates, Inc.

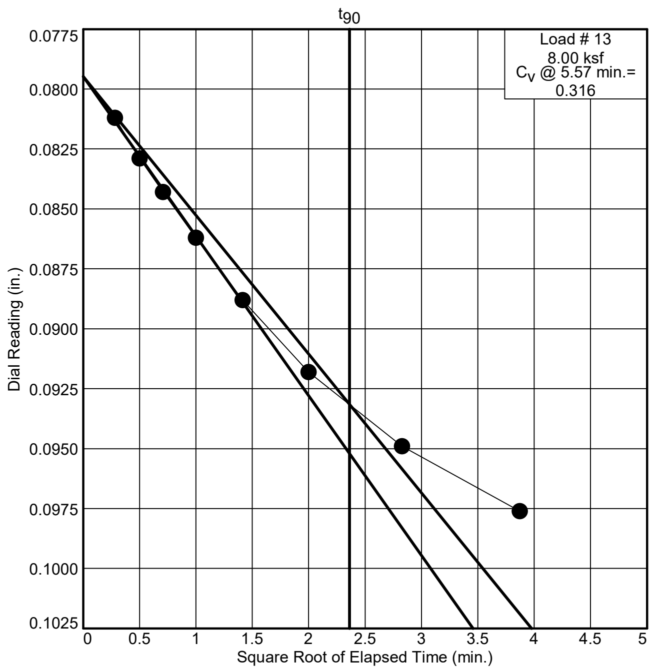
Biddeford, Maine

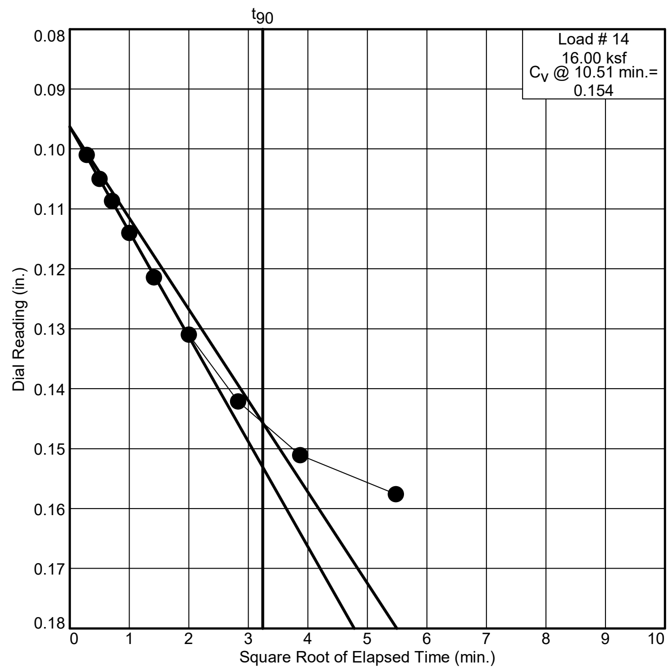
Lab No. 17264

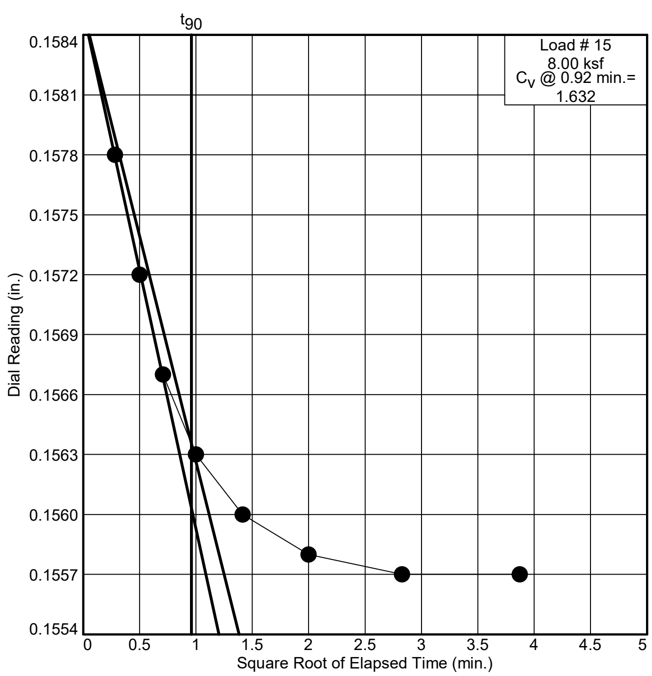
Dial Reading vs. Time

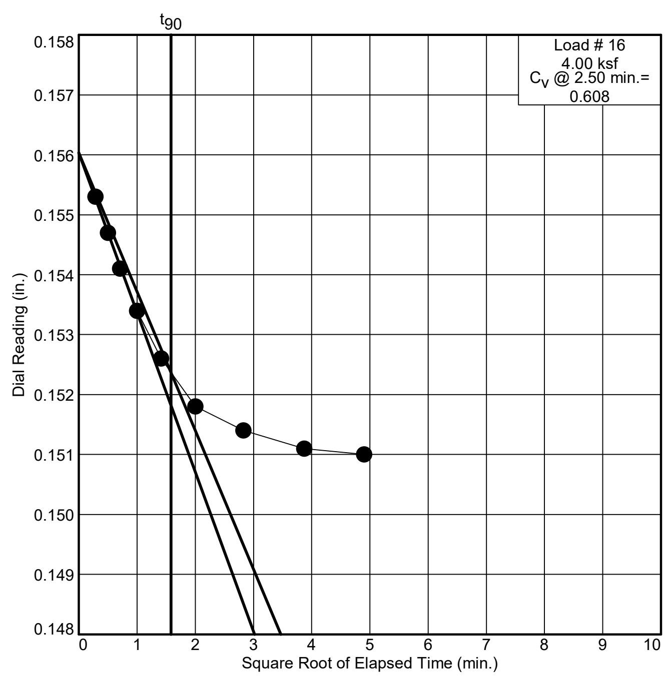
Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-102C Depth: 50.6 Sample Number: U-2









R.W. Gillespie & Associates, Inc.

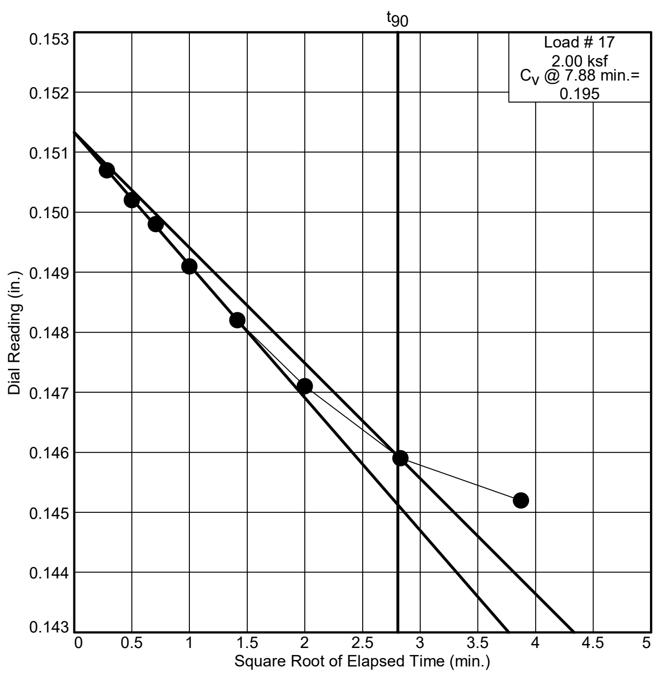
Biddeford, Maine

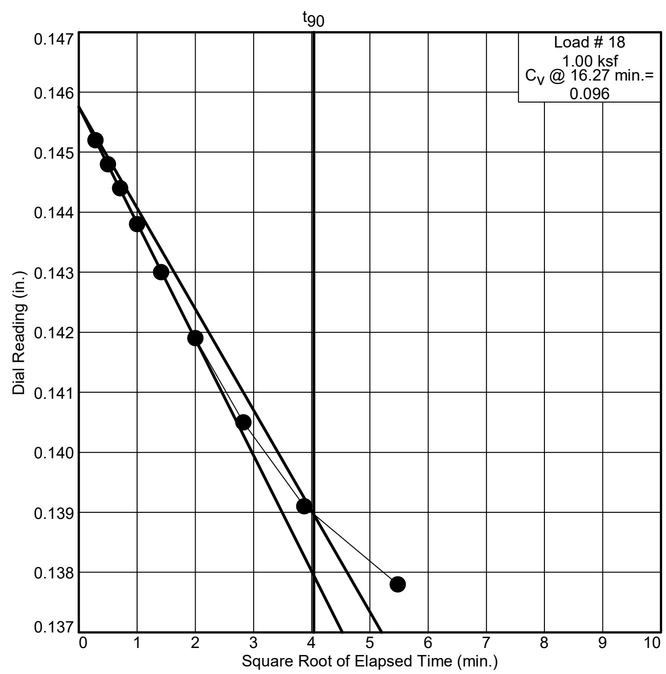
Lab No. 17264

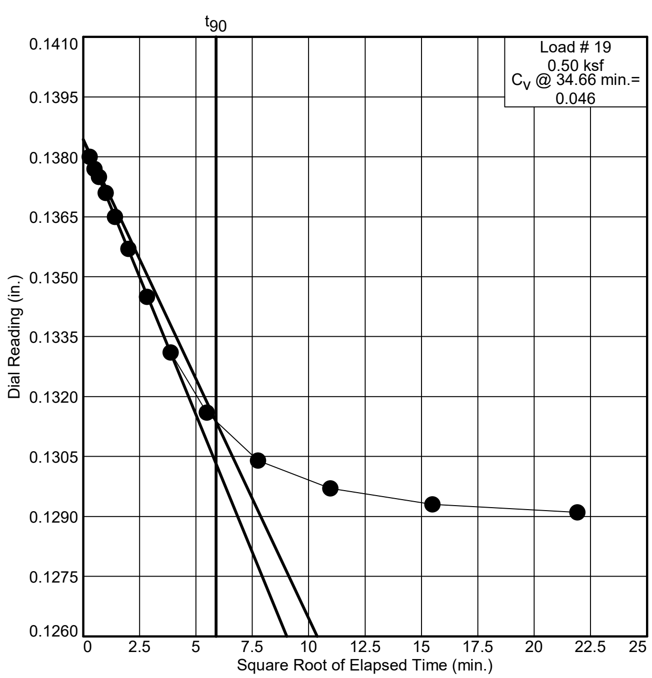
Dial Reading vs. Time

Project No.: 1368-021
Project: Noyes Bridge SEA#22-012, WIN 2618.00

Location: BB-CMB-102C   Depth: 50.6   Sample Number: U-2





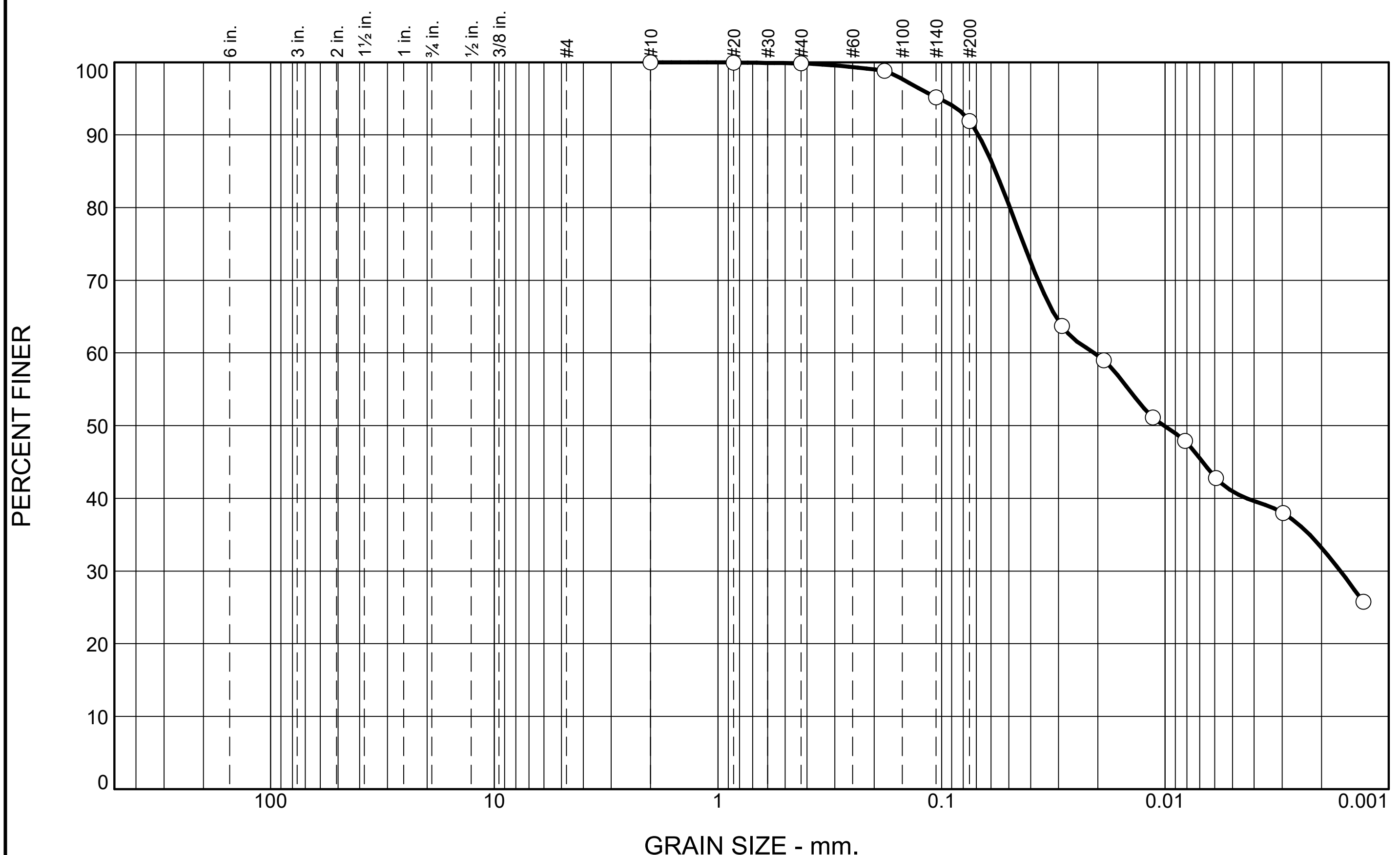


R.W. Gillespie & Associates, Inc.

Biddeford, Maine

Lab No. 17264

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	8.0	58.7	33.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	100.0		
#40	99.9		
#80	98.8		
#140	95.2		
#200	91.9		
0.0290 mm.	63.7		
0.0188 mm.	59.0		
0.0113 mm.	51.1		
0.0082 mm.	47.9		
0.0059 mm.	42.8		
0.0030 mm.	38.0		
0.0013 mm.	25.8		

* (no specification provided)

Soil Description

silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.0684 D_{85}= 0.0573 D_{60}= 0.0208
D_{50}= 0.0101 D_{30}= 0.0016 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= ML AASHTO= A-4(0)

Remarks

Moisture Content: 29.6%

Location: BB-CMB-101
Sample Number: S-6D **Depth:** 18-20' **Date:** 11/08/2022

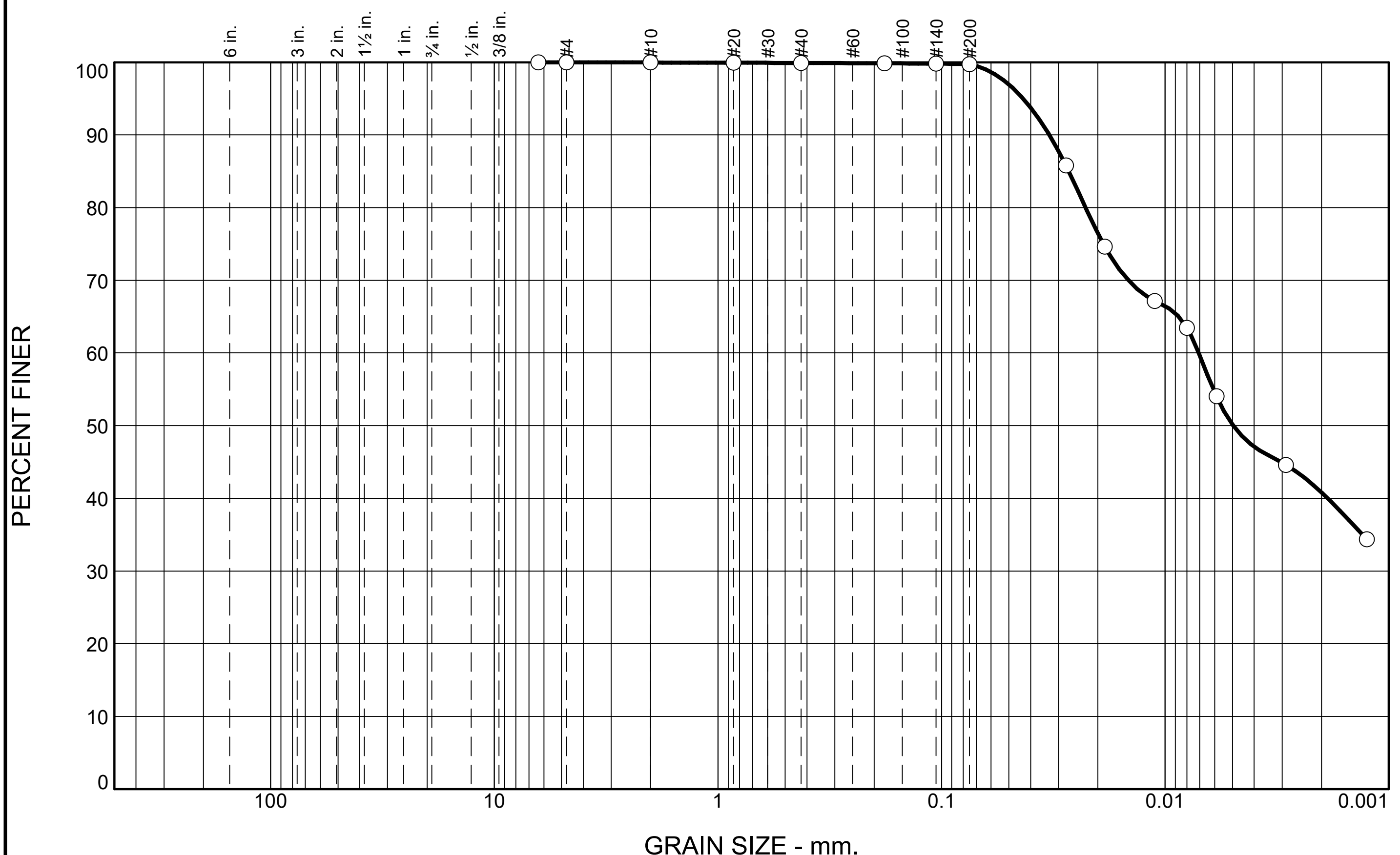
R.W. Gillespie & Associates, Inc. Biddeford, Maine

Client: Schonewald Engineering Associates, Inc
Project: Noyes Bridge SEA#22-012, WIN 2618.00
Cumberland, ME
Project No: 1368-021 **Lab No.** 17265

Tested By: CAG **Checked By:** MTG

 MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	0.2	58.9	40.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/4"	100.0		
#4	100.0		
#10	100.0		
#20	99.9		
#40	99.9		
#80	99.8		
#140	99.8		
#200	99.7		
0.0278 mm.	85.8		
0.0186 mm.	74.6		
0.0111 mm.	67.1		
0.0080 mm.	63.5		
0.0059 mm.	54.0		
0.0029 mm.	44.6		
0.0013 mm.	34.4		

* (no specification provided)

Soil Description

lean clay

Atterberg Limits

PL= 21.9 LL= 35.8 PI= 13.9

Coefficients

D_{90}= 0.0330 D_{85}= 0.0270 D_{60}= 0.0071
D_{50}= 0.0050 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(15)

Remarks

Moisture Content: 33.5%

Location: BB-CMB-101
Sample Number: S-7D **Depth:** 20-22' **Date:** 11/08/2022

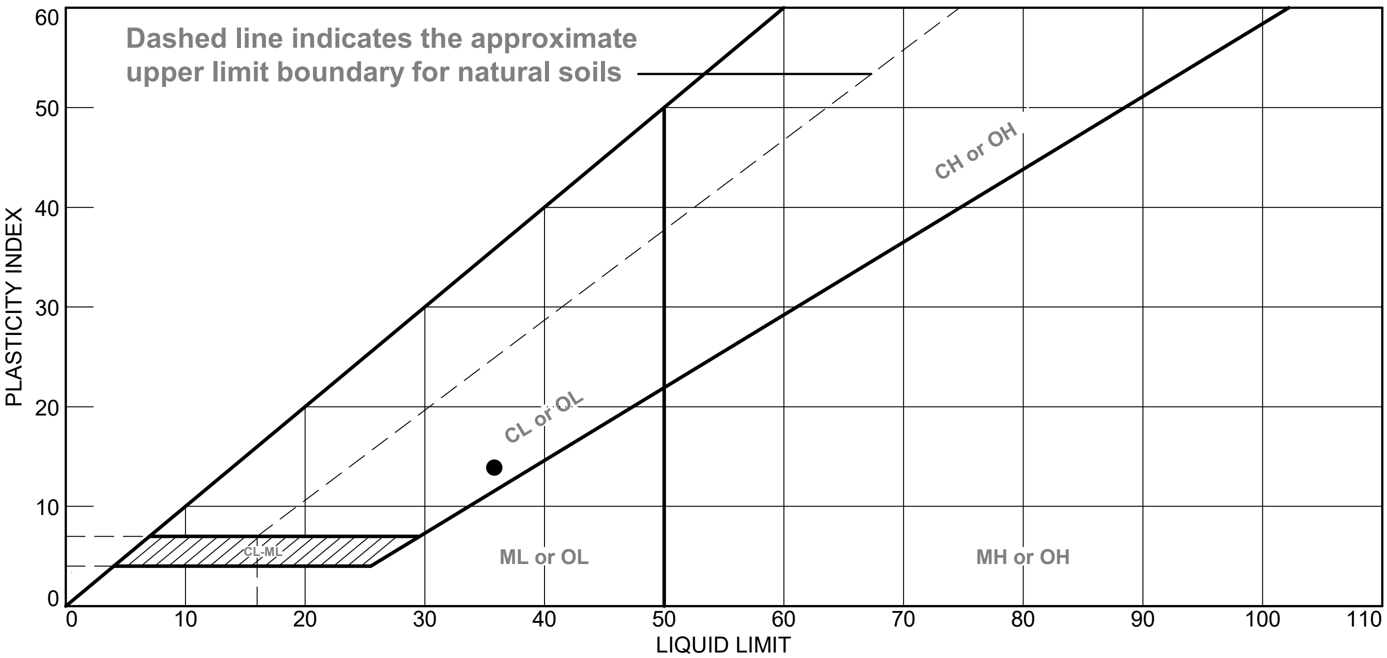
R.W. Gillespie & Associates, Inc. Biddeford, Maine

Client: Schonewald Engineering Associates, Inc
Project: Noyes Bridge SEA#22-012, WIN 2618.00
Cumberland, ME
Project No: 1368-021 **Lab No.** 17266

Tested By: CAG **Checked By:** MTG

MTG

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	lean clay	35.8	21.9	13.9	99.9	99.7	CL

Project No. 1368-021 **Client:** Schonewald Engineering Associates, Inc

Project: Noyes Bridge SEA#22-012, WIN 2618.00

Cumberland, ME

Location: BB-CMB-101

Sample Number: S-7D **Depth:** 20-22'

Remarks:

R.W. Gillespie & Associates, Inc.

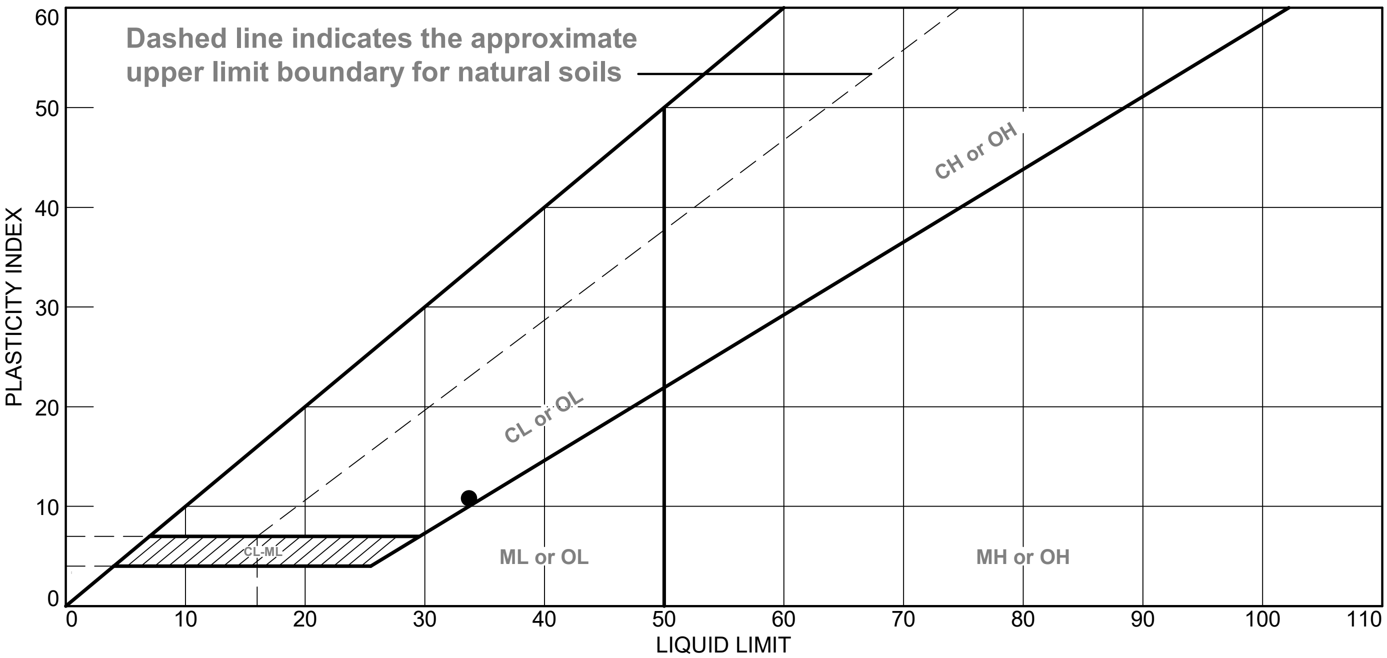
Biddeford, Maine

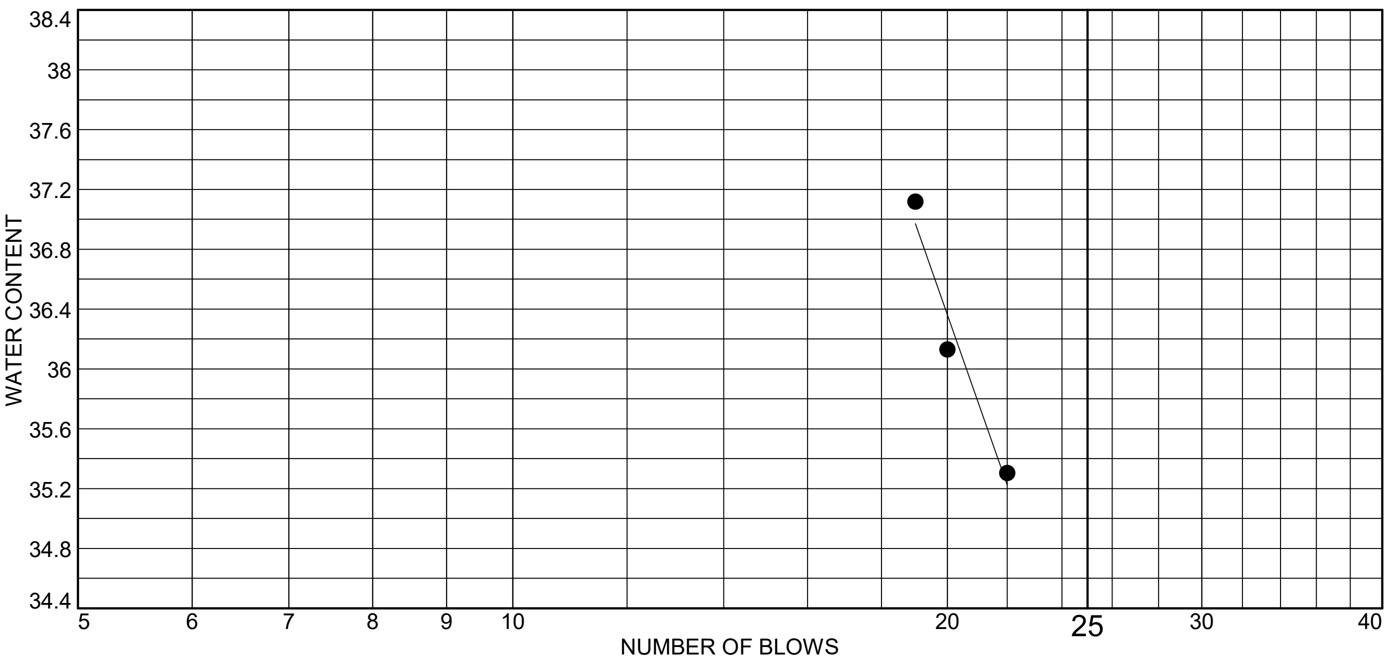
Lab No. 17266

Tested By: CAG **Checked By:** MTG

 MTG

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	lean clay	33.7	22.9	10.8	95	90	CL

Project No. 1368-021 **Client:** Schonewald Engineering Associates, Inc

Project: Noyes Bridge SEA#22-012, WIN 2618.00

Cumberland, ME

Location: BB-CMB-101

Sample Number: S-8D **Depth:** 22-24'

Remarks:

● Moisture content: 37.6%

R.W. Gillespie & Associates, Inc.

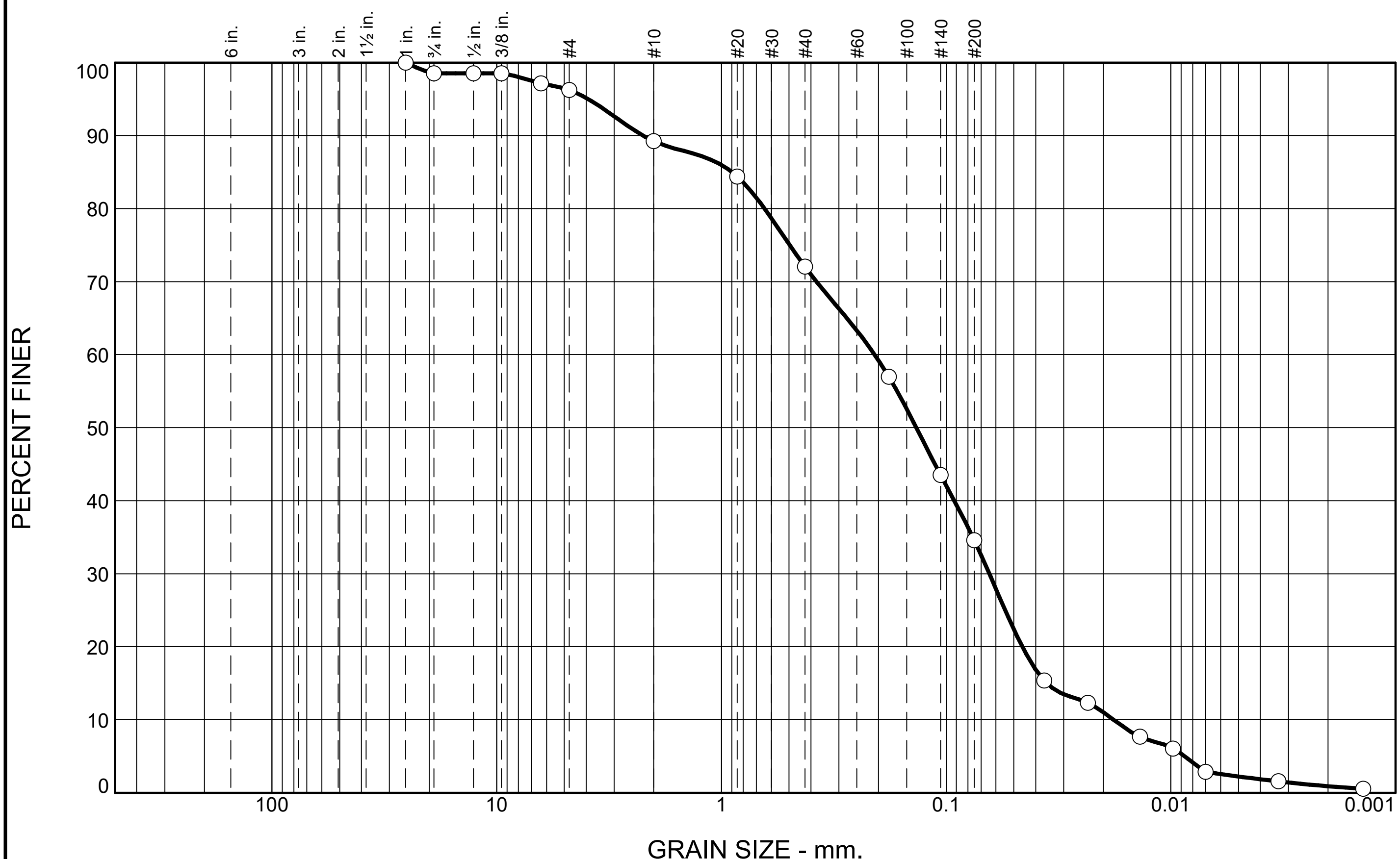
Biddeford, Maine

Lab No. 17267

Tested By: CAG **Checked By:** MTG

 MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.5	2.3	7.0	17.1	37.5	33.7	0.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	100.0		
3/4"	98.5		
1/2"	98.5		
3/8"	98.5		
1/4"	97.2		
#4	96.2		
#10	89.2		
#20	84.4		
#40	72.1		
#80	57.0		
#140	43.5		
#200	34.6		
0.0367 mm.	15.4		
0.0234 mm.	12.3		
0.0137 mm.	7.7		
0.0098 mm.	6.1		
0.0070 mm.	2.9		
0.0033 mm.	1.6		
0.0014 mm.	0.6		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 2.2319 D_{85}= 0.8992 D_{60}= 0.2082
D_{50}= 0.1358 D_{30}= 0.0643 D_{15}= 0.0357
D_{10}= 0.0180 C_u= 11.59 C_c= 1.10

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Moisture Content: 47.5%
Orgainic Content: 4.5%

Location: BB-CMB-102C
Sample Number: S-6D **Depth:** 16-18' **Date:** 12/02/2022

R.W. Gillespie & Associates, Inc. Biddeford, Maine

Client: Schonewald Engineering Associates, Inc
Project: Noyes Bridge SEA#22-012, WIN 2618.00
Cumberland, ME
Project No: 1368-021 **Lab No.** 17268

Tested By: CAG **Checked By:** MTG

 MTG

ORGANIC CONTENT DETERMINATIONS

AASHTO T-267 Determination of Organic Content in Soils by Loss on Ignition

Project Name:	Noyes Bridge, Cumberland (SEA #22-012, WIN 2618.00)	Lab No.	17268
Project No.	1368-021	Date:	December 2, 2022
Client:	Schonewald Engineering Associates, Inc.		
Project Location:	Cumberland, ME		

Moisture Content						
Boring No.						
Sample No.						
Tare No.						
Wt of Dish + Wet Soil (g)						
Wt of Dish + Dry Soil (g)						
Wt. of Tare (g)						
Wt. of Water (g)						
Wt. Of Dry Soil (g)						
Percent Moisture						

Organic Content						
Boring No.	BB-CMB-102C	BB-CMB-102C				
Sample No.	S6D	S6D				
Dish, Cover, Soil Pre Ignition (0.01 g)	35.50	38.37				
Dish, Cover, Soil Post Ignition (0.01 g)	33.90	36.63				
Dish, Cover (0.01 g)	0.00	0.00				
Wt. of Organic Matter (g)	1.6	1.7				
Wt. Of Soil (g)	35.5	38.4				
Percent Organics	4.5%	4.5%				
	AVG:	4.5%				

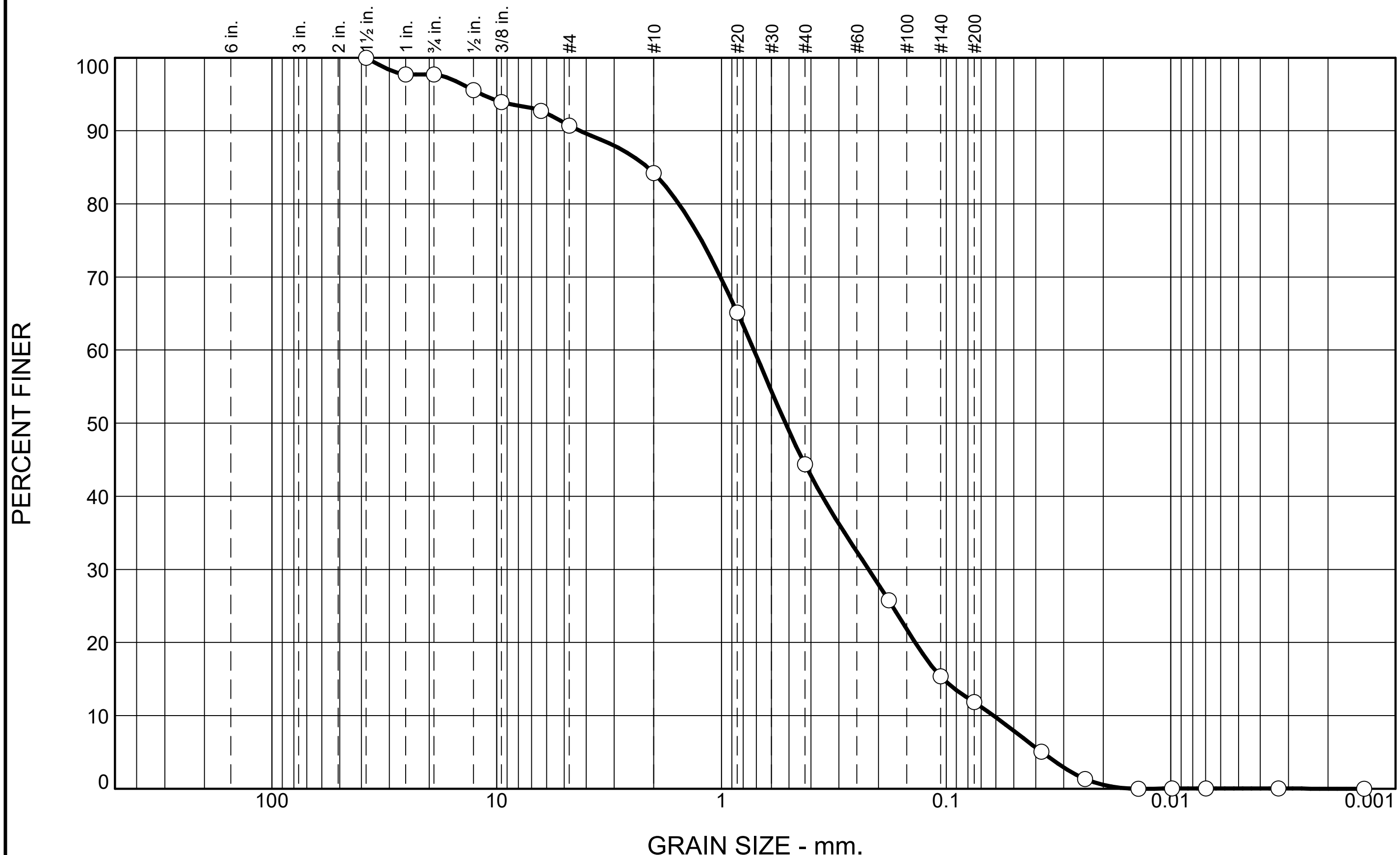
Checked by: MTG

R.W. GILLESPIE & ASSOCIATES, INC.

20 Pomerleau Street, Suite 100, Biddeford ME 04005, 207-286-8008 / 177 Shattuck Way, Suite 1 West, Newington NH 03801, 603-427-0244

 MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	2.3	7.0	6.5	39.8	32.6	11.8	0.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 1/2"	100.0		
1"	97.7		
3/4"	97.7		
1/2"	95.5		
3/8"	93.9		
1/4"	92.7		
#4	90.7		
#10	84.2		
#20	65.1		
#40	44.4		
#80	25.8		
#140	15.4		
#200	11.8		
0.0377 mm.	5.1		
0.0241 mm.	1.3		
0.0140 mm.	0.0		
0.0099 mm.	0.0		
0.0070 mm.	0.0		
0.0033 mm.	0.0		
0.0014 mm.			

* (no specification provided)

Soil Description

poorly graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 4.2625 D_{85}= 2.1333 D_{60}= 0.7178
D_{50}= 0.5185 D_{30}= 0.2213 D_{15}= 0.1031
D_{10}= 0.0616 C_u= 11.65 C_c= 1.11

Classification

USCS= SP-SM AASHTO= A-1-b

Remarks

Moisture Content: 77.8%
Orgainic Content: 4.8%

Location: BB-CMB-102C
Sample Number: S-7D **Depth:** 18-20' **Date:** 12/02/2022

R.W. Gillespie & Associates, Inc. Biddeford, Maine

Client: Schonewald Engineering Associates, Inc
Project: Noyes Bridge SEA#22-012, WIN 2618.00
Cumberland, ME
Project No: 1368-021 **Lab No.** 17269

Tested By: JMT/CAG **Checked By:** MTG

 MTG

ORGANIC CONTENT DETERMINATIONS

AASHTO T-267 Determination of Organic Content in Soils by Loss on Ignition

Project Name:	Noyes Bridge, Cumberland (SEA #22-012, WIN 2618.00)	Lab No.	17269
Project No.	1368-021	Date:	December 2, 2022
Client:	Schonewald Engineering Associates, Inc.		
Project Location:	Cumberland, ME		

Moisture Content						
Boring No.						
Sample No.						
Tare No.						
Wt of Dish + Wet Soil (g)						
Wt of Dish + Dry Soil (g)						
Wt. of Tare (g)						
Wt. of Water (g)						
Wt. Of Dry Soil (g)						
Percent Moisture						

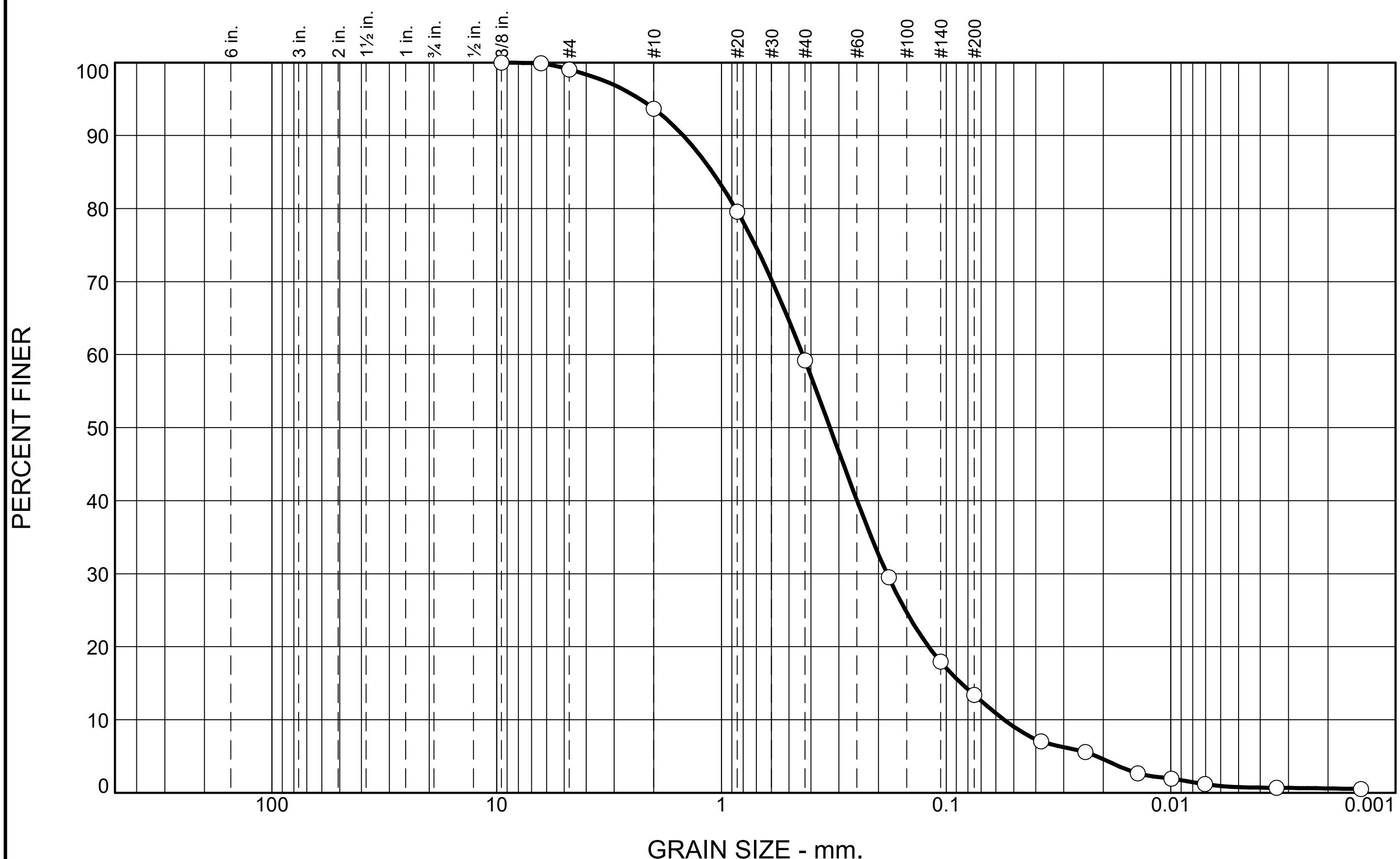
Organic Content						
Boring No.	BB-CMB-102C	BB-CMB-102C				
Sample No.	S7D	S7D				
Dish, Cover, Soil Pre Ignition (0.01 g)	165.92	207.30				
Dish, Cover, Soil Post Ignition (0.01 g)	164.33	206.58				
Dish, Cover (0.01 g)	132.31	192.75				
Wt. of Organic Matter (g)	1.6	0.7				
Wt. Of Soil (g)	33.6	14.5				
Percent Organics	4.7%	4.9%				
	AVG:	4.8%				

Checked by: MTG

R.W. GILLESPIE & ASSOCIATES, INC.

 MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.0	5.3	34.5	45.8	12.8	0.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
1/4"	99.9		
#4	99.0		
#10	93.7		
#20	79.6		
#40	59.2		
#80	29.5		
#140	17.9		
#200	13.4		
0.0378 mm.	7.0		
0.0241 mm.	5.6		
0.0140 mm.	2.7		
0.0099 mm.	1.9		
0.0071 mm.	1.2		
0.0034 mm.	0.7		
0.0014 mm.	0.5		

* (no specification provided)

Soil Description

silty sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.4804 D_{85}= 1.0966 D_{60}= 0.4349
D_{50}= 0.3288 D_{30}= 0.1832 D_{15}= 0.0857
D_{10}= 0.0553 C_u= 7.87 C_c= 1.40

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Moisture Content: 25.8%
Organic Content: 0.6%

Location: BB-CMB-102C
Sample Number: S-8D **Depth:** 20-22' **Date:** 12/02/2022

R.W. Gillespie & Associates, Inc. Biddeford, Maine

Client: Schonewald Engineering Associates, Inc
Project: Noyes Bridge SEA#22-012, WIN 2618.00
Cumberland, ME
Project No: 1368-021 **Lab No.** 17270

Tested By: CAG **Checked By:** MTG

 MTG

ORGANIC CONTENT DETERMINATIONS

AASHTO T-267 Determination of Organic Content in Soils by Loss on Ignition

Project Name:	Noyes Bridge, Cumberland (SEA #22-012, WIN 2618.00)	Lab No.	17270
Project No.	1368-021	Date:	December 2, 2022
Client:	Schonewald Engineering Associates, Inc.		
Project Location:	Cumberland, ME		

Moisture Content						
Boring No.						
Sample No.						
Tare No.						
Wt of Dish + Wet Soil (g)						
Wt of Dish + Dry Soil (g)						
Wt. of Tare (g)						
Wt. of Water (g)						
Wt. Of Dry Soil (g)						
Percent Moisture						

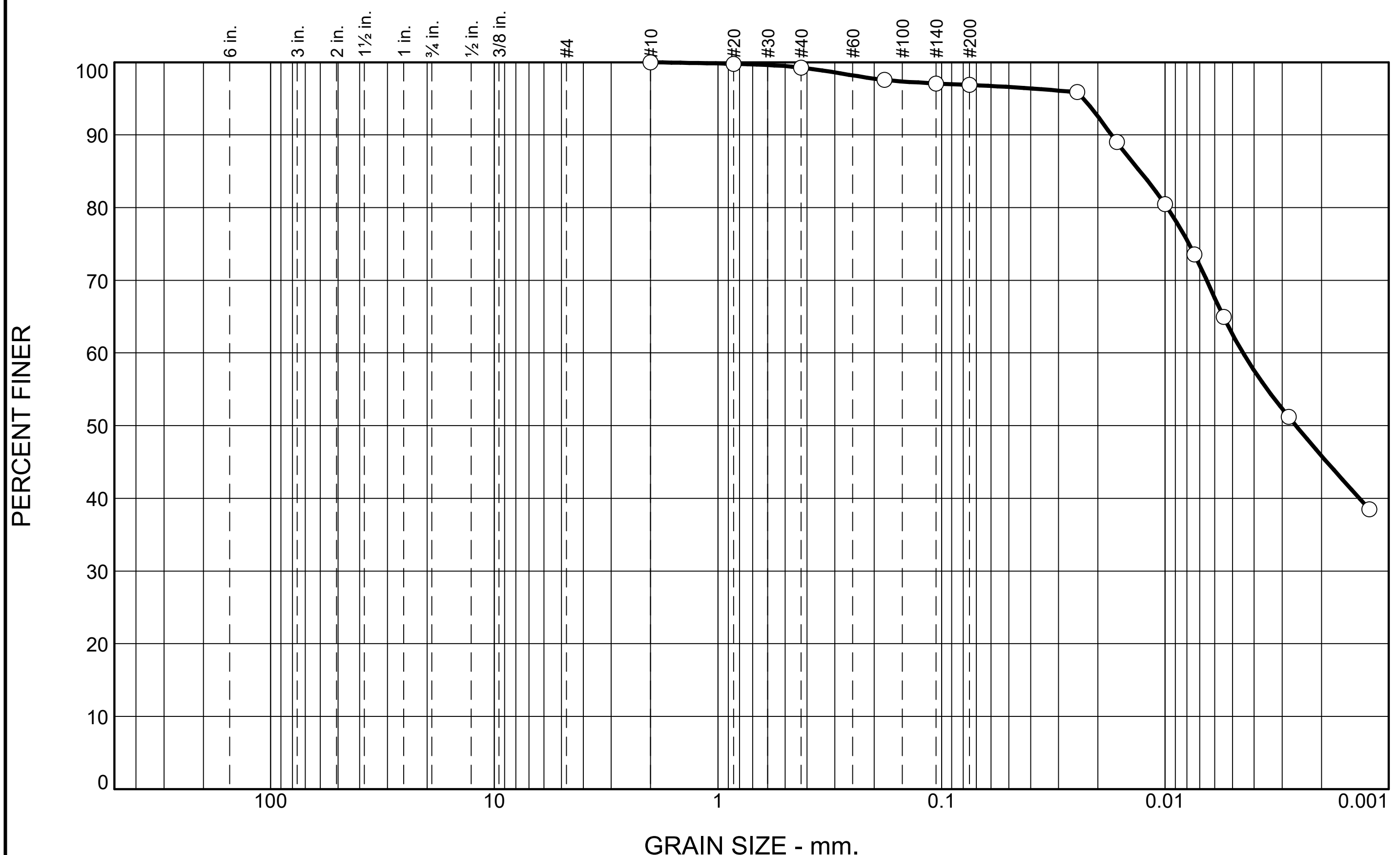
Organic Content						
Boring No.	BB-CMB-102C	BB-CMB-102C	BB-CMB-102C	BB-CMB-102C		
Sample No.	S8D (1)	S8D (1-MW)	S8D (2)	S8D (2-MW)		
Dish, Cover, Soil Pre Ignition (0.01 g)	108.95	35.18	121.91	41.84		
Dish, Cover, Soil Post Ignition (0.01 g)	108.75	34.98	121.667	41.59		
Dish, Cover (0.01 g)	73.76	0.00	80.07	0.00		
Wt. of Organic Matter (g)	0.2	0.2	0.2	0.2		
Wt. Of Soil (g)	35.2	35.2	41.8	41.8		
Percent Organics	0.5%	0.6%	0.6%	0.6%		
	AVG:	0.6%	AVG:	0.6%		

Checked by: MTG

R.W. GILLESPIE & ASSOCIATES, INC.

 MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.7	2.4	51.0	45.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.8		
#40	99.3		
#80	97.6		
#140	97.0		
#200	96.9		
0.0248 mm.	95.9		
0.0165 mm.	89.0		
0.0100 mm.	80.5		
0.0074 mm.	73.5		
0.0055 mm.	64.9		
0.0028 mm.	51.2		
0.0012 mm.	38.5		

* (no specification provided)

Soil Description

lean clay

Atterberg Limits

PL= 20.8 LL= 40.9 PI= 20.1

Coefficients

D_{90}= 0.0174 D_{85}= 0.0130 D_{60}= 0.0045
D_{50}= 0.0026 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(21)

Remarks

Moisture Content:38.2%

Location: BB-CMB-102C
Sample Number: S-9D **Depth:** 22-24' **Date:** 12/02/2022

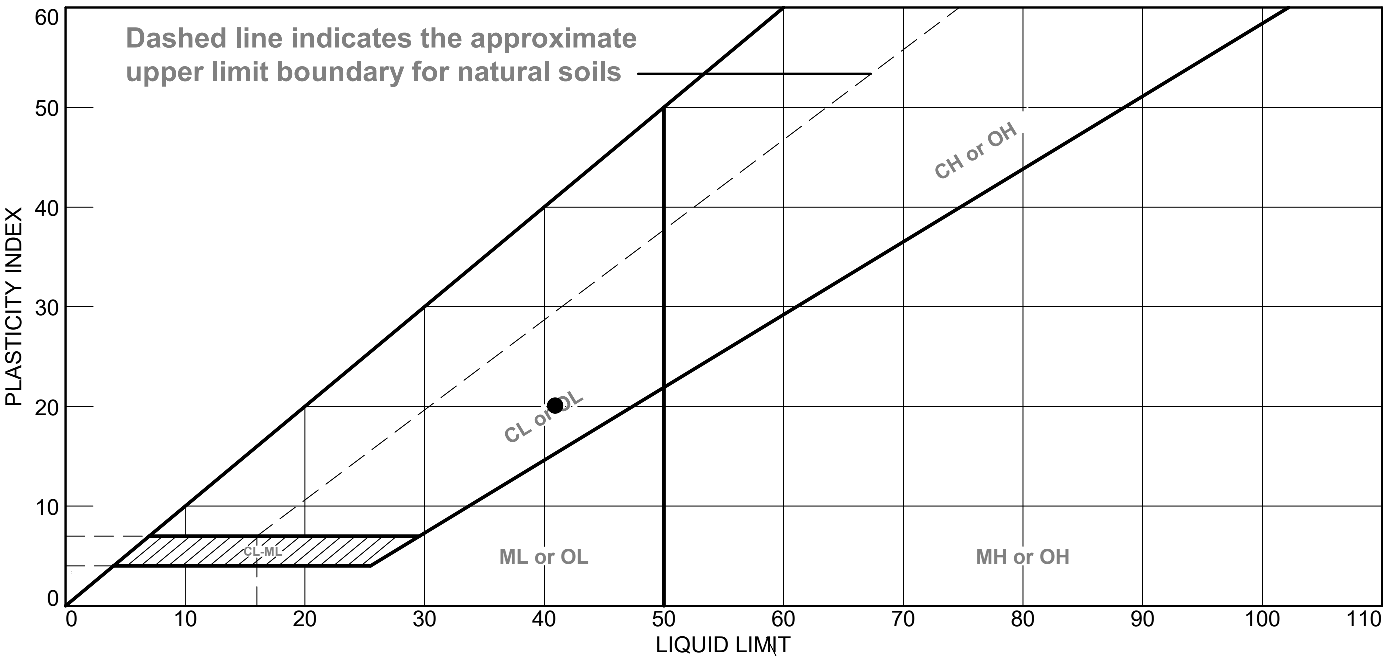
R.W. Gillespie & Associates, Inc. Biddeford, Maine

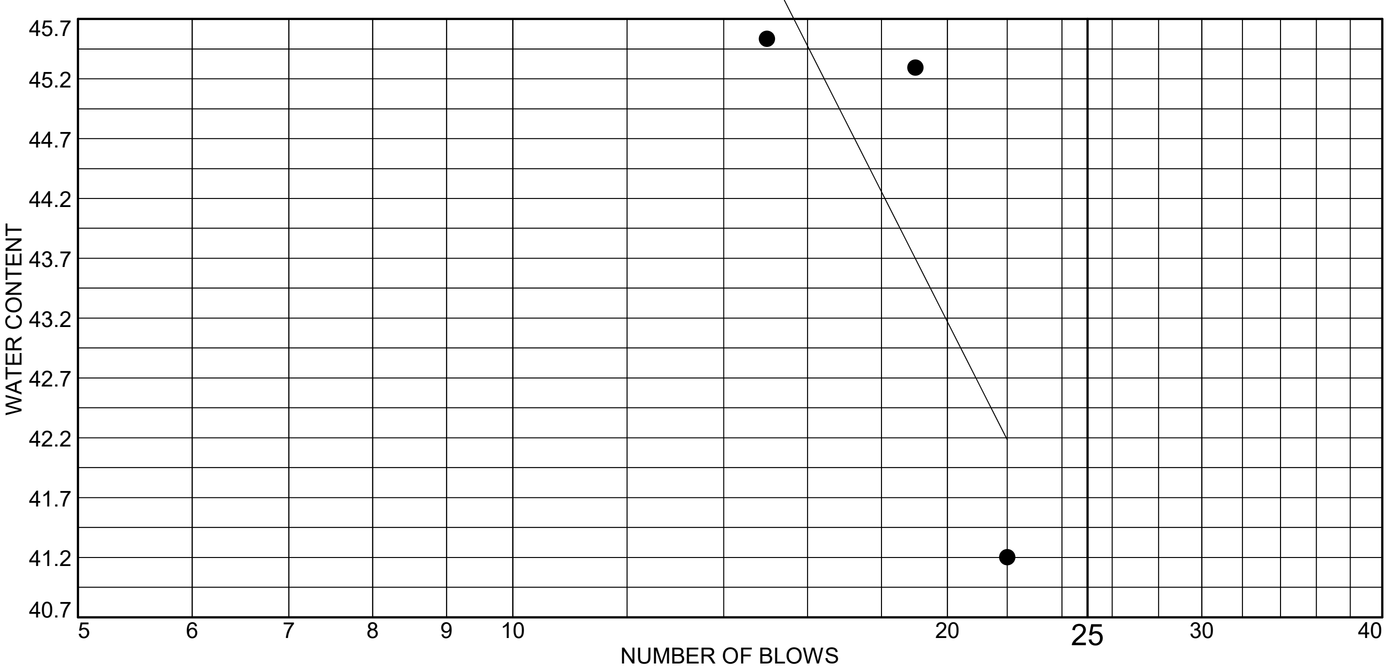
Client: Schonewald Engineering Associates, Inc
Project: Noyes Bridge SEA#22-012, WIN 2618.00
Cumberland, ME
Project No: 1368-021 **Lab No.** 17271

Tested By: CAG **Checked By:** MTG

 MTG

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	lean clay	40.9	20.8	20.1	99.3	96.9	CL

Project No. 1368-021 **Client:** Schonewald Engineering Associates, Inc

Project: Noyes Bridge SEA#22-012, WIN 2618.00

Cumberland, ME

Location: BB-CMB-102C

Sample Number: S-9D **Depth:** 22-24'

Remarks:

R.W. Gillespie & Associates, Inc.

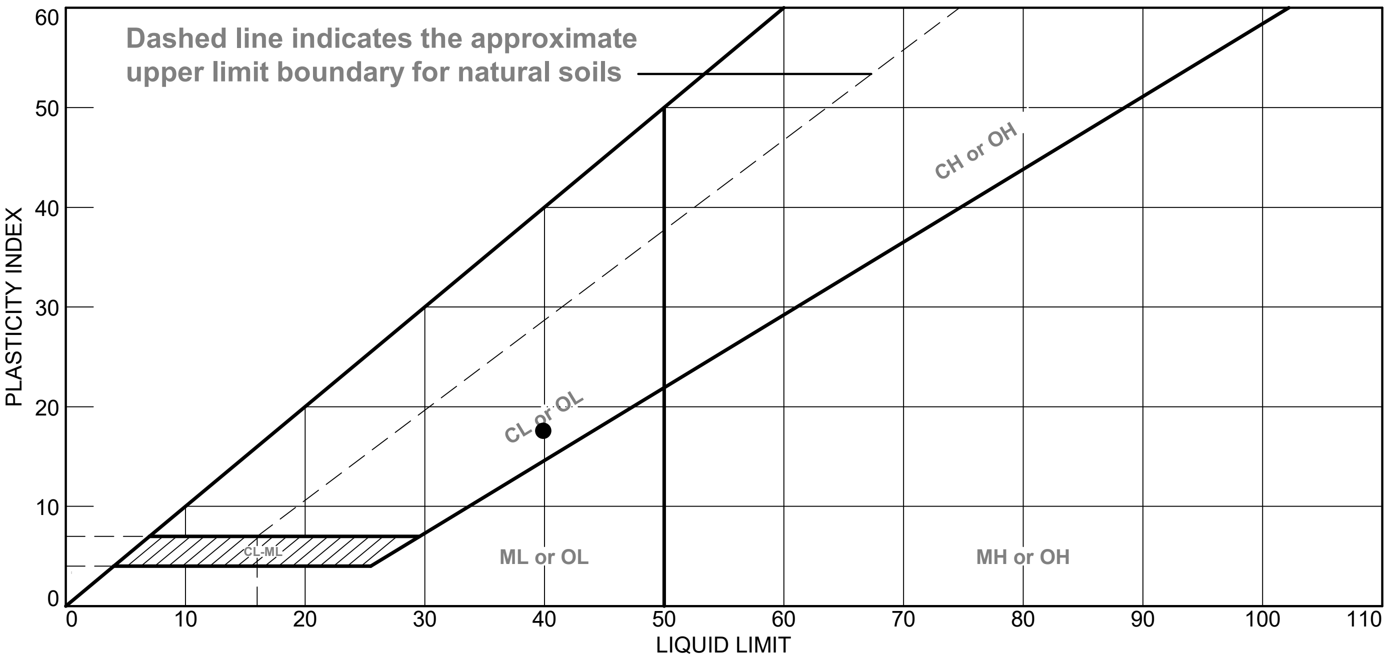
Biddeford, Maine

Lab No. 17271

Tested By: CAG **Checked By:** MTG

 MTG

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	lean clay	39.9	22.3	17.6			

Project No. 1368-021 **Client:** Schonewald Engineering Associates, Inc

Project: Noyes Bridge SEA#22-012, WIN 2618.00

Cumberland, ME

Location: BB-CMB-102C

Sample Number: S-10D **Depth:** 24-26'

R.W. Gillespie & Associates, Inc.

Biddeford, Maine

Remarks:

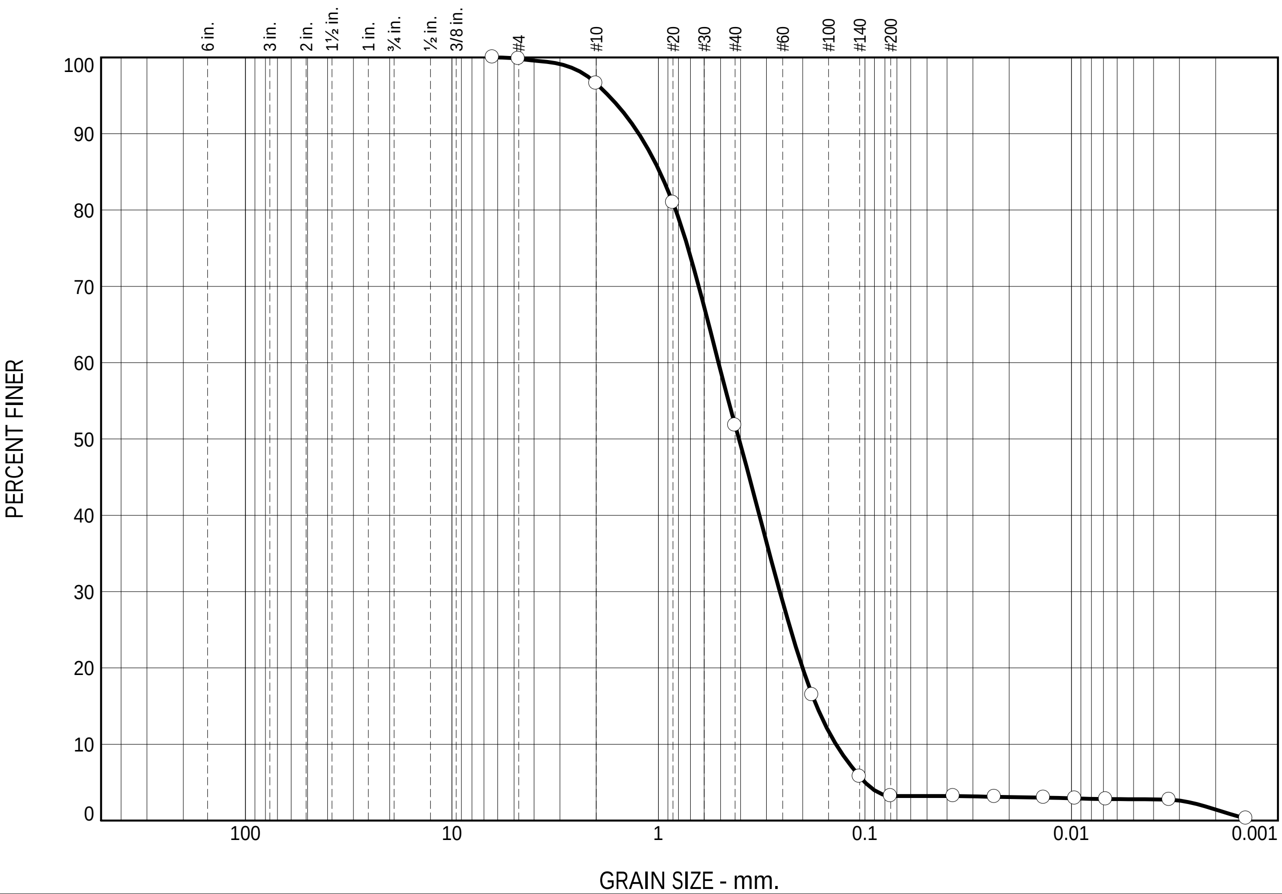
● Moisture Content: 41.2%

Lab No. 17272

Tested By: CAG **Checked By:** MTG

 MTG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	3.2	44.8	48.6	1.8	1.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/4"	100.0		
#4	99.8		
#10	96.6		
#20	81.0		
#40	51.8		
#80	16.5		
#140	5.8		
#200	3.2		
0.0372 mm.	3.2		
0.0235 mm.	3.1		
0.0136 mm.	3.0		
0.0096 mm.	2.9		
0.0068 mm.	2.8		
0.0034 mm.	2.7		
0.0014 mm.	0.3		

* (no specification provided)

Soil Description

poorly graded sand

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.2449 D_{85}= 0.9850 D_{60}= 0.5118
D_{50}= 0.4073 D_{30}= 0.2583 D_{15}= 0.1713
D_{10}= 0.1381 C_u= 3.71 C_c= 0.94

Classification

USCS= SP AASHTO= A-3

Remarks

Moisture Content: 5.8%

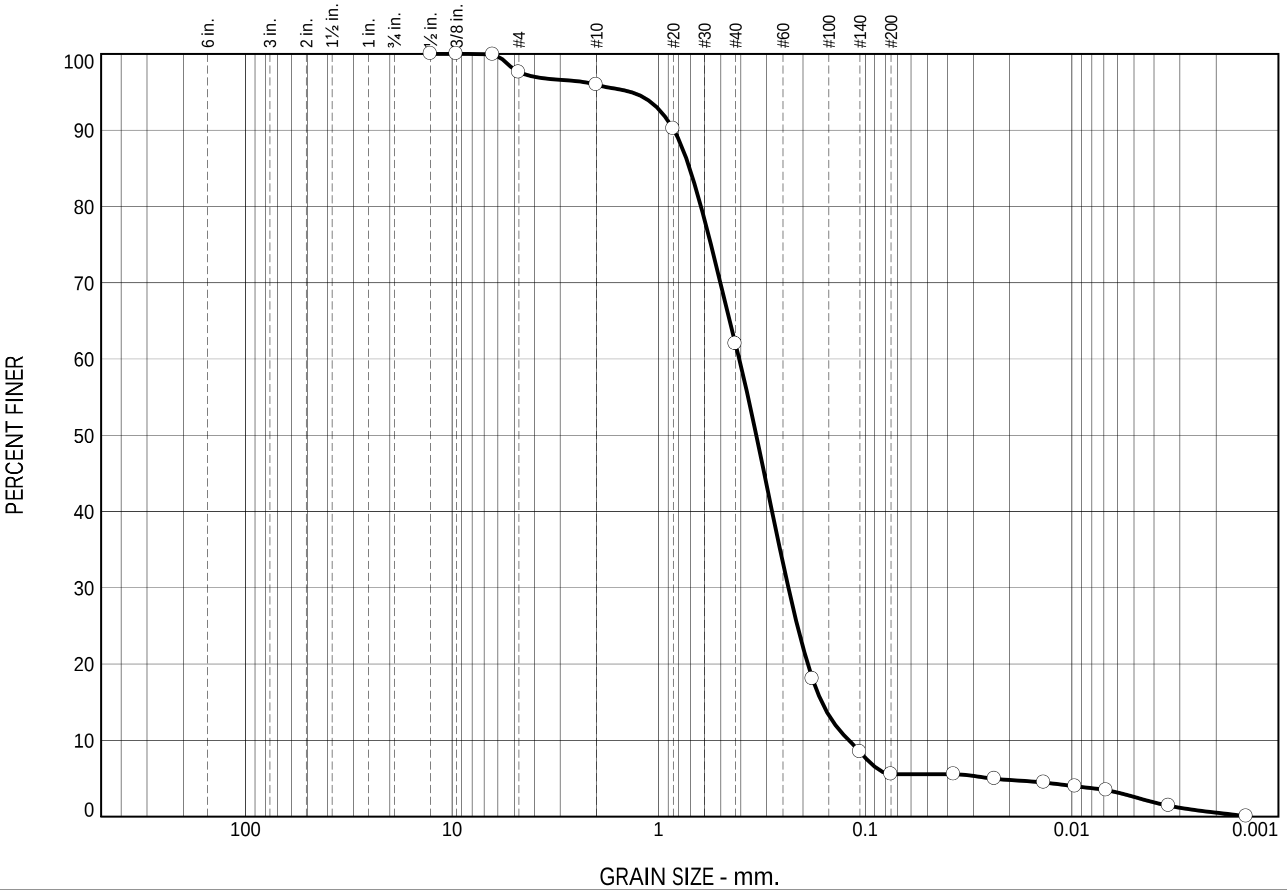
Location: BB-CMD-201
Sample Number: 3D Depth: 9-11' Date: 07/23/2025

R.W. Gillespie
& Associates, Inc.
Biddeford, Maine

Client: Schonewald Engineering Associates, Inc.
Project: WIN 26480: Cumberland Noyes (SEA 25-112)
Cumberland, ME
Project No: 1368-028 Lab No. 18606-01

Tested By: CJC/HFS Checked By: CAG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.4	1.7	33.9	56.4	5.1	0.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100.0		
3/8"	100.0		
1/4"	99.9		
#4	97.6		
#10	95.9		
#20	90.2		
#40	62.0		
#80	18.1		
#140	8.5		
#200	5.6		
0.0372 mm.	5.5		
0.0236 mm.	5.0		
0.0136 mm.	4.5		
0.0096 mm.	4.0		
0.0068 mm.	3.5		
0.0034 mm.	1.4		
0.0014 mm.	0.0		

* (no specification provided)

Soil Description

poorly graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.8423 D_{85}= 0.7080 D_{60}= 0.4074
D_{50}= 0.3369 D_{30}= 0.2355 D_{15}= 0.1623
D_{10}= 0.1199 C_u= 3.40 C_c= 1.14

Classification

USCS= SP-SM AASHTO= A-3

Remarks

Moisture Content: 34.4%

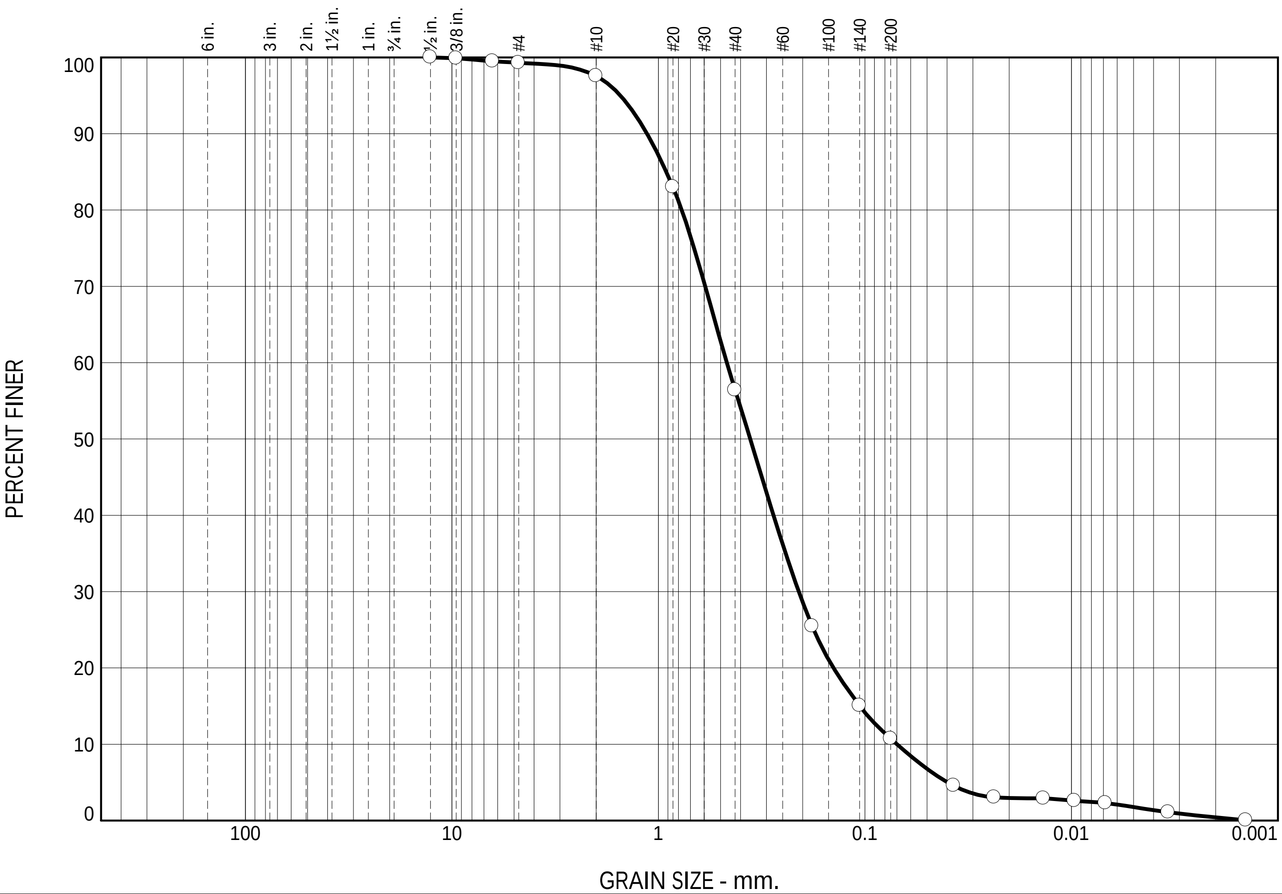
Location: BB-CMD-201
Sample Number: 4D Depth: 14-16' Date: 07/23/20025

R.W. Gillespie
& Associates, Inc.
Biddeford, Maine

Client: Schonewald Engineering Associates, Inc.
Project: WIN 26480: Cumberland Noyes (SEA 25-112)
Cumberland, ME
Project No: 1368-028 Lab No. 18606-02

Tested By: CJC/HFS Checked By: CAG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.7	1.7	41.2	45.7	10.3	0.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100.0		
3/8"	99.9		
1/4"	99.5		
#4	99.3		
#10	97.6		
#20	83.0		
#40	56.4		
#80	25.5		
#140	15.1		
#200	10.7		
0.0371 mm.	4.6		
0.0236 mm.	3.0		
0.0136 mm.	2.9		
0.0097 mm.	2.6		
0.0068 mm.	2.3		
0.0034 mm.	1.1		
0.0014 mm.	0.0		

* (no specification provided)

Soil Description

well-graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.1353 D_{85}= 0.9156 D_{60}= 0.4664
D_{50}= 0.3592 D_{30}= 0.2091 D_{15}= 0.1056
D_{10}= 0.0699 C_u= 6.67 C_c= 1.34

Classification

USCS= SW-SM AASHTO= A-2-4(0)

Remarks

Moisture Content: 33.6%

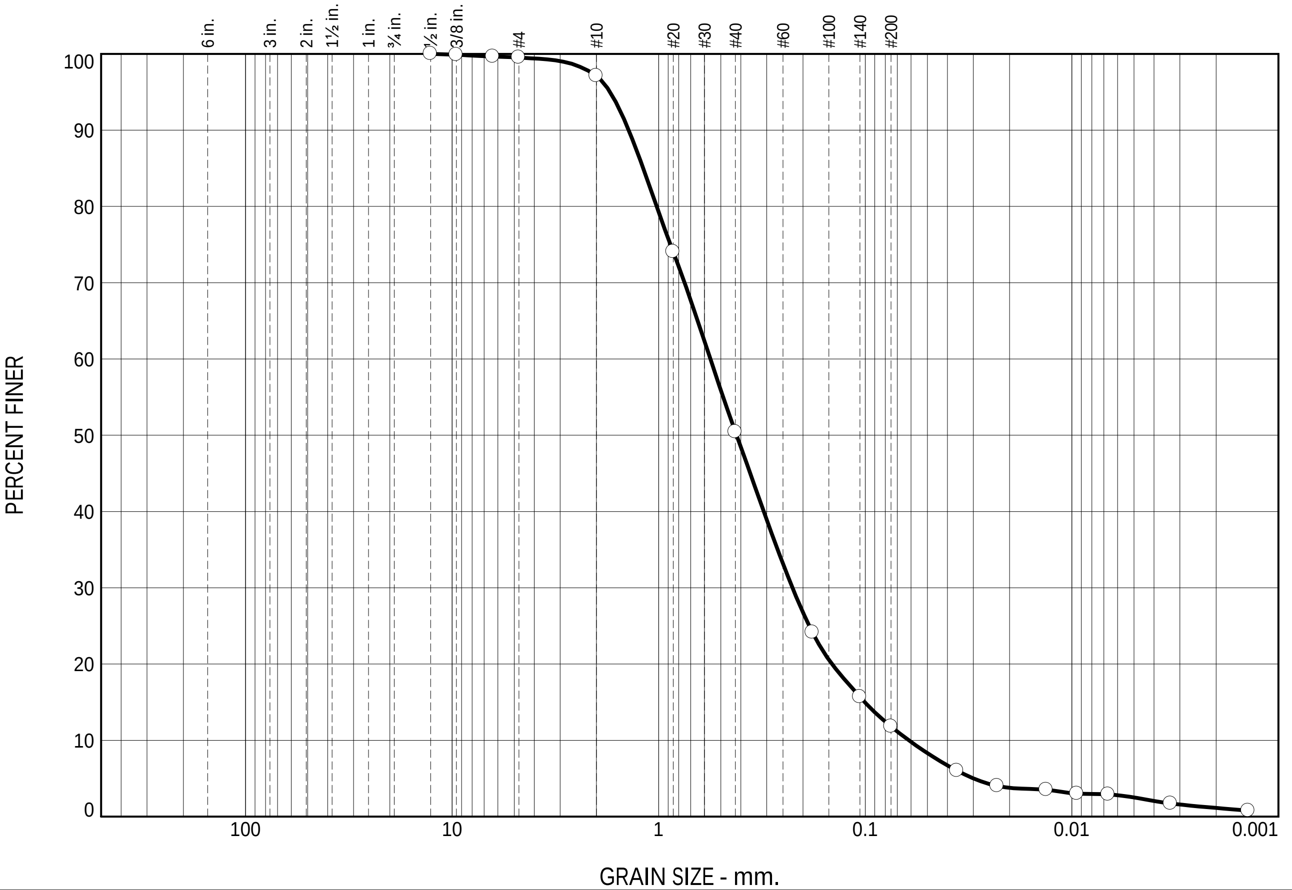
Location: BB-CMD-201
Sample Number: 5D Depth: 16-18' Date: 07/23/2025

R.W. Gillespie
& Associates, Inc.
Biddeford, Maine

Client: Schonewald Engineering Associates, Inc.
Project: WIN 26480: Cumberland Noyes (SEA 25-112)
Cumberland, ME
Project No: 1368-028 Lab No. 18606-03

Tested By: CJC/HFS Checked By: CAG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	2.4	46.7	38.6	10.7	1.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100.0		
3/8"	99.9		
1/4"	99.6		
#4	99.5		
#10	97.1		
#20	74.0		
#40	50.4		
#80	24.1		
#140	15.7		
#200	11.8		
0.0359 mm.	6.0		
0.0229 mm.	4.0		
0.0133 mm.	3.5		
0.0094 mm.	3.0		
0.0067 mm.	2.9		
0.0033 mm.	1.7		
0.0014 mm.	0.8		

* (no specification provided)

Soil Description

well-graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.3970 D_{85}= 1.1884 D_{60}= 0.5620
D_{50}= 0.4196 D_{30}= 0.2251 D_{15}= 0.1005
D_{10}= 0.0615 C_u= 9.14 C_c= 1.47

Classification

USCS= SW-SM AASHTO= A-1-b

Remarks

Moisture Content: 22.6%

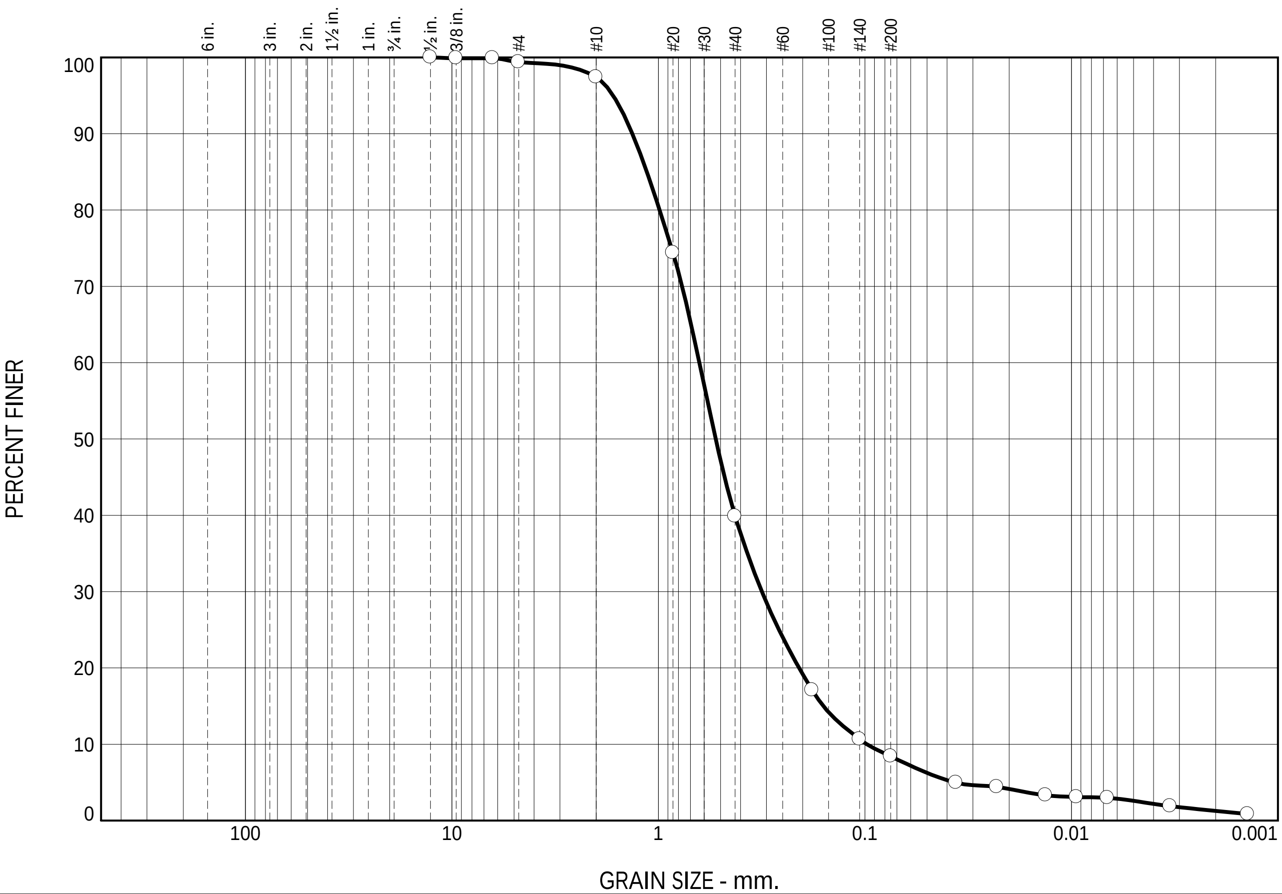
Location: BB-CMD-201
Sample Number: 6D Depth: 18-20' Date: 07/23/2025

R.W. Gillespie
& Associates, Inc.
Biddeford, Maine

Client: Schonewald Engineering Associates, Inc.
Project: WIN 26480: Cumberland Noyes (SEA 25-112)
Cumberland, ME
Project No: 1368-028 Lab No. 18606-04

Tested By: CJC/HFS Checked By: CAG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.6	2.0	57.5	31.5	7.1	1.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1/2"	100.0		
3/8"	99.9		
1/4"	99.9		
#4	99.4		
#10	97.4		
#20	74.4		
#40	39.9		
#80	17.1		
#140	10.7		
#200	8.4		
0.0362 mm.	5.0		
0.0229 mm.	4.4		
0.0133 mm.	3.3		
0.0094 mm.	3.1		
0.0067 mm.	3.0		
0.0033 mm.	1.9		
0.0014 mm.	0.8		

* (no specification provided)

Soil Description

well-graded sand with silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.3373 D_{85}= 1.1376 D_{60}= 0.6331
D_{50}= 0.5278 D_{30}= 0.3155 D_{15}= 0.1590
D_{10}= 0.0978 C_u= 6.47 C_c= 1.61

Classification

USCS= SW-SM AASHTO= A-1-b

Remarks

Moisture Content: 24.6%

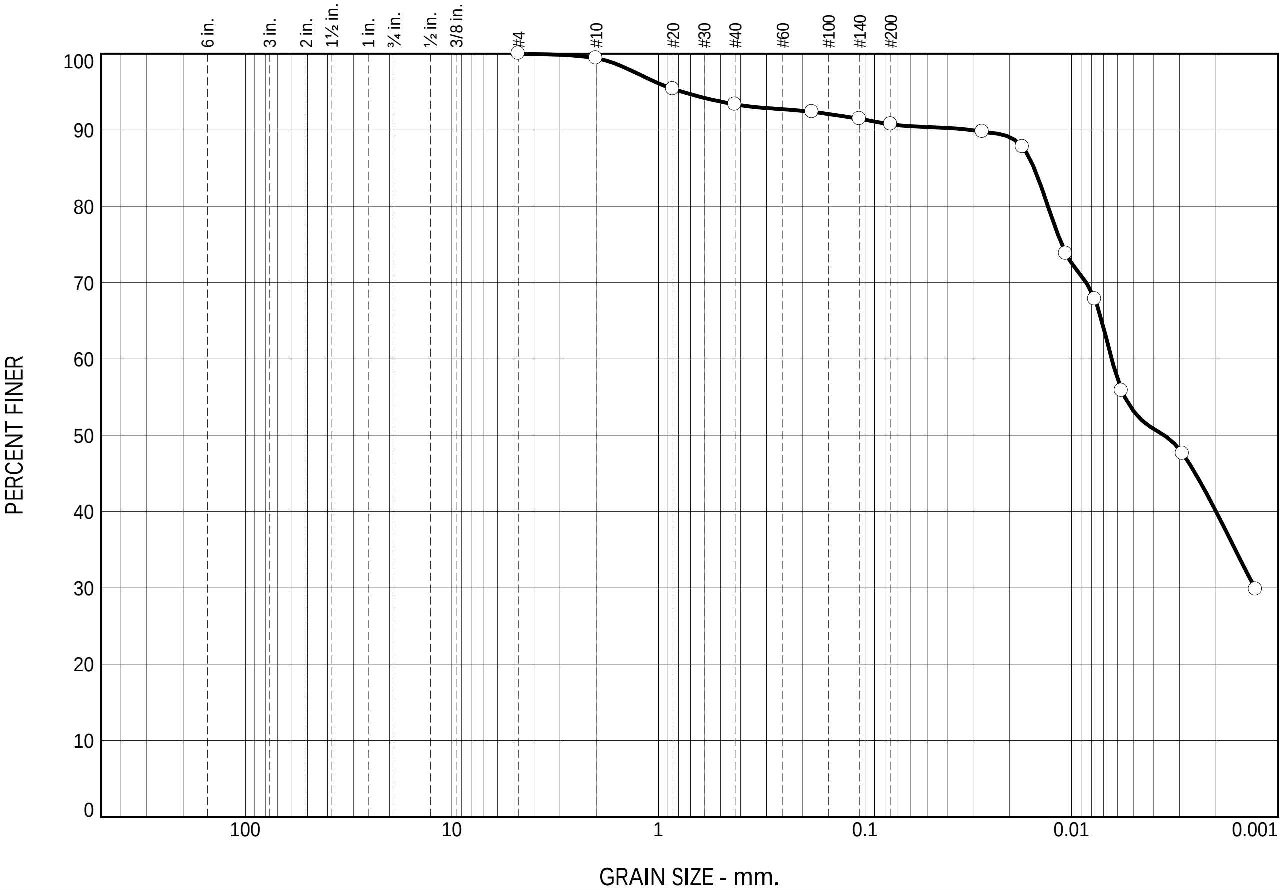
Location: BB-CMD-201
Sample Number: 7D Depth: 20-22' Date: 07/23/2025

R.W. Gillespie
& Associates, Inc.
Biddeford, Maine

Client: Schonewald Engineering Associates, Inc.
Project: WIN 26480: Cumberland Noyes (SEA 25-112)
Cumberland, ME
Project No: 1368-028 Lab No. 18606-05

Tested By: CJC/HFS Checked By: CAG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.6	6.0	2.7	50.7	40.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.4		
#20	95.4		
#40	93.4		
#80	92.4		
#140	91.5		
#200	90.7		
0.0270 mm.	89.8		
0.0173 mm.	87.8		
0.0106 mm.	73.8		
0.0077 mm.	67.8		
0.0057 mm.	55.9		
0.0029 mm.	47.6		
0.0013 mm.	29.8		

* (no specification provided)

Soil Description

lean clay

Atterberg Limits

PL= 22.9 LL= 40.0 PI= 17.1

Coefficients

D_{90}= 0.0308 D_{85}= 0.0152 D_{60}= 0.0064
D_{50}= 0.0036 D_{30}= 0.0013 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(17)

Remarks

Moisture Content: 35.9%

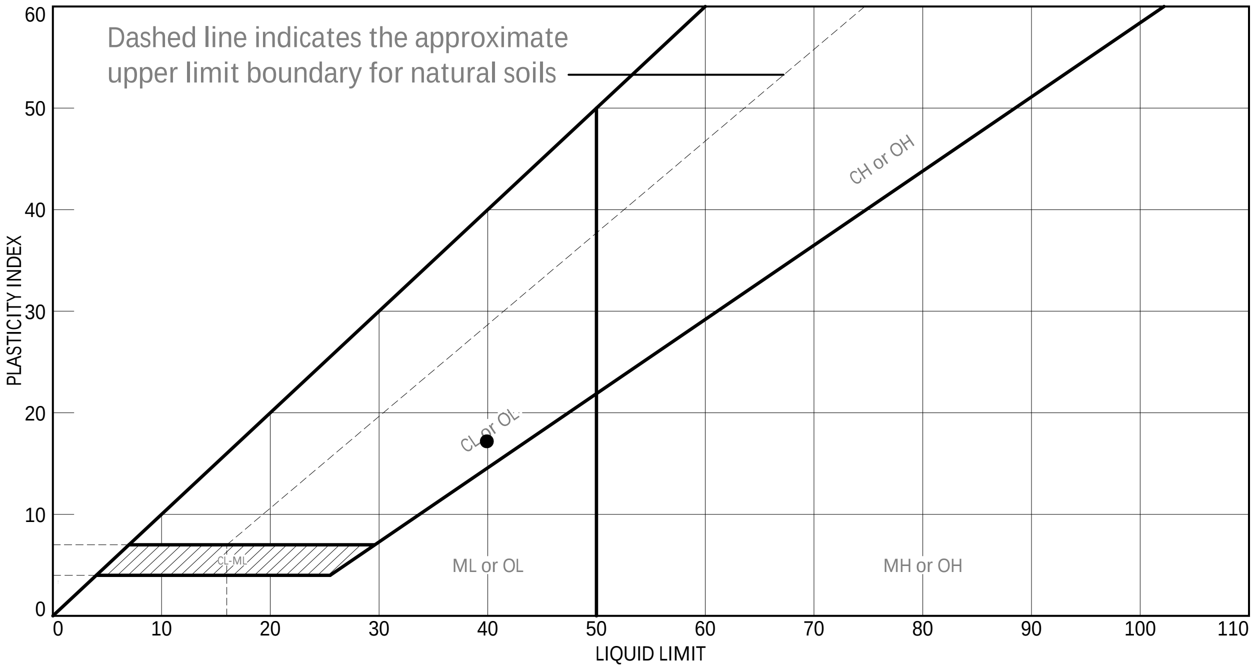
Location: BB-CMD-201
Sample Number: 8D Depth: 22-24' Date: 07/23/2025

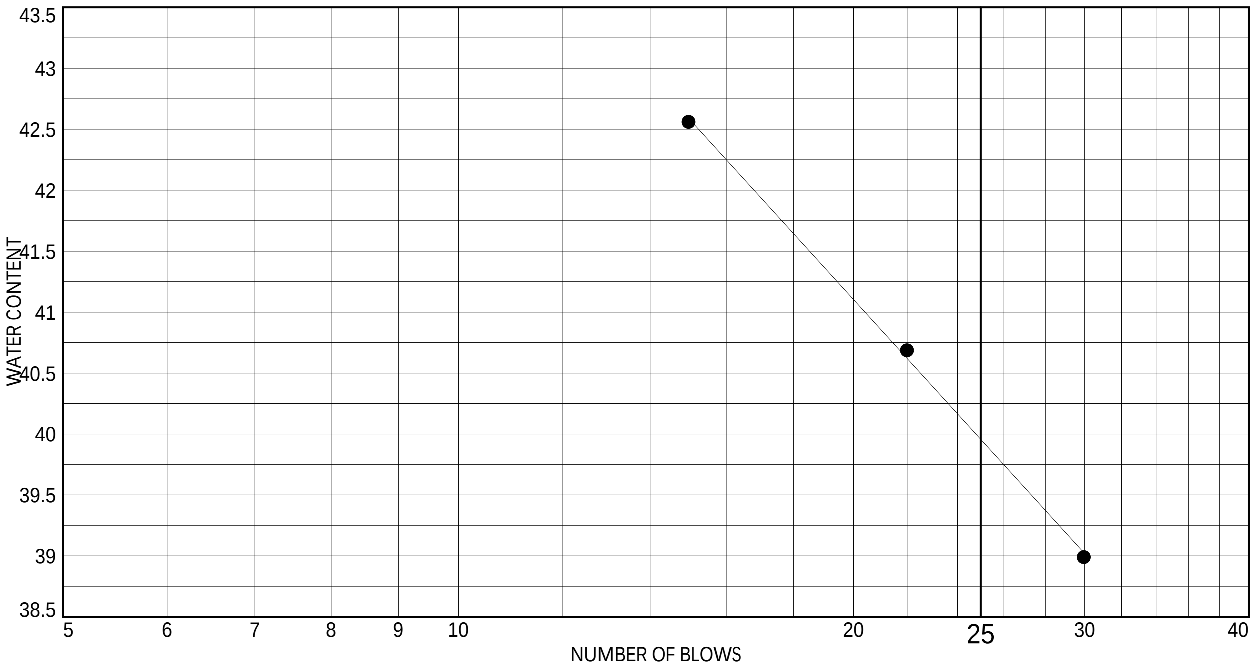
R.W. Gillespie
& Associates, Inc.
Biddeford, Maine

Client: Schonewald Engineering Associates, Inc.
Project: WIN 26480: Cumberland Noyes (SEA 25-112)
Cumberland, ME
Project No: 1368-028 Lab No. 18606-06

Tested By: CJC/HFS Checked By: CAG

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	lean clay	40.0	22.9	17.1	93.4	90.7	CL

Project No. 1368-028 Client: Schonewald Engineering Associates, Inc.

Project: WIN 26480: Cumberland Noyes (SEA 25-112)

Cumberland, ME

Location: BB-CMD-201

Sample Number: 8D Depth: 22-24'

Remarks:

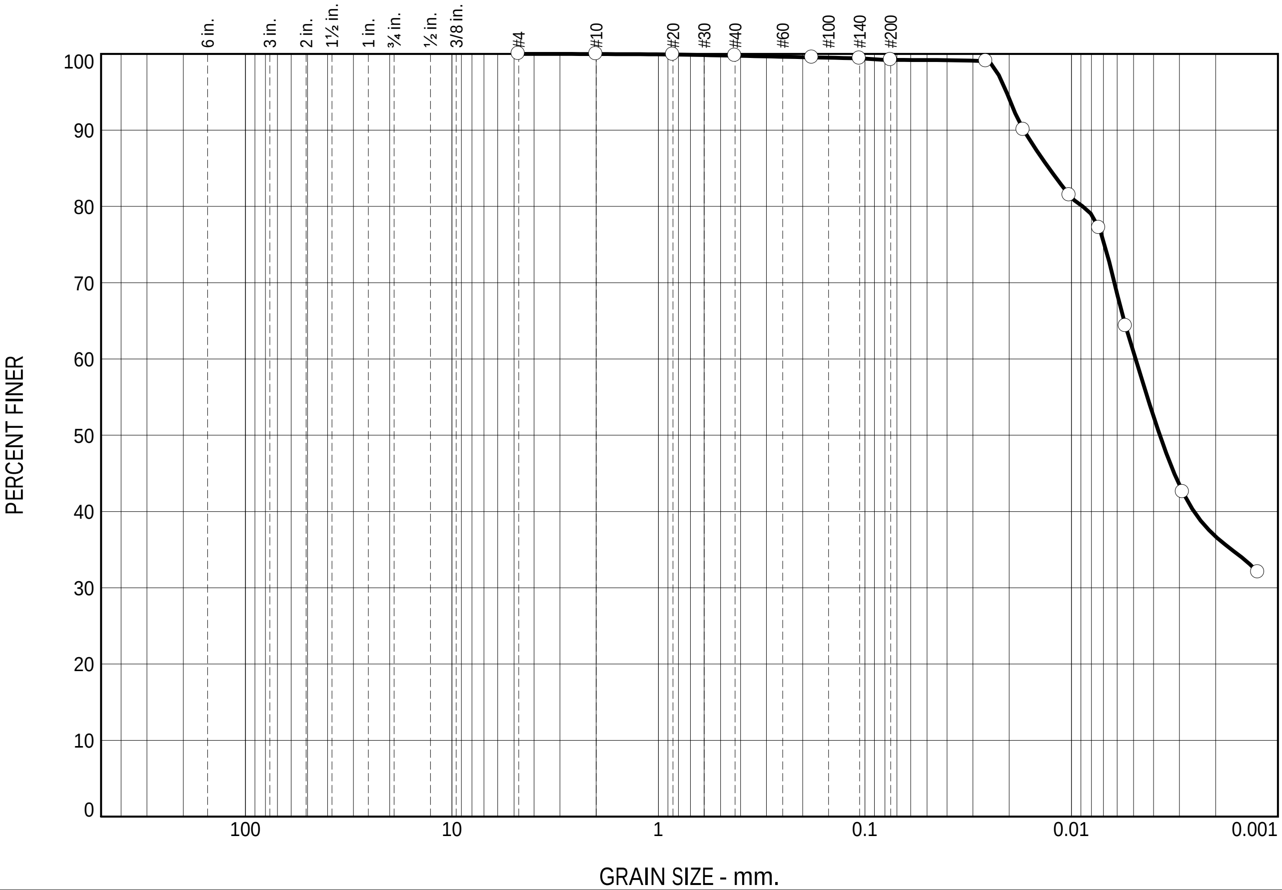
R.W. Gillespie & Associates, Inc.

Biddeford, Maine

Lab No. 18606-06

Checked By: CAG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.2	0.6	62.5	36.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	99.9		
#40	99.8		
#80	99.5		
#140	99.4		
#200	99.2		
0.0259 mm.	99.1		
0.0171 mm.	90.1		
0.0102 mm.	81.5		
0.0074 mm.	77.2		
0.0055 mm.	64.3		
0.0029 mm.	42.6		
0.0012 mm.	32.0		

* (no specification provided)

Soil Description

lean clay

Atterberg Limits

PL= 23.0 LL= 39.6 PI= 16.6

Coefficients

D_{90}= 0.0170 D_{85}= 0.0128 D_{60}= 0.0049
D_{50}= 0.0037 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(19)

Remarks

Moisture Content: 41.0%

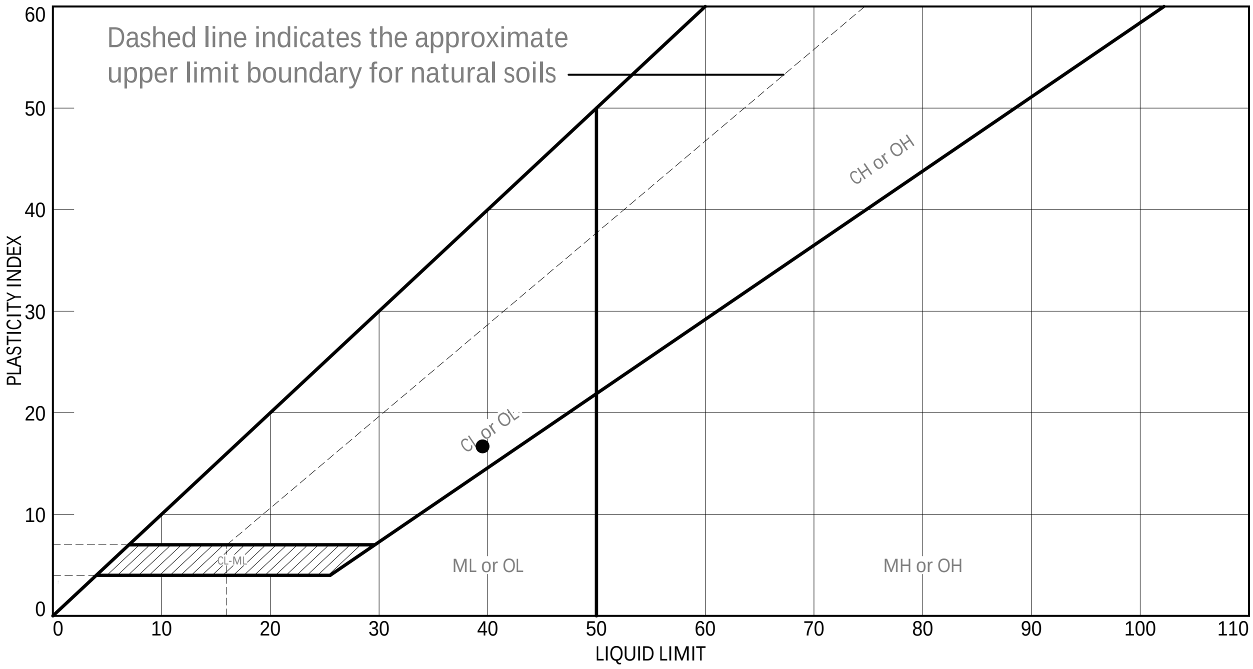
Location: BB-CMD-201
Sample Number: 9D Depth: 24-26' Date: 07/23/2025

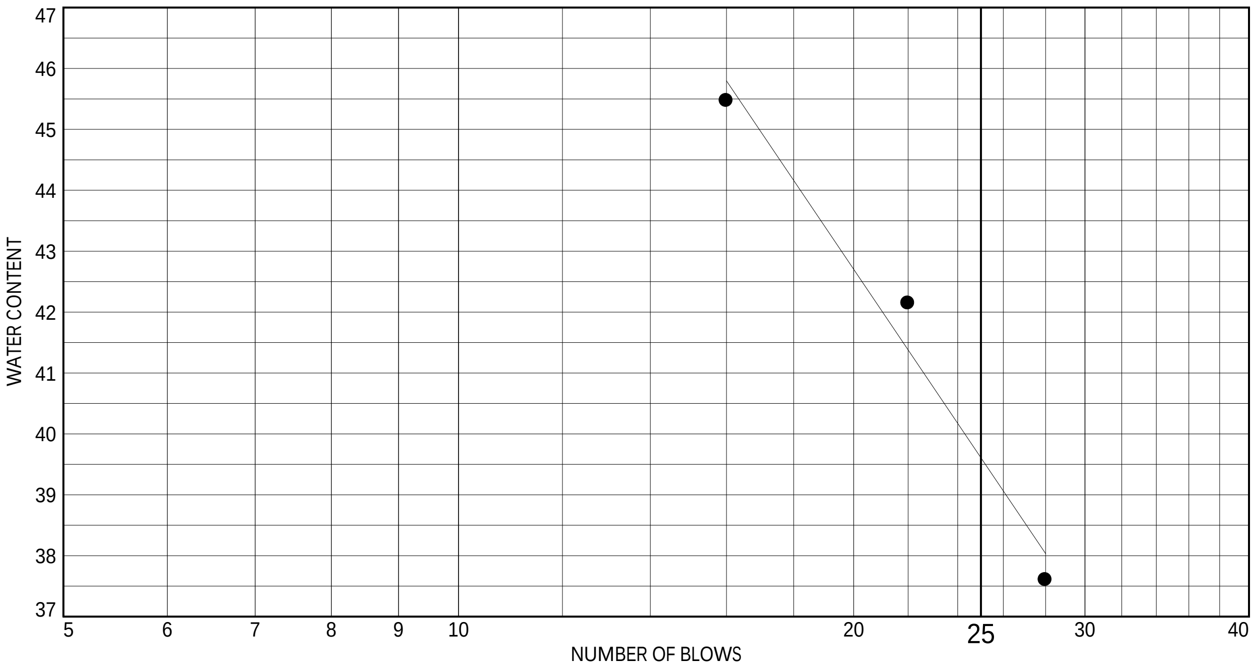
R.W. Gillespie
& Associates, Inc.
Biddeford, Maine

Client: Schonewald Engineering Associates, Inc.
Project: WIN 26480: Cumberland Noyes (SEA 25-112)
Cumberland, ME
Project No: 1368-028 Lab No. 18606-07

Tested By: CJC/HFS Checked By: CAG

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	lean clay	39.6	23.0	16.6	99.8	99.2	CL

Project No. 1368-028 Client: Schonewald Engineering Associates, Inc.

Project: WIN 26480: Cumberland Noyes (SEA 25-112)

Cumberland, ME

Location: BB-CMD-201

Sample Number: 9D Depth: 24-26'

Remarks:

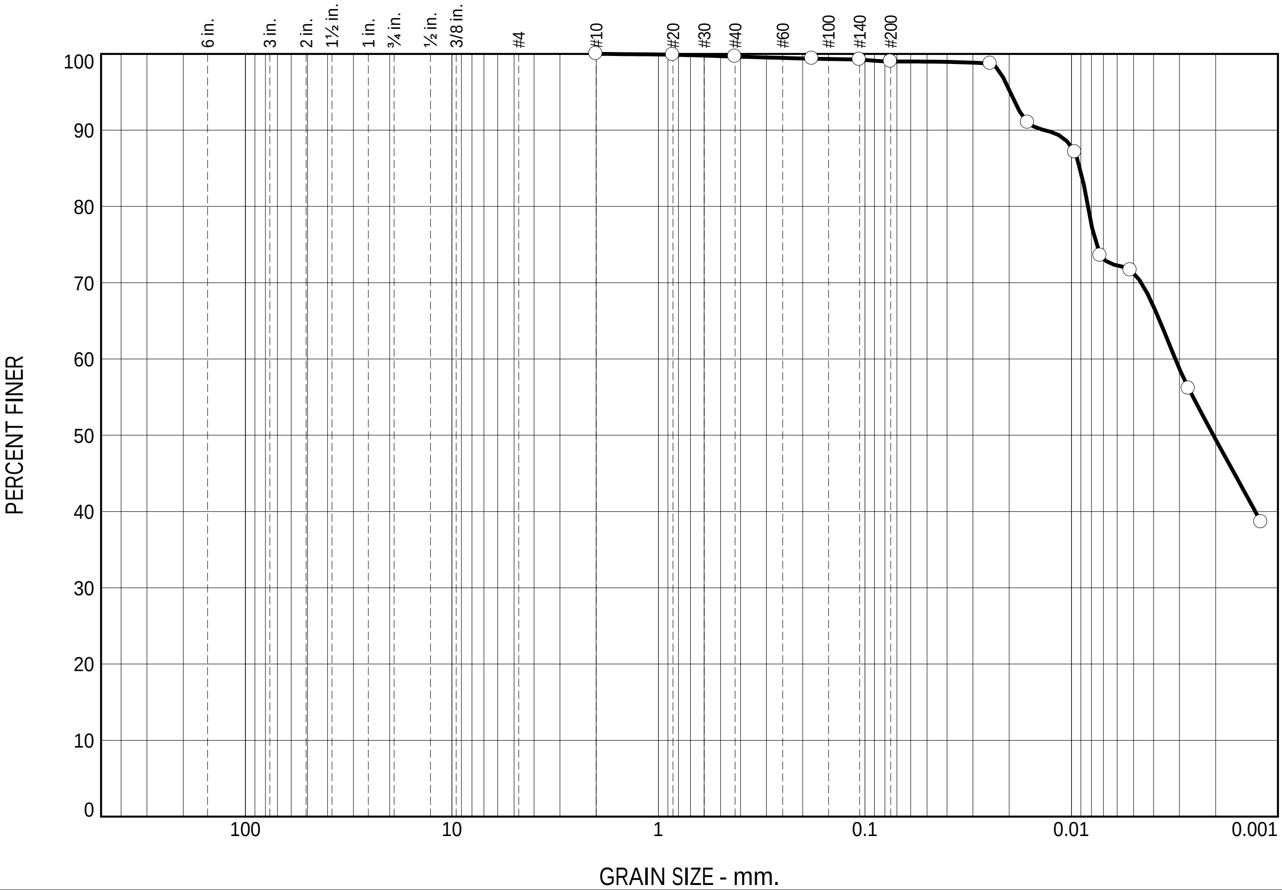
R.W. Gillespie & Associates, Inc.

Biddeford, Maine

Lab No. 18606-07

Checked By: CAG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.4	0.6	49.6	49.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	99.6		
#80	99.4		
#140	99.2		
#200	99.0		
0.0246 mm.	98.7		
0.0163 mm.	91.0		
0.0096 mm.	87.1		
0.0072 mm.	73.6		
0.0052 mm.	71.6		
0.0027 mm.	56.1		
0.0012 mm.	38.6		

* (no specification provided)

Soil Description

lean clay

Atterberg Limits

PL= 23.7 LL= 41.7 PI= 18.0

Coefficients

D_{90}= 0.0135 D_{85}= 0.0090 D_{60}= 0.0031
D_{50}= 0.0021 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(20)

Remarks

Moisture Content: 43.1%

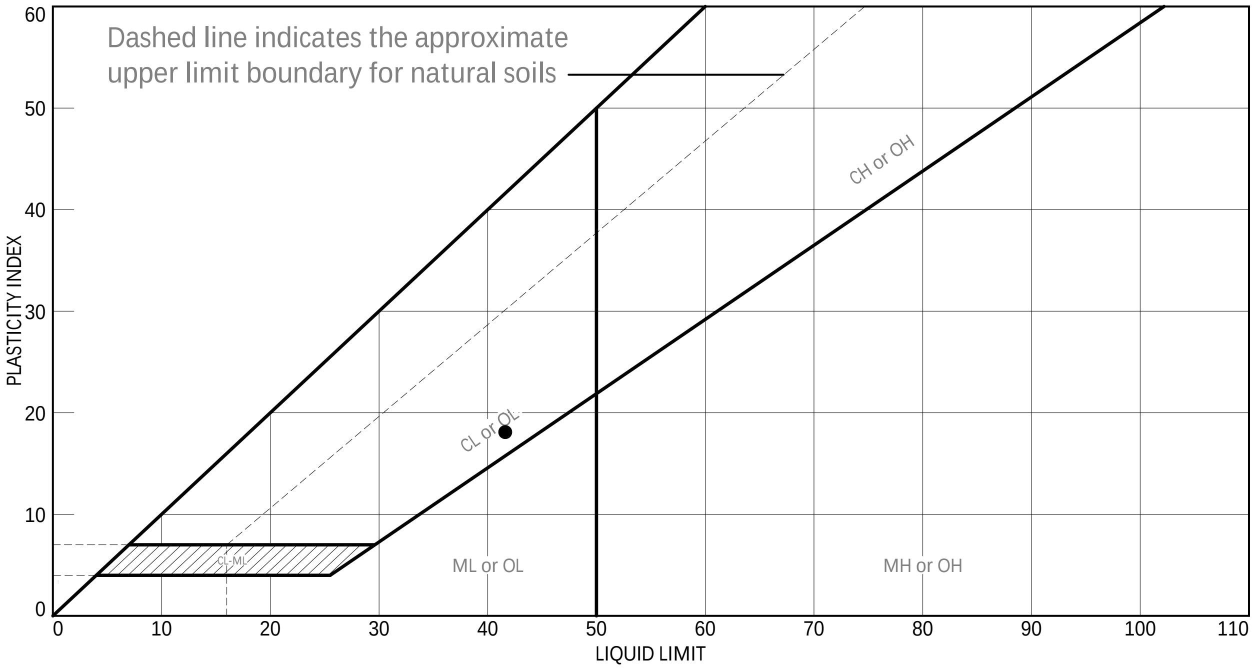
Location: BB-CMD-201
Sample Number: 10D Depth: 26-28' Date: 07/23/2025

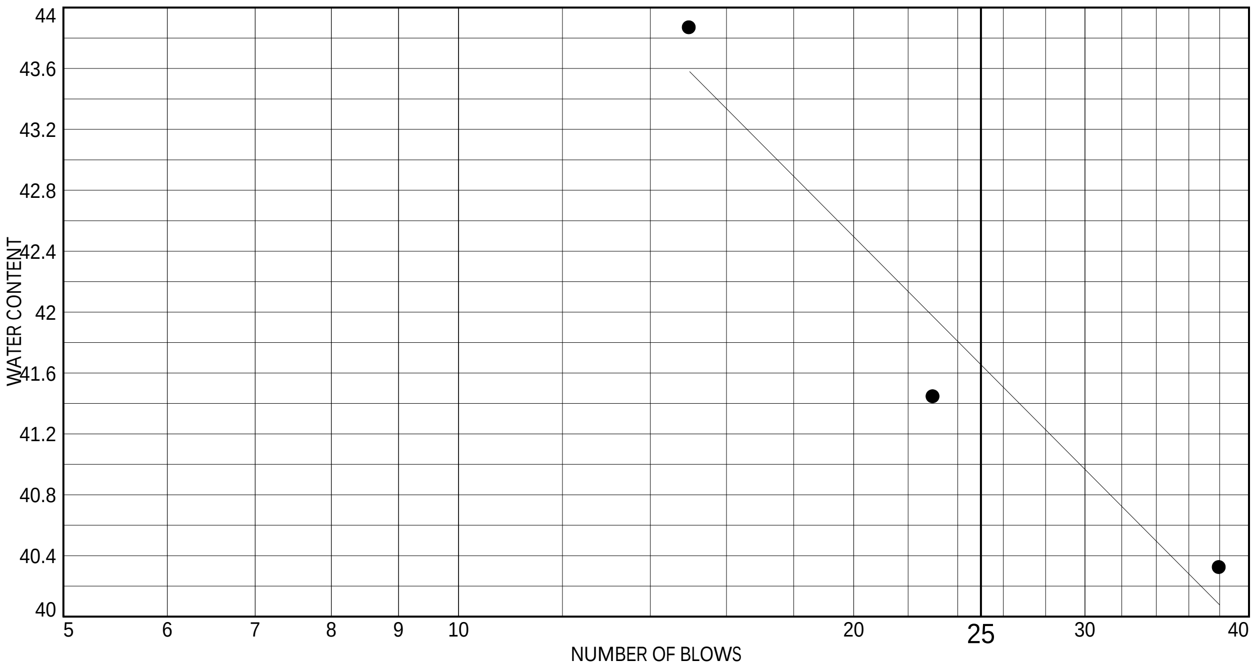
R.W. Gillespie
& Associates, Inc.
Biddeford, Maine

Client: Schonewald Engineering Associates, Inc.
Project: WIN 26480: Cumberland Noyes (SEA 25-112)
Cumberland, ME
Project No: 1368-028 Lab No. 18606-08

Tested By: CJC/HFS Checked By: CAG

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	lean clay	41.7	23.7	18.0	99.6	99.0	CL

Project No. 1368-028 Client: Schonewald Engineering Associates, Inc.

Project: WIN 26480: Cumberland Noyes (SEA 25-112)

Cumberland, ME

Location: BB-CMD-201

Sample Number: 10D Depth: 26-28'

Remarks:

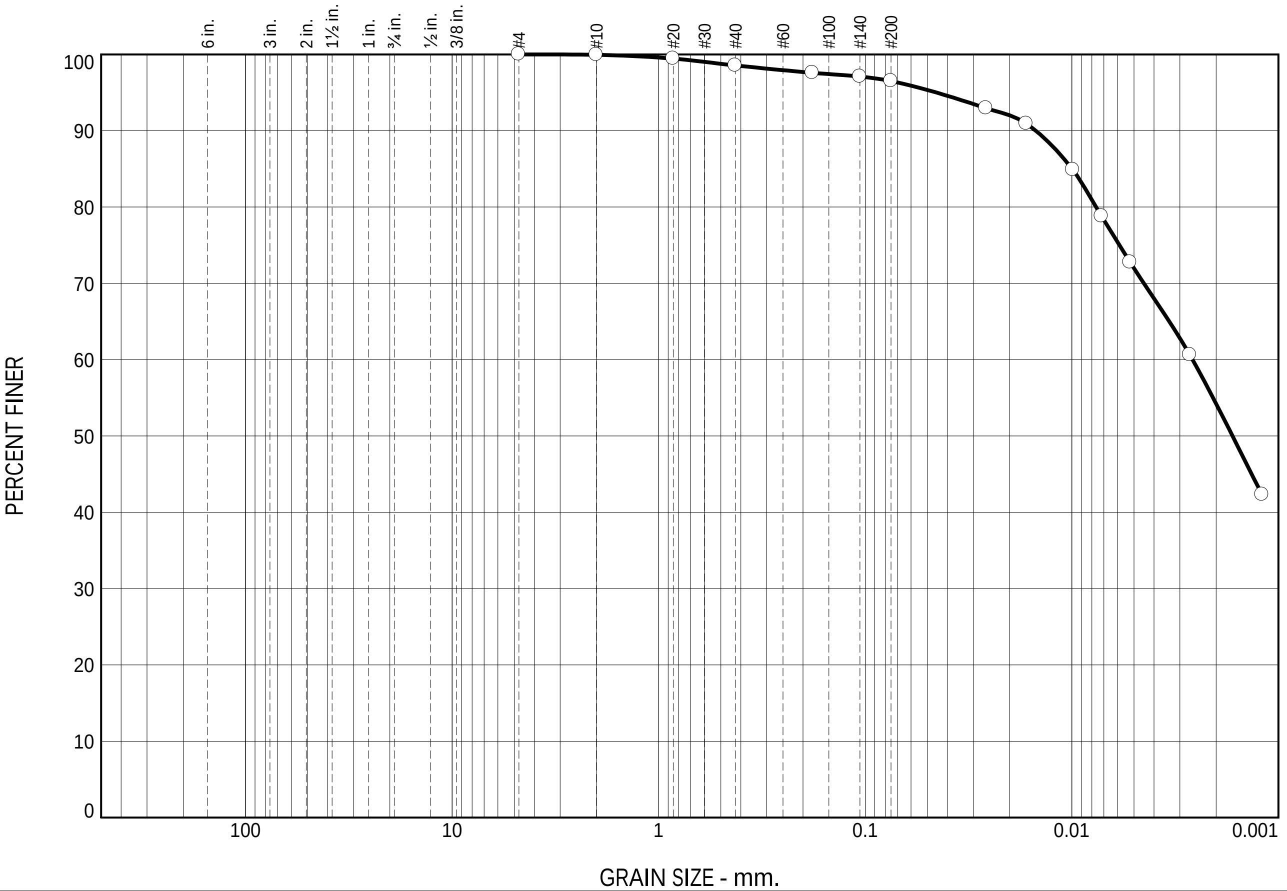
R.W. Gillespie & Associates, Inc.

Biddeford, Maine

Lab No. 18606-08

Checked By: CAG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	1.4	2.0	42.3	54.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.9		
#20	99.4		
#40	98.5		
#80	97.6		
#140	97.1		
#200	96.5		
0.0260 mm.	92.9		
0.0166 mm.	90.9		
0.0099 mm.	84.8		
0.0072 mm.	78.8		
0.0052 mm.	72.7		
0.0027 mm.	60.6		
0.0012 mm.	42.3		

* (no specification provided)

Soil Description

lean clay

Atterberg Limits

PL= 23.9 LL= 39.3 PI= 15.4

Coefficients

D_{90}= 0.0149 D_{85}= 0.0100 D_{60}= 0.0026
D_{50}= 0.0017 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(16)

Remarks

Moisture Content: 48.4%

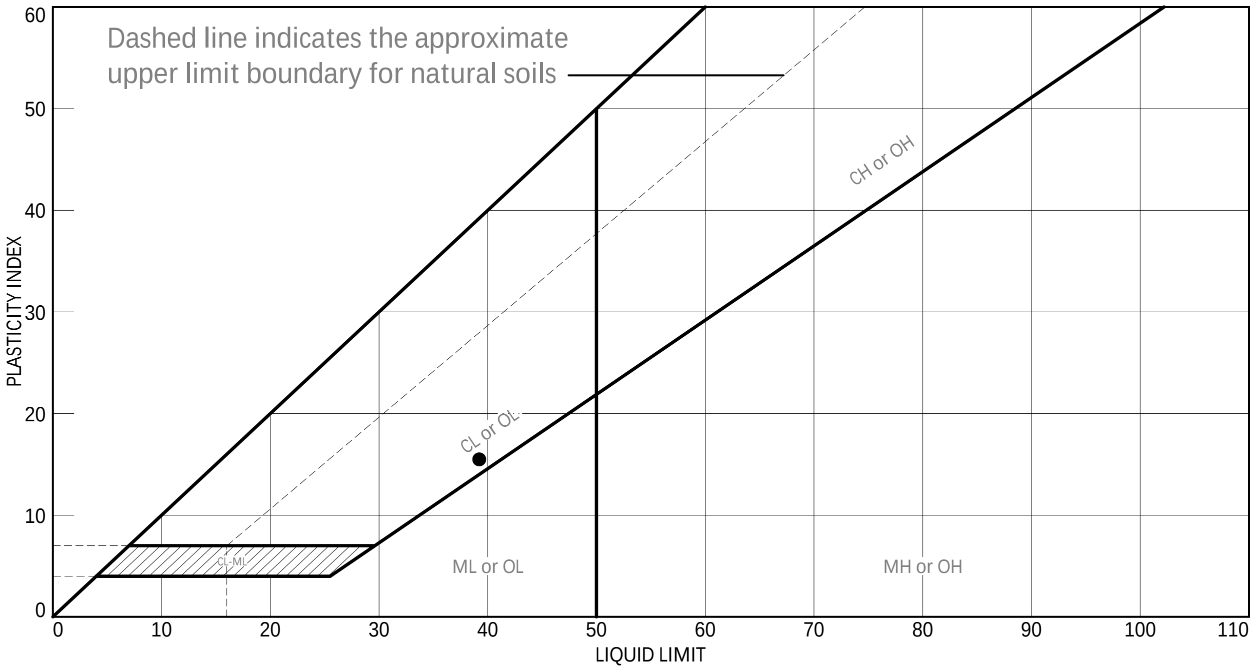
Location: BB-CMD-201
Sample Number: 11D Depth: 28-30' Date: 07/23/2025

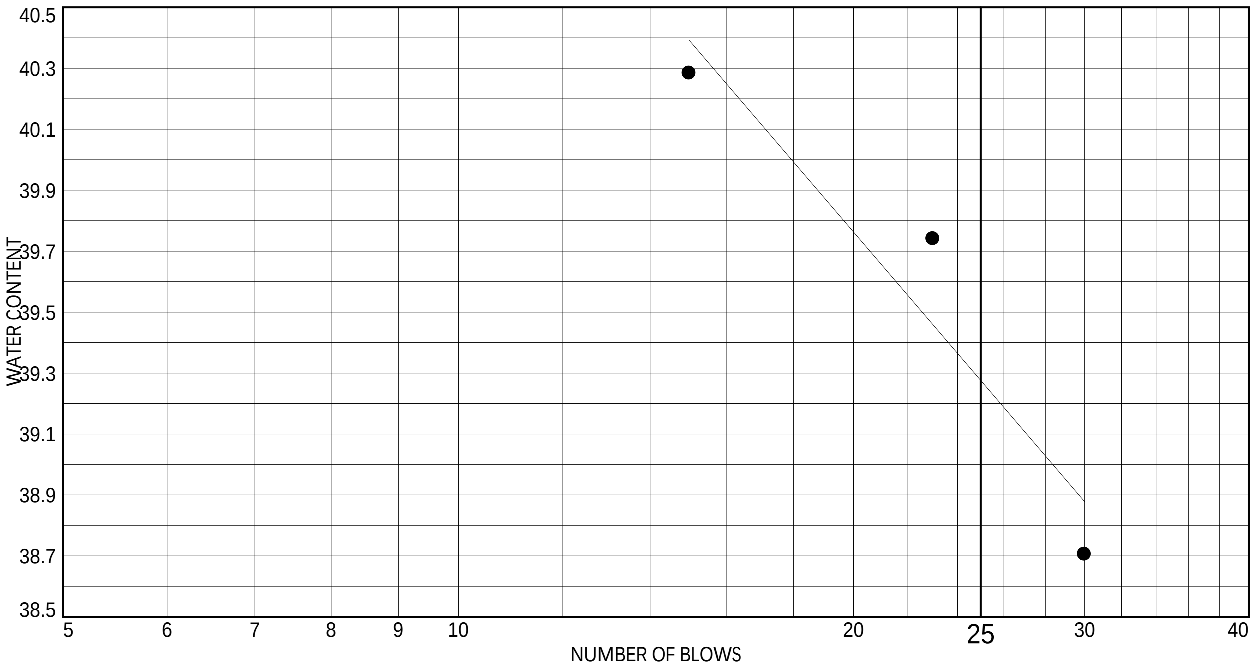
R.W. Gillespie
& Associates, Inc.
Biddeford, Maine

Client: Schonewald Engineering Associates, Inc.
Project: WIN 26480: Cumberland Noyes (SEA 25-112)
Cumberland, ME
Project No: 1368-028 Lab No. 18606-09

Tested By: CJC/HFS Checked By: CAG

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	lean clay	39.3	23.9	15.4	98.5	96.5	CL

Project No. 1368-028 Client: Schonewald Engineering Associates, Inc.

Project: WIN 26480: Cumberland Noyes (SEA 25-112)

Cumberland, ME

Location: BB-CMD-201

Sample Number: 11D Depth: 28-30'

Remarks:

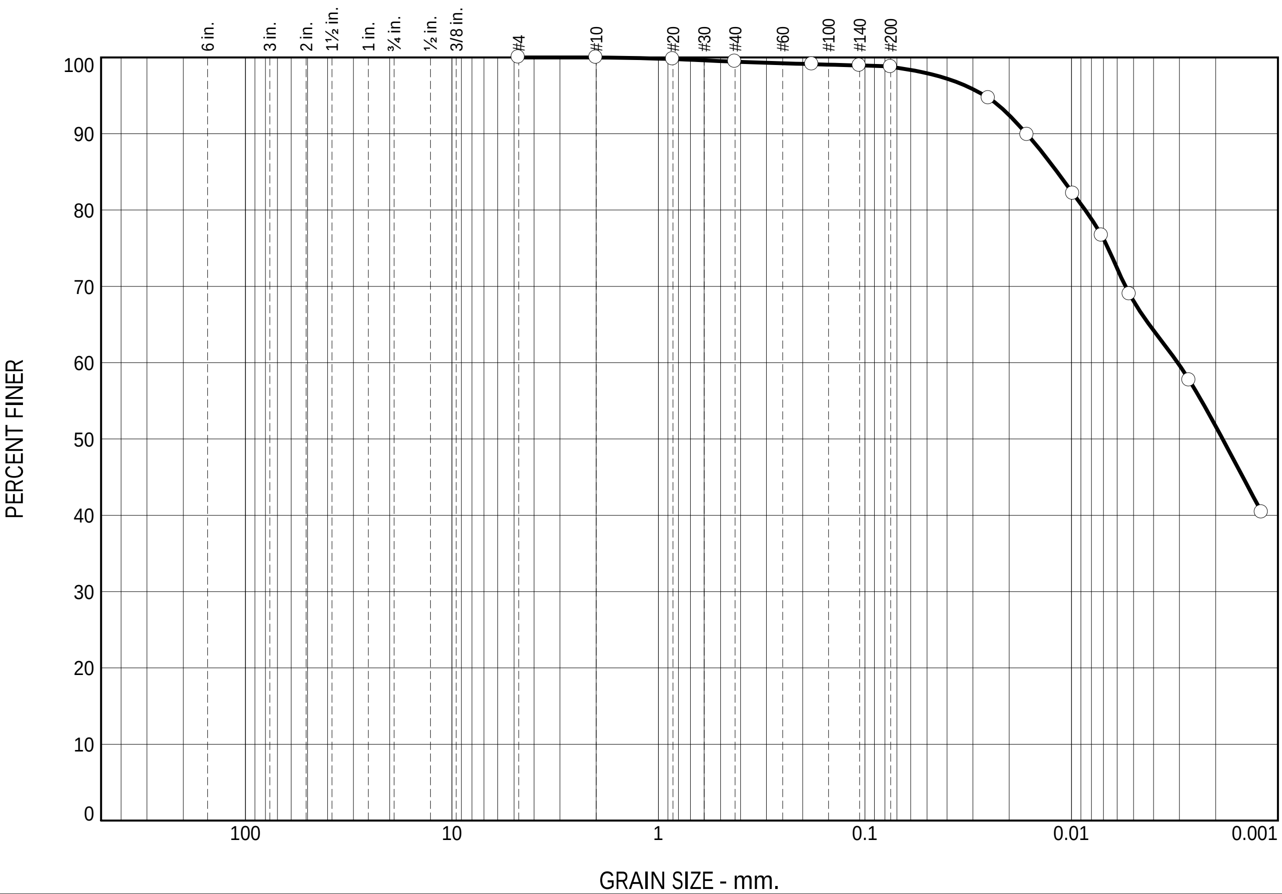
R.W. Gillespie & Associates, Inc.

Biddeford, Maine

Lab No. 18606-09

Checked By: CAG

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.6	0.7	47.0	51.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	99.8		
#40	99.4		
#80	99.1		
#140	98.9		
#200	98.7		
0.0251 mm.	94.7		
0.0163 mm.	89.9		
0.0098 mm.	82.2		
0.0071 mm.	76.7		
0.0052 mm.	69.0		
0.0027 mm.	57.7		
0.0012 mm.	40.4		

* (no specification provided)

Soil Description

lean clay

Atterberg Limits

PL= 23.3 LL= 37.8 PI= 14.5

Coefficients

D_{90}= 0.0165 D_{85}= 0.0117 D_{60}= 0.0031
D_{50}= 0.0019 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(16)

Remarks

Moisture Content: 47.0%

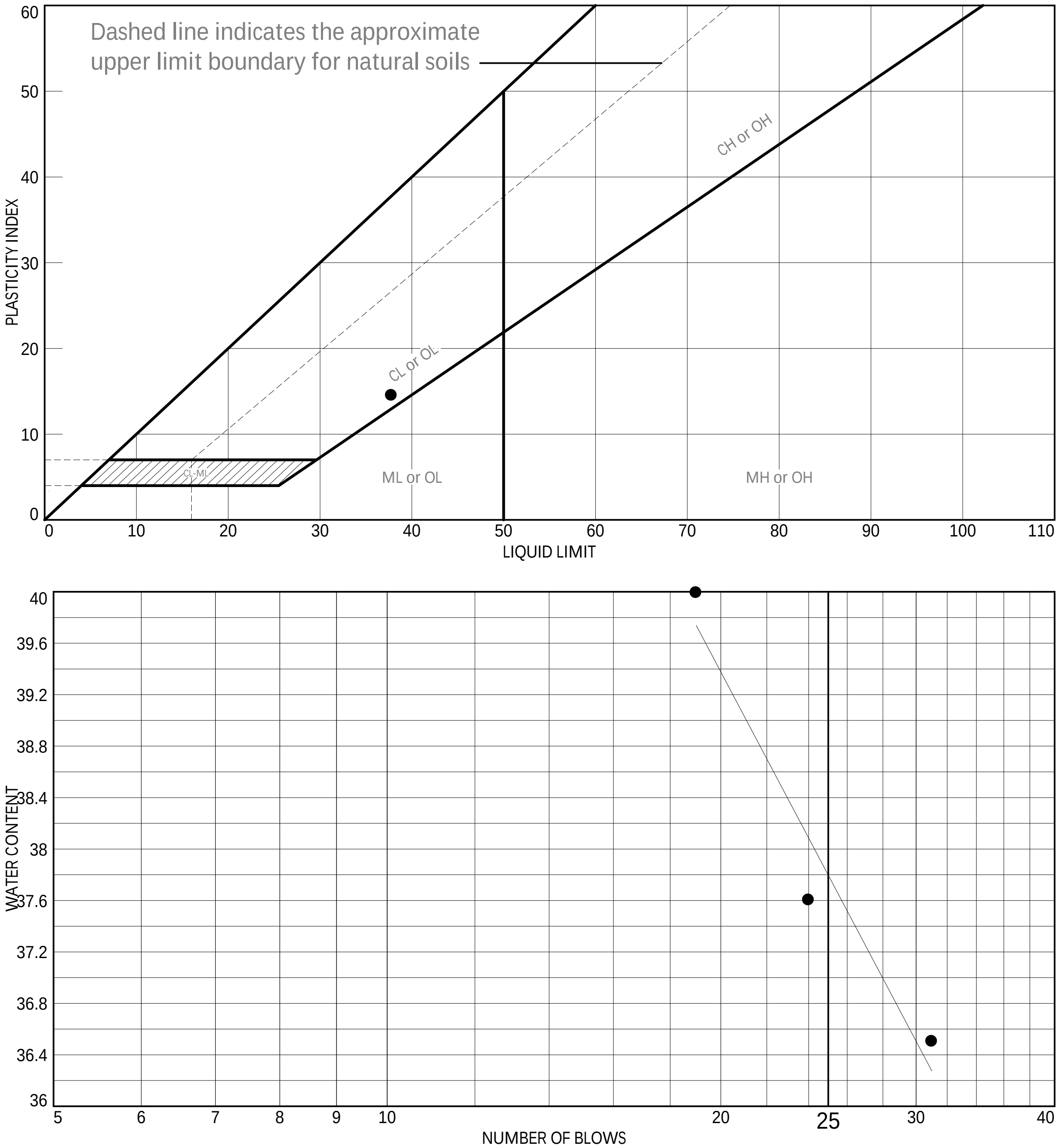
Location: BB-CMD-201
Sample Number: 12D Depth: 34-36' Date: 07/23/2025

R.W. Gillespie
& Associates, Inc.
Biddeford, Maine

Client: Schonewald Engineering Associates, Inc.
Project: WIN 26480: Cumberland Noyes (SEA 25-112)
Cumberland, ME
Project No: 1368-028 Lab No. 18606-10

Tested By: CJC/HFS Checked By: CAG

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	lean clay	37.8	23.3	14.5	99.4	98.7	CL

Project No. 1368-028 Client: Schonewald Engineering Associates, Inc.

Project: WIN 26480: Cumberland Noyes (SEA 25-112)

Cumberland, ME

Location: BB-CMD-201

Sample Number: 12D Depth: 34-36'

Remarks:

R.W. Gillespie & Associates, Inc.

Biddeford, Maine

Lab No. 18606-10

Checked By: CAG

APPENDIX E

SUPPORTING CALCULATIONS

Project: MaineDOT Noyes Bridge Replacement	WIN 26180.00	**Proj. No.**	25-112
Location: Cumberland, ME	**Last updated:** Oct. 25	**By**	IVS
Subject: Geotechnical Calculations	**Checked:** 10/25	**By**	SJR
bearing resistance evaluation - box culvert bearing pad on alluvium		**By**	

AASHTO LRFD Bridge Design Manual (9th Edition, 2020)

box culvert 22 ft span by 10 ft rise
bearing pad subgrade consisting of alluvium
alluvium consists of non-plastic, saturated, very loose to loose, fine to medium sand and (organic) silt; SW-SM, SM, or SP-SM (typ)

Service Limit State - presumptive value based on soil type and relative density/ consistency [Table C10.6.2.5.1-1]

bearing soil: alluvium (f-m Sand and Silt) USC SW-SM and SM

density/consistency: loose range: 2-4; very loose range: 2 → **USE 2 KSF** **Service Limit State**

(resistance factor for service limit state is 1.0)

Strength Limit State - following Section 10.6.3.1

bearing soil: alluvium (f-m Sand and Silt) USC SW-SM and SM

density/consistency: very loose to loose

nominal bearing resistance (qn) = $c\,N_{cm} + \gamma\,D_f\,N_{qm}\,C_{wq} + 0.5\,\gamma\,B\,N_{\gamma m}\,C_{w\gamma}$

cohesion (c) term + surcharge (q) term + footing width (γ) term

with: $N_{cm} = N_c\,S_c$; $N_{qm} = N_q\,S_q$; $N_{gm} = N_\gamma\,S_\gamma$

& where: N_c, N_q, and N_γ are bearing capacity factors, function of φ and c, Table 10.6.3.1.2a-1

C_{wq} and $C_{w\gamma}$ are correction factors for groundwater depth, function of D_w and D_f, Table 10.6.3.1.2a-2

S_c, S_q, and S_γ are correction factors for footing shape, function of B, L, φ, Table 10.6.3.1.2a-3

input parameters:

angle of internal friction	φ_f =	26	deg
		0.454	radians
soil unit weight	γ =	0.115	kcf
undrained shear strength	c =	0	ksf
footing depth/ embedment	D_f =	2	ft
footing width	B =	22	ft
footing length	L =	110	ft
groundwater (relative to GS and D_f)	D_w =	0 (at base of footing)	

N_c	=	22.3	table
N_q	=	11.9	table
N_γ	=	12.5	table
S_c	=	1.11	calculated (formulas in table for φf > 0)
S_q	=	1.10	calculated
S_γ	=	0.92	calculated
C_{wq}	=	0.5	table
$C_{w\gamma}$	=	0.5	table

nominal bearing resistance (q_n) = $c\,N_{cm} + \gamma\,D_f\,N_{qm}\,C_{wq} + 0.5\,\gamma\,B\,N_{\gamma m}\,C_{w\gamma}$

= 8.8 ksf

resistance factor (φ_b) = 0.45 Table T10.5.5.2.2-1

bearing resistance (q_R) = $q_n * \varphi_b$

= 3.9 ksf **USE 3 KSF** **Strength Limit State**

NOTE: somewhat conservative since does not account for 2-foot thick high-friction-angle bearing pad

Project: MaineDOT Noyes Bridge Replacement	WIN 26180.00			**Proj. No.**	25-112
Location: Cumberland, ME		**Last updated:**	Oct. 25	**By**	IVS
Subject: Geotechnical Calculations		**Checked:**	10/25	**By**	SJR
bearing resistance evaluation - box culvert bearing pad on marine silt-clay				**By**	

AASHTO LRFD Bridge Design Manual (9th Edition, 2020)

box culvert 22 ft span by 10 ft rise
bearing pad subgrade consisting of marine silt-clay
marine silt-clay consists of moderately plastic, soft, silty clay; CL; Su ~ 400 psf

Service Limit State - presumptive value based on soil type and relative density/ consistency [Table C10.6.2.5.1-1]

bearing soil: marine silt-clay (soft, Silty CLAY) USC CL

ensity/consistency: loose range: 1-2
soft range: 1-2

USE 1 KSF **Service Limit State**

(resistance factor for service limit state is 1.0)

Strength Limit State - following Section 10.6.3.1

bearing soil: marine silt-clay (soft, Silty CLAY) USC CL
density/consistency: soft (Su~400 psf)

nominal bearing resistance (qn) = $c\,N_{cm} + \gamma\,D_f\,N_{qm}\,C_{wq} + 0.5\,\gamma\,B\,N_{\gamma m}\,C_{w\gamma}$

cohesion (c) term + surcharge (q) term + footing width (γ) term

with: $N_{cm} = N_c\,S_c$, $N_{qm} = N_q\,S_q$, $N_{gm} = N_\gamma\,S_\gamma$

& where: N_c, N_q, and N_γ are bearing capacity factors
function of φ and c
Table 10.6.3.1.2a-1

C_{wq} and $C_{w\gamma}$ are correction factors for groundwater depth
function of D_w and D_f
Table 10.6.3.1.2a-2

S_c, S_q, and S_γ are correction factors for footing shape
function of B, L, φ
Table 10.6.3.1.2a-3

input parameters:

Parameter	Symbol	Value	Units
angle of internal friction	φ_f =	0	deg
		0.000	radians
soil unit weight	γ =	0.110	kcf
undrained shear strength	c =	0.400	ksf
footing depth/ embedment	D_f =	2	ft
footing width	B =	22	ft
footing length	L =	110	ft
groundwater (relative to GS and D_f)	D_w =	0 (at base of footing)	

Factor		Value	Source
N_c	=	5.14	table
N_q	=	1.0	table
N_γ	=	0.0	table
S_c	=	1.04	calculated (formulas in table for φf = 0)
S_q	=	1.0	calculated (formulas in table for φf = 0)
S_γ	=	1.0	calculated (formulas in table for φf = 0)
C_{wq}	=	0.5	table
$C_{w\gamma}$	=	0.5	table

nominal bearing resistance (q_n) = $c\,N_{cm} + \gamma\,D_f\,N_{qm}\,C_{wq} + 0.5\,\gamma\,B\,N_{\gamma m}\,C_{w\gamma}$

= 2.2 ksf

resistance factor (φ_b) = 0.45 Table T10.5.5.2.2-1

bearing resistance (q_R) = $q_n * \varphi_b$

= 1.0 ksf **USE 1 KSF** **Strength Limit State**

NOTE: conservative since does not account for overlying alluvium or 2-foot thick high-friction-angle bearing pad

Table C10.6.2.5.1-1—Presumptive Bearing Resistance for Spread Footing Foundations at the Service Limit State Modified after U.S. Department of the Navy (1982)

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

10.6.2.5.2—Semiempirical Procedures for Bearing Resistance

Bearing resistance on rock shall be determined using empirical correlation to the Geomechanic Rock Mass Rating System, RMR. Local experience should be considered in the use of these semi-empirical procedures.

If the recommended value of presumptive bearing resistance exceeds either the unconfined compressive strength of the rock or the nominal resistance of the concrete, the presumptive bearing resistance shall be taken as the lesser of the unconfined compressive strength of the rock or the nominal resistance of the concrete. The nominal resistance of concrete shall be taken as $0.3f'_c$.

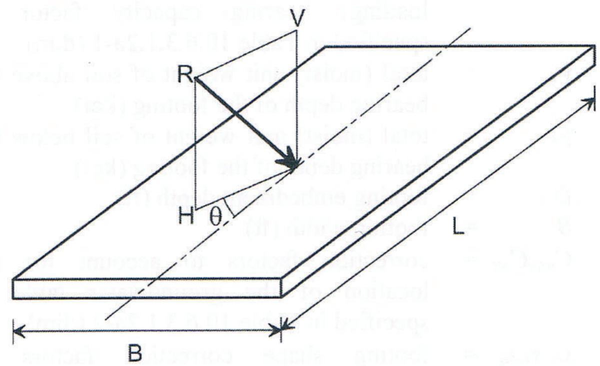


Figure C10.6.3.1.2a-1—Inclined Loading Conventions

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

MARINE SILT-CLAY

ALLUVIUM

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

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

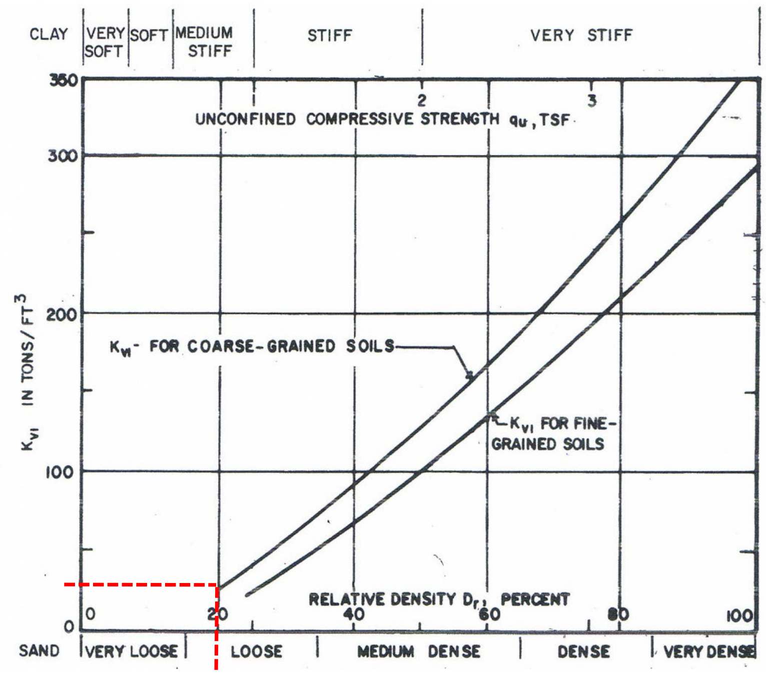
D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

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

Project: MaineDOT Noyes Bridge Replacement WIN 26180.00 **Proj. No.** 25-112
Location: Cumberland, ME **Last updated:** Oct. 25 **By** IVS
Subject: Geotechnical Calculations **Checked:** **By**
modulus of subgrade reaction **By**

determine modulus of subgrade reaction (K_b) for the design of the base slab of the box culvert
following procedures outlined in NAVFAC DM 7-1, Chapter 5 and NAVFAC DM 7-2, Chapter 3

Step 1: select modulus of subgrade reaction for a 1-foot square plate (K_{VI})
based on relative density of coarse-grained soil (including non-plastic silt) or consistency of fine-grained soil
take from Figure 6, NAVFAC DM 7-1, Chapter 5



Note: tcf *1.157 = pci

for Cumberland Noyes:
soil at bearing layer subgrade consists of very loose to loose, non-plastic silt and fine to medium sand (USC SW-SM and SM
from figure, K_{VI} = 25 tcf ~ 30 pci (for a 1-foot square plate)

since groundwater is assumed to be at or near the culvert base slab, use K_{VI} / 2 in computations
therefore, use K_{VI} ~ 15 pci (for a 1-foot square plate)

Step 2: determine the modulus of subgrade reaction for foundation width B (Kb)
based on K_{VI}
from NAVFAC DM 7-2, Chapter 3

for granular soils:

$$K_b = K_{VI} * \left[\frac{B+1}{2B}\right]^2$$

for cohesive soils:

$$K_b = K_{VI} / B$$

for Cumberland Noyes:
granular soils
culvert span = 22 ft
K_b = 4 pci

Project: MaineDOT Noyes Bridge Replacement	WIN 26180.00		**Proj. No.**	22-012
Location: Cumberland, ME	**Last updated:**	Jul 2024	**By**	IVS
Subject: Preliminary Geotechnical Calculations	**Checked:**		**By**	
bearing pressure evaluation			**By**	

Objective: Evaluate whether the replacement box culvert will result in an increase in load on the underlying soils with respect to settlement potential.

Evaluation:

Step 1:

Initial assessment based on visual evaluation.
Refer to sketch on following page.

Conclusion: Increase in load at bearing elevation is not anticipated as alluded to on sketch.

Step 2:

More detailed assessment based on anticipated bearing pressure at bottom of base slab of culvert and approximated existing overburden pressure at same elevation.

Anticipated bearing pressure at bottom of base slab was provided by TYLin, structural engineer, and is included as page 3.

Based on TYLin's evaluation, a bearing pressure equal to **1.60 ksf** applied along the bottom of the base sab of the proposed culvert.

The bearing pressure was calculated from the top of the proposed roadway to the bottom of the proposed box, as follows:

cover	5	ft
top slab	1.25	ft
rise	10	ft
bottom slab	1.25	ft
TOTAL	17.5	ft

and includes infill and flow within the culvert; does not include live loads; is the total unfactored load (Service 1).

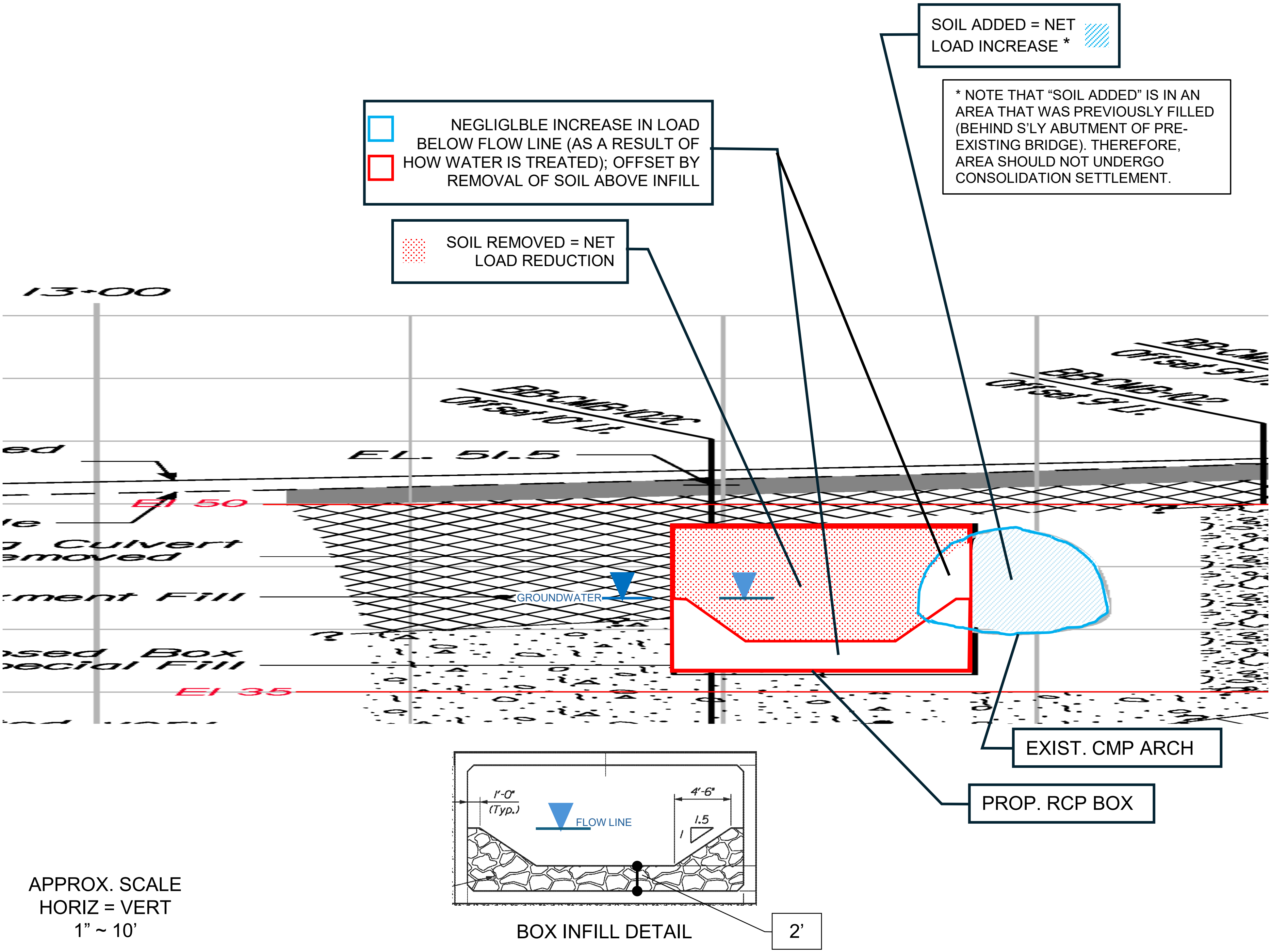
Estimated existing overburden pressure at the same elevation was calculated as follows:

total height of exist soil column	17.0	ft	(~6 inches lower than proposed road grade)
height of groundwater	6.2	ft	(encountered at fill-alluvium interface ~ existing culvert invert)
thickness of fill	10.8	ft	
thickness of alluvium	6.2	ft	
unit weight fill/ road gravels/ pavement	128	pcf	
unit weight alluvium	120	pcf	
buoyant unit weight alluvium	58	pcf	

existing overburden pressure = (10.8 ft * 0.128 kcf) + (6.2 ft * 0.058 kcf)
= **1.74 ksf**

(Note that live loads are anticipated to remain the same, so may be ignored in both the existing and proposed conditions.)

Conclusion: The estimated existing overburden pressure at the proposed bottom of the culvert base slab is slightly greater than the anticipated bearing pressure of the replacement structure.


SOIL ADDED = NET LOAD INCREASE *
* NOTE THAT "SOIL ADDED" IS IN AN AREA THAT WAS PREVIOUSLY FILLED (BEHIND S'LY ABUTMENT OF PRE-EXISTING BRIDGE). THEREFORE, AREA SHOULD NOT UNDERGO CONSOLIDATION SETTLEMENT.
NEGLIGLBLE INCREASE IN LOAD BELOW FLOW LINE (AS A RESULT OF HOW WATER IS TREATED); OFFSET BY REMOVAL OF SOIL ABOVE INFILL
SOIL REMOVED = NET LOAD REDUCTION
13+00
EL. 51.5
El 50
El 35
GROUNDWATER
EXIST. CMP ARCH
PROP. RCP BOX
1'-0" (Typ.)
4'-6"
FLOW LINE
1.5
1
2'
BOX INFILL DETAIL
APPROX. SCALE
HORIZ = VERT
1" ~ 10'

Cumberland Noyes Box Culvert Pressure Calculation

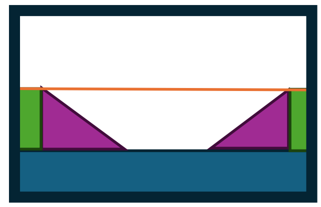
Design:	Nick DiMariano	7/24/2024
Check:	Daniel Myers	7/25/2024

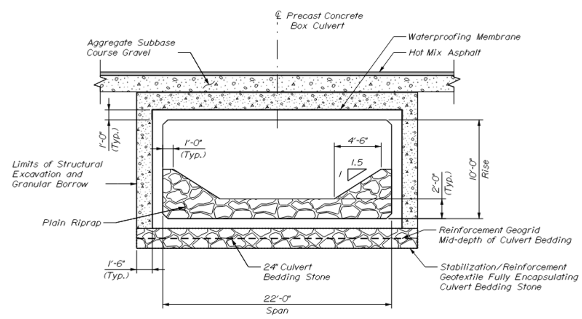
Assumptions:
1. Bearing pressure is calculated at the bottom at the centerline of the proposed concrete box culvert.
2. Pressure is equally distributed at the bottom of the box .
3. Bearing pressure is calculated from the top of the proposed roadway to the bottom of the proposed box .
4. No traffic/ live load over on roadway.
5. Unit weights are dry unit weights. Saturated Unit Weight included for riprap below water level.
6. Culvert is filled with water up to riprap shelf
7. Water level is high enough to saturate riprap, but we are assuming no buoyancy.
8. The Total pressure is unfactored (i.e. Service 1)

Unit Weight Bituminous:	147	pcf	
Unit Weight of Base Course:	135	pcf	
Unit Weight of Granular Borrow:	125	pcf	
Dry Unit weight of Plain Riprap:	100	pcf	
Saturated Unit Weight of Plain Riprap:	124.96	pcf	
Unit Weight of Concrete:	150	pcf	
Unit Weight of Water:	62.4	pcf	
Thickness of Box Ceiling:	1.25	ft	
Thickness of Box Floor:	1.25	ft	
Height of Box Rise:	10	ft	
Width of Box Walls:	1	ft	
Box Span Length:	22	ft	
Base Length:	24.00	ft	
Riprap base thickness:	2	ft	
Riprap base width:	22	ft	
Riprap slope rise:	3	ft	
Riprap slope run:	4.5	ft	
Riprap Shelf:	1	ft	
Riprap base cross sectional area:	44	ft	
Riprap slope cross sectional area:	6.75	sqft	(Each)
Riprap Shelf cross sectional Area:	3	sqft	(Each)
Total riprap area:	63.50	sqft	
Height of Bituminous:	0.5	ft	
Height of Base Course:	1.5	ft	
Height of Granular Borrow:	3	ft	(Maximum 5 ft total of material above box as the grade increases)
Height of water:	5.00	ft	
Weight from riprap:	7935.0	plf	
Weight of concrete box:	12000.0	plf	
Weight of water trapezoid:	2901.6	plf	
Weight of granular borrow:	9000.0	plf	
Weight of Base course:	4860.0	plf	
Weight of Bituminous:	1764.0	plf	
Total Weight:	38460.6	plf	
Total Pressure at bottom of culvert:	**1.60**	ksf	

(input cell)	: Input
(result cell)	: Result

Riprap porosity: 0.4





BOX CULVERT SECTION