

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

GEOTECHNICAL DESIGN REPORT

For the Replacement of:

**STOCKTON SPRINGS UNDERPASS BRIDGE
STOCKTON SPRINGS, MAINE**



Prepared by:

Michael J. Moreau, P.E.
Geotechnical Engineer

Reviewed by:

Laura Krusinski, P.E.
Senior Geotechnical Engineer

Waldo County
WIN 15108.00

Fed No. BH-1510(800)X
December 5, 2011

Soils Report No. 2011-30
Bridge No. 5760

TABLE OF CONTENTS

Section	Page
GEOTECHNICAL DESIGN SUMMARY	1
1.0 INTRODUCTION.....	5
2.0 GEOLOGIC SETTING.....	5
3.0 SUBSURFACE INVESTIGATION	5
4.0 LABORATORY TESTING	6
5.0 SUBSURFACE CONDITIONS	6
6.0 FOUNDATION ALTERNATIVES.....	8
7.0 GEOTECHNICAL DESIGN RECOMMENDATIONS	8
7.1 MSE WALL WRAPPED ABUTMENT DESIGN	8
7.1.1 MSE Wall Design.....	8
7.1.2 Vehicle Collision, Parapet and Traffic Barrier Design	9
7.1.3 MSE Wall Construction Considerations	10
7.2 ABUTMENT SPREAD FOOTING SUBGRADE PREPARATION.....	10
7.3 SEMI-INTEGRAL STUB ABUTMENT DESIGN	11
7.3.1 Stub Abutment Design	11
7.3.2 Abutment Construction Considerations	12
7.4 SETTLEMENT	13
7.5 FROST PROTECTION	13
7.6 SEISMIC DESIGN CONSIDERATIONS	13
7.7 CONSTRUCTION CONSIDERATIONS	14
7.7.1 Excavation	14
7.7.2 Subgrade Preparation	14
7.7.3 Dewatering	15
7.7.4 Reuse of Excavated Soil.....	15
7.7.5 Embankment Fill Areas.....	15
7.7.6 Erosion Control Recommendations	16
8.0 CLOSURE	16

References

Tables

Table 5-1 Approximate Bedrock Depth and Elevation at the Boring Locations
Table 7-1 Equivalent Height of Soil for Estimating Live Load Surcharge

Sheets

Sheet 1 - Location Map
Sheet 2 - Boring Location Plan
Sheet 3 - Interpretive Subsurface Profile
Sheets 4 and 5 - Boring Logs

TABLE OF CONTENTS (Cont.)

Appendices

Appendix A - Boring Logs

Appendix B - Laboratory Test Data

Appendix C – Calculations

Appendix D – Special Provisions

GEOTECHNICAL DESIGN SUMMARY

This report provides geotechnical recommendations for the replacement of the Stockton Springs Underpass Bridge over Route 1 in Stockton Springs, Maine. The proposed replacement bridge will be a single-span, approximately 83 foot long, steel girder superstructure. The replacement bridge will incorporate semi-integral stub abutments on spread footings constructed behind Mechanically Stabilized Earth (MSE) walls. The new bridge will be constructed on the existing alignment. The replacement bridge design will conform to the requirements of the Bridge Design Guide (BDG) and the AASHTO LRFD Bridge Design Specifications, Fifth Edition, 2010, with 2010 Interims (herein referred to as LRFD). The design and construction recommendations below are discussed in greater detail in Section 7.0, Geotechnical Design Recommendations.

Mechanically Stabilized Earth (MSE) Wall Wrapped Abutments – Each stub abutment will be supported on an MSE wall and reinforced earth structure. Design and construction of the walls shall be in accordance with Maine Department of Transportation (MaineDOT) Special Provision 636, Mechanically Stabilized Earth Retaining Wall (See Appendix D, Special Provisions). These walls shall be a design-build item designed by a Professional Engineer licensed in Maine and retained by the contractor. The internal and external stability of the MSE walls shall be designed for all additional vertical and horizontal loads imposed by the abutment footing and the bridge superstructure. These loads shall include lateral earth pressure on the abutment and superstructure end diaphragm. It is important that these additional vertical and horizontal loads be noted on the plans for use by the MSE wall designer.

The factored bearing resistance for an MSE reinforced soil mass founded on compacted fill or natural glacial till soil subgrade should be evaluated at the strength limit state using factored loads and a bearing resistance of 14.1 ksf. A factored bearing resistance of 6 ksf should be used to limit settlement to 1-inch when analyzing the service limit state, and for preliminary reinforcement length sizing. The MSE mass shall be assessed at the service limit state using a resistance factor of $\phi = 1.0$ for settlement and horizontal movement, and the overall stability shall be assessed at the Service I Load Combination with a resistance factor, ϕ , of 0.65. We recommend that the designer use a Coulomb active earth pressure coefficient, K_a , of 0.31 to evaluate the external stability of the wall. The wall designer shall estimate the traffic surcharge as a uniform horizontal earth pressure due to 2.0 feet of soil.

A sliding resistance factor, ϕ , of 1.0 shall be applied to the nominal sliding resistance of soil-on-soil beneath the MSE mass. Sliding computations for resistance to lateral loads shall assume a maximum frictional coefficient of 0.58 (tan 30 degrees) at the foundation soil to soil in-fill interfaces. For the lowest MSE level, the eccentricity of factored loads at the strength limit state shall not exceed one-quarter (1/4) of the base dimensions, in either direction for footings or MSE reinforced soil bases on soil. The MSE wall designer may assume Soil Type 4 backfill soil material for the MSE wall volume backfill with the following properties: $\phi = 32$ degrees, $\gamma = 125$ pcf.

MSE walls constructed within 30 feet of the edge of the roadway shall be protected by crash worthy barriers or designed for Extreme Event II loading using a resistance factor $\phi = 1.0$. Parapets or traffic barriers constructed over or in line with the U-shaped return wingwalls have additional design requirements (See Section 7.1.2, Vehicle Collision, Parapet and Traffic Barrier Design). Guardrail constructed on top of the return wingwalls shall be placed a minimum of 3.0 feet from the wall face and driven to 5.0 feet below grade.

During construction, any unsuitable or organic soil encountered below the planned MSE soil mass subgrade level or any leveling pad subgrade shall be removed and replaced with compacted gravel borrow meeting the requirements of MaineDOT Standard Specification 703.20. A concrete leveling pad with a width no less than 2.0 feet shall be provided to support the MSE wall face elements. The leveling pad for the wall panels shall be founded a minimum of 5.5 feet below finished exterior grade for frost protection.

In accordance with LRFD, estimated minimum reinforcement lengths of 22 and 24 feet are required for Abutments 1 and 2, respectively, and shall be uniform throughout the entire height of the wall. Backfill within the reinforced mass must meet the requirements of MaineDOT Standard Specification 703.20, Gravel Borrow, except the maximum particle size shall be limited to 4 inches. To minimize water infiltration into the reinforced soil and resulting corrosion of the metal reinforcing strips, the MSE reinforced soil mass construction shall include an asphalt or concrete cap material in front of the abutment and an impermeable, minimum 30 mil thick, HDPE geomembrane that is textured on two sides installed over the top of the MSE reinforced soil mass.

Abutment Subgrade Preparation – We recommend that the bottom of the abutment spread footings be embedded within the MSE reinforced soil zone 3 feet and be constructed over a bed of compacted ¾-inch crushed stone that is 3.0 feet thick. The crushed stone should be placed in 8-inch maximum lifts and compacted with at least 4 passes of a walk-behind vibratory plate or roller compactor with a minimum static weight of 200 lb.

Semi-Integral Stub Abutment Design – The design of abutments founded on spread footings at the strength limit state shall consider factored bearing resistance, eccentricity, lateral sliding and structural failure. At the service limit state, spread footing design shall be assessed for horizontal movement and overall stability. Also at the service limit state, a bearing resistance of 4 ksf shall be used to limit settlement to ½-inch as discussed below.

Bearing resistance for abutment spread footings founded on an MSE reinforced soil mass shall be investigated at the strength limit state using factored loads and a factored bearing resistance of 7 ksf. A factored bearing resistance of 4 ksf and a resistance factor of 1.0 shall be used when analyzing the service limit state and for preliminary footing sizing. No footing shall be less than 2.0 feet wide regardless of the applied bearing pressure or bearing material.

A sliding resistance factor ϕ_r of 0.80 shall be applied to the nominal sliding resistance of cast-in-place concrete footings on sand. Sliding computations for resistance to lateral loads shall assume a maximum frictional coefficient of 0.45 (tan 24 degrees) at the footing-soil interface. For spread footings on soil, the eccentricity of factored loads at the strength limit state shall not exceed one-quarter (1/4) of the footing dimensions, in either direction.

The stub abutments should be designed for active earth pressure over the rigid abutment height and a uniform pressure distribution due to the height of soil behind the superstructure/end diaphragm. The superstructure backwall (end diaphragm) should be designed for full passive pressure with a load factor of $\gamma_p = 1.5$. When designing for active and passive earth pressures, a Rankine active earth pressure coefficient, $K_a = 0.31$ and a Coulomb passive earth pressure coefficient, $K_p = 6.89$ shall be used.

Because a structural approach slab is not specified for this project, full live load surcharge on the abutments is required. The design live load surcharge is dependent on abutment height (see Section 7.3.1, Stub Abutment Design). The designer may assume Soil Type 4 backfill soil material with the following properties: $\phi = 32$ degrees, $\gamma = 125$ pcf.

The planned spread footing bottom elevations are approximately 169.4 ft and 172.7 for Abutments 1 and 2, respectively. The minimum distance from the abutment centerline of bearing to the outer edge of the MSE wall facing shall be 3.5 feet. The minimum distance between the back face of the wall panel and the front face of the footing shall be at least 6 inches. A minimum distance of 2 feet should be provided between the back of the MSE panels and the abutment breastwall. The designer should also include a minimum clearance of 4.0 feet between the bottom of the superstructure and the top of the MSE fill in front of the abutment. Stub abutment footings constructed over a 3.0-foot thick bed of $\frac{3}{4}$ -inch crushed stone may be constructed 3.0 feet below adjacent finish grade. Backfill within 10 feet of the stub abutment shall meet the requirements of MaineDOT Standard Specification 703.19, Granular Borrow for Underwater Backfill.

Abutment and wingwall designs shall include a drainage system to intercept any groundwater. Drainage behind the structure shall be in accordance with the MaineDOT Bridge Design Guide.

Settlement – We anticipate that engineered fills up to approximately 18 feet high will be required to construct the MSE wall supported stub abutments and bridge approaches. We estimate settlement on the order of $\frac{3}{4}$ -inch or less will occur beneath the MSE mass as the result of wall fill and bridge loads. Most of this settlement will occur during construction and post-construction settlement will be negligible.

Frost Protection – We recommend that the MSE wall leveling pad footings and any spread footing foundation be constructed a minimum of 5.5 feet below finish exterior grade for frost protection. This minimum embedment depth applies to foundations placed on soil, including MSE wall leveling pads. To minimize interference with MSE soil mass reinforcement and to provide frost protection, the stub abutment spread footing foundation may be constructed on a 3.0-foot thick bed of crushed stone at a depth of 3.0 feet within the MSE soil mass. We also recommend that the existing abutment and pier foundations be removed in their entirety to minimize frost heave of the completed pavement surface.

Seismic Design Considerations – Seismic analysis is not required for single-span bridges regardless of seismic zone. Nevertheless, superstructure connections and bridge seat dimensions shall be designed in accordance with LRFD requirements. The Stockton Springs

Underpass Bridge seismic design parameters are presented in Section 7.6, Seismic Design Considerations.

Construction Considerations –

Excavation

- The contractor shall remove the existing abutments and pier foundations in their entirety and replace with granular backfill to minimize pavement heaving. Also, construction of the new MSE walls will require significant soil excavation. Earth support systems, shoring or braced excavations may be needed.
- If encountered, unsuitable soils should also be excavated from the subgrade to a depth of one foot and replaced with compacted gravel borrow.

Subgrade Preparation

- After excavating to the subgrade level in the MSE reinforced soil zone, the contractor should proof-roll the surface to identify any weak soil areas.
- The high fines and water contents of the native glacial till make this soil susceptible to water-softening, disturbance and rutting as a result of exposure to water or construction traffic. If disturbance and/or rutting occur, the contractor shall remove and replace the disturbed soil materials and replace it with compacted granular borrow.
- If any of the MSE wall leveling pad footings are designed to bear on existing fill soils, over-excavate the footing location 2.0 feet and replace the excavated soil with granular borrow. Prior to placing the granular borrow, subject the fill subgrade soil to Proctor testing and then compact the fill subgrade to 95% of the maximum dry density as determined by AASHTO T-180. The contractor should subsequently place granular borrow up to the proposed new subgrade level and compact it to 95% of the AASHTO T-180 maximum dry density prior to constructing the leveling pad footings.

Dewatering

- Control groundwater and surface water infiltration to permit construction in-the-dry.
- Cofferdams, temporary ditches, pumping from sumps, granular drainage blankets, stone ditch protection, or hand-laid riprap with geotextile underlayment may be needed to divert groundwater if significant seepage is encountered during excavation.

Reuse of Excavated Soil

- Do not use excavated existing subbase aggregate for pavement structure construction or to re-base shoulders or for the MSE soil volume. Excavated subbase sand and gravel may be used as fill below subgrade elevation in fill embankment areas.
- Do not use excavated glacial till soils for fill anywhere beneath the pavement structure or dressing slopes except that these soils may be used to dress slopes below the bottom elevation of the shoulder subbase gravel.
- Silty native soils or existing fill soils may be used as common borrow in accordance with MaineDOT Standard Specification Sections 203 and 703. It may be necessary to spread out and dry portions of these soils that are excessively moist.

Embankment Fill Areas

- Bench existing slope soils in accordance with MaineDOT Standard Specification 203.09, Preparation of Embankment Area, where new fill slope extensions are constructed over existing slopes.

Erosion Control

- Use MaineDOT Best Management Practices, February 2008, to minimize erosion of fine-grained soils found on the project site.

1.0 INTRODUCTION

MaineDOT plans to replace the Stockton Springs Underpass Bridge over Route 1 in the Town of Stockton Springs, Waldo County, Maine. We show the project location on Sheet 1, Location Map, appended to this report. We conducted subsurface investigations at the bridge site to develop geotechnical recommendations for the bridge replacement. This report summarizes our findings, discusses our evaluation of the subsurface conditions and presents our geotechnical recommendations for design and construction of the bridge foundations.

The existing three-span bridge was built in 1957. Spans 1 through 3 are approximately 35 feet, 55 feet, and 42 feet in length, respectively. The bridge superstructure is made of reinforced concrete T-beams founded on reinforced concrete pier columns constructed over reinforced concrete spread footings and stub abutments. The stub abutments have widened bases as opposed to being constructed on spread footings. The bridge had a sufficiency rating of 48.7 in 2010.

MaineDOT is proposing a single-span steel girder superstructure replacement bridge approximately 83 feet long founded on MSE-supported stub abutments with spread footings. The new bridge will be on the same alignment as the existing bridge with a minor grade rise near the center of the bridge. The new bridge will have an approximate out-to-out width of 36 feet. The bridge will be closed to traffic during construction to allow faster construction.

2.0 GEOLOGIC SETTING

The existing Stockton Springs Underpass Bridge foundations and approaches are constructed onto the backslopes and base of a large open cut in the native glacial till. The highway cut was excavated for the construction of a section of Route 1 by-passing the Town of Stockton Springs. Drainage from the bridge site generally follows the Route 1 ditch lines in the southwesterly direction.

The Maine Geologic Survey (MGS) “Surficial Geology of Castine Quadrangle, Maine,” Open-file No. 86-9 (1986) indicates that surficial soils in the vicinity of the Stockton Springs Underpass Bridge consists of glacial till. The glacial till is typically a heterogeneous mixture of sand, silt, clay, and stones. There is also a nearby glaciomarine soil unit contact, but we did not encounter any glaciomarine sediments in our explorations.

According to the “Bedrock Geologic Map of Maine,” MGS, (1985), the bedrock at the Stockton Springs Underpass Bridge site consists of Ordovician sulfidic or carbonaceous pelite of the Penobscot Formation. Locally the bedrock has been identified as metasedimentary phyllite and is part of the Penobscot Formation.

3.0 SUBSURFACE INVESTIGATION

We investigated subsurface conditions at the site by drilling four test borings, BB-SSU-101

through BB-SSU-104, conducted by the MaineDOT drill crew. The borings were conducted in April and June 2009. The MaineDOT geotechnical team member selected the boring locations and drilling methods, designated the type and depth of sampling techniques, and identified field and laboratory testing requirements. A MaineDOT New England Transportation Technician Certification Program (NETTCP) Certified Subsurface Inspector logged the subsurface conditions in the borings. The boring locations are shown on Sheet 2, Boring Location Plan, provided at the end of this report. We present a profile depicting the generalized soil stratigraphy at the bridge site on Sheet 3, Interpretive Subsurface Profile. Details and sampling methods used, field data obtained, and soil and groundwater conditions encountered are presented on Sheets 4 and 5, Boring Logs, and in Appendix A, Boring Logs, provided at the end of this report.

We used solid stem auger and cased wash boring techniques to conduct the borings. Soil samples were obtained, where possible, at 5-foot intervals using Standard Penetration Test (SPT) methods. The standard penetration resistances, or N-values, discussed in this report are corrected for average hammer energy transfer. We compute the corrected or, N_{60} -values, by applying an average hammer energy transfer factor of 0.84 to the raw field N-values obtained with the MaineDOT drill rig. All of the borings were terminated with bedrock cores. Bedrock was cored using an NQ-2 core barrel producing a 2.0-inch diameter rock core. The MaineDOT survey crew determined the boring location coordinates in the field when they collected the project survey data. The survey coordinates are based on the NAVD 88 datum.

4.0 LABORATORY TESTING

We conducted a laboratory soil testing program on selected samples recovered from the test borings to evaluate soil classification, material reuse, and subgrade soil properties. Laboratory testing consisted of twenty-five (25) standard grain size analyses with natural water contents. We present results of laboratory testing in Appendix B, Laboratory Test Data. The AASHTO and Unified Soil Classification System (USCS) soil classification and water content data are also presented on the boring logs in Appendix A.

5.0 SUBSURFACE CONDITIONS

Regional surficial geology maps show that the bridge site is situated in an area of bedrock outcrops and glacial till deposits. There is also a nearby glaciomarine soil unit contact, but we did not encounter any glaciomarine sediments in our explorations. We typically found glacial till soils over bedrock. However, the bridge itself is situated over a highway cut section. Consequently, the soil behind the existing abutments and at the pier locations is predominantly granular fill overlying glacial till. All of the boring locations are underlain by metasedimentary phyllite bedrock. A summary description of the subsurface conditions follows:

Granular Fill - We encountered granular fill to a depth of approximately 10.0, 5.0, 4.0, and 5.0 feet below ground surface (bgs) in BB-SSU-101, BB-SSU-102, BB-SSU-103, and BB-SSU-104, respectively. Based on the boring logs, the fill layer is generally comprised of fine

to coarse sand with some gravel, trace to little silt and occasional cobbles. The SPT N_{60} -values in the granular fill ranged from 13 to 36 blows per foot (bpf) indicating that the unit is medium dense to dense in consistency.

The granular fill samples tested had water contents ranging between 3 and 10 percent. Grain size analyses conducted on selected samples of the fill soils indicate that the soils are classified as A-1-b by the AASHTO Classification System and SM and SW-SM under the Unified Soil Classification System.

Glacial Till - The glacial till found in the borings comprised of sandy silt or silt with some sand and trace to some gravel with occasional cobbles. The thickness of this soil unit ranged between approximately 69 and 65 feet in borings BB-SSU-101 and BB-SSU-104, respectively, at the existing abutment locations. Beneath the underpass bridge along Route 1, the glacial till thickness ranged between approximately 53 and 52 feet in borings BB-SSU-102 and BB-SSU-103, respectively. SPT N_{60} -values ranged from 69 to 140 bpf, indicating these deposits are very dense in consistency. We generally observed the glacial till unit over bedrock in each of the borings except that a cobbly/rock fragment layer approximately 5.0 feet thick was observed above bedrock at BB-SSU-103, and an apparent 2.3 foot thick layer of sand, gravel, silt and rock fragments occurred above bedrock at BB-SSU-104.

The glacial till samples had water contents ranging between 7 and 13 percent. Grain size analyses conducted on selected samples of the till soils indicate that the soils are classified as A-1-b, A-2-4, and A-4 by the AASHTO Classification System and SM and ML under the Unified Soil Classification System.

Bedrock - We encountered bedrock at approximate depths of 78.7, 57.8, 55.7 and 70.3 feet bgs at BB-SSU-101, BB-SSU-102, BB-SSU-103 and BB-SSU-104, respectively. Locally, the bedrock is mapped as the Penobscot Formation which is made up of sulfidic or carbonaceous pelite. Visual identification of rock cores indicates that the bedrock is a grey and black, fine-grained, phyllite, soft to moderately hard, slightly to moderately weathered, and moderately to highly fractured. We determined that the rock quality designation (RQD) of the bedrock ranged from 0 to 46 percent which correlates to a very poor to poor rock mass quality. The table below summarizes the top of bedrock elevations at the boring locations:

Existing Substructure	Boring	Station	Approx. Depth To Bedrock (feet bgs)	Approx. Elevation of Bedrock Surface (feet)
Abutment No. 1	BB-SSU-101	6+65.7, 13.5 LT	78.7	99.3
Shoulder in Front of Pier No. 1	BB-SSU-102	7+39.3, 21.7 RT	57.8	104.5
Shoulder in Front of Pier No. 2	BB-SSU-103	7+48.8, 31.8 LT	55.7	105.5
Abutment No. 2	BB-SSU-104	8+32.1, 8.6 RT	70.3	114.7

Table 5-1. Approximate Bedrock Depth and Elevation at the Boring Locations

Groundwater - We interpreted groundwater levels at the boring locations based on field observations. Groundwater occurred at approximate depths of 17.0, 9.0, 2.1 and 18.0 feet bgs at BB-SSU-101, BB-SSU-102, BB-SSU-103 and BB-SSU-104 respectively. However, the groundwater level will fluctuate with seasonal changes, runoff, and adjacent construction activities.

For a more detailed description of the subsurface conditions, please refer to Appendix A, Boring Logs attached to this report.

6.0 FOUNDATION ALTERNATIVES

The project team considered several bridge alternatives including concrete and steel girder superstructures supported on stub abutments over spread footings, full height abutments on spread footings, and pile-supported integral stub abutments. The preliminary design process identified steel beams supported by semi-integral stub abutments on spread footings founded on a MSE reinforced soil mass as the most viable and practicable replacement for the existing bridge at this site. Consequently, the following section presents geotechnical design recommendations for semi-integral stub abutments wrapped in a MSE reinforced soil mass.

7.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

The design team has identified a steel girder superstructure supported by semi-integral stub abutments on spread footings wrapped in a MSE reinforced soil mass to replace the bridge at the Stockton Springs site. The proposed replacement bridge will be approximately 83 feet long. The new bridge will be on the same alignment as the existing bridge with a minor grade rise at the center bridge location. The new bridge will have an out-to-out width of approximately 36 feet. The design methodology used in the following evaluation is referenced from the AASHTO LRFD Bridge Design Specifications, Fifth Edition, 2010, with 2010 Interims.

7.1 MSE Wall Wrapped Abutment Design

Mechanically stabilized earth walls will be used to support the stub abutment foundations for the replacement bridge. In final build-out, each wall will have an approximately 12 to 15-foot high exposed face with U-shape return wingwalls. Each wall will be approximately 45 feet long beneath the bridges with the return wingwalls extending approximately 30 to 50 feet back to the existing highway cut backslope.

7.1.1 MSE Wall Design

The walls shall be designed by a Professional Engineer retained by the contractor in accordance with MaineDOT Special Provision 636 and LRFD Article 11.10. Design of the MSE wall elements should consider the permanent and transient loads as specified in LRFD Articles 3.4.1 and 11.10.5.2. The MSE wall special provision will also include requirements

for facing elements, reinforcing strips, backfill material and compaction, impervious membrane, drainage, etc. Special Provision 636 is presented in Appendix D, Special Provisions, at the end of this report.

For the Stockton Springs project, the internal and external stability of the MSE walls shall be designed for all additional vertical and horizontal loads imposed by the abutment footing and the bridge superstructure. These loads shall include lateral earth pressure on the abutment and superstructure end diaphragm. It is important that these loads be included on the plans for use by the MSE wall designer. The MSE wall design shall also consider the minimum abutment foundation setback distances described in Section 7.3.1, Stub Abutment Design.

The bearing resistance factor, ϕ , for MSE walls on soil is 0.65 per LRFD Table 11.5.6.1. The factored bearing resistance for an MSE reinforced soil mass founded on compacted fill or natural glacial till soil subgrade should be evaluated at the strength limit state using factored loads and a bearing resistance of 14.1 ksf. Based on presumptive bearing resistance values, a factored bearing resistance of 6 ksf should be used to limit settlement to 1-inch when analyzing the service limit state, and for preliminary MSE reinforcing length sizing. The MSE mass shall be assessed at the service limit state using a resistance factor of $\phi = 1.0$ for settlement and horizontal movement, and the overall stability shall be assessed at the Service I Load Combination with a resistance factor, ϕ , of 0.65 (satisfy bearing resistance).

The wall designer must also evaluate failure by sliding. A sliding resistance factor, ϕ , of 1.0 shall be applied to the nominal sliding resistance of soil-on-soil beneath the MSE mass. Sliding computations for resistance to lateral loads shall assume a maximum frictional coefficient of 0.58 (tan 30 degrees) at the foundation soil to soil interface. For the lowest MSE level, the eccentricity of factored loads at the strength limit state shall not exceed one-quarter (1/4) of the MSE wall base dimensions, in either direction for MSE wall bases on soil. The MSE wall designer may assume Soil Type 4 (BDG Section 3.6.1) for MSE wall volume backfill material soil properties. The backfill properties are as follows: $\phi = 32$ degrees, $\gamma = 125$ pcf.

We recommend that the designer use a Coulomb active earth pressure coefficient, K_a , of 0.31 to evaluate the external stability of the wall. Additional lateral earth pressure due to construction surcharge or live load (traffic) surcharge is required per Section 3.6.8 of the BDG. The wall designer may estimate the traffic surcharge as a uniform horizontal earth pressure due to an equivalent height of soil (h_{eq}) of 2.0 feet, per LRFD Table 3.11.6.4-2.

7.1.2 Vehicle Collision, Parapet and Traffic Barrier Design

MSE walls constructed within 30 feet of the edge of the roadway must be protected from vehicular collision with barriers as specified in LRFD Article 3.6.5.1. If barriers are not used, the walls and structural facing panels shall be designed for an equivalent static force of 400 kips assumed to act in any direction in a horizontal plane at a distance of 4.0 feet above the ground surface. The Extreme Event II limit state design check related to collision by vehicles includes bearing resistance, eccentricity, sliding and structural failure. A resistance factor $\phi = 1.0$ is used for the Extreme Event II limit state as specified in LRFD Article 11.5.7. The extreme event factored bearing resistance is 21.7 ksf.

Parapets or traffic barriers constructed over or in line with the front face of the U-shaped return wingwalls shall be designed to resist overturning moments by their own mass. Additional design requirements for barriers on MSE walls are in LRFD 11.10.10.2. The upper layers of soil reinforcement shall have sufficient tensile capacity to resist a concentrated horizontal load γP_H where P_H is 10 kips distributed over the barrier length of 5.0 feet. Parapets and traffic barriers shall satisfy crash testing requirements as specified in LRFD Section 13, Railings. Guardrail constructed on top of the return wingwalls shall be placed a minimum of 3.0 feet from the wall face and driven to 5.0 feet below grade. The upper two rows of reinforcement shall be designed for the additional loads specified in LRFD 11.10.10.2.

7.1.3 MSE Wall Construction Considerations

During construction, any unsuitable or organic soil encountered below the planned MSE soil mass subgrade level or leveling pad subgrade shall be removed and replaced with compacted gravel borrow meeting the requirements of MaineDOT Standard Specification 703.20. A concrete leveling pad with a width no less than 2.0 feet shall be provided to support the MSE wall face elements. The front face of the wall and the wall leveling pad shall be founded a minimum of 5.5 feet below finished exterior grade for frost protection.

The minimum length of reinforcement for MSE walls supporting bridge abutments shall be the greater of 22 feet or $0.6(H+d) + 6.5$ feet, where H is the wall height as measured from the leveling pad and d is the height of soil above the wall behind the abutment. The reinforcement length shall be uniform throughout the entire height of the wall unless supporting design calculations are presented that show satisfactory performance of variable length reinforcement. For the Stockton Springs project, the minimum reinforcement lengths are estimated to be 22 and 24 feet for Abutments 1 and 2, respectively. Backfill within the reinforced mass must meet the requirements of MaineDOT Standard Specification 703.20, Gravel Borrow, except the maximum particle size shall be limited to 4 inches. The backfill within the reinforced mass shall also meet the electrochemical requirements specified in Special Provision 636.

A concrete or asphalt fill will be placed between the top of the MSE wall and the abutment breastwall to provide surface drainage away from the MSE fill at this location. The MSE fill must also be covered with an impermeable membrane to prevent water infiltration and corrosion of the reinforcing strips. The membrane shall consist of low permeability 30 mil HDPE that is textured on both sides. The membrane shall be installed near the top of the reinforced soil zone and shall be bonded to the back of the MSE wall and front of the abutment footing, and another segment attached to the back of the footing extending over the remaining length of the reinforcing strips. The surface of the membrane should be sloped to shed water infiltrating from the road surface above.

7.2 Abutment Spread Footing Subgrade Preparation

We recommend that abutment spread footings be constructed on a bed of compacted $\frac{3}{4}$ -inch crushed stone 3.0 feet thick placed within the MSE reinforced soil mass. See Appendix D,

Special Provisions, at the end of this report for specific gradation requirements for the $\frac{3}{4}$ -inch crushed stone. The crushed stone should be placed in 8-inch thick maximum lifts and compacted with at least 4 passes of a walk-behind vibratory plate or roller compactor with a minimum static weight of 200 lb.

7.3 Semi-Integral Stub Abutment Design

7.3.1 Stub Abutment Design

The stub abutment spread footings will be founded on a bed of crushed stone placed over compacted gravel borrow within the MSE reinforced soil mass. Footings constructed on MSE-supported reinforced earth shall be designed for all applicable load combinations specified in LRFD Articles 3.4.1 and 11.5.5, and 11.6.2 through 11.6.6. The design of abutments on MSE walls shall also be in accordance with LRFD Article 11.10.11 and FHWA Geotechnical Engineering Circular 011, Vols. 1 and 2 (2009), (FHWA-NHI-10-024 and FHWA-NHI-10-025). The design of abutments founded on spread footings at the strength limit state shall consider factored bearing resistance, eccentricity, lateral sliding and structural failure. At the service limit state, spread footing design shall be assessed for horizontal movement and overall stability. Also at the service limit state, a bearing resistance of 4 ksf shall be used to limit settlement to $\frac{1}{2}$ -inch as discussed below.

Abutment footings shall be proportioned to provide stability against bearing capacity failure. Bearing resistance for abutment spread footings founded on an MSE reinforced soil mass shall be investigated at the strength limit state using factored loads and a factored bearing resistance of 7 ksf. A factored bearing resistance of 4 ksf and a resistance factor of 1.0 shall be used when analyzing the service limit state and for preliminary footing sizing. In no instance shall the factored bearing stress exceed the nominal resistance of the footing concrete, which is $0.3 f'_c$. No footing shall be less than 2.0 feet wide regardless of the applied bearing pressure or bearing material.

In accordance with LRFD Table 10.5.5.2.2-1, a sliding resistance factor ϕ_r of 0.80 shall be applied to the nominal sliding resistance of cast-in-place concrete footings on sand. Sliding computations for resistance to lateral loads shall assume a maximum frictional coefficient of 0.45 (tan 24 degrees) at the footing-soil interface. For spread footings on soil, the eccentricity of factored loads at the strength limit state shall not exceed one-quarter ($\frac{1}{4}$) of the footing dimensions, in either direction.

The stub abutments should be designed for active earth pressure over the rigid abutment height and a uniform pressure distribution due to the height of soil behind the superstructure/end diaphragm. The superstructure backwall (end diaphragm) should be designed for full passive pressure with a load factor $\gamma_p = 1.5$. When designing for active and passive earth pressures, we recommend using a Rankine active earth pressure coefficient, $K_a = 0.31$ and a Coulomb passive earth pressure coefficient, $K_p = 6.89$.

Additional lateral earth pressure due to construction surcharge or live load surcharge is required per Section 3.6.8 of the BDG for the stub abutments. Full live load surcharge is

required for the Stockton Springs Underpass Bridge because no approach slab will be used. The live load surcharge on the stub abutments may be estimated as a uniform earth pressure due to an equivalent height of soil (h_{eq}) taken from the table below:

Abutment Height (feet)	h_{eq} (feet)
5.0	4.0
10.0	3.0
≥ 20.0	2.0

Table 7-1. Equivalent Height of Soil for Estimating Live Load Surcharge

The designer may assume Soil Type 4 (BDG Section 3.6.1) for backfill material soil properties. The backfill properties are as follows: $\phi = 32$ degrees, $\gamma = 125$ pcf.

7.3.2 Abutment Construction Considerations

Currently, the stub abutment spread footing bottom elevations are approximately 169.4 ft and 172.7 ft for Abutments 1 and 2, respectively, within the MSE reinforced soil mass. MSE supported bridge abutment spread footings must also conform to the following additional criteria:

- A minimum distance of 3.5 feet should be provided between the outer edge of the MSE wall facing and the centerline of bearing on the abutment.
- The minimum distance between the back face of the MSE wall panels and the front face of the abutment footing shall be 6 inches.
- A minimum distance of 2 feet should be provided between the back of the top MSE panel and the abutment breastwall. The top of the MSE mass in front of the abutment footing should be surfaced with an impermeable treatment.
- The designer should include a minimum clearance of 4.0 feet between the bottom of the superstructure and the top of the MSE fill in front of the abutment.
- Stub abutment spread footings constructed over a 3.0-foot thick bed of compacted crushed stone within the MSE reinforced soil mass may be constructed at a depth of 3.0 feet below the MSE reinforced soil finished grade.

Backfill within 10 feet of the stub abutment shall conform to MaineDOT Specification 703.19, Granular Borrow for Underwater Backfill. This gradation specifies 10 percent or less of material passing the No. 200 sieve. This material is specified in order to reduce the amount of fines and to minimize frost action behind the structure. The contractor shall place and compact the backfill soil in accordance with the MaineDOT Standard Specifications.

All abutment designs shall include a drainage system behind the abutments to intercept any groundwater in accordance with BDG Section 5.4.1.4.

7.4 Settlement

The current bridge replacement plans include minor profile changes on the order of 1.5 feet. We anticipate that engineered fills approximately 18 feet high will be required to construct the MSE wall wrapped stub abutments and bridge approaches over the native glacial till soils. We estimate settlement on the order of $\frac{3}{4}$ -inch will occur beneath the MSE mass as the result of wall fill and bridge loads. Most of this settlement will occur during construction and post-construction settlement will be negligible.

7.5 Frost Protection

Based on State of Maine frost depth maps, BDG Figure 5-1, the site has a design-freezing index of approximately 1460 F-degree days. This correlates to a frost depth of 6.8 feet. We also considered frost depth projections computed by Modberg software developed by the US Army Cold Regions Research and Engineering Laboratory. The Modberg frost penetration software estimated a frost depth of 5.3 feet. Consequently, we recommend that any foundations or leveling pads for MSE walls constructed at the site be founded a minimum of 5.5 feet below finished exterior grade. These minimum embedment depths apply only to foundations constructed on soil and not those founded on bedrock. We also recommend that the existing abutment and pier foundations be removed in their entirety to minimize frost heave of the completed pavement surface.

To minimize interference with MSE soil mass reinforcement and to provide frost protection, the stub abutment spread footing foundation may be constructed on a 3.0-foot thick bed of $\frac{3}{4}$ -inch crushed stone at a depth of 3.0 feet. This foundation system also assumes that an impervious treatment will be applied between the back of the MSE wall and the front face of the abutment and an impermeable membrane will be constructed over the MSE soil mass.

7.6 Seismic Design Considerations

The Stockton Springs Underpass Bridge is not classified as a major structure since construction costs will be less than \$10 million dollars. The bridge is on the National Highway System but is not considered “essential” or “critical” according to the operational classifications of LRFD Article 3.10.5. LRFD Article 4.7.4.2 specifies that seismic analysis is not required for any single-span bridge regardless of seismic zone. However, superstructure connections, bridge seat dimensions and support lengths at expansion bearings should all be designed per LRFD Articles 3.10.9 and 4.7.4.4.

The following parameters were determined for the site from the USGS Seismic Parameters CD provided with the LRFD Manual and LRFD Articles 3.10.3.1 and 3.10.6:

- Peak Ground Acceleration coefficient (PGA) = 0.063g
- Design spectral acceleration coefficient at 0.2-second period, $S_{DS} = 0.165g$
- Design spectral acceleration coefficient at 1.0-second period, $S_{D1} = 0.072g$
- Site Class C (very dense soil and rock with $N_{avg} > 50$ blows per foot for the upper 100 feet of the soil/rock profile)
- Seismic Zone 1, based on an $S_{D1} < 0.15g$

See Appendix C, Calculations at the end of this report for supporting documentation.

7.7 Construction Considerations

7.7.1 Excavation

We recommend that the contractor remove the existing abutments and pier foundations in their entirety. Also, construction of the MSE wrapped abutment structures will require significant soil excavation. Earth support systems, shoring or braced excavations may be needed.

If encountered, unsuitable soils should also be excavated from the subgrade to a depth of one foot and replaced with compacted gravel borrow. Gravel borrow should conform to MaineDOT Standard Specification 703.20, Gravel Borrow. The gravel borrow should be compacted to 95 percent of the Modified Proctor maximum dry density (AASHTO T-180).

Surface water should be diverted from the foundation excavation throughout the period of construction. We recommend removing any groundwater encountered at the base of the foundation excavation by using a sump pump located in a corner of the excavation outside of the foundation footprint.

7.7.2 Subgrade Preparation

After excavating to the subgrade leveling the MSE reinforced soil zone, the contractor should proof-roll the surface to identify any weak soil areas. If the subgrade soil contains cobbles or boulders, we recommend that the contractor remove any cobbles and boulders larger than 6 inches in diameter. The silty native soils at the site are susceptible to water softening, rutting and/or disturbance as a result of exposure to water or construction activity. The contractor must protect the subgrade from exposure to water and any unnecessary construction traffic. If disturbance and/or rutting occur, we recommend that the contractor remove the disturbed soil materials and replace it with compacted granular borrow.

If any of the MSE wall leveling pads are designed to bear on existing fill soils, over-excavate the footing location 2.0 feet and replace the excavated soil with granular borrow. Prior to placing the granular borrow, we recommend that the contractor subject the fill subgrade soil to Proctor testing and then compact the fill subgrade to 95% of the maximum dry density as determined by AASHTO T-180. The contractor should subsequently place granular borrow up to the proposed new subgrade level and compact it to 95% of the AASHTO T-180 maximum dry density prior to constructing the footings.

7.7.3 Dewatering

The native glacial till soils within the project area are both poorly drained and moderately to highly frost susceptible. In some locations, these soil units may be saturated and significant water seepage may be encountered during excavation. The groundwater may be trapped in layers and lenses of coarse-grained soil. We anticipate that this seepage will be temporary but there may be localized sloughing and near-surface instability of some soil slopes.

The contractor should control groundwater and surface water infiltration to permit construction in-the-dry. We recommend that the contractor use cofferdams, temporary ditches, sumps, granular drainage blankets, stone ditch protection, or hand-laid riprap with geotextile underlayment to divert groundwater if significant seepage is encountered during construction. We also recommend using French drains daylighted to nearby ditches if significant seepage is encountered in the subgrade along the construction areas. If the amount of seepage is significant, we anticipate that pumping from sumps will likely be needed to control the water.

7.7.4 Reuse of Excavated Soil

The project plans call for excavation of the existing approach areas to achieve planned grades. In the process, the contractor will excavate both the existing subbase gravel, and subgrade fill soils. We do not recommend using the excavated subbase aggregate to re-base the bridge approaches. Excavated subbase and subgrade sand and gravel may be used as fill below subgrade elevation in fill embankment areas (but not the MSE reinforced soil volume) provided all other requirements of MaineDOT Standard Specification Sections 203 and 703 are met.

We do not recommend using any glacial till soil excavation as fill beneath the pavement structure. The glacial till may be used as common borrow in accordance with MaineDOT Standard Specification Sections 203 and 703. Contractors should expect that, prior to placement and compaction, it may be necessary to spread out and dry portions of these soils that are excessively moist. This soil may also be used for dressing slopes, but only below the bottom elevation of the shoulder subbase gravel.

7.7.5 Embankment Fill Areas

The current project plans require construction of fill extensions along the bridge approaches. The plans indicate that 2:1 (H:V) side slopes will be constructed. We recommend benching the existing slope soils in accordance with MaineDOT Standard Specification 203.09, Preparation of Embankment Area, where new fill slope extensions are constructed over existing slopes.

7.7.6 Erosion Control Recommendations

The fine-grained soils along the project are susceptible to erosion. We recommend using appropriate erosion control measures during construction as described in the MaineDOT Best Management Practices February 2008 guidelines to minimize erosion of the fine-grained soils at the site.

8.0 CLOSURE

This report has been prepared for use by the MaineDOT Bridge Program for specific application to the replacement of the Stockton Springs Underpass Bridge over Route 1 in Stockton Springs, Maine. We have prepared the report in accordance with generally accepted soil 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. Further, the analyses and recommendations are based in part upon limited soil explorations completed at discrete locations on the project 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.

We recommend that we be provided the opportunity for a general review of the final design drawings and specifications in order that we may verify that the earthwork and foundation recommendations have been properly interpreted and implemented in the design.

REFERENCES

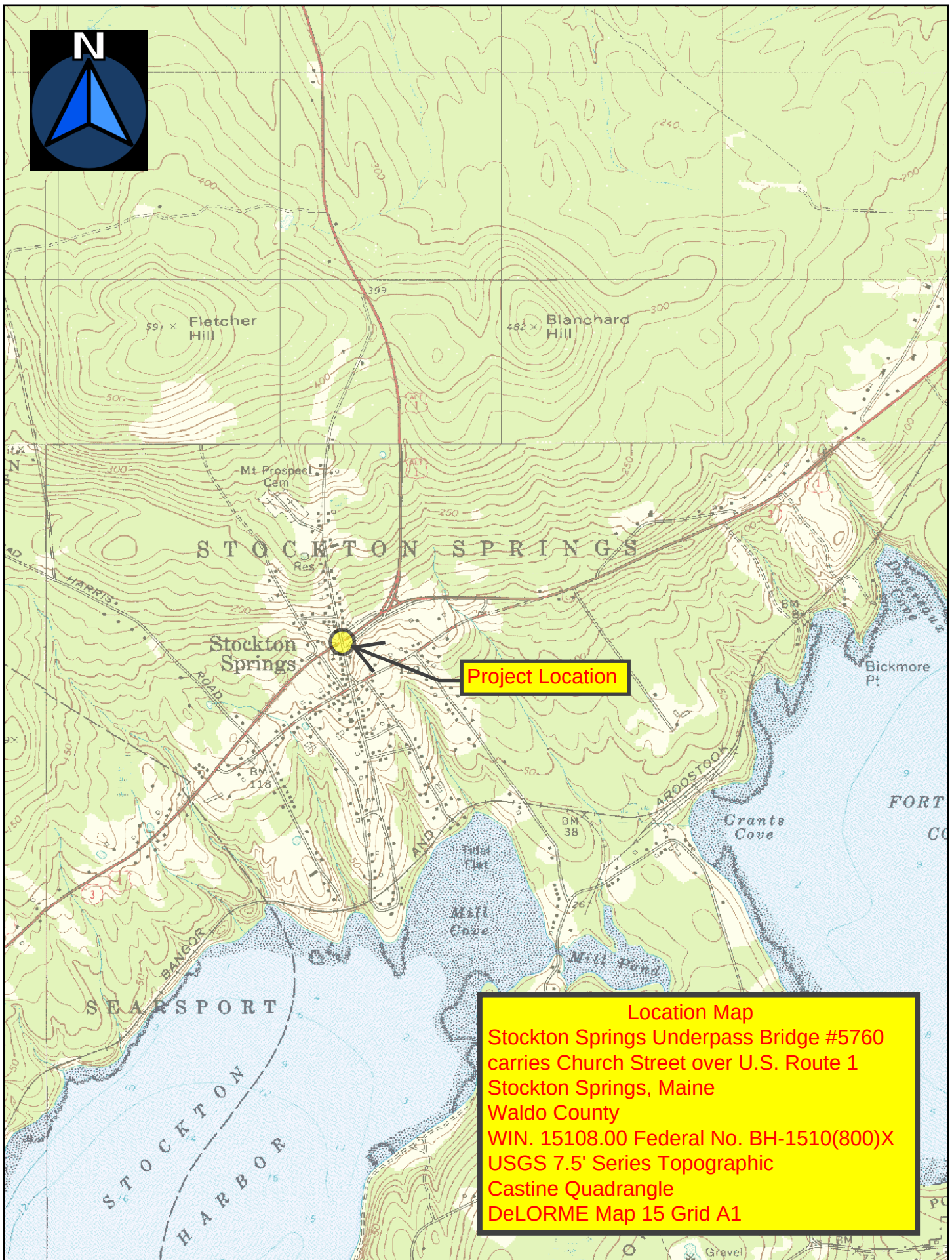
AASHTO, (2010), LRFD Bridge Design Specifications, Fifth Edition, with 2010 Interims, AASHTO, Washington, D.C.

Bowles, Joseph E. (1996), Foundation Analysis and Design, Fifth Edition, McGraw-Hill, New York, NY.

Federal Highway Administration, (2009), FHWA GEC 011, Volumes I and II, FHWA-NHI-10-024 and FHWA-NHI-10-025, Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design & Construction, National Highway Institute, Federal Highway Administration, U. S. Dept. of Transportation, Washington, D.C.

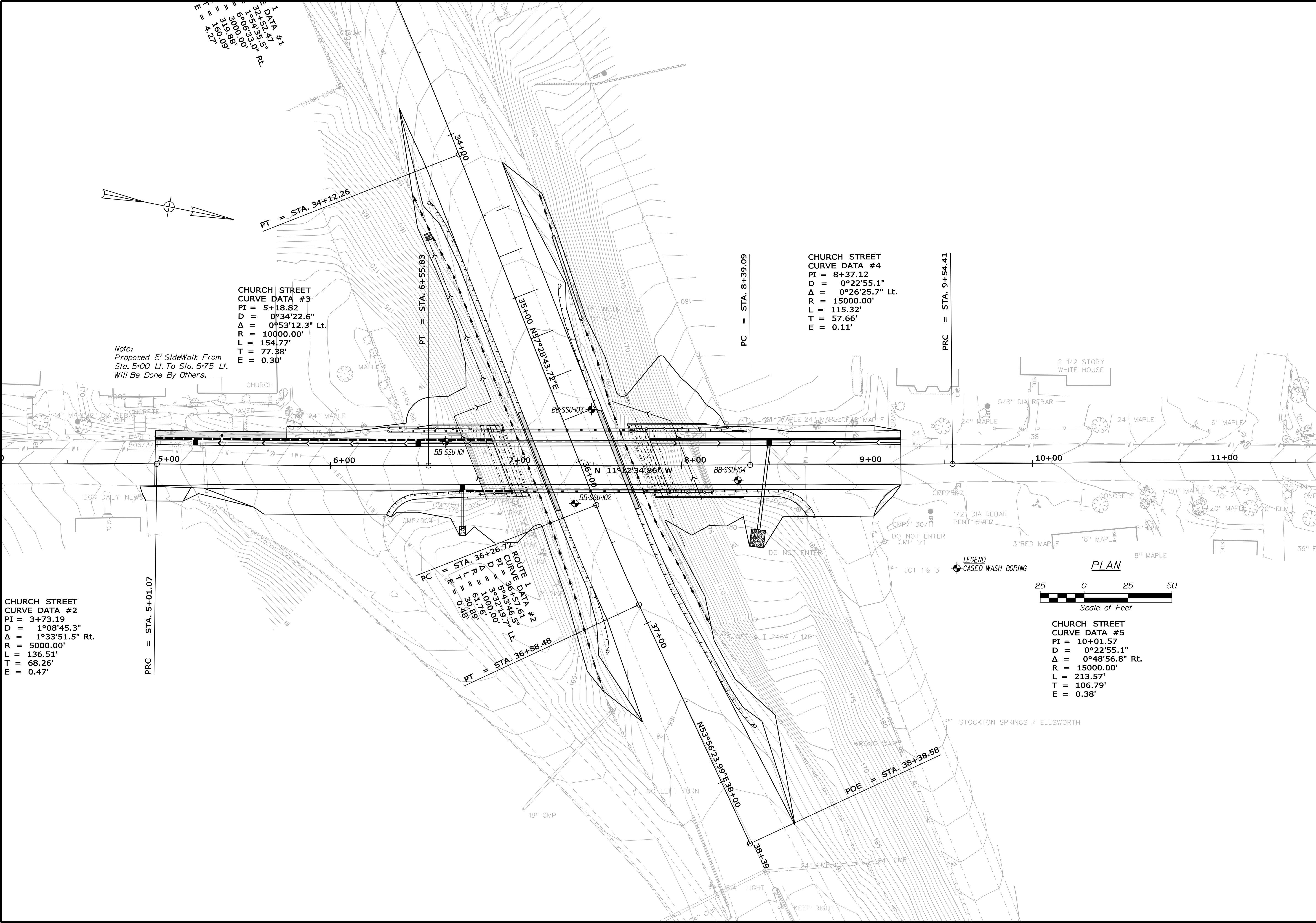
MaineDOT, (2003), Bridge Design Guide, MaineDOT Bridge Program, Augusta, ME.

Sheets



Map Scale 1:24000

The Maine Department of Transportation provides this publication for information only. Reliance upon this information is at user risk. It is subject to revision and may be incomplete depending upon changing conditions. The Department assumes no liability if injuries or damages result from this information. This map is not intended to support emergency dispatch. Road names used on this map may not match official road names.



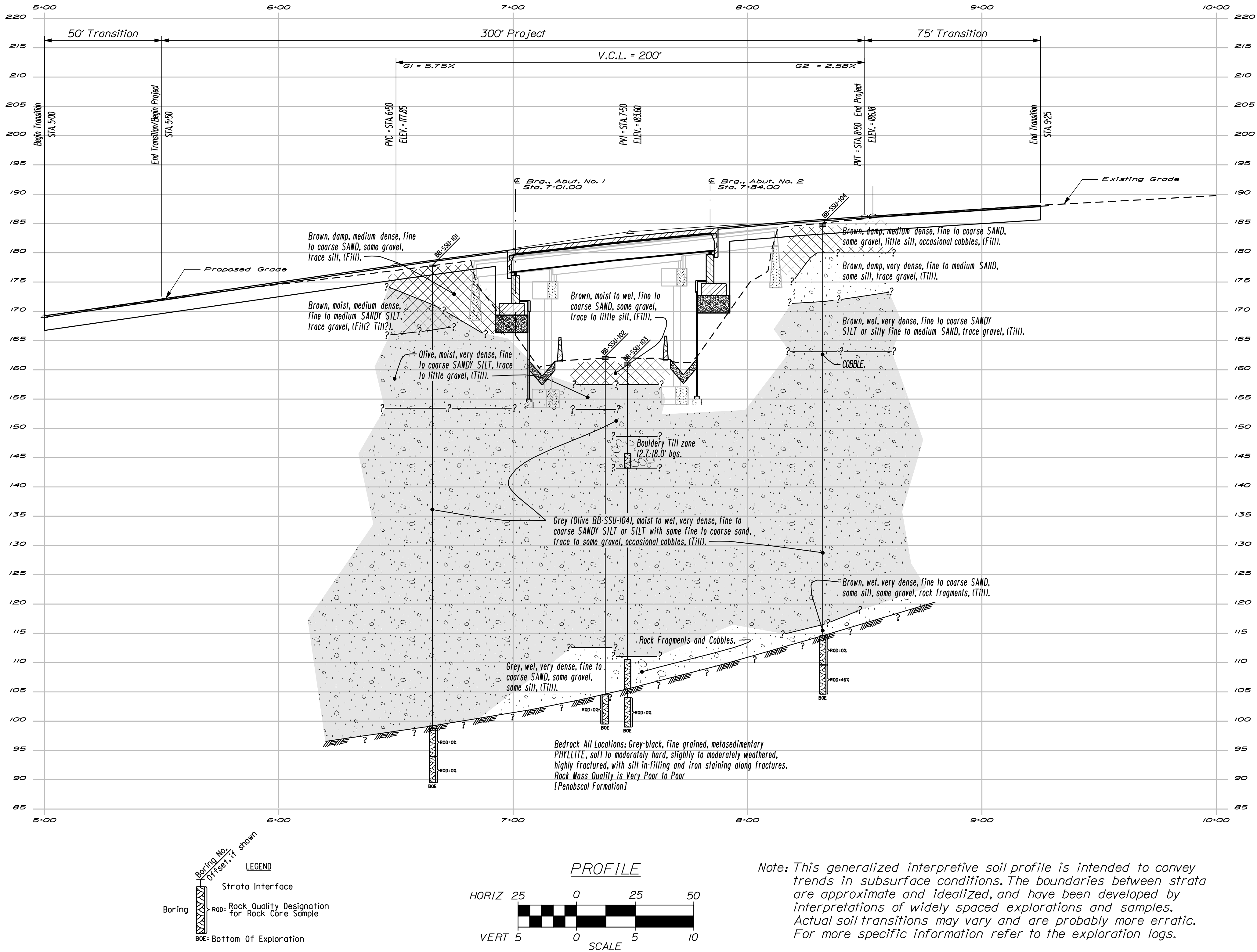
SHEET NUMBER 2 OF 5	STOCKTON SPRINGS UNDERPASS ROUTE 1 STOCKTON SPRINGS WALDO COUNTY	PROJ. MANAGER	D. Anderson	BY	DATE
		DESIGN-DETAILED	M. MOREAU	T. WHITE	JULY 2003
		CHECKED-REVISED			
	BORING LOCATION PLAN	DESIGN2-DETAILED2			
		DESIGN3-DETAILED3			
		REVISIONS 1			
		REVISIONS 2			
		REVISIONS 3			
		REVISIONS 4			
		FIELD CHANGES			
STATE OF MAINE DEPARTMENT OF TRANSPORTATION					
BH-1510(800)X					
BRIDGE NO. 5760					
WIN					
15108.00					
BRIDGE PLANS					

Date:11/30/2011

Username: terry.white

Division: GEOTECH

Filename: ...\\00\\geotech\\msta\\007_ISP1.dgn



SHEET NUMBER 3 OF 5	STOCKTON SPRINGS UNDERPASS ROUTE 1				PROJ. MANAGER D. Anderson	BY T. WHITE	DATE JULY 2008	STATE OF MAINE DEPARTMENT OF TRANSPORTATION		
	STOCKTON SPRINGS WALDO COUNTY				DESIGN-DETAILED	CHECKED-REVIEWED		SIGNATURE		
	INTERPRETIVE SUBSURFACE PROFILE				DESIGN DET AILED	DESIGN DET AILED				
					REVISIONS 1	REVISIONS 1		P.E. NUMBER		
					REVISIONS 2	REVISIONS 2		DATE		
					REVISIONS 3	REVISIONS 3		BRIDGE NO. 5760	WIN 15108.00	BRIDGE PLANS
					REVISIONS 4	REVISIONS 4				
					FIELD CHANGES	FIELD CHANGES				

Maine Department of Transportation										Project:Stockton Springs Underpass Bridge										Boring No.: BB-SSU-101									
Soil/Rock Exploration Log										Location: Stockton Springs, Maine										WIN: 15108.00									
US CUSTOMARY UNITS																													
Driller: MaineDOT		Elevation (ft.): 178.0		Auger ID/001: 5" Solid Stem		Operator: B. Wilder/C. Giles		Datum: NAVD 88		Sampler: Standard Split Spoon		Logged By: B. Wilder		Rig Type: CME 45C		Hammer Wt./Fall: 140#/30"		Date Start/Finish: 4/29/09-4/30/09		Drilling Method: Coated Wash Boring		Core Barrel: NO-2"		Boring Location: 6465.7, 13.5 ft Lt.		Casing ID/001: HW		Water Level#: 17.0' bgs.	
Hammer Efficiency Factor: 0.84		Hammer Type: Automatic (S)		Rope & Cathode (S)		Hydraulic (S)		Rope & Cathode (S)		Hydraulic (S)		Hammer Type: Automatic (S)		Rope & Cathode (S)		Hydraulic (S)		Hammer Type: Automatic (S)		Rope & Cathode (S)		Hydraulic (S)		Hammer Type: Automatic (S)		Rope & Cathode (S)		Hydraulic (S)	
Definitions: S = Split Spoon Sample SS = Solid Stem Auger LL = Liquid Limit PL = Plasticity Limit UC = Unconfined Compressive Strength (ksi) WC = Water Content, percent MC = Moisture Shrinkage A = Thin Wall Tube Sample W = Weight of 140lb. hammer N = 140lb. blow shear test N ₆₀ = 60lb. blow shear test N ₁₀₀ = 100lb. blow shear test N ₂₀₀ = 200lb. blow shear test N ₄₀₀ = 400lb. blow shear test N ₈₀₀ = 800lb. blow shear test N ₁₆₀₀ = 1600lb. blow shear test N ₃₂₀₀ = 3200lb. blow shear test N ₆₄₀₀ = 6400lb. blow shear test N ₁₂₈₀₀ = 12800lb. blow shear test N ₂₅₆₀₀ = 25600lb. blow shear test N ₅₁₂₀₀ = 51200lb. blow shear test N ₁₀₂₄₀₀ = 102400lb. blow shear test N ₂₀₄₈₀₀ = 204800lb. blow shear test N ₄₀₉₆₀₀ = 409600lb. blow shear test N ₈₁₉₂₀₀ = 819200lb. blow shear test N ₁₆₃₈₄₀₀ = 1638400lb. blow shear test N ₃₂₇₆₈₀₀ = 3276800lb. blow shear test N ₆₅₅₃₆₀₀ = 6553600lb. blow shear test N ₁₃₁₀₇₂₀₀ = 13107200lb. blow shear test N ₂₆₂₁₄₄₀₀ = 26214400lb. blow shear test N ₅₂₄₂₈₈₀₀ = 52428800lb. blow shear test N ₁₀₄₈₅₇₆₀₀ = 104857600lb. blow shear test N ₂₀₉₇₁₅₂₀₀ = 209715200lb. blow shear test N ₄₁₉₄₃₀₄₀₀ = 419430400lb. blow shear test N ₈₃₈₈₆₀₈₀₀ = 838860800lb. blow shear test N ₁₆₇₇₇₂₁₆₀₀ = 1677721600lb. blow shear test N ₃₃₅₅₄₄₃₂₀₀ = 3355443200lb. blow shear test N ₆₇₁₀₈₈₆₄₀₀ = 6710886400lb. blow shear test N ₁₃₄₂₁₇₇₂₈₀₀ = 13421772800lb. blow shear test N ₂₆₈₄₃₅₄₅₆₀₀ = 26843545600lb. blow shear test N ₅₃₆₈₇₀₉₁₂₀₀ = 53687091200lb. blow shear test N ₁₀₇₃₇₄₁₈₂₄₀₀ = 107374182400lb. blow shear test N ₂₁₄₇₄₈₃₆₄₈₀₀ = 214748364800lb. blow shear test N ₄₂₉₄₉₆₇₂₉₆₀₀ = 429496729600lb. blow shear test N ₈₅₈₉₉₃₄₅₉₂₀₀ = 858993459200lb. blow shear test N ₁₇₁₇₉₈₆₉₁₈₄₀₀ = 1717986918400lb. blow shear test N ₃₄₃₅₉₇₃₈₃₆₈₀₀ = 3435973836800lb. blow shear test N ₆₈₇₁₉₄₇₆₇₃₆₀₀ = 6871947673600lb. blow shear test N ₁₃₇₄₃₈₉₅₃₄₇₂₀₀ = 13743895347200lb. blow shear test N ₂₇₄₈₇₇₉₀₆₉₄₄₀₀ = 27487790694400lb. blow shear test N ₅₄₉₇₅₅₈₁₃₈₈₈₀₀ = 54975581388800lb. blow shear test N ₁₀₉₉₅₁₁₆₂₇₇₇₆₀₀ = 109951162777600lb. blow shear test N ₂₁₉₉₀₂₃₂₅₅₅₅₂₀₀ = 219902325555200lb. blow shear test N ₄₃₉₈₀₄₆₅₁₁₁₀₄₀₀ = 439804651110400lb. blow shear test N ₈₇₉₆₀₉₃₀₂₂₂₀₈₀₀ = 879609302220800lb. blow shear test N ₁₇₅₉₂₁₈₆₀₄₄₄₁₆₀₀ = 1759218604441600lb. blow shear test N ₃₅₁₈₄₃₇₂₀₈₈₈₃₂₀₀ = 3518437208883200lb. blow shear test N ₇₀₃₆₈₇₄₄₁₇₇₆₆₄₀₀ = 7036874417766400lb. blow shear test N ₁₄₀₇₃₇₄₈₈₃₅₅₃₂₈₀₀ = 14073748835532800lb. blow shear test N ₂₈₁₄₇₄₉₇₆₇₁₀₆₅₆₀₀ = 28147497671065600lb. blow shear test N ₅₆₂₉₄₉₉₅₃₄₂₁₃₁₂₀₀ = 56294995342131200lb. blow shear test N ₁₁₂₅₈₉₉₉₀₆₈₄₂₆₂₄₀₀ = 112589990684262400lb. blow shear test N ₂₂₅₁₇₉₉₈₁₃₆₈₅₂₄₈₀₀ = 225179981368524800lb. blow shear test N ₄₅₀₃₅₉₉₆₂₇₃₇₀₄₉₆₀₀ = 450359962737049600lb. blow shear test N ₉₀₀₇₁₉₉₂₅₄₇₄₀₉₉₂₀₀ = 900719925474099200lb. blow shear test N ₁₈₀₁₄₃₉₈₅₀₉₄₈₁₉₈₄₀₀ = 1801439850948198400lb. blow shear test N ₃₆₀₂₈₇₉₇₀₁₈₉₆₃₉₆₈₀₀ = 3602879701896396800lb. blow shear test N ₇₂₀₅₇₅₉₄₀₃₇₉₂₇₉₃₆₀₀ = 7205759403792793600lb. blow shear test N ₁₄₄₁₁₅₁₈₈₀₇₅₈₅₅₈₇₂₀₀ = 14411518807585587200lb. blow shear test N ₂₈₈₂₃₀₃₇₆₁₅₁₇₁₁₇₄₄₀₀ = 28823037615171174400lb. blow shear test N ₅₇₆₄₆₀₇₅₂₃₀₃₄₂₃₄₈₈₀₀ = 57646075230342348800lb. blow shear test N ₁₁₅₂₉₂₁₅₀₄₆₀₆₈₄₆₉₇₆₀₀ = 115292150460684697600lb. blow shear test N ₂₃₀₅₈₄₃₀₀₉₂₁₃₆₉₃₉₅₂₀₀ = 230584300921369395200lb. blow shear test N ₄₆₁₁₆₈₆₀₁₈₄₂₇₃₈₇₉₀₄₀₀ = 461168601842738790400lb. blow shear test N ₉₂₂₃₃₇₂₀₃₆₈₅₄₇₇₅₈₀₈₀₀ = 922337203685477580800lb. blow shear test N ₁₈₄₄₆₇₄₄₀₇₃₇₀₉₅₅₁₆₁₆₀₀ = 1844674407370955161600lb. blow shear test N ₃₆₈₉₃₄₈₈₁₄₇₄₁₉₁₀₃₂₃₂₀₀ = 3689348814741910323200lb. blow shear test N ₇₃₇₈₆₉₇₆₂₉₄₈₃₈₂₀₆₄₆₄₀₀ = 7378697629483820646400lb. blow shear test N ₁₄₇₅₇₃₉₅₂₅₈₉₆₇₆₄₁₂₉₂₈₀₀ = 14757395258967641292800lb. blow shear test N ₂₉₅₁₄₇₉₀₅₁₇₉₃₅₂₈₂₅₈₅₆₀₀ = 29514790517935282585600lb. blow shear test N ₅₉₀₂₉₅₈₁₀₃₅₈₇₀₅₆₅₁₇₁₂₀₀ = 59029581035870565171200lb. blow shear test N ₁₁₈₀₅₉₁₆₂₀₇₁₇₄₁₁₃₀₃₄₂₄₀₀ = 118059162071741130342400lb. blow shear test N ₂₃₆₁₁₈₃₂₄₁₄₃₄₈₂₂₆₀₆₈₄₈₀₀ = 236118324143482260684800lb. blow shear test N ₄₇₂₂₃₆₆₄₈₂₈₆₉₆₄₅₂₁₃₆₉₆₀₀ = 472236648286964521369600lb. blow shear test N ₉₄₄₄₇₃₂₉₆₅₇₃₉₂₉₀₄₂₇₃₉₂₀₀ = 944473296573929042739200lb. blow shear test N ₁₈₈₈₉₄₆₅₉₃₁₄₇₈₅₈₀₈₅₄₇₈₄₀₀ = 1888946593147858085478400lb. blow shear test N ₃₇₇₇₈₉₃₁₈₆₂₉₅₇₁₆₁₇₀₉₅₆₈₀₀ = 3777893186295716170956800lb. blow shear test N ₇₅₅₅₇₈₆₃₇₂₅₉₁₄₃₂₃₄₁₉₁₃₆₀₀ = 7555786372591432341913600lb. blow shear test N ₁₅₁₁₁₅₇₂₇₄₅₁₈₂₈₆₄₆₈₃₈₂₇₂₀₀ = 15111572745182864683827200lb. blow shear test N ₃₀₂₂₃₁₄₅₄₉₀₃₆₅₇₂₉₃₆₇₆₅₄₄₀₀ = 30223145490365729367654400lb. blow shear test N ₆₀₄₄₆₂₉₀₉₈₀₇₃₁₄₅₈₇₃₅₃₀₈₈₀₀ = 60446290980731458735308800lb. blow shear test N ₁₂₀₈₉₂₅₈₁₉₆₁₄₆₂₉₁₇₄₇₀₆₁₇₆₀₀ = 120892581961462917470617600lb. blow shear test N ₂₄₁₇₈₅₁₆₃₉₂₂₉₂₅₈₃₄₉₄₁₂₃₅₂₀₀ = 241785163922925834941235200lb. blow shear test N ₄₈₃₅₇₀₃₂₇₈₄₅₈₅₁₆₆₉₈₈₂₄₇₀₄₀₀ = 483570327845851669882470400lb. blow shear test N ₉₆₇₁₄₀₆₅₅₆₉₁₇₀₃₃₃₉₇₆₄₉₄₀₈₀₀ = 967140655691703339764940800lb. blow shear test N ₁₉₃₄₂₈₁₃₁₁₃₈₃₄₀₆₆₇₉₅₂₉₈₈₁₆₀₀ = 1934281311383406679529881600lb. blow shear test N ₃₈₆₈₅₆₂₆₂₂₇₆₆₈₁₃₃₅₉₀₅₉₇₆₃₂₀₀ = 3868562622766813359059763200lb. blow shear test N ₇₇₃₇₁₂₅₂₄₅₅₃₃₆₂₆₇₁₈₁₁₉₅₂₆₄₀₀ = 7737125245533626718119526400lb. blow shear test N ₁₅₄₇₄₂₅₀₄₉₁₀₆₇₂₅₃₄₃₆₂₃₉₀₅₂₈₀₀ = 15474250491067253436239052800lb. blow shear test N ₃₀₉₄₈₅₀₀₉₈₂₁₃₄₅₀₆₈₇₂₄₇₈₁₀₅₆₀₀ = 30948500982134506872478105600lb. blow shear test N ₆₁₈₉₇₀₀₁₉₆₄₂₆₉₀₁₃₇₄₄₉₅₆₂₁₁₂₀₀ = 61897001964269013744956211200lb. blow shear test N ₁₂₃₇₉₄₀₀₃₉₂₈₅₃₈₀₂₇₄₈₉₉₁₂₄₂₂₄₀₀ = 123794003928538027489912422400lb. blow shear test N ₂₄₇₅₈₈₀₀₇₈₅₇₀₇₆₀₅₄₉₇₉₈₂₄₈₄₄₈₀₀ = 247588007857076054979824844800lb. blow shear test N ₄₉₅₁₇₆₀₁₅₇₁₄₁₅₂₁₀₉₉₅₉₆₄₉₆₈₉₆₀₀ = 495176015714152109959649689600lb. blow shear test N ₉₉₀₃₅₂₀₃₁₄₂₈₃₀₄₂₁₉₉₁₉₂₉₉₃₇₉₂₀₀ = 990352031428304219919299379200lb. blow shear test N ₁₉₈₀₇₀₄₀₆₂₈₅₆₆₀₈₄₃₉₈₃₈₅₉₈₇₅₈₄₀₀ = 1980704062856608439838598758400lb. blow shear test N ₃₉₆₁₄₀₈₁₂₅₇₁₃₂₁₆₈₇₉₆₇₇₁₉₇₅₁₆₈₀₀ = 3961408125713216879677197516800lb. blow shear test N ₇₉₂₂₈₁₆₂₅₁₄₂₆₄₃₃₇₅₉₃₅₄₃₉₅₀₃₃₆₀₀ = 7922816251426433759354395033600lb. blow shear test N ₁₅₈₄₅₆₃₂₅₀₂₈₅₂₈₆₇₅₁₈₇₀₈₇₉₀₀₆₇₂₀₀ = 15845632502852867518708790067200lb. blow shear test N ₃₁₆₉₁₂₆₅₀₀₅₇₀₅₇₃₅₀₃₇₄₁₇₅₈₀₁₃₄₄₀₀ = 31691265005705735037417580134400lb. blow shear test N ₆₃₃₈₂₅₃₀₀₁₁₄₁₁₄₇₀₀₇₄₈₃₅₁₆₀₂₆₈₈₀₀ = 63382530011411470074835160268800lb. blow shear test N ₁₂₆₇₆₅₀₆₀₀₂₂₈₂₂₉₄₀₁₄₉₆₇₀₃₂₀₅₃₇₆₀₀ = 126765060022822940149670320537600lb. blow shear test N ₂₅₃₅₃₀₁₂₀₀₄₅₆₄₅₈₈₀₂₉₉₃₄₀₆₄₁₀₇₅₂₀₀ = 253530120045645880299340641075200lb. blow shear test N ₅₀₇₀₆₀₂₄₀₀₉₁₂₉₁₇₆₀₅₉₈₆₈₁₂₈₂₁₅₀₄₀₀ = 507060240091291760598681282150400lb. blow shear test N ₁₀₁₄₁₂₀₄₈₀₁₈₂₅₈₃₅₂₁₁₉₇₃₆₂₅₆₄₃₀₀₈₀₀ = 1014120480182583521197362564300800lb. blow shear test N ₂₀₂₈₂₄₀₉₆₀₃₆₅₁₆₇₀₄₂₃₉₄₇₂₅₁₂₈₆₀₁₆₀₀ = 2028240960365167042394725128601600lb. blow shear test N ₄₀₅₆₄₈₁₉₂₀₇₃₀₃₃₄₀₈₄₇₈₉₄₅₀₂₅₇₂₀₃₂₀₀ = 4056481920730334084789450257203200lb. blow shear test N ₈₁₁₂₉₆₃₈₄₁₄₆₀₆₆₈₁₆₉₅₇₈₉₀₀₅₁₄₄₀₆₄₀₀ = 8112963841460668169578900514406400lb. blow shear test N ₁₆₂₂₅₉₂₇₆₈₂₉₂₁₃₃₆₃₃₉₁₅₇₈₀₁₀₂₈₈₁₂₈₀₀ = 16225927682921336339157801028812800lb. blow shear test N ₃₂₄₅₁₈₅₅₃₆₅₈₄₂₆₇₂₆₇₈₃₁₅₆₀₂₀₅₇₆₂₅₆₀₀ = 32451855365842672678315602057625600lb. blow shear test N ₆₄₉₀₃₇₁₀₇₃₁₆₈₅₃₄₅₃₅₆₆₃₁₂₀₄₁₁₅₂₅₁₂₀₀ = 64903710731685345356631204115251200lb. blow shear test N ₁₂₉₈₀₇₄₂₁₄₆₃₃₇₀₆₉₀₇₁₃₂₆₂₄₈₂₂₃₀₅₀₂₄₀₀ = 129807421463370690713262482230502400lb. blow shear test N ₂₅₉₆₁₄₈₄₂₉₂₆₇₄₁₃₈₁₄₂₆₅₂₄₉₆₄₄₆₁₀₀₄₈₀₀ = 259614842926741381426524964461004800lb. blow shear test N ₅₁₉₂₂₉₆₈₅₈₅₃₄₈₂₇₆₂₈₅₃₀₄₉₉₂₈₉₂₂₀₀₉₆₀₀ = 519229685853482762853049928922009600lb. blow shear test N ₁₀₃₈₄₅₉₃₇₁₇₀₆₉₆₅₄₄₅₇₀₆₀₉₉₈₅₇₈₄₄₁₉₂₀₀ = 103845937170696544570609985784419200lb. blow shear test N ₂₀₇₆₉₁₈₇₄₃₄₁₃₉₃₀₈₉₁₄₁₂₁₉₉₇₁₅₆₈₈₃₈₄₀₀ = 207691874341393089141219971568838400lb. blow shear test N ₄₁₅₃₈₃₇₄₈₆₈₂₇₈₆₁₇₈₂₈₂₄₃₉₉₄₃₁₃₇₆₇₆₈₀₀ = 415383748682786178282439943137676800lb. blow shear test N ₈₃₀₇₆₇₄₉₇₃₆₅₅₇₂₃₅₆₅₆₄₈₇₉₈₈₆₂₇₅₃₅₃₆₀₀ = 830767497365572356564879886275353600lb. blow shear test N ₁₆₆₁₅₃₄₉₉₄₇₃₁₁₄₄₇₁₃₁₂₉₇₅₉₇₇₂₅₅₀₇₀₇₂₀₀ = 1661534994731144713129759772550707200lb. blow shear test N ₃₃₂₃₀₆₉₉₈₉₄₆₂₂₈₉₄₂₆₂₅₉₅₁₉₅₄₅₁₀₁₄₁₄₄₀₀ = 3323069989462289426259519545101414400lb. blow shear test N ₆₆₄₆₁₃₉₉₇₈₉₂₄₅₇₈₈₅₂₅₁₉₀₃₉₀₉₀₂₀₂₈₂₈₈₀₀ = 6646139978924578852519039090202828800lb. blow shear test N ₁₃₂₉₂₂₇₉₉₅₇₈₄₉₁₅₇₇₀₅₀₃₈₀₇₈₁₈₀₄₀₅₆₅₇₆₀₀ = 13292279957849157705038078180405657600lb. blow shear test N ₂₆₅₈₄₅₅₉₉₁₅₆₉₈₃₁₅₄₁₀₀₇₆₁₅₆₃₆₀₈₁₁₃₁₅₂₀₀ = 26584559915698315410076156360811315200lb. blow shear test N ₅₃₁₆₉₁₁₉₈₃₁₃₉₆₆₃₀₈₂₀₁₅₂₃₁₂₇₂₁₆₂₂₆₃₀₄₀₀ = 53169119831396630820152312721622630400lb. blow shear test N ₁₀₆₃₃₈₂₃₉₆₆₂₇₉₃₂₆₁₆₄₀₃₀₄₆₂₅₄₄₃₂₄₅₂₆₀₈₀₀ = 106338239662793261640304625443245260800lb. blow shear test N ₂₁₂₆₇₆₄₇₉₃₂₅₅₈₆₅₂₃₂₈₀₆₀₉₂₅₀₈₈₆₄₉₀₅₂₁₆₀₀ = 212676479325586523280609250886490521600lb. blow shear test N ₄₂₅₃₅₂₉₅₈₆₅₁₁₇₃₀₄₆₅₆₁₂₁₈₅₀₁₇₇₂₉₈₁₀₄₃₂₀₀ = 425352958651173046561218501772981043200lb. blow shear test N ₈₅₀₇₀₅₉₁₇₃₀₂₃₄₆₀₉₃₁₂₂₄₃₇₀₀₃₅₄₅₉₆₂₀₈₆₄₀₀ = 850705917302346093122437003545962086400lb. blow shear test N ₁₇₀₁₄₁₁₈₃₄₆₀₄₆₉₂₁₈₆₂₄₄₈₇₄₀₀₇₀₉₁₉₂₄₁₇₂₈₀₀ = 1701411834604692186244874007091924172800lb. blow shear test N ₃₄₀₂₈₂₃₆₆₉₂₀₉₃₈₄₃₇₂₄₈₉₇₄₈₀₁₄₁₈₃₈₄₈₃₄₅₆₀₀ = 3402823669209384372489748014183848345600lb. blow shear test N ₆₈₀₅₆₄₇₃₃₈₄₁₈₇₆₈₇₄₄₉₇₉₄₉₆₀₂₈₃₆₇₆₉₆₆₉₁₂₀₀ = 6805647338418768744979496028367696691200lb. blow shear test N ₁₃₆₁₁₂₉₄₆₇₆₈₃₇₅₃₇₄₉₅₉₅₈₉₉₂₀₅₆₇₃₅₃₉₃₃₈₂₄₀₀ = 13611294676837537495958992056735393382400lb. blow shear test N ₂₇₂₂₂₅₈₉₃₅₃₆₇₅₀₇₄₉₉₁₉₁₇₉₈₄₁₁₃₄₇₀₇₈₆₇₆₄₈₀₀ = 27222589353675074991917984113470786764800lb. blow shear test N ₅₄₄₄₅₁₇₈₇₀₇₃₅₀₁₄₉₉₈₃₈₃₅₉₆₈₂₂₆₉₄₁₅₇₃₅₂₉₆₀₀ = 54445178707350149983835968226941573529600lb. blow shear test N ₁₀₈₈₉₀₃₅₇₄₁₄₇₀₀₂₉₉₉₆₇₆₇₁₉₃₆₄₅₃₈₈₃₁₄₇₀₅₉₂₀₀ = 108890357414700299967671936453883147059200lb. blow shear test N ₂₁₇₇₈₀₇₁₄₈₂₉₄₀₀₅₉₉₉₃₅₃₄₃₈₇₂₉₀₇₇₆₆₂₉₄₁₁₈₄₀₀ = 217780714829400599935343872907766294118400lb. blow shear test N ₄₃₅₅₆₁₄₂₉₆₅₈₈₀₁₁₉₉₈₇₀₆₈₇₇₄₅₈₁₅₅₃₂₅₈₈₂₃₆₈₀₀ = 435561429658801199870687745815532588236800lb. blow shear test N ₈₇₁₁₂₂₈₅₉₃₁₇₆₀₂₃₉₉₇₄₁₃₇₅₄₉₁₆₃₁₀₆₅₁₇₆₄₇₃₆₀₀ = 871122859317602399741375491631065176473600lb. blow shear test N ₁₇₄₂₂₄₅₇₁₈₆₃₅₂₀₄₇₉₉₄₈₂₇₅₀₉₈₃₂₆₂₁₃₀₃₅₂₉₄₇₂₀₀ = 1742245718635204799482750983262130352947200lb. blow shear test N ₃₄₈₄₄₉₁₄₃₇₂₇₀₄₀₉₅₉₈₉₆₅₅₀₁₉₆₆₅₂₄₂₆₀₇₀₅₈₉₄₄₀₀ = 3484491437270409598965501966524260705894400lb. blow shear test N ₆₉₆₈₉₈₂₈₇₄₅₄₀₈₁₉₁₉₇₉₃₁₀₀₃₉₃₃₀₄₈₅₂₁₄₁₁₇₈₈₈₀₀ = 6968982874540819197931003933048521411788800lb. blow shear test N ₁₃₉₃₇₉₆₅₇₄₉₀₈₁₆₃₈₃₉₅₈₆₂₀₀₇₈₆₆₀₉₇₀₄₂₈₂₃₅₇₇₆₀₀ = 13937965749081638395862007866097042823577600lb. blow shear test N ₂₇₈₇₅₉₃₁₄₉₈₁₆₃₂₇₆₇₉₁₇₂₄₀₁₅₇₃₂₁₉₄₀₈₅₆₄₇₁₅₅₂₀₀ = 27875931498163276791724015732194085647155200lb. blow shear test N ₅₅₇₅₁₈₆₂₉₉₆₃₂₆₅₅₃₅₈₃₄₄₈₀₃₁₄₆₄₃₈₈₁₇₁₂₉₄₃₁₀₄₀₀ = 55751862996326553583448031464388171294310400lb. blow shear test N ₁₁₁₅₀₃₇₂₅₉₉₂₆₅₃₁₀₇₁₆₆₈₉₆₀₆₂₉₂₈₇₇₆₃₄₂₅₈₈₆₂₀₈₀₀ = 111503725992653107166896062928776342588620800lb. blow shear test N ₂₂₃₀₀₇₄₅₁₉₈₅₃₀₆₂₁₄₃₃₃₇₉₂₁₂₅₈₅₇₅₅₂₆₈₅₁₇₇₂₄₁₆₀₀ = 223007451985306214333792125857552685177241600lb. blow shear test N ₄₄₆₀₁₄₉₀₃₉₇₀₆₁₂₄₂₈₆₆₇₅₈₄₂₅₁₇₁₅₁₀₅₃₇₀₃₅₄₄₈₃₂₀₀ = 446014903970612428667584251715105370354483200lb. blow shear test N ₈₉₂₀₂₉₈₀₇₉₄₁₂₂₄₈₅₇₃₃₅₁₆₈₅₀₃₄₃₀₂₁₀₇₄₀₇₀₈₉₆₆₄₀₀ = 892029807941224857335168503430210740708966400lb. blow shear test N ₁₇₈₄₀₅₉₆₁₅₈₈₂₄₄₉₇₁₄₆₇₀₃₃₇₀₀₆₈₆₀₄₂₁₄₈₁₄₁₇₉₃₂₈₀₀ = 1784059615882449714670337006860421481417932800lb. blow shear test N ₃₅₆₈₁₁₉₂₃₁₇₆₄₈₉₉₄₂₉₃₄₀₆₇₄₀₁₃₇₂₀₈₄₂₉₆₂₈₃₅₈₆₅₆₀₀ = 3568119231764899429340674013720842962835865600lb. blow shear test N ₇₁₃₆₂₃₈₄₆₃₅₂₉₇₉₈₈₅₈₆₈₁₃₄₈₀₂₇₄₄₁₆₈₅₉₂₅₆₇₁₇₃₁₂₀₀ = 7136238463529798858681348027441685925671731200lb. blow shear test N ₁₄₂₇₂₄₇₆₉₂₇₀₅₉₅₉₇₇₁₇₃₆₂₆₉₆₀₅₄₈₈₃₃₇₁₈₅₁₃₄₃₄₆₂₄₀₀ = 14272476927059597717362696054883371851343462400lb. blow shear test N ₂₈₅₄₄₉₅₃₈₅₄₁₁₉₁₉₅₄₃₄₇₂₅₃₉₂₁₀₉₇₆₆₇₄₃₇₀₂₆₈₆₉₂₄₈₀₀ = 28544953854119195434725392109766743702686924800lb. blow shear test N ₅₇₀₈₉₉₀₇₇₀₈₂₃₈₃₉₀₈₆₉₄₅₀₇₈₄₂₁₉₅₃₃₄₈₇₄₀₅₃₇₃₈₄₉₆₀₀ = 57089907708238390869450784219533487405373849600lb. blow shear test N ₁₁₄₁₇₉₈₁₅₄₁₆₄₇₆₇₈₁₇₃₈₉₀₁₅₆₈₄₃₉₀₆₆₉₇₄₈₁₀₇₄₇₆₉₉₂₀₀ = 114179815416476781738901568439066974810747699200lb. blow shear test N ₂₂₈₃₅₉₆₃₀₈₃₂₉₅₃₅₆₃₄₇₇₈₀₃₁₃₆₈₇₈₁₃₃₉₄₉₆₂₁₄₉₅₃₉₈₄₀₀ = 228359630832953563477803136878133949621495398400lb. blow shear test N ₄₅₆₇₁₉₂₆₁₆₆₅₉₀₇₁₂₆₉₅₅₆₀₆₂₇₃₇₅₆₂₆₇₈₉₉₂₄₂₉₉₀₇₉₆₈₀₀ = 456719261665907126955606273756267899242990796800lb. blow shear test N ₉₁₃₄₃₈₅₂₃₃₃₁₈₁₄₂₅₃₉₁₁₂₁₂₅₄₇₅₁₂₅₃₅₇₉																													

[illegible]

OF 5 SHEET NUMBER	STOCKTON SPRINGS UNDERPASS ROUTE 1 STOCKTON SPRINGS WALDO COUNTY	PROJ. MANAGER D. ANDERSON DESIGN-DETAILED M. MOREAU CHECKED-REVISED T. WHITE DATE JULY 2003	STATE OF MAINE DEPARTMENT OF TRANSPORTATION
	BORING LOGS	SIGNATURE P.E. NUMBER DATE	
			BH-1510(800)X BRIDGE NO. 5760 WIN 15'108.00 BRIDGE PLANS

Appendix A

Boring Logs

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Stockton Springs Underpass Bridge #5760 Church Street & Route 1 Location: Stockton Springs, Maine		Boring No.: BB-SSU-101 WIN: 15108.00					
Driller: MaineDOT			Elevation (ft.) 178.0		Auger ID/OD: 5" Solid Stem						
Operator: B. Wilder/C. Giles			Datum: NAVD 88		Sampler: Standard Split Spoon						
Logged By: B. Wilder			Rig Type: CME 45C		Hammer Wt./Fall: 140#/30"						
Date Start/Finish: 4/29/09-4/30/09			Drilling Method: Cased Wash Boring		Core Barrel: NQ-2"						
Boring Location: 6+65.7, 13.5 ft Lt.			Casing ID/OD: HW		Water Level*: 17.0' bgs.						
Hammer Efficiency Factor: 0.84			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 = Insitu Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Insitu 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 = Insitu Field Vane Shear Strength (psf) T _v = Pocket Torvane Shear Strength (psf) q _p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw field SPT N-value Hammer Efficiency Factor = Annual Calibration Value N ₆₀ = SPT N-uncorrected corrected for hammer efficiency N ₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected		S _{u(lab)} = Lab Vane Shear Strength (psf) WC = water content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test				
Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)			
0							SSA	177.70		PAVEMENT. Brown, damp, medium dense, fine to coarse SAND, some gravel, trace silt (Fill). (2D) 5.0-6.0' bgs.	G#209257 A-1-b, SW-SM WC=3.8%
5	1D	24/14	1.00 - 3.00	6/9/6/6	15	21		172.00			
10	3D	24/18	10.00 - 12.00	11/25/27/26	52	73		168.00		Olive, moist, very dense, fine to coarse SANDY SILT, trace to little gravel, occasional cobbles, (Till). Similar to above. Similar to above, but wet. aOH= Open Hole with large Roller Cone.	G#209259 A-4, ML WC=10.1% G#209260 A-4, SM WC=7.9%
15	4D	24/20	15.00 - 17.00	17/36/46/50	82	115		154.00			
20	5D	9.6/5	20.00 - 20.80	37/50(3.6")	---		aOH				
25											
Remarks: The very dense glacial till is well bonded or cemented.											
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 1 of 4	
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.										Boring No.: BB-SSU-101	

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Stockton Springs Underpass Bridge #5760 Church Street & Route 1 Location: Stockton Springs, Maine		Boring No.: BB-SSU-101 WIN: 15108.00					
Driller: MaineDOT		Elevation (ft.): 178.0		Auger ID/OD: 5" Solid Stem							
Operator: B. Wilder/C. Giles		Datum: NAVD 88		Sampler: Standard Split Spoon							
Logged By: B. Wilder		Rig Type: CME 45C		Hammer Wt./Fall: 140#/30"							
Date Start/Finish: 4/29/09-4/30/09		Drilling Method: Cased Wash Boring		Core Barrel: NQ-2"							
Boring Location: 6+65.7, 13.5 ft Lt.		Casing ID/OD: HW		Water Level*: 17.0' bgs.							
Hammer Efficiency Factor: 0.84		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 = Insitu Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Insitu 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 = Insitu Field Vane Shear Strength (psf) T_v = Pocket Torvane Shear Strength (psf) q_p = Unconfined Compressive Strength (ksf) N_u-uncorrected = Raw field SPT N-value Hammer Efficiency Factor = Annual Calibration Value N₆₀ = SPT N-uncorrected corrected for hammer efficiency N₆₀ = (Hammer Efficiency Factor/60%)*N_u-uncorrected S_u(lab) = Lab Vane Shear Strength (psf) WC = water content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test											
Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)			
25	6D	6/6	25.00 - 25.50	55	---					Grey, wet, very dense, fine to coarse SANDY SILT, trace to little gravel, (Till).	G#209261 A-4, ML WC=8.1%
30	7D	6/6	30.00 - 30.50	57	---						
35	8D	24/24	35.00 - 37.00	30/39/32/32	71	99					
40	9D	6/6	40.00 - 40.50	50	---						
45	10D	24/24	45.00 - 47.00	21/38/44/57	82	115					
50											
Remarks: The very dense glacial till is well bonded or cemented.											
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 2 of 4	
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.										Boring No.: BB-SSU-101	

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Stockton Springs Underpass Bridge #5760 Church Street & Route 1 Location: Stockton Springs, Maine		Boring No.: BB-SSU-101 WIN: 15108.00					
Driller: MaineDOT		Elevation (ft.): 178.0		Auger ID/OD: 5" Solid Stem							
Operator: B. Wilder/C. Giles		Datum: NAVD 88		Sampler: Standard Split Spoon							
Logged By: B. Wilder		Rig Type: CME 45C		Hammer Wt./Fall: 140#/30"							
Date Start/Finish: 4/29/09-4/30/09		Drilling Method: Cased Wash Boring		Core Barrel: NQ-2"							
Boring Location: 6+65.7, 13.5 ft Lt.		Casing ID/OD: HW		Water Level*: 17.0' bgs.							
Hammer Efficiency Factor: 0.84		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 = Insitu Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Insitu 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 = Insitu Field Vane Shear Strength (psf) T_v = Pocket Torvane Shear Strength (psf) q_p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw field SPT N-value Hammer Efficiency Factor = Annual Calibration Value N₆₀ = SPT N-uncorrected corrected for hammer efficiency N₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected S_{u(lab)} = Lab Vane Shear Strength (psf) WC = water content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test											
Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)			
50	11D	12/12	50.00 - 51.00	28/50	---					Grey, wet, very dense, fine to coarse SANDY SILT, trace gravel, (Till).	G#209262 A-4, SM WC=7.2%
55											
60	12D	6/5	60.00 - 60.50	55	---					Grey, wet, very dense, SILT, some fine to coarse sand and gravel, occasional cobbles, (Till).	G#209262 A-4, SM WC=7.2%
65										Similar to above, but wet.	G#209262 A-4, SM WC=7.2%
70	13D	6/6	70.00 - 70.50	58	---					Similar to above, but wet.	G#209262 A-4, SM WC=7.2%
75										Similar to above, but wet.	G#209262 A-4, SM WC=7.2%

Remarks:

The very dense glacial till is well bonded or cemented.

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

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

Page 3 of 4

Boring No.: BB-SSU-101

[illegible]

Maine Department of Transportation <u>Soil/Rock Exploration Log</u> US CUSTOMARY UNITS				Project: Stockton Springs Underpass Bridge #5760 Church Street & Route 1 Location: Stockton Springs, Maine				Boring No.: BB-SSU-102 WIN: 15108.00																																																																																																																																																																																																																
Driller: MaineDOT				Elevation (ft.) 162.3				Auger ID/OD: 5" Solid Stem																																																																																																																																																																																																																
Operator: B. Wilder/C. Giles				Datum: NAVD 88				Sampler: Standard Split Spoon																																																																																																																																																																																																																
Logged By: B. Wilder				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"																																																																																																																																																																																																																
Date Start/Finish: 6/9/09-6/9/09				Drilling Method: Cased Wash Boring				Core Barrel: NQ-2"																																																																																																																																																																																																																
Boring Location: 7+39.3, 21.7 ft Rt.				Casing ID/OD: HW				Water Level*: 9.0' bgs.																																																																																																																																																																																																																
Hammer Efficiency Factor: 0.84				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 = Insitu Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Insitu 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 = Insitu Field Vane Shear Strength (psf) T _v = Pocket Torvane Shear Strength (psf) q _p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw field SPT N-value Hammer Efficiency Factor = Annual Calibration Value N ₆₀ = SPT N-uncorrected corrected for hammer efficiency N ₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected																																																																																																																																																																																																																
								S _{u(lab)} = Lab Vane Shear Strength (psf) WC = water content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test																																																																																																																																																																																																																
<table><tr><th rowspan="2">Depth (ft.)</th><th colspan="8">Sample Information</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/ AASHTO and Unified Class</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing Blows</th><th>Elevation (ft.)</th></tr><tr><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>SSA</td><td>161.80</td><td rowspan="10"></td><td>PAVEMENT.</td><td rowspan="3">G#209263 A-1-b, SM WC=7.3%</td></tr><tr><td></td><td>1D</td><td>24/18</td><td>1.00 - 3.00</td><td>11/12/9/18</td><td>21</td><td>29</td><td></td><td></td><td></td><td>Brown, moist, medium dense, fine to coarse SAND, some gravel, little silt (Fill).</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="3">G#209264 A-4, SM WC=8.5%</td></tr><tr><td></td><td>2D</td><td>12/12</td><td>5.00 - 6.00</td><td>20/55</td><td>---</td><td></td><td>251</td><td>157.30</td><td></td><td>Olive, moist, very dense, fine to coarse SANDY SILT, little gravel.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>137</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>OPEN HOLE</td><td></td><td></td><td></td><td rowspan="3">G#209265 A-4, ML WC=8.5%</td></tr><tr><td>10</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td>3D</td><td>12/12</td><td>10.00 - 11.00</td><td>42/55</td><td>---</td><td></td><td></td><td>153.80</td><td></td><td>Grey, moist, very dense, SILT, some fine to coarse sand, little gravel, or fine to coarse SANDY SILT, little gravel, (Till).</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="3">G#209266 A-4, SM WC=8.2%</td></tr><tr><td>15</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td>4D</td><td>24/20</td><td>15.00 - 17.00</td><td>25/40/40/50</td><td>80</td><td>112</td><td></td><td></td><td></td><td>Similar to above.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="3"></td></tr><tr><td>20</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td>5D</td><td>12/12</td><td>20.00 - 21.00</td><td>20/52</td><td>---</td><td></td><td></td><td></td><td></td><td>Similar to above.</td></tr><tr><td>25</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>												Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	0							SSA	161.80		PAVEMENT.	G#209263 A-1-b, SM WC=7.3%		1D	24/18	1.00 - 3.00	11/12/9/18	21	29				Brown, moist, medium dense, fine to coarse SAND, some gravel, little silt (Fill).												5											G#209264 A-4, SM WC=8.5%		2D	12/12	5.00 - 6.00	20/55	---		251	157.30		Olive, moist, very dense, fine to coarse SANDY SILT, little gravel.								137											OPEN HOLE				G#209265 A-4, ML WC=8.5%	10													3D	12/12	10.00 - 11.00	42/55	---			153.80		Grey, moist, very dense, SILT, some fine to coarse sand, little gravel, or fine to coarse SANDY SILT, little gravel, (Till).												G#209266 A-4, SM WC=8.2%	15													4D	24/20	15.00 - 17.00	25/40/40/50	80	112				Similar to above.													20													5D	12/12	20.00 - 21.00	20/52	---					Similar to above.	25											
Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class																																																																																																																																																																																																													
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)																																																																																																																																																																																																																
0							SSA	161.80		PAVEMENT.	G#209263 A-1-b, SM WC=7.3%																																																																																																																																																																																																													
	1D	24/18	1.00 - 3.00	11/12/9/18	21	29						Brown, moist, medium dense, fine to coarse SAND, some gravel, little silt (Fill).																																																																																																																																																																																																												
5												G#209264 A-4, SM WC=8.5%																																																																																																																																																																																																												
	2D	12/12	5.00 - 6.00	20/55	---		251	157.30			Olive, moist, very dense, fine to coarse SANDY SILT, little gravel.																																																																																																																																																																																																													
							137																																																																																																																																																																																																																	
							OPEN HOLE					G#209265 A-4, ML WC=8.5%																																																																																																																																																																																																												
10																																																																																																																																																																																																																								
	3D	12/12	10.00 - 11.00	42/55	---			153.80			Grey, moist, very dense, SILT, some fine to coarse sand, little gravel, or fine to coarse SANDY SILT, little gravel, (Till).																																																																																																																																																																																																													
												G#209266 A-4, SM WC=8.2%																																																																																																																																																																																																												
15																																																																																																																																																																																																																								
	4D	24/20	15.00 - 17.00	25/40/40/50	80	112				Similar to above.																																																																																																																																																																																																														
20																																																																																																																																																																																																																								
	5D	12/12	20.00 - 21.00	20/52	---					Similar to above.																																																																																																																																																																																																														
25																																																																																																																																																																																																																								
Remarks: The very dense glacial till is well bonded or cemented.																																																																																																																																																																																																																								
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 1 of 3																																																																																																																																																																																																														
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.										Boring No.: BB-SSU-102																																																																																																																																																																																																														

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Stockton Springs Underpass Bridge #5760 Church Street & Route 1 Location: Stockton Springs, Maine		Boring No.: BB-SSU-102 WIN: 15108.00																																																																																																																																																																																																																																																											
Driller: MaineDOT		Elevation (ft.) 162.3		Auger ID/OD: 5" Solid Stem																																																																																																																																																																																																																																																													
Operator: B. Wilder/C. Giles		Datum: NAVD 88		Sampler: Standard Split Spoon																																																																																																																																																																																																																																																													
Logged By: B. Wilder		Rig Type: CME 45C		Hammer Wt./Fall: 140#/30"																																																																																																																																																																																																																																																													
Date Start/Finish: 6/9/09-6/9/09		Drilling Method: Cased Wash Boring		Core Barrel: NQ-2"																																																																																																																																																																																																																																																													
Boring Location: 7+39.3, 21.7 ft Rt.		Casing ID/OD: HW		Water Level*: 9.0' bgs.																																																																																																																																																																																																																																																													
Hammer Efficiency Factor: 0.84		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 = Insitu Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Insitu 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 = Insitu Field Vane Shear Strength (psf) T _v = Pocket Torvane Shear Strength (psf) q _p = Unconfined Compressive Strength (ksf) N _{uncorrected} = Raw field SPT N-value Hammer Efficiency Factor = Annual Calibration Value N ₆₀ = SPT N-uncorrected corrected for hammer efficiency N ₆₀ = (Hammer Efficiency Factor/60%)*N _{uncorrected}																																																																																																																																																																																																																																																													
		S _{u(lab)} = Lab Vane Shear Strength (psf) WC = water content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test																																																																																																																																																																																																																																																															
<table><tr><th rowspan="2">Depth (ft.)</th><th colspan="8">Sample Information</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/ AASHTO and Unified Class.</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing Blows</th><th>Elevation (ft.)</th></tr><tr><td>25</td><td>6D</td><td>18/18</td><td>25.00 - 26.50</td><td>20/29/50</td><td>79</td><td>111</td><td></td><td></td><td rowspan="16"></td><td rowspan="16">Grey, moist, very dense, SILT, some fine to coarse sand, little gravel, or fine to coarse SANDY SILT, little gravel, (Till).</td><td rowspan="16">G#209267 A-4, ML WC=9.0%</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>30</td><td>MD</td><td>1.2/0</td><td>30.00 - 30.10</td><td>50(1.2")</td><td>---</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>35</td><td>7D</td><td>6/4</td><td>35.50 - 36.00</td><td>55(6")</td><td>---</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>40</td><td>8D</td><td>18/18</td><td>40.00 - 41.50</td><td>33/43/53</td><td>96</td><td>134</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>45</td><td>9D</td><td>9.6/9.6</td><td>45.00 - 45.80</td><td>51/50(3.6")</td><td>---</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>50</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>										Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	25	6D	18/18	25.00 - 26.50	20/29/50	79	111				Grey, moist, very dense, SILT, some fine to coarse sand, little gravel, or fine to coarse SANDY SILT, little gravel, (Till).	G#209267 A-4, ML WC=9.0%																																					30	MD	1.2/0	30.00 - 30.10	50(1.2")	---																																																										35	7D	6/4	35.50 - 36.00	55(6")	---																															40	8D	18/18	40.00 - 41.50	33/43/53	96	134																														45	9D	9.6/9.6	45.00 - 45.80	51/50(3.6")	---																															50								
Depth (ft.)	Sample Information								Graphic Log		Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.																																																																																																																																																																																																																																																					
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)																																																																																																																																																																																																																																																									
25	6D	18/18	25.00 - 26.50	20/29/50	79	111				Grey, moist, very dense, SILT, some fine to coarse sand, little gravel, or fine to coarse SANDY SILT, little gravel, (Till).	G#209267 A-4, ML WC=9.0%																																																																																																																																																																																																																																																						
30	MD	1.2/0	30.00 - 30.10	50(1.2")	---																																																																																																																																																																																																																																																												
35	7D	6/4	35.50 - 36.00	55(6")	---																																																																																																																																																																																																																																																												
40	8D	18/18	40.00 - 41.50	33/43/53	96	134																																																																																																																																																																																																																																																											
45	9D	9.6/9.6	45.00 - 45.80	51/50(3.6")	---																																																																																																																																																																																																																																																												
50																																																																																																																																																																																																																																																																	
Remarks: The very dense glacial till is well bonded or cemented.																																																																																																																																																																																																																																																																	
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 2 of 3																																																																																																																																																																																																																																																							
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.										Boring No.: BB-SSU-102																																																																																																																																																																																																																																																							

[illegible]

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Stockton Springs Underpass Bridge #5760 Church Street & Route 1 Location: Stockton Springs, Maine		Boring No.: BB-SSU-103 WIN: 15108.00																																																																																																																																																																																					
Driller: MaineDOT			Elevation (ft.) 161.2		Auger ID/OD: 5" Solid Stem																																																																																																																																																																																						
Operator: B. Wilder/C. Giles			Datum: NAVD 88		Sampler: Standard Split Spoon																																																																																																																																																																																						
Logged By: B. Wilder			Rig Type: CME 45C		Hammer Wt./Fall: 140#/30"																																																																																																																																																																																						
Date Start/Finish: 6/8/09-6/8/09			Drilling Method: Cased Wash Boring		Core Barrel: NQ-2"																																																																																																																																																																																						
Boring Location: 7+48.8, 31.8 ft L.t.			Casing ID/OD: HW		Water Level*: 2.1' bgs.																																																																																																																																																																																						
Hammer Efficiency Factor: 0.84			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 = Insitu Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Insitu 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 = Insitu Field Vane Shear Strength (psf) T_v = Pocket Torvane Shear Strength (psf) q_p = Unconfined Compressive Strength (ksf) N_{uncorrected} = Raw field SPT N-value Hammer Efficiency Factor = Annual Calibration Value N₆₀ = SPT N-uncorrected corrected for hammer efficiency N₆₀ = (Hammer Efficiency Factor/60%)*N_{uncorrected} S_{u(lab)} = Lab Vane Shear Strength (psf) WC = water content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test																																																																																																																																																																																											
<table><tr><th rowspan="2">Depth (ft.)</th><th colspan="8">Sample Information</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/ AASHTO and Unified Class.</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing Blows</th><th>Elevation (ft.)</th></tr><tr><td rowspan="3">0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>SSA</td><td>160.80</td><td rowspan="24"></td><td>PAVEMENT.</td><td rowspan="3">G#209269 A-1-b, SW-SM WC=9.5%</td></tr><tr><td>1D</td><td>24/15</td><td>1.00 - 3.00</td><td>10/8/5/3</td><td>13</td><td>18</td><td></td><td></td><td>Brown, wet, medium dense, fine to coarse SAND, some gravel, trace silt (Fill).</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td rowspan="3">5</td><td></td><td></td><td></td><td></td><td></td><td></td><td>29</td><td>157.20</td><td rowspan="3">Grey, wet, very dense, SILT, some fine to coarse sand, little gravel, or fine to coarse SANDY SILT, little gravel, (Till). Spun large Roller Cone ahead to 10.0' bgs.</td><td rowspan="3">G#209270 A-4, ML WC=8.6%</td></tr><tr><td>2D</td><td>12/12</td><td>5.00 - 6.00</td><td>24/66</td><td>---</td><td></td><td>328</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>OPEN HOLE</td><td></td><td></td></tr><tr><td rowspan="3">10</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="3">Similar to above.</td><td rowspan="3">G#209271 A-4, ML WC=9.1%</td></tr><tr><td>3D</td><td>24/23</td><td>10.00 - 12.00</td><td>23/38/46/46</td><td>84</td><td>118</td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td rowspan="3">15</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>148.50</td><td rowspan="3">Boulder from 12.7-15.8' bgs.</td><td rowspan="3">G#209272 A-4, ML WC=8.6%</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>R1</td><td>30/10</td><td>15.50 - 18.00</td><td>RQD = N/A%</td><td></td><td></td><td>NQ-2</td><td>145.70</td><td>R1:BOULDER - TILL. (R1 in Sample Cup) R1:Core Times (min:sec) 15.5-16.5' (2:02) 16.5-17.5' (2:01) 17.5-18.0' (2:12) Core Blocked in Till.</td></tr><tr><td rowspan="3">20</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>143.20</td><td rowspan="3">Grey, wet, very dense, SILT, some fine to coarse sand, trace to some gravel, (Till). Roller Coned ahead from 18.0-20.0' bgs. Similar to above, but occasional cobbles.</td><td rowspan="3"></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>4D</td><td>24/24</td><td>20.00 - 22.00</td><td>24/36/37/38</td><td>73</td><td>102</td><td></td><td></td><td></td></tr><tr><td>25</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>								Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	0							SSA	160.80		PAVEMENT.	G#209269 A-1-b, SW-SM WC=9.5%	1D	24/15	1.00 - 3.00	10/8/5/3	13	18			Brown, wet, medium dense, fine to coarse SAND, some gravel, trace silt (Fill).											5							29	157.20	Grey, wet, very dense, SILT, some fine to coarse sand, little gravel, or fine to coarse SANDY SILT, little gravel, (Till). Spun large Roller Cone ahead to 10.0' bgs.	G#209270 A-4, ML WC=8.6%	2D	12/12	5.00 - 6.00	24/66	---		328										OPEN HOLE			10									Similar to above.	G#209271 A-4, ML WC=9.1%	3D	24/23	10.00 - 12.00	23/38/46/46	84	118													15								148.50	Boulder from 12.7-15.8' bgs.	G#209272 A-4, ML WC=8.6%										R1	30/10	15.50 - 18.00	RQD = N/A%			NQ-2	145.70	R1:BOULDER - TILL. (R1 in Sample Cup) R1:Core Times (min:sec) 15.5-16.5' (2:02) 16.5-17.5' (2:01) 17.5-18.0' (2:12) Core Blocked in Till.	20								143.20	Grey, wet, very dense, SILT, some fine to coarse sand, trace to some gravel, (Till). Roller Coned ahead from 18.0-20.0' bgs. Similar to above, but occasional cobbles.											4D	24/24	20.00 - 22.00	24/36/37/38	73	102				25											
Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.																																																																																																																																																																																
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)																																																																																																																																																																																			
0							SSA	160.80		PAVEMENT.	G#209269 A-1-b, SW-SM WC=9.5%																																																																																																																																																																																
	1D	24/15	1.00 - 3.00	10/8/5/3	13	18				Brown, wet, medium dense, fine to coarse SAND, some gravel, trace silt (Fill).																																																																																																																																																																																	
5							29	157.20		Grey, wet, very dense, SILT, some fine to coarse sand, little gravel, or fine to coarse SANDY SILT, little gravel, (Till). Spun large Roller Cone ahead to 10.0' bgs.	G#209270 A-4, ML WC=8.6%																																																																																																																																																																																
	2D	12/12	5.00 - 6.00	24/66	---		328																																																																																																																																																																																				
								OPEN HOLE																																																																																																																																																																																			
10										Similar to above.	G#209271 A-4, ML WC=9.1%																																																																																																																																																																																
	3D	24/23	10.00 - 12.00	23/38/46/46	84	118																																																																																																																																																																																					
15								148.50		Boulder from 12.7-15.8' bgs.	G#209272 A-4, ML WC=8.6%																																																																																																																																																																																
	R1	30/10	15.50 - 18.00	RQD = N/A%			NQ-2	145.70				R1:BOULDER - TILL. (R1 in Sample Cup) R1:Core Times (min:sec) 15.5-16.5' (2:02) 16.5-17.5' (2:01) 17.5-18.0' (2:12) Core Blocked in Till.																																																																																																																																																																															
20								143.20		Grey, wet, very dense, SILT, some fine to coarse sand, trace to some gravel, (Till). Roller Coned ahead from 18.0-20.0' bgs. Similar to above, but occasional cobbles.																																																																																																																																																																																	
	4D	24/24	20.00 - 22.00	24/36/37/38	73	102																																																																																																																																																																																					
25																																																																																																																																																																																											
Remarks: The very dense glacial till is well bonded or cemented.																																																																																																																																																																																											
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 1 of 3																																																																																																																																																																																	
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.										Boring No.: BB-SSU-103																																																																																																																																																																																	

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Stockton Springs Underpass Bridge #5760 Church Street & Route 1 Location: Stockton Springs, Maine		Boring No.: BB-SSU-103 WIN: 15108.00							
Driller: MaineDOT		Elevation (ft.): 161.2		Auger ID/OD: 5" Solid Stem									
Operator: B. Wilder/C. Giles		Datum: NAVD 88		Sampler: Standard Split Spoon									
Logged By: B. Wilder		Rig Type: CME 45C		Hammer Wt./Fall: 140#/30"									
Date Start/Finish: 6/8/09-6/8/09		Drilling Method: Cased Wash Boring		Core Barrel: NQ-2"									
Boring Location: 7+48.8, 31.8 ft Lt.		Casing ID/OD: HW		Water Level*: 2.1' bgs.									
Hammer Efficiency Factor: 0.84		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 = Insitu Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Insitu 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 = Insitu Field Vane Shear Strength (psf) T _v = Pocket Torvane Shear Strength (psf) q _p = Unconfined Compressive Strength (ksf) N _{uncorrected} = Raw field SPT N-value Hammer Efficiency Factor = Annual Calibration Value N ₆₀ = SPT N-uncorrected corrected for hammer efficiency N ₆₀ = (Hammer Efficiency Factor/60%)*N _{uncorrected}									
		S _{u(lab)} = Lab Vane Shear Strength (psf) WC = water content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test											
Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.		
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)					
25	5D	24/24	25.00 - 27.00	19/26/37/55	63	88				Grey, wet, very dense, SILT, some fine to coarse sand, trace to some gravel, (Till).	G#209273 A-4, ML WC=9.8%		
30	6D	12/12	30.00 - 31.00	39/50	---							Similar to above.	G#209274 A-4, SM WC=9.1%
35	7D	12/12	35.00 - 36.00	30/50	---				Similar to above.	G#209274 A-4, SM WC=9.1%			
40	8D	20.4/20.4	40.00 - 41.70	43/44/47/50(2.4)	91	127			Similar to above.	G#209274 A-4, SM WC=9.1%			
45	9D	18/18	45.00 - 46.50	24/42/50	92	129			Similar to above.	G#209274 A-4, SM WC=9.1%			
50													
Remarks: The very dense glacial till is well bonded or cemented.													
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.										Page 2 of 3			
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.										Boring No.: BB-SSU-103			

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Stockton Springs Underpass Bridge #5760 Church Street & Route 1 Location: Stockton Springs, Maine				Boring No.: BB-SSU-103 WIN: 15108.00							
Driller: MaineDOT				Elevation (ft.): 161.2				Auger ID/OD: 5" Solid Stem							
Operator: B. Wilder/C. Giles				Datum: NAVD 88				Sampler: Standard Split Spoon							
Logged By: B. Wilder				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"							
Date Start/Finish: 6/8/09-6/8/09				Drilling Method: Cased Wash Boring				Core Barrel: NQ-2"							
Boring Location: 7+48.8, 31.8 ft Lt.				Casing ID/OD: HW				Water Level*: 2.1' bgs.							
Hammer Efficiency Factor: 0.84				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 = Insitu Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Insitu 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 = Insitu Field Vane Shear Strength (psf) T _v = Pocket Torvane Shear Strength (psf) q _p = Unconfined Compressive Strength (ksf) N-uncorrected = Raw field SPT N-value Hammer Efficiency Factor = Annual Calibration Value N ₆₀ = SPT N-uncorrected corrected for hammer efficiency N ₆₀ = (Hammer Efficiency Factor/60%)*N-uncorrected							
				S _u (lab) = Lab Vane Shear Strength (psf) WC = water content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test											
Sample Information										Graphic Log		Visual Description and Remarks		Laboratory Testing Results/ AASHTO and Unified Class.	
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.)							
50	10D R2	3.6/3.6 60/10	50.00 - 50.30 50.70 - 55.70	50(3.6") RQD = N/A%	---		NQ-2	111.20 110.50		Rock fragments. Roller Coned ahead from 50.3-50.7' bgs.	50.00- 50.70-				
										R2: COBBLES. R2: Core Times (min:sec) 50.7-51.7' (1:10) 51.7-52.7' (1:10) 52.7-53.7' (0:30) 53.7-54.7' (1:10) 54.7-55.7' (0:35) 17% Recovery					
55							RC	105.50		Top of Bedrock at Elev. 105.5' Roller Coned ahead in apparent weathered rock from 55.7'-57.2' bgs.	55.70-				
	R3	60/30	57.20 - 62.20	RQD = 0%			NQ-2			R3: Bedrock: Grey-black, fine-grained, metasedimentary, PHYLLITE, soft, moderately weathered, highly fractured, core is granulized, fractures are silt in-filled and iron stained. Rock Mass Quality is Very Poor. [Penobscot Formation] R3: Core Times (min:sec) 57.2-58.2' (2:45) 58.2-59.2' (2:40) 59.2-60.2' (2:45) 60.2-61.2' (2:43) 61.2-62.2' (4:10) 50% Recovery					
60								99.00		Bottom of Exploration at 62.20 feet below ground surface.	62.20-				
65															
70															
75															
Remarks: The very dense glacial till is well bonded or cemented.															
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.												Page 3 of 3			
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.												Boring No.: BB-SSU-103			

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS				Project: Stockton Springs Underpass Bridge #5760 Church Street & Route 1 Location: Stockton Springs, Maine		Boring No.: BB-SSU-104 WIN: 15108.00																																																																																																																																																																																																				
Driller: MaineDOT			Elevation (ft.) 185.0		Auger ID/OD: 5" Solid Stem																																																																																																																																																																																																					
Operator: B. Wilder/C. Giles			Datum: NAVD 88		Sampler: Standard Split Spoon																																																																																																																																																																																																					
Logged By: B. Wilder			Rig Type: CME 45C		Hammer Wt./Fall: 140#/30"																																																																																																																																																																																																					
Date Start/Finish: 4/14/09, 4/28/09			Drilling Method: Cased Wash Boring		Core Barrel: NQ-2"																																																																																																																																																																																																					
Boring Location: 8+32.1, 8.6 ft Rt.			Casing ID/OD: HW		Water Level*: 18.0' bgs.																																																																																																																																																																																																					
Hammer Efficiency Factor: 0.84			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 = Insitu Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Insitu 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 = Insitu Field Vane Shear Strength (psf) T_v = Pocket Torvane Shear Strength (psf) q_p = Unconfined Compressive Strength (ksf) N_{uncorrected} = Raw field SPT N-value Hammer Efficiency Factor = Annual Calibration Value N₆₀ = SPT N-uncorrected corrected for hammer efficiency N₆₀ = (Hammer Efficiency Factor/60%)*N_{uncorrected} S_{u(lab)} = Lab Vane Shear Strength (psf) WC = water content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test																																																																																																																																																																																																										
<table><tr><th rowspan="2">Depth (ft.)</th><th colspan="8">Sample Information</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/ AASHTO and Unified Class.</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing Blows</th><th>Elevation (ft.)</th></tr><tr><td rowspan="3">0</td><td></td><td></td><td></td><td></td><td></td><td></td><td>SSA</td><td>184.45</td><td rowspan="10"></td><td rowspan="3">PAVEMENT.</td><td rowspan="3">G#209275 A-1-b, SW-SM WC=2.8%</td></tr><tr><td>1D</td><td>24/17</td><td>1.00 - 3.00</td><td>12/12/14/14</td><td>26</td><td>36</td><td></td><td></td><td>Brown, damp, dense, fine to coarse SAND, some gravel, little silt, occasional cobbles (Fill).</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td rowspan="3">5</td><td>2D</td><td>24/18</td><td>5.00 - 7.00</td><td>6/24/25/45</td><td>49</td><td>69</td><td></td><td>180.00</td><td>Brown, damp, very dense, fine to coarse SAND, some silt, trace gravel.</td><td rowspan="3">G#209226 A-2-4, SM WC=8.1%</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td rowspan="3">10</td><td>3D</td><td>24/20</td><td>10.00 - 12.00</td><td>17/35/31/22</td><td>66</td><td>92</td><td></td><td></td><td>Similar to above.</td><td rowspan="3">G#209227 A-4, ML WC=13.3%</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td rowspan="3">15</td><td>4D</td><td>24/24</td><td>15.00 - 17.00</td><td>9/21/33/33</td><td>54</td><td>76</td><td>17</td><td>172.00</td><td>Brown, wet, very dense, fine to coarse SANDY SILT, trace gravel (Till) .</td><td rowspan="3">G#209228 A-4, SM WC=12.2%</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td>58</td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td>97</td><td></td><td></td></tr><tr><td rowspan="3">20</td><td></td><td></td><td></td><td></td><td></td><td></td><td>158</td><td>167.00</td><td></td><td rowspan="3">G#209229 A-4, ML</td></tr><tr><td>5D</td><td>24/20</td><td>19.00 - 21.00</td><td>25/31/42/37</td><td>73</td><td>102</td><td>83</td><td></td><td>Brown, wet, very dense, silty fine to medium SAND, trace coarse sand and gravel (Till).</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td>131</td><td></td><td></td></tr><tr><td rowspan="3">25</td><td></td><td></td><td></td><td></td><td></td><td></td><td>213</td><td>163.00</td><td></td><td rowspan="3">G#209229 A-4, ML</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td>503</td><td></td><td>Cobble from 22.4-22.8' bgs.</td></tr><tr><td>6D</td><td>10.8/10.8</td><td>24.00 - 24.90</td><td>54/50(4.8")</td><td>---</td><td></td><td>aOH</td><td></td><td>Grey, wet, very dense, SILT, some fine to coarse sand, little gravel, (Till).</td></tr></table>								Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	0							SSA	184.45		PAVEMENT.	G#209275 A-1-b, SW-SM WC=2.8%	1D	24/17	1.00 - 3.00	12/12/14/14	26	36			Brown, damp, dense, fine to coarse SAND, some gravel, little silt, occasional cobbles (Fill).										5	2D	24/18	5.00 - 7.00	6/24/25/45	49	69		180.00	Brown, damp, very dense, fine to coarse SAND, some silt, trace gravel.	G#209226 A-2-4, SM WC=8.1%																			10	3D	24/20	10.00 - 12.00	17/35/31/22	66	92			Similar to above.	G#209227 A-4, ML WC=13.3%																			15	4D	24/24	15.00 - 17.00	9/21/33/33	54	76	17	172.00	Brown, wet, very dense, fine to coarse SANDY SILT, trace gravel (Till) .	G#209228 A-4, SM WC=12.2%							58									97			20							158	167.00		G#209229 A-4, ML	5D	24/20	19.00 - 21.00	25/31/42/37	73	102	83		Brown, wet, very dense, silty fine to medium SAND, trace coarse sand and gravel (Till).							131			25							213	163.00		G#209229 A-4, ML							503		Cobble from 22.4-22.8' bgs.	6D	10.8/10.8	24.00 - 24.90	54/50(4.8")	---		aOH		Grey, wet, very dense, SILT, some fine to coarse sand, little gravel, (Till).
Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class.																																																																																																																																																																																															
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)																																																																																																																																																																																																		
0							SSA	184.45		PAVEMENT.	G#209275 A-1-b, SW-SM WC=2.8%																																																																																																																																																																																															
	1D	24/17	1.00 - 3.00	12/12/14/14	26	36						Brown, damp, dense, fine to coarse SAND, some gravel, little silt, occasional cobbles (Fill).																																																																																																																																																																																														
5	2D	24/18	5.00 - 7.00	6/24/25/45	49	69		180.00		Brown, damp, very dense, fine to coarse SAND, some silt, trace gravel.	G#209226 A-2-4, SM WC=8.1%																																																																																																																																																																																															
10	3D	24/20	10.00 - 12.00	17/35/31/22	66	92				Similar to above.	G#209227 A-4, ML WC=13.3%																																																																																																																																																																																															
15	4D	24/24	15.00 - 17.00	9/21/33/33	54	76	17	172.00		Brown, wet, very dense, fine to coarse SANDY SILT, trace gravel (Till) .	G#209228 A-4, SM WC=12.2%																																																																																																																																																																																															
							58																																																																																																																																																																																																			
							97																																																																																																																																																																																																			
20							158	167.00		G#209229 A-4, ML																																																																																																																																																																																																
	5D	24/20	19.00 - 21.00	25/31/42/37	73	102	83		Brown, wet, very dense, silty fine to medium SAND, trace coarse sand and gravel (Till).																																																																																																																																																																																																	
							131																																																																																																																																																																																																			
25							213	163.00		G#209229 A-4, ML																																																																																																																																																																																																
							503		Cobble from 22.4-22.8' bgs.																																																																																																																																																																																																	
	6D	10.8/10.8	24.00 - 24.90	54/50(4.8")	---		aOH		Grey, wet, very dense, SILT, some fine to coarse sand, little gravel, (Till).																																																																																																																																																																																																	
Remarks: The very dense glacial till is well bonded or cemented.																																																																																																																																																																																																										
Stratification lines represent approximate boundaries between soil types; transitions may be gradual. * Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.										Page 1 of 4 Boring No.: BB-SSU-104																																																																																																																																																																																																

Maine Department of Transportation Soil/Rock Exploration Log US CUSTOMARY UNITS						Project: Stockton Springs Underpass Bridge #5760 Church Street & Route 1 Location: Stockton Springs, Maine						Boring No.: BB-SSU-104 WIN: 15108.00																																																																																																																																																																																																																								
Driller: MaineDOT						Elevation (ft.): 185.0						Auger ID/OD: 5" Solid Stem																																																																																																																																																																																																																								
Operator: B. Wilder/C. Giles						Datum: NAVD 88						Sampler: Standard Split Spoon																																																																																																																																																																																																																								
Logged By: B. Wilder						Rig Type: CME 45C						Hammer Wt./Fall: 140#/30"																																																																																																																																																																																																																								
Date Start/Finish: 4/14/09, 4/28/09						Drilling Method: Cased Wash Boring						Core Barrel: NQ-2"																																																																																																																																																																																																																								
Boring Location: 8+32.1, 8.6 ft Rt.						Casing ID/OD: HW						Water Level*: 18.0' bgs.																																																																																																																																																																																																																								
Hammer Efficiency Factor: 0.84						Hammer Type: Automatic☑ Hydraulic☐ Rope & Cathead☐																																																																																																																																																																																																																														
Definitions: D = Split Spoon Sample R = Rock Core Sample S_u = Insitu Field Vane Shear Strength (psf) S_{u(lab)} = Lab Vane Shear Strength (psf) MD = Unsuccessful Split Spoon Sample attempt SSA = Solid Stem Auger T_v = Pocket Torvane Shear Strength (psf) WC = water content, percent U = Thin Wall Tube Sample HSA = Hollow Stem Auger q_p = Unconfined Compressive Strength (ksf) LL = Liquid Limit MU = Unsuccessful Thin Wall Tube Sample attempt RC = Roller Cone N-uncorrected = Raw field SPT N-value PL = Plastic Limit V = Insitu Vane Shear Test, PP = Pocket Penetrometer WOH = weight of 140lb. hammer Hammer Efficiency Factor = Annual Calibration Value PI = Plasticity Index MV = Unsuccessful Insitu Vane Shear Test attempt WOR/C = weight of rods or casing N₆₀ = SPT N-uncorrected corrected for hammer efficiency G = Grain Size Analysis C = Consolidation Test																																																																																																																																																																																																																																				
<table><tr><th rowspan="2">Depth (ft.)</th><th colspan="9">Sample Information</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/ AASHTO and Unified Class</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N₆₀</th><th>Casing Blows</th><th>Elevation (ft.)</th></tr><tr><td>25</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="12">156.00</td><td rowspan="12"></td><td rowspan="4">aOH= Open Hole with large Roller Cone Grey, wet, very dense, SILT, some fine to coarse sand, little gravel, (Till).</td><td rowspan="4">WC=8.5%</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>30</td><td>7D</td><td>6/6</td><td>30.00 - 30.50</td><td>54</td><td>---</td><td></td><td></td><td></td><td>Olive, wet, very dense, SILT, some fine to coarse sand, trace to some gravel, occasional cobbles, (Till).</td><td rowspan="12">G#209230 A-4, ML WC=9.3%</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>35</td><td>8D</td><td>18/18</td><td>35.00 - 36.50</td><td>37/42/58</td><td>100</td><td>140</td><td></td><td></td><td>Similar to above.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>40</td><td>9D</td><td>24/24</td><td>40.00 - 42.00</td><td>19/35/42/44</td><td>77</td><td>108</td><td></td><td></td><td>Similar to above.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>45</td><td>10D</td><td>10.8/10.8</td><td>45.00 - 45.90</td><td>41/55(4.8")</td><td>---</td><td></td><td></td><td></td><td>Similar to above.</td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>50</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>																		Depth (ft.)	Sample Information									Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)	25									156.00		aOH= Open Hole with large Roller Cone Grey, wet, very dense, SILT, some fine to coarse sand, little gravel, (Till).	WC=8.5%																									30	7D	6/6	30.00 - 30.50	54	---				Olive, wet, very dense, SILT, some fine to coarse sand, trace to some gravel, occasional cobbles, (Till).	G#209230 A-4, ML WC=9.3%																															35	8D	18/18	35.00 - 36.50	37/42/58	100	140			Similar to above.																															40	9D	24/24	40.00 - 42.00	19/35/42/44	77	108			Similar to above.																					45	10D	10.8/10.8	45.00 - 45.90	41/55(4.8")	---				Similar to above.																					50											
Depth (ft.)	Sample Information									Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class																																																																																																																																																																																																																								
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N ₆₀	Casing Blows	Elevation (ft.)																																																																																																																																																																																																																												
25									156.00		aOH= Open Hole with large Roller Cone Grey, wet, very dense, SILT, some fine to coarse sand, little gravel, (Till).	WC=8.5%																																																																																																																																																																																																																								
30	7D	6/6	30.00 - 30.50	54	---						Olive, wet, very dense, SILT, some fine to coarse sand, trace to some gravel, occasional cobbles, (Till).	G#209230 A-4, ML WC=9.3%																																																																																																																																																																																																																								
35	8D	18/18	35.00 - 36.50	37/42/58	100	140					Similar to above.																																																																																																																																																																																																																									
40	9D	24/24	40.00 - 42.00	19/35/42/44	77	108			Similar to above.																																																																																																																																																																																																																											
45	10D	10.8/10.8	45.00 - 45.90	41/55(4.8")	---				Similar to above.																																																																																																																																																																																																																											
50																																																																																																																																																																																																																																				
Remarks: The very dense glacial till is well bonded or cemented.																																																																																																																																																																																																																																				
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.												Page 2 of 4																																																																																																																																																																																																																								
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.												Boring No.: BB-SSU-104																																																																																																																																																																																																																								

[illegible]

Maine Department of Transportation <u>Soil/Rock Exploration Log</u> US CUSTOMARY UNITS				Project: Stockton Springs Underpass Bridge #5760 Church Street & Route 1 Location: Stockton Springs, Maine				Boring No.: BB-SSU-104 WIN: 15108.00																																																																																																											
Driller: MaineDOT				Elevation (ft.) 185.0				Auger ID/OD: 5" Solid Stem																																																																																																											
Operator: B. Wilder/C. Giles				Datum: NAVD 88				Sampler: Standard Split Spoon																																																																																																											
Logged By: B. Wilder				Rig Type: CME 45C				Hammer Wt./Fall: 140#/30"																																																																																																											
Date Start/Finish: 4/14/09, 4/28/09				Drilling Method: Cased Wash Boring				Core Barrel: NQ-2"																																																																																																											
Boring Location: 8+32.1, 8.6 ft Rt.				Casing ID/OD: HW				Water Level*: 18.0' bgs.																																																																																																											
Hammer Efficiency Factor: 0.84				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 = Insitu Vane Shear Test, PP = Pocket Penetrometer MV = Unsuccessful Insitu 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				Su = Insitu Field Vane Shear Strength (psf) Tv = Pocket Torvane Shear Strength (psf) qp = Unconfined Compressive Strength (ksf) N-uncorrected = Raw field SPT N-value Hammer Efficiency Factor = Annual Calibration Value N60 = SPT N-uncorrected corrected for hammer efficiency N60 = (Hammer Efficiency Factor/60%)*N-uncorrected																																																																																																											
				Su(lab) = Lab Vane Shear Strength (psf) WC = water content, percent LL = Liquid Limit PL = Plastic Limit PI = Plasticity Index G = Grain Size Analysis C = Consolidation Test																																																																																																															
<table><tr><th rowspan="2">Depth (ft.)</th><th colspan="8">Sample Information</th><th rowspan="2">Graphic Log</th><th rowspan="2">Visual Description and Remarks</th><th rowspan="2">Laboratory Testing Results/ AASHTO and Unified Class</th></tr><tr><th>Sample No.</th><th>Pen./Rec. (in.)</th><th>Sample Depth (ft.)</th><th>Blows (6 in.) Shear Strength (psf) or RQD (%)</th><th>N-uncorrected</th><th>N60</th><th>Casing</th><th>Blows</th></tr><tr><td>75</td><td>R2</td><td>60/60</td><td>75.40 - 80.40</td><td>RQD = 46%</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>R1:Core Times (min:sec) 70.4-71.4' (9:16) 71.4-72.4' (11:35) 72.4-73.4' (9:00) 73.4-74.4' (9:10) 74.4-75.4' (9:50) 100% Recovery R2:Core Times (min:sec) 75.4-76.4' (7:15) 76.4-77.4' (7:23) 77.4-78.4' (5:35) 78.4-79.4' (6:12) 79.4-80.4' (7:25) 100% Recovery Bottom of Exploration at 80.40 feet below ground surface.</td><td></td></tr><tr><td>80</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>85</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>90</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>95</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>100</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table>												Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing	Blows	75	R2	60/60	75.40 - 80.40	RQD = 46%								R1:Core Times (min:sec) 70.4-71.4' (9:16) 71.4-72.4' (11:35) 72.4-73.4' (9:00) 73.4-74.4' (9:10) 74.4-75.4' (9:50) 100% Recovery R2:Core Times (min:sec) 75.4-76.4' (7:15) 76.4-77.4' (7:23) 77.4-78.4' (5:35) 78.4-79.4' (6:12) 79.4-80.4' (7:25) 100% Recovery Bottom of Exploration at 80.40 feet below ground surface.		80														85														90														95														100													
Depth (ft.)	Sample Information								Graphic Log	Visual Description and Remarks	Laboratory Testing Results/ AASHTO and Unified Class																																																																																																								
	Sample No.	Pen./Rec. (in.)	Sample Depth (ft.)	Blows (6 in.) Shear Strength (psf) or RQD (%)	N-uncorrected	N60	Casing	Blows																																																																																																											
75	R2	60/60	75.40 - 80.40	RQD = 46%								R1:Core Times (min:sec) 70.4-71.4' (9:16) 71.4-72.4' (11:35) 72.4-73.4' (9:00) 73.4-74.4' (9:10) 74.4-75.4' (9:50) 100% Recovery R2:Core Times (min:sec) 75.4-76.4' (7:15) 76.4-77.4' (7:23) 77.4-78.4' (5:35) 78.4-79.4' (6:12) 79.4-80.4' (7:25) 100% Recovery Bottom of Exploration at 80.40 feet below ground surface.																																																																																																							
80																																																																																																																			
85																																																																																																																			
90																																																																																																																			
95																																																																																																																			
100																																																																																																																			
Remarks: The very dense glacial till is well bonded or cemented.																																																																																																																			
Stratification lines represent approximate boundaries between soil types; transitions may be gradual.																																																																																																																			
* Water level readings have been made at times and under conditions stated. Groundwater fluctuations may occur due to conditions other than those present at the time measurements were made.																																																																																																																			
Page 4 of 4																																																																																																																			
Boring No.: BB-SSU-104																																																																																																																			

Appendix B

Laboratory Test Data

Laboratory Testing Summary Sheet

Town(s): Stockton Springs

Project Number: 15108.00

[illegible]

Classification of these soil samples is in accordance with AASHTO Classification System M-145-40. This classification is followed by the "Frost Susceptibility Rating" from zero (non-frost susceptible) to Class IV (highly frost susceptible).

The "Frost Susceptibility Rating" is based upon the MaineDOT and Corps of Engineers Classification Systems.

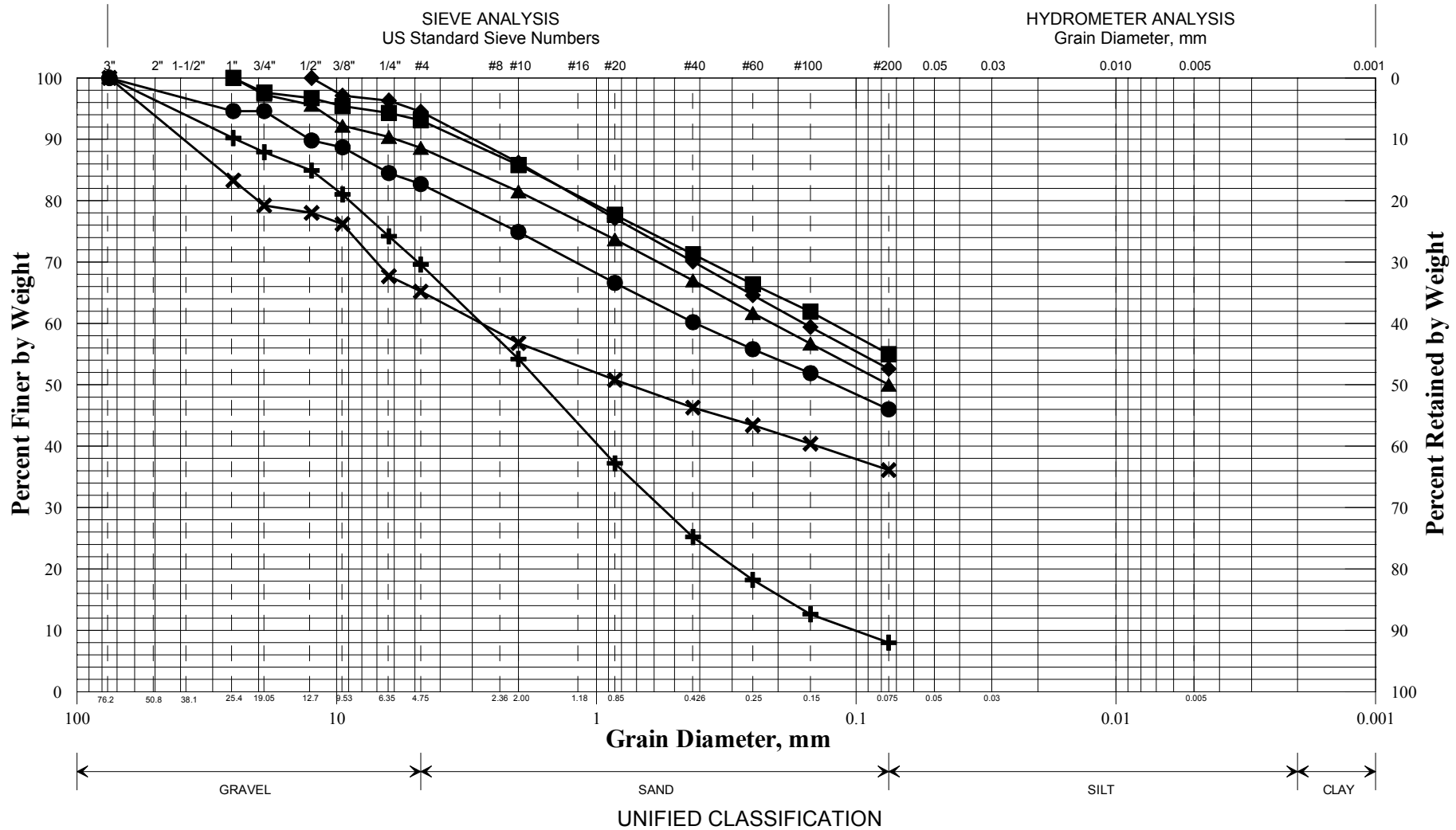
GSDC = Grain Size Distribution Curve as determined by AASHTO T 88-93 (1996) and/or ASTM D 422-63 (Reapproved 1998)

WC = water content as determined by AASHTO T 265-93 and/or ASTM D 2216-98

LL = Liquid limit as determined by AASHTO T 89-96 and/or ASTM D 4318-98

PI = Plasticity Index as determined by AASHTO 90-96 and/or ASTM D4318-98

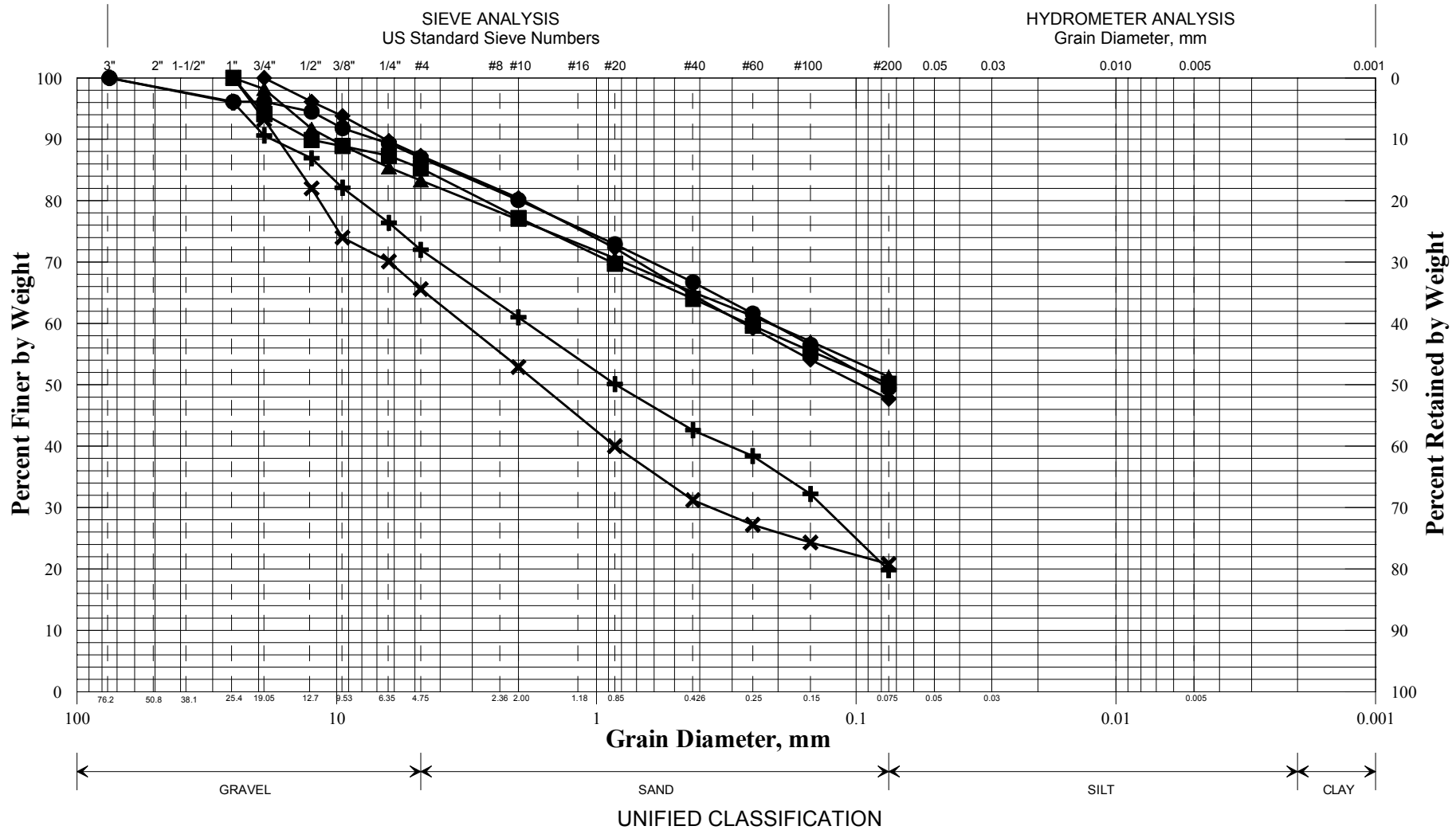
State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
+	BB-SSU-101/1D	6+65.7	13.5 LT	1.0-3.0	SAND, some gravel, trace silt.	3.8			
◆	BB-SSU-101/2D(A)	6+65.7	13.5 LT	6.0-7.0	SANDY SILT, trace gravel.	10.3			
■	BB-SSU-101/3D	6+65.7	13.5 LT	10.0-12.0	SANDY SILT, trace gravel.	10.1			
●	BB-SSU-101/4D	6+65.7	13.5 LT	15.0-17.0	SANDY SILT, little gravel.	7.9			
▲	BB-SSU-101/8D	6+65.7	13.5 LT	35.0-37.0	SANDY SILT, trace gravel.	8.1			
×	BB-SSU-101/12D	6+65.7	13.5 LT	60.0-60.5	SILT, some gravel, some sand.	7.2			

WIN	
015108.00	
Town	
Stockton Springs	
Reported by/Date	
WHITE, TERRY A	8/5/2009

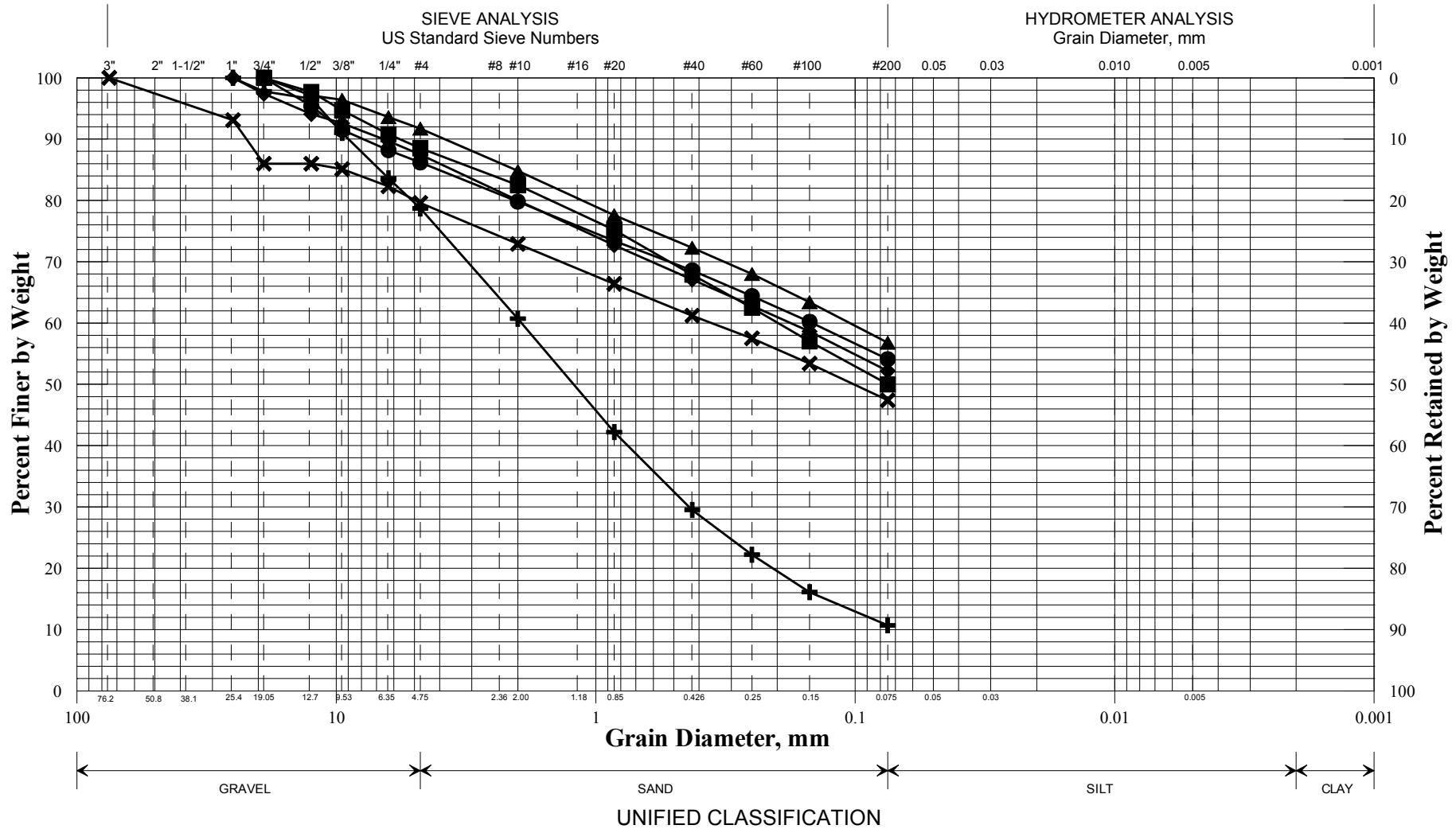
State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
+	BB-SSU-102/1D	7+39.3	21.7 RT	1.0-3.0	SAND, some gravel, little silt.	7.3			
◆	BB-SSU-102/2D	7+39.3	21.7 RT	5.0-6.0	SANDY SILT, little gravel.	8.5			
■	BB-SSU-102/3D	7+39.3	21.7 RT	10.0-11.0	SILT, some sand, little gravel.	8.5			
●	BB-SSU-102/4D	7+39.3	21.7 RT	15.0-17.0	SANDY SILT, little gravel.	8.2			
▲	BB-SSU-102/8D	7+39.3	21.7 RT	40.0-41.6	SILT, some sand, little gravel.	9.0			
×	BB-SSU-102/10D	7+39.3	21.7 RT	50.0-50.5	SAND, some gravel, some silt.	10.1			

WIN
015108.00
Town
Stockton Springs
Reported by/Date
WHITE, TERRY A 8/5/2009

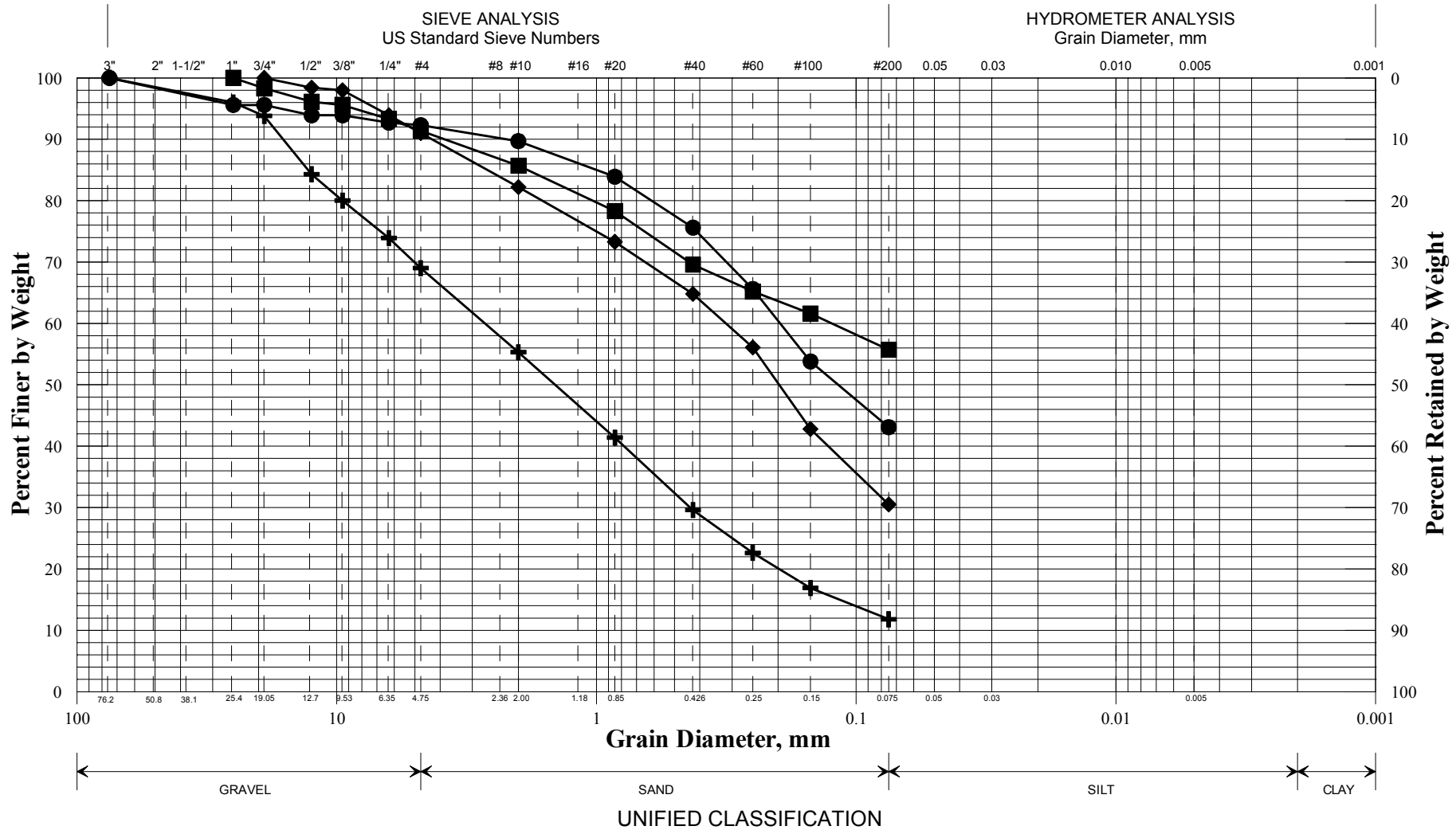
State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
+	BB-SSU-103/1D	7+48.8	31.8 LT	1.0-3.0	SAND, some gravel, trace silt.	9.5			
◆	BB-SSU-103/2D	7+48.8	31.8 LT	5.0-6.0	SILT, some sand, little gravel.	8.6			
■	BB-SSU-103/3D	7+48.8	31.8 LT	10.0-12.0	SANDY SILT, little gravel.	9.1			
●	BB-SSU-103/R1	7+48.8	31.8 LT	15.5-18.0	SILT, some sand, little gravel.	8.6			
▲	BB-SSU-103/6D	7+48.8	31.8 LT	30.0-31.0	SILT, some sand, trace gravel.	9.8			
×	BB-SSU-103/9D	7+48.8	31.8 LT	45.0-46.5	SILT, some sand, some gravel.	9.1			

WIN
015108.00
Town
Stockton Springs
Reported by/Date
WHITE, TERRY A 8/5/2009

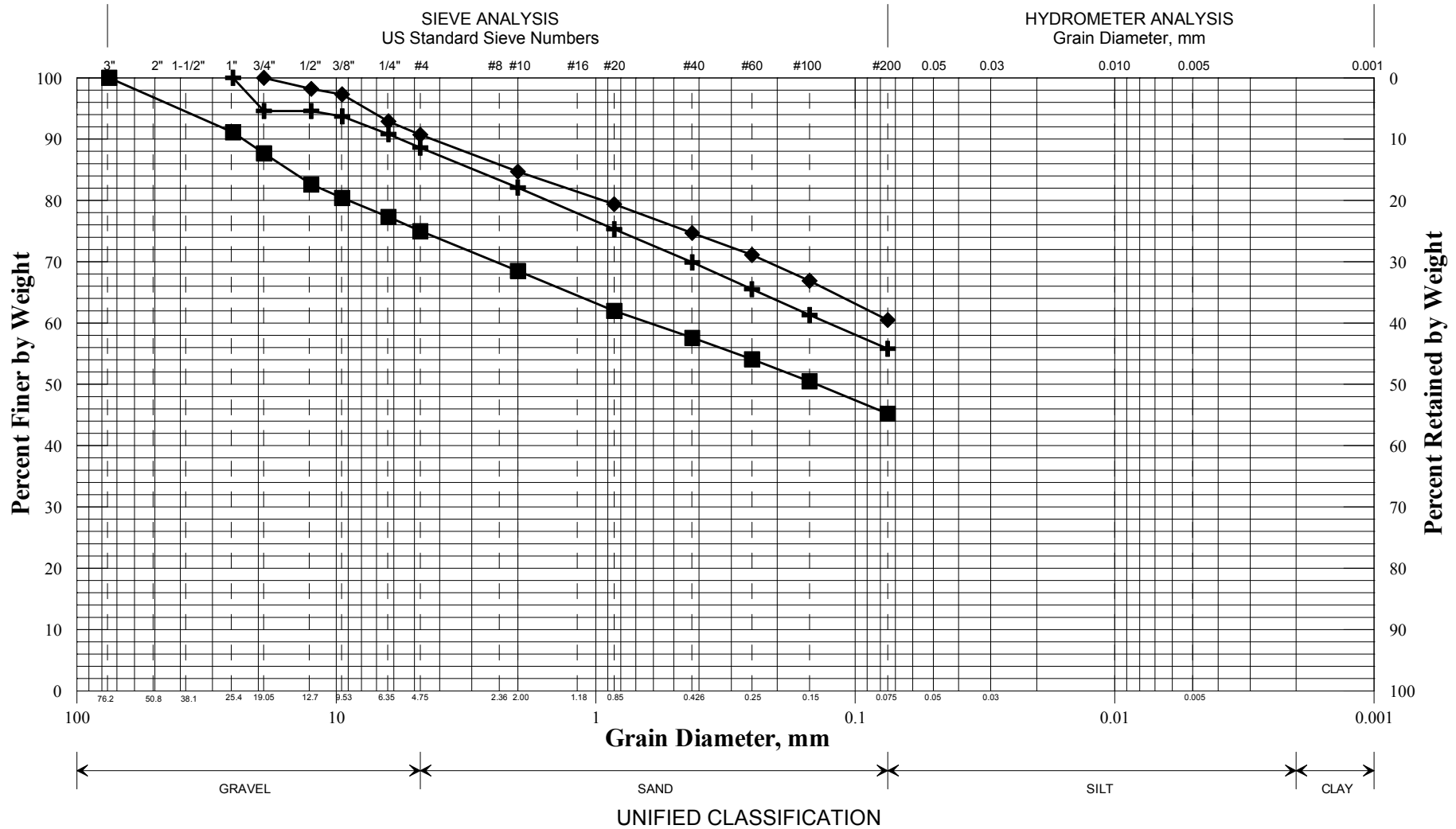
State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
+	BB-SSU-104/1D	8+32.1	8.6 RT	1.0-3.0	SAND, some gravel, little silt.	2.8			
◆	BB-SSU-104/2D	8+32.1	8.6 RT	5.0-7.0	SAND, some silt, trace gravel.	8.1			
■	BB-SSU-104/4D	8+32.1	8.6 RT	15.0-17.0	SANDY SILT, trace gravel.	13.3			
●	BB-SSU-104/5D	8+32.1	8.6 RT	19.0-21.0	Silty SAND, trace gravel.	12.2			
▲									
×									

WIN	
015108.00	
Town	
Stockton Springs	
Reported by/Date	
WHITE, TERRY A	8/5/2009

State of Maine Department of Transportation
GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
+	BB-SSU-104/6D	8+32.1	8.6 RT	24.0-24.9	SILT, some sand, little gravel.	8.5			
◆	BB-SSU-104/9D	8+32.1	8.6 RT	40.0-42.0	SILT, some sand, trace gravel.	9.3			
■	BB-SSU-104/12D	8+32.1	8.6 RT	60.0-61.0	SILT, some sand, some gravel.	8.5			
●									
▲									
×									

WIN	
015108.00	
Town	
Stockton Springs	
Reported by/Date	
WHITE, TERRY A	8/5/2009

Appendix C

Calculations

FROST PENETRATION:

Method 1

--- ModBerg Results ---

Project Location: Belfast, Maine

Air Design Freezing Index = 1188 F-days
N-Factor = 0.80
Surface Design Freezing Index = 950 F-days
Mean Annual Temperature = 45.5 deg F
Design Length of Freezing Season = 118 days

Layer
#:Type t w% d Cf Cu Kf Ku L

1-Coarse 63.6 10.0 125.0 28 34 2.0 1.6 1,800

t = Layer thickness, in inches.
w% = Moisture content, in percentage of dry density.
d = Dry density, in lbs/cubic ft.
Cf = Heat Capacity of frozen phase, in BTU/(cubic ft degree F).
Cu = Heat Capacity of thawed phase, in BTU/(cubic ft degree F).
Kf = Thermal conductivity in frozen phase, in BTU/(ft hr degree).
Ku = Thermal conductivity in thawed phase, in BTU/(ft hr degree).
L = Latent heat of fusion, in BTU / cubic ft.

Total Depth of Frost Penetration = 5.30 ft = 63.6 in.

Method 2

From the Maine Design Freezing Index Map:

DFI = 1460 degree-days

Site has Coarse-Grained Soils With Wn = 10%

From the 2003 Bridge Design Guide Table 5-1:

$\text{Frost_depth} := [0.6 \cdot (82.1\text{in} - 79.2\text{in}) + 79.2\text{in}]$

$\text{Frost_depth} = 80.94\text{in}$

$\text{Frost_depth} = 6.75\text{ft}$

Use 5.5 feet

ABUTMENT AND WINGWALL ACTIVE AND PASSIVE EARTH PRESSURES:

Rankine Theory - Active Earth Pressure from MaineDOT Bridge Design Guide Section 3.6.5.2, pg. 3-7

Either Rankine or Coulomb may be used for long-heeled cantilever walls where the failure surface is uninterrupted by the top of the wall stem. In general, use Rankine though.

Soil angle of internal friction:

$$\phi := 32\text{deg}$$

Slope angle of backfill soil from horizontal:

$$\beta := 0\text{deg}$$

$$K_a := \tan \left[45\text{deg} - \left(\frac{\phi}{2} \right) \right]^2$$

$$K_a = 0.31$$

Coulomb Theory - Active Earth Pressure from MaineDOT Bridge Design Guide Section 3.6.5.2, pg. 3-7

For gravity walls, semi-gravity walls, prefabricated modular walls, and cantilever walls and abutments with short heels where wall and backfill interface friction is considered, use Coulomb Theory

Angle of back face of wall:

$$\alpha := 90\text{deg}$$

Soil angle of internal friction:

$$\phi := 32\text{deg}$$

Slope angle of backfill soil from horizontal:

$$\beta := 0\text{deg}$$

$$\delta = \beta$$

$$\delta := \beta$$

$$K_a := \frac{\sin(\alpha + \phi)^2}{\sin(\alpha)^2 \cdot \sin(\alpha - \delta) \cdot \left(1 + \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - \beta)}{\sin(\alpha - \delta) \cdot \sin(\beta + \alpha)}} \right)^2}$$

$$K_a = 0.31$$

Rankine Theory - Passive Earth Pressure from Bowles 5th Edition Section 11-5, pg 602

Soil angle of internal friction:

$$\phi := 32\text{deg}$$

Slope angle of backfill soil from horizontal:

$$\beta := 0\text{deg}$$

$$K_{p_rank} := \frac{\cos(\beta) + \sqrt{\cos(\beta)^2 - \cos(\phi)^2}}{\cos(\beta) - \sqrt{\cos(\beta)^2 - \cos(\phi)^2}}$$

$$K_{p_rank} = 3.25$$

Coulomb Theory - Passive Earth Pressure from MaineDOT Bridge Design Guide Section 3.6.6, pg. 3-8

Angle of back face of wall:

$$\alpha := 90\text{deg}$$

Soil angle of internal friction:

$$\phi := 32\text{deg}$$

Friction angle between fill and wall:

From LRFD Table 3.11.5.3-1, pg. 3-74, δ ranges from 17 to 22

$$\delta := 20\text{deg}$$

Angle of backfill from horizontal:

$$\beta := 0\text{deg}$$

$$K_p := \frac{\sin(\alpha - \phi)^2}{\sin(\alpha)^2 \cdot \sin(\alpha + \delta) \cdot \left(1 - \sqrt{\frac{\sin(\phi + \delta) \cdot \sin(\phi - \beta)}{\sin(\alpha - \delta) \cdot \sin(\beta + \alpha)}} \right)^2}$$

$$K_p = 6.89$$

MSE REINFORCED EARTH WALL BEARING RESISTANCE:

Consider this for use with MSE wall system on compacted sand and gravel fill or glacial till.

SERVICE LIMIT STATE:

LRFD Table C10.6.2.6.1-1, (Based on NAVFAC DM 7.2) - "Presumptive Bearing Resistances for Spread Footing Foundations at the Service Limit State"

<u>Bearing Material</u>	<u>Consistency in Place</u>	<u>Bearing Resistance</u> (kips per sq. foot)	<u>Value</u>	<u>Recommend</u>
Coarse to Medium sand, little gravel	Very dense	8 to 12	8 ksf	
	Medium dense to dense	4 to 8	6 ksf	
	Loose	2 to 4	3 ksf	

Recommend **6.0 ksf** to control settlements for **Service Limit State** analyses and for preliminary reinforcement length sizing for MSE Walls.

STRENGTH LIMIT STATE:

Nominal and Factored Bearing Resistance for MSE reinforced soil mass on fill soils at the Strength Limit State:

Assumptions:

1. Footings will be embedded 5.5 feet for frost protection.

$$D_f := 5.5\text{ft}$$

2. Assumed parameters for soils:
Assume granular fill

Moist unit weight: $\gamma_m := 125\text{pcf}$

Saturated unit weight: $\gamma_{\text{sat}} := 130\text{pcf}$

Soil angle of internal friction: $\phi_{\text{ns}} := 32$

Undrained shear strength (cohesion): $c_{\text{ns}} := 0\text{psf}$

3. Use Terzaghi square footing shape factors

Assume Groundwater near ground surface
based on boring data:

$$D_w := 0.0 \cdot \text{ft}$$

Unit weight of water:

$$\gamma_w := 62.4 \text{ pcf}$$

Effective Stress at the footing bearing level:

$$q_{\text{eff_str}} := D_w \cdot \gamma_m + (D_f - D_w) \cdot (\gamma_{\text{sat}} - \gamma_w)$$

$$q_{\text{eff_str}} = 0.37 \cdot \text{ksf}$$

MSE Wall Base for full height wall is 22 ft wide

$$B := 22 \text{ ft}$$

Terzaghi Shape Factors from Table 4-1, p. 220
For square footing:

$$S_c := 1.3$$

$$S_\gamma := 0.8$$

Meyerhof Bearing Capacity Factors For $\phi = 32$ deg

Bowles 5th Ed. Table 4-4 pg. 223

$$N_c := 35.47$$

$$N_q := 23.2$$

$$N_\gamma := 22.0$$

Nominal Bearing Resistance per Terzaghi equation

Bowles 5th Ed. Table 4-1 pg. 220

$$q_{\text{nom}} := c_{ns} \cdot N_c \cdot S_c + q_{\text{eff_str}} \cdot N_q + 0.5(\gamma_{\text{sat}} - \gamma_w) \cdot B \cdot N_\gamma \cdot S_\gamma$$

$$q_{\text{nom}} = 21.7 \cdot \text{ksf}$$

Resistance Factor from LRFD Table 10.5.5.2.2-1 pg.
10-32:

$$\phi_b := 0.65$$

$$q_{\text{fac}} := q_{\text{nom}} \cdot \phi_b$$

$$q_{\text{fac}} = 14.1 \cdot \text{ksf}$$

**Recommend 14.1 ksf Strength Limit State Factored
Bearing Resistance for MSE wall base**

EXTREME LIMIT STATE:

Nominal and Factored Bearing Resistance for MSE wall on glacial till at the Extreme Limit State considering vehicle collision force CT:

q_{nom} from above:

$$q_{nom} = 21.7 \cdot ksf$$

Resistance Factor from LRFD Article 11.5.7 pg. 11-12:

$$\phi := 1.0$$

$$q_{fac} := q_{nom} \cdot \phi$$

$$q_{fac} = 21.7 \cdot ksf$$

The Extreme Limit State Factored Bearing Resistance for MSE wall base

MSE MASS SETTLEMENT ANALYSIS:

Estimate Settlement for MSE Wall Mass On Soil Using Hough Method:

Ref. LRFD Section 10.6.2.4.2, pg. 10-58

Assumptions:

- B=20 ft (MSE mass)
- Approximately 18 feet new fill in MSE reinforced mass
- Bridge load contribution approximately 0.4×7 ksf
- Use SPT blow counts for each layer - Note that till was very dense and "N" values sometimes not achieved, but blow counts for penetrated interval were used (conservative)
- Assume MSE Reinforced Mass constructed at approximate Elev. 155
- Assume Ground Water at base of the MSE Reinforced Soil Mass
- Influence factors from LRFD Figure 10.6.2.4.1-1, pg. 10-56
- Bearing Capacity Indices $C' = 210$ from LRFD Figure 10.6.2.4.2-1, pg. 10-59

Calculate Average SPT Blow Counts for 10-Foot Layers

Elevation	101	102	103	104	10 Foot Layer Average
155	55	75	90	54	86
150	57	97	118	140	
145	99	112		108	91
140	50	72	102	96	
135	115	111	88	95	89
130	78	50	89		
125		55	80	95	91
120	55	134	127		
115		101	129	50	80
110	58	60			

Determine C' Values Using "Well Graded Silty Sand and Gravel" Curve.

All SPT Values Exceed Curve. Use:

$$C' := 300$$

Determine I Values

$$z := \begin{pmatrix} 5 \\ 15 \\ 25 \\ 35 \\ 45 \end{pmatrix} \text{ ft} \quad H := 10 \text{ ft} \quad I := \begin{pmatrix} 0.95 \\ 0.65 \\ 0.45 \\ 0.35 \\ 0.27 \end{pmatrix}$$

$$\Delta\sigma_v := [(18 \text{ ft} \cdot 125 \text{ pcf}) + (0.4 \cdot 7 \text{ ksf})] \cdot I \quad \Delta\sigma_v = \begin{pmatrix} 4.8 \\ 3.28 \\ 2.27 \\ 1.77 \\ 1.36 \end{pmatrix} \cdot \text{ksf}$$

$$\gamma_t := 130 \text{ pcf} \quad \gamma_w := 62.4 \text{ pcf} \quad (\gamma') := \gamma_t - \gamma_w \quad \gamma' = 67.6 \cdot \text{pcf}$$

$$\sigma_o := \gamma_t \cdot 5.5 \text{ ft} + \gamma' \cdot z \quad \sigma_o = \begin{pmatrix} 1.05 \\ 1.73 \\ 2.41 \\ 3.08 \\ 3.76 \end{pmatrix} \cdot \text{ksf}$$

$$\Delta H := \left[H \cdot \left(\frac{1}{C'} \right) \cdot \log \left(\frac{\sigma_o + \Delta\sigma_v}{\sigma_o} \right) \right] \quad \Delta H = \begin{pmatrix} 0.3 \\ 0.18 \\ 0.12 \\ 0.08 \\ 0.05 \end{pmatrix} \cdot \text{in}$$

$$\Delta H_{\text{TOTAL}} := 0.30 \cdot \text{in} + 0.18 \cdot \text{in} + 0.12 \text{ in} + 0.08 \text{ in} + 0.05 \text{ in}$$

$$\Delta H_{\text{TOTAL}} = 0.73 \cdot \text{in}$$

OK, Say 3/4 inch or less settlement below MSE mass.

ABUTMENT SPREAD FOOTING BEARING RESISTANCE :

Consider this for bridge abutment spread footings on MSE backfill soils.

SERVICE LIMIT STATE:

Limit bearing resistance on reinforced volume to 4ksf FHWA-NHI-00-043 "Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes," November 2009

$$q_{nom} := 4ksf$$

$$q_{factored_bc} := q_{nom} \cdot 1.0$$

$$q_{factored_bc} = 4 \cdot ksf$$

Recommend **4.0 ksf** maximum bearing resistance for **Service Limit State** analyses (based on 1/2-inch settlement) and for preliminary footing sizing **ONLY**.

STRENGTH LIMIT STATE:

FHWA-NHI-00-043 "Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes," November 2009, Pg. 6-5

Recommend **7.0 ksf** maximum bearing resistance for **Strength Limit State** analyses.



U. S. Department of Transportation
Federal Highway Administration

Publication No. FHWA-NHI-10-024
FHWA GEC 011 – Volume I
November 2009

NHI Courses No. 132042 and 132043

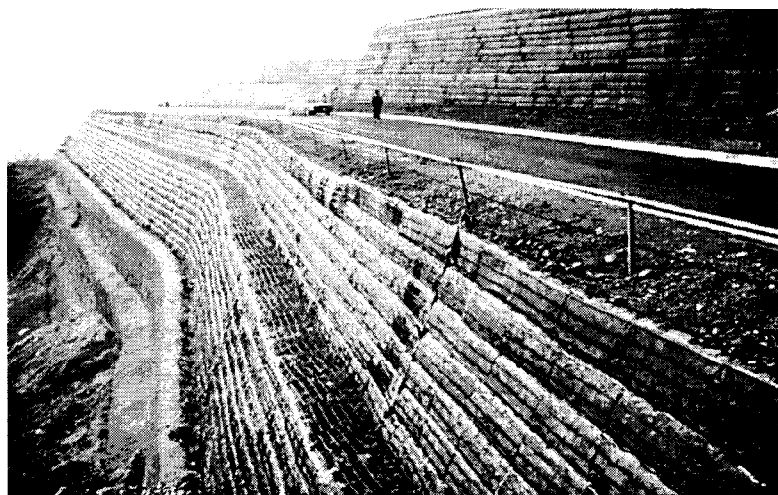
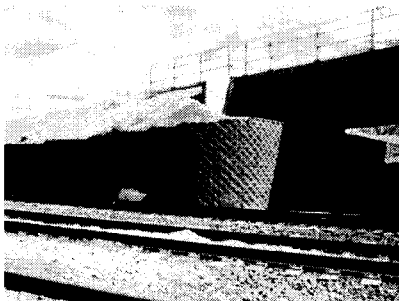
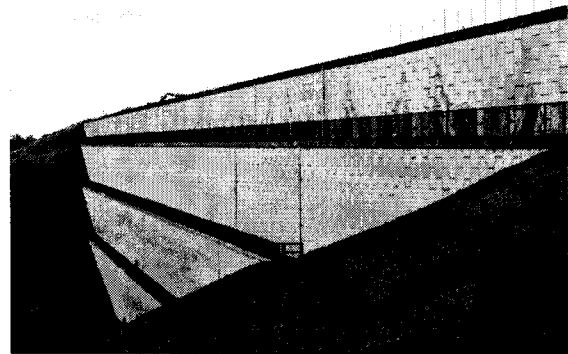
Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volume I

Developed following:

*AASHTO LRFD Bridge Design
Specifications, 4th Edition, 2007,
with 2008 and 2009 Interims.*

and

*AASHTO LRFD Bridge Construction
Specifications, 2nd Edition, 2004, with
2006, 2007, 2008, and 2009 Interims.*



- Require a minimum offset from the front of the facing to the centerline of the bridge bearing of 3.5 ft (1 m).
- Require a minimum clear distance, c_f , of 6 in. (150 mm) between the back face of the facing panels and the front edge of the footing.
- In areas that are susceptible for frost, the frost effect can develop from both the top of the wall as well as the front of the wall. Where significant frost penetration is anticipated, place the abutment footing on a bed of non-frost susceptible compacted coarse aggregate (e.g., No. 57 as specified in AASHTO M 43). The thickness of the aggregate bed should be minimum 3 ft (1 m) or 1 ft (0.3 m) below deepest anticipated frost penetration depth, whichever is greater. Separation geotextile should be provided at the interface of No. 57 coarse aggregate and the surrounding fills (reinforced, retained and above the footing base). Adjoining sections of the separation geotextile should be overlapped by a minimum of 1 ft (0.3 m).
- For the analysis of the spread footing on top of the reinforced soil zone, use the following values of bearing resistance of the reinforced soil zone
 - For service limit state, bearing resistance = 4 ksf (200 kPa) to limit the vertical movement to less than approximately 0.5 in. (12.5 mm)
 - For strength limit state, factored bearing resistance = 7 ksf (335 kPa)
(Note: AASHTO does not provide a value of factored bearing resistance at strength limit state and the recommended value is based on the authors' experience.)
- Use the maximum horizontal force at top reinforcement level below the abutment for the design of connections of the panels at all reinforcement levels.
- Extend the density, length and cross-section of reinforcements of the abutments to wingwalls, for a horizontal distance which is greater of the following:
 - 50 percent of the maximum height, H , of the abutment wall face.
 - $c_f + b_f + 3$ ft (1 m) where c_f and b_f are as shown in Figure 6-2
- There will be 2-way soil reinforcement within the length of reinforcement perpendicular to the abutment face. It is preferable that reinforcement is not placed on top of each other in the zone of 2-way reinforcement. The overlapping reinforcement should be separated by 3 to 6 in. (75 to 150 mm) of soil or some multiple of compacted fill height. This may be achieved by appropriately adjusting the steps of the leveling pad between the abutment face wall and the wing walls. This practice is especially recommended where a corrosion monitoring program is implemented in the abutment area (Elias et al., 2009).

SEISMIC ANALYSIS:

PIN 15108 Stockton Springs
Date and Time: 9/29/2009 11:38:36 AM

Conterminous 48 States
2007 AASHTO Bridge Design Guidelines
AASHTO Spectrum for 7% PE in 75 years
State - Maine
Zip Code - 04981
Zip Code Latitude = 44.534300
Zip Code Longitude = -068.892500
Site Class B

Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	
0.0	0.063	PGA - Site Class B
0.2	0.137	Ss - Site Class B
1.0	0.042	S1 - Site Class B

Conterminous 48 States
2007 AASHTO Bridge Design Guidelines
Spectral Response Accelerations SDs and SD1

State - Maine
Zip Code - 04981
Zip Code Latitude = 44.534300
Zip Code Longitude = -068.892500
As = FpgaPGA, SDs = FaSs, and SD1 = FvS1
Site Class C - Fpga = 1.20, Fa = 1.20, Fv = 1.70
Data are based on a 0.05 deg grid spacing.

Period (sec)	Sa (g)	
0.0	0.076	As - Site Class C
0.2	0.165	SDs - Site Class C
1.0	0.072	SD1 - Site Class C

Appendix D

Special Provisions

SPECIAL PROVISION
SECTION 636
MECHANICALLY STABILIZED EARTH RETAINING WALL

The following replaces Standard Specification Section 636 in its entirety:

636.01 Description The work under this item shall consist of design, fabrication, furnishing, transportation, and erection of Mechanically Stabilized Earth (MSE) retaining wall system of the required type, including miscellaneous items necessary for a complete installation.

The MSE retaining walls shall consist of reinforcing strips or reinforcing mesh earth wall systems utilizing architectural precast concrete facing panels supported on cast-in-place concrete leveling pads. All reinforcing strips or mesh material shall consist of galvanized steel. The wall structures shall be dimensioned to achieve the design criteria shown on the plans and specified herein.

The MSE retaining walls shall be constructed in accordance with these specifications and in conformity with the lines, grades, design criteria, and dimensions shown on the plans or established by the Geotechnical Engineer.

636.02 Quality Assurance. The MSE retaining wall system shall be one of the approved wall systems noted in the Contract Documents.

All necessary materials, except backfill and cast in-place concrete shall be obtained from the approved system designer.

Mechanically Stabilized Earth (MSE) retaining walls shall be designed and constructed as specified herein. The design shall be subject to review and acceptance by the Geotechnical Engineer. The acceptability of a MSE retaining wall design shall be at the sole discretion of the Geotechnical Engineer. Any additional design, construction or other costs arising as a result of rejection of a retaining wall design by the Geotechnical Engineer shall be borne by the Contractor.

Precast facing panels shall be manufactured in a concrete products plant with approved facilities. Before proceeding with production, precast sample units shall be provided for the Resident's acceptance. These samples shall be kept at the plant to be used for comparison purposes during production.

All calculations and Shop Drawings shall be signed and sealed by a licensed Professional Engineer registered in accordance with the laws of the State of Maine and specializing in geotechnical construction.

The Contractor installing the MSE retaining walls shall have demonstrated experience constructing MSE walls and shall use personnel having demonstrated experience in the installation procedures recommended by the manufacturer and as specified herein.

All MSE walls shall be built in accordance with the plans and accepted shop drawings for the proposed wall systems.

A qualified representative from the wall design-supplier shall be present during construction of the MSE walls. The services of the qualified representative shall be at no additional cost to the project. The qualified experienced technical representative will advise the Contractor and the Resident concerning proper installation procedures.

The vendor's representative shall specify the required back-batter so that the final position of the wall is vertical. Furthermore, footing berms shall be placed in front of the first three (3) levels of panels erected, to maintain verticality.

636.03 Design Requirements The MSE retaining walls shall be designed to provide the grade separation shown on the plans with a service life of not less than 100 years.

The MSE wall system shall be designed in accordance with:

1. The manufacturer's requirements
2. The Contract Plans
3. The requirements specified herein
4. AASHTO LRFD Bridge Design Specifications, current edition
5. AASHTO LRFD Bridge Construction Specifications, current edition
6. FHWA-NHI-10-024, Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volume I, November 2009,
7. FHWA-NHI-10-025, Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Volume II, November 2009,
8. FHWA-NHI-09-087, Corrosion/Degradation of Soil Reinforcements for Mechanically Stabilized Earth Walls and Reinforced Soil Slopes, November 2009.

Where conflicting requirements occur, the more stringent requirements shall govern.

The MSE wall design shall follow the general dimensions of the wall envelope shown on the plans. Base of footing elevation shall be as shown on the plans, or may be lower. All wall elements shall be within the right-of-way limits shown on the plans. The panels shall be placed so as not to interfere with drainage or other utilities, or other potential obstructions.

All appurtenances behind in front of, under, mounted upon, or passing through the wall such as drainage structures, utilities, fences, concrete parapet wall or other appurtenances shown on the plans shall be accounted for in the stability design of the wall.

Facing panels shall have tongue and groove, ship lap or similar approved connections along all joints, both vertical and horizontal. Where foundation conditions indicate large differential settlements, vertical full-height slip joints shall be provided. The shape of the panels shall be such that adjacent panels will have continuous, vertical joints, or as noted on the plans.

MSE facing panels shall be installed on cast-in-place concrete leveling pads. The top of the leveling pad shall be located at or below the theoretical leveling pad elevation. The minimum wall embedment shall be 4.0 ft as measured to the top of the leveling pad, or as shown on the plans, whichever is greater. The top of the face panels shall be at or above the top of the panel elevation shown on the plans. Where coping or barrier is used, the wall face shall extend up into the coping or barrier a minimum of 2 in.

The MSE walls shall be dimensioned so that the factored bearing resistance of the foundation soils, as noted on the plans, is not exceeded. Requirements for over excavation of native foundation soils and replacement with compacted structural fill are detailed on the plans.

The design by the wall system supplier shall consider the stability of the wall as outlined below and in the Contract Documents:

(a) Failure Plane The theoretical failure plane within the reinforced soil mass shall be determined per LRFD Section 11 and be analyzed so that the soil stabilizing components extend sufficiently beyond the failure plane within the reinforced soil mass to stabilize the material. External loads which affect the internal stability such as those applied through piling, bridge footings, traffic, slope surcharge, hydrostatic, and seismic loads shall be accounted for in the design.

(b) External Stability - Load and Resistance Factors Loads and load combinations selected for design shall be consistent with AASHTO LRFD. Application of load factors shall be taken as specified in AASHTO LRFD. Sliding resistance factors and bearing resistance factors shall be consistent with LRFD Section 10. Overturning provisions of LRFD Section 11 shall apply.

MSE walls shall be designed to resist failure by instability of temporary construction slope. Passive pressure in front of the wall mass shall be assumed to be zero for design purposes. The factored applied bearing pressures under the MSE mass for each reinforced length shall be clearly indicated on the design drawing.

(c) Internal Stability - Load and Resistance Factors Evaluation of reinforcement pullout, reinforcement rupture and panel connection pullout or rupture shall be consistent with LRFD Section 11. Loads, load combinations and load factors shall be as specified in LRFD Article 11. Resistance factors for internal design shall be consistent with LRFD Article 11. Maximum reinforcement loads shall be calculated using the Simplified Method approach. Calculations for factored stresses and resistances shall be based upon

assumed conditions at the end of the design life. The design life of steel soil reinforcements shall comply with LRFD Section 11.

(d) Backfill and Foundation Soils Parameters. The friction angle of the select backfill used in the reinforced fill zone for the internal stability design of the wall shall be assumed to be 34° unless noted otherwise. The friction angle of the foundation soils and random backfill shall be assumed to be 30° unless otherwise shown on the plans.

(e) Reinforcement Length. The soil reinforcement shall be the same length from the bottom to the top of each wall section. The reinforcement length defining the width of the entire reinforced soil mass may vary with wall height. The minimum length of the soil reinforcement shall be 8 ft, but shall not be less than 70 percent of the wall height, H, for walls with level surcharges, or 70 percent of H1 for walls with a sloped surcharge or walls supporting an abutment. The mechanical wall height, H or H1, shall be the vertical difference between the top of the leveling footing and the elevation at which the failure surface, as described above, intercepts the ground surface supported by the wall.

(f) Steel Reinforcement For steel reinforcements, all structural connections, tie strips and loop inserts, the following galvanization and carbon steel loss rates shall be assumed:

	<u>mils/year/side</u>
Zinc galvanizing (first 2 years)	0.58
Zinc galvanizing (subsequent years to depletion):	0.16
Carbon Steel (after zinc depletion to 100 yrs):	0.47

Calculations for factored stresses and resistances in steel reinforcements and connections, including tie-strips and loop inserts, shall be based upon assumed conditions at the end of the design life. (or: The nominal long-term design strength in steel reinforcements and connections, including tie-strips and loop inserts shall be determined at the end of the service life.) The applied factored reinforcement loads shall be calculated in accordance with LRFD Section, and shall be checked against the nominal tensile strength multiplied by a resistance factor per LRFD Table 11.5.6-1. Transverse and longitudinal grid members shall be sized in accordance with ASTM A185/A158M.

When the expected differential settlement normal to the wall exceeds 3 in, the lower level reinforcement facing connections shall be designed to accommodate the increased tensile forces due to settlement.

(g) Facing Panel Requirements

1. Facing panels shall be designed to resist compaction stresses that occur during wall erection.

2. The minimum thickness for concrete panels in the zone of embedded connections shall be 5.5 in and 3.5 in elsewhere. The minimum concrete cover shall be 1.5 in. Facing panels shall meet the design requirements of LRFD 11.10.2.3
3. The wall facing shall be designed to accommodate differential settlements of 1/100 ft.
4. The minimum spacing between adjacent panels shall be $\frac{3}{4}$ inches in order to accommodate differential settlements without impairing the appearance of the facing or compromising the structural integrity of the individual panels. Joints between panels shall be no more than 0.75 in. Joint between panels shall have a ship lap configuration or tongue and groove connection. There shall be no openings through the wall facing, except for utilities to pass through the wall. Slip joints to accommodate differential settlement shall be included where shown on the plans.
5. Where wall or wall sections intersect with an angle of 130° or less, a special vertical corner element panel shall be used. The corner element panel shall cover the joint of the panels that abut the corner and allow for independent movement of the abutting panels. Corner elements shall not be formed by connecting standard facing panels that abut the acute corner.

636.04 Materials The Contractor shall be responsible for the purchase or manufacture of the precast concrete facing panels, reinforcing mesh or strips, panel/reinforcement connections, bearing pads, joint filler, and all other necessary components. The Contractor shall furnish to the Resident the appropriate Certificates of Compliance certifying that the applicable wall materials meet the requirements of the project specifications. All materials used in the construction of the MSE retaining walls shall meet the requirements specified in the following subsections of the Maine Standard Specifications and as specified herein.

Materials not conforming to this section of the specifications, or from sources not listed in the contract documents, shall not be used without written consent from the Resident.

636.041 Reinforced Concrete Facing Panels Reinforced concrete facing panels shall meet the requirements specified in the following subsections:

Structural Precast Concrete Units	712.061
Drainage Geotextile	722.02

636.042 Precast Panel Tolerances and Surface Finish Concrete surface for the front face shall have a smooth steel formed finish, or as noted on the plans. The rear face shall have an unformed surface finish. The rear face of the panel shall be roughly screeded to eliminate open pockets of aggregate and surface distortions in excess of $\frac{1}{4}$ in. All uncoated steel projecting

from the panel unit shall be galvanized in accordance with ASTM A123/A123M (AASHTO M 111) with a minimum coating thickness of 2 oz/ft².

Precast panel tolerances shall comply with the following; units that do not meet the listed tolerances will be rejected.

1. Panel dimensions (edge to edge of concrete) within $\pm 3/16$ in.
2. Panel thickness: $\pm 1/4$ in.
3. Squareness. The length difference between the two diagonals shall not exceed $1/2$ in.
4. Distance between the centerline of dowel and dowel sleeve, and to centerline of reinforcing steel shall be $\pm 1/8$ in.
5. Face of panel to centerline of dowel and dowel sleeve, and to centerline of reinforcing steel shall be $\pm 1/8$ in.
6. Position of panel connection devices (Tie Strip) shall be ± 1 in.
7. Location of Coil and loop Imbeds shall be $\pm 1/8$ in.
8. Warping of the exposed panel face shall not exceed $1/4$ in. in 5 ft.
9. Surface defects on smooth-formed surfaces measured over a length of 5 ft shall not exceed $1/8$ in. Surface defects on textured-finished surfaces measured over a length of 5 ft shall not exceed $5/16$ in.

636.043 Reinforcing All reinforcing, tie strips, and attachment devices shall be carefully inspected to insure they are true to size and free from defects that may impair their strength and durability.

A. Reinforcing Mesh shall be shop fabricated from cold drawn steel wire conforming to the requirements of AASHTO M 32 (ASTM A82/A82M) yield strength minimum of 65 ksi and shall be welded into the finished mesh fabric in accordance with AASHTO M 55 (ASTM A185/A185M). Galvanizing shall be in accordance with AASHTO M 111 (ASTM A123/A123M) after fabrication. The minimum coating thickness shall be 2 oz/ft². Any damage done to the mesh galvanization prior to the installation shall be repaired in an acceptable manner and provide a minimum galvanized coating of 2 oz/ft².

B. Reinforcing Strips shall be fabricated from hot rolled bars to the required shape and dimensions. Their physical and mechanical properties shall conform to AASHTO M 223 (ASTM A572/A572M) Grade 65, or approved equal. Reinforcing strips shall be hot dipped galvanized in accordance with AASHTO M 111 (ASTM A123/A123M) after fabrication. The minimum galvanization coating thickness shall be 2 oz/ft². Any damage done to the mesh galvanization prior to the installation shall be repaired 2 oz/ft².

C. Tie strips shall be fabricated of hot rolled steel conforming to ASTM A1011/A1011M, Grade 50 or equivalent. Tie strips shall be hot dipped galvanized in accordance with AASHTO M 111 (ASTM A123/A123M) after fabrication. The minimum coating thickness shall be 2 oz/ft².

D. The tie strips and reinforcing strips shall be cut to lengths and tolerances shown on the submitted plans. Holes for bolts shall be punched in the locations shown.

636.044 Attachment Devices

A. Steel clevis loop embeds shall be fabricated of cold drawn steel wire conforming to ASTM A510, UNS G 10350 or AASHTO M 32 (ASTM A82/A82M). Loop embeds shall be welded in accordance with AASHTO M 55 (ASTM A185/A185M). Both shall have electrodeposited coatings of zinc applied in accordance with ASTM B633.

B. Fasteners shall consist of hexagonal cap screw bolts and nuts, which are galvanized and conform to the requirements of AASHTO M 164 (ASTM A325) or equivalent.

C. Connector pins and mat bars shall be fabricated from AASHTO M 183 (ASTM A36/A36M) steel and welded to the soil reinforcement mats as shown on the plans. Galvanization shall conform to AASHTO M111 (ASTM A123/A123M) with a minimum coating thickness of 2 oz/ft². Connector bars shall be fabricated of cold drawn steel wire conforming to the requirements of ASTM A82/A82M (AASHTO M 32) and galvanized in accordance with ASTM A123/A123M.

D. Structural plate connectors and fasteners used for yokes to connect reinforcements to wall panels around pile or utility conflicts shall conform to the material requirements for reinforcing strips and fasteners in 677.042 (c).

636.045 Joint Materials Joint material shall be installed to the dimensions and thicknesses specified below, or in accordance with the plans or approved shop drawings.

A. Provide flexible foam strips for filler for vertical joints between panels, and in horizontal joints where pads are used.

B. Provide in horizontal joints between panels either preformed EPDM rubber pads conforming to ASTM D2000 for 4AA, or 812 rubbers or neoprene elastomeric pads having a Durometer Hardness of 55±5, or high density polyethylene pads with a minimum density of 0.946 g/cm³ in accordance with ASTM D1505

636.046 Nonwoven Drainage Geotextile Cover all joints between panels on the back side of the wall with a geotextile fabric meeting the minimum requirements of 722.02 Class 2. Slit film and multifilament woven and resin bonded woven geotextile fabrics are not allowed for this application. The minimum width of the fabric shall be 12 in. Lap fabric at least 12 in. where splices are required. Nonwoven Drainage Geotextile shall be bonded with an approved adhesive compound to the back face covering all joints between panels. Adhesives used to hold the geotextile filter fabric material to the rear of the facing panels prior to backfill placement shall be supplied by the wall supplier and approved by the Resident.

636.047 Concrete Leveling Pad The cast-in-place leveling pad shall be constructed of Class A concrete conforming to the requirements of Section 502 - Structural Concrete. Leveling pad shall have minimum dimensions of 6 in thickness and 12 in width and be placed at the design elevation shown on the shop drawings within a 1/8 in tolerance.

636.048 Backfill Materials All backfill materials used in the MSE Walls volume shall conform to Gravel Borrow conforming to the requirements of Section 703.20, with the following additional requirements:

A. The maximum aggregate size is limited to 4 in (U.S Sieve Size - 102 mm)

B. Soundness The material shall be substantially free of shale or other soft, poor durability particles. The materials shall have a magnesium sulfate soundness loss, as determined by AASHTO T104 (ASTM C88), of less than 30 percent after four cycles.

C. Electrochemical Requirements The backfill materials shall meet the following criteria:

Requirements		Test Methods
Resistivity	>3,000 ohm-centimeters	AASHTO T 288
pH between	Between 5 and 10, inclusive	AASHTO T 289
Chlorides	<100 parts per million	AASHTO T 291
Sulfates	<200 parts per million	AASHTO T 290
Organic Content	<1%	AASHTO T 267-86

D. The plasticity index (PI) as determined by AASHTO T90 shall not exceed 6.

E. The select backfill material shall exhibit a peak angle of internal friction of not less than 34 degrees, as determined by the standard Direct Shear Test, AASHTO T 236 (ASTM D3080-72), on the portion finer than the 2 mm [#10 sieve], compacted to 95 percent of AASHTO T 99, Methods C or D (with oversized correction as outlined in Note 7) at optimum moisture content. No testing is required for backfills where 80 percent of sizes are greater than 3/4 in. (19 mm) Before construction begins, the borrow material selected shall be subject to show conformance with this frictional requirement. Compliance with the test requirements shall be the responsibility of the Contractor, who shall furnish a copy of the backfill test results prior to construction.

636.049 Crushed Stone for Abutment Foundation Crushed stone for use in the foundation layer below the abutment shall be crushed stone conforming to the requirements of MaineDOT Standard Specification Section 703.31.

636.050 Impervious Membrane An impervious geomembrane shall be installed near the top of the reinforced backfill to reduce the chance of water infiltrating into the reinforced backfill. The geomembrane shall be bonded to the inside face of the wall panels and extend perpendicularly from the wall face into the fill, while being parallel to the top of the wall. The membrane should be sloped to drain away from the facing and outlet beyond the reinforcing zone. The impervious geomembrane shall extend into the fill a distance of 1 ft beyond the MSE reinforcement. The geomembrane shall have a minimum thickness of 30 mil (0.03 in, 1/32 in)

The geomembrane shall have both sides textured with a rough finish to improve resistance against sliding. The texture shall be approved by the Resident before installation. The geomembrane shall be shown on the design drawings of the MSE submittal of the Contractor.

636.051 Acceptance of Material The Contractor shall furnish to the Resident a Certificate of Compliance certifying that the above materials comply with the applicable contract specifications including the backfill material, in accordance with Section 700. A copy of all test results performed by the Contractor necessary to assure contract compliance shall also be furnished to the Resident. Acceptance will be based on the Certificate of Compliance, accompanying test reports, and visual inspection by the Resident.

636.06 Submittals

A. Design computations demonstrating compliance with the criteria specified herein and shown on the plans, shall be prepared, signed and stamped by a licensed Professional Engineer licensed in the State of Maine and specializing in geotechnical engineering. Design calculations that consist of computer generated output shall be supplemented with at least one hand calculation and graphic demonstrating the design methodology used. Design calculations shall provide thorough documentation of the sources of equations used and material properties.

The design calculations shall include:

1. Statement of all assumptions made and copies of all references used in the calculations.
2. Analyses demonstrating compliance with all applicable earth, water, surcharges, seismic, or other loads, as specified herein and required by AASHTO LRFD.
3. Analyses or studies demonstrating durability and corrosion resistance of retaining wall systems for the proposed location and environment. The designer shall provide all corrosion protection devices necessary for the retaining wall to have a minimum service life of 100 years in the proposed location and environment.

B. A detailed resume of the wall designer listing similar projects with references, and demonstrating necessary experience to perform the MSE retaining wall design, including a brief description of each project that is similar in scope.

C. A detailed listing of MSE walls that the Contractor has constructed including a brief description of each project and a listing of personnel who will construct the walls demonstrating their experience in construction of MSE retaining walls. A reference shall be included for each project listed. As a minimum, the reference shall include an individual's name, address and current phone number.

D. Manufacturer's product data for the MSE wall system, including material, manufacture and erection specifications, all specified erection equipment necessary, details of buried MSE wall elements, special details required of reinforcing layout around drainage structures and sign foundations, structures design properties, type of backfill and details for connections between facing panels.

E. Details of precast yard and concrete mix design.

F. Shop drawing showing the configuration and all details, dimensions, quantities and cross sections necessary to construct the MSE wall, including but not limited to the following:

1. A plan view of the wall, which shall include Contract limits, stations and offsets, and the face of wall line shown on the plans.

2. An elevation view of the wall which shall include the elevation at the top of the wall at all horizontal and vertical break points and at least every 50 ft along the face of the wall, all steps in the leveling pads, the designation as to the type of retaining wall system(s), and an indication of the final ground line and calculated factored bearing pressures. The face of wall shown on the plans shall be indicated.

3. A typical cross section or cross sections showing the elevation relationship between existing ground conditions and proposed grades, and the proposed wall configuration, including details for the proposed methods for connecting to existing conditions. The sections shall also indicate the location of the face of wall shown on the plans.

4. General notes pertaining to design criteria and wall construction.

5. A listing of material quantities for each wall.

6. Details of sleeves and pipes and other embedded items to be installed through the walls.

7. Clearly indicated details for construction of walls or reinforcing elements around drainage, foundations, utilities or any other potential obstructions.

8. Details of the architectural treatment of facing panels.

9. Drainage design detail and design scheme.

10. Location of utilities.

11. Sequence and schedule of construction, including overall construction schedule.
12. Methods of excavation and backfill.
13. Method of maintaining stability of excavated trenches.
14. Method of monitoring plumbness and deviation of wall.
15. Excavation support system, if any.
16. Any acceptance testing and frequency.
17. Details and location of all necessary construction and expansion joints along the wall.
18. Connection details at the interface of the wall and any adjacent proposed cast in place retaining wall or abutment structure.
19. Details of impermeable membrane connection to abutment in roadway runoff collection system.

636.07 Delivery, Storage and Handling

A. Contractor shall check the material upon delivery to assure that the proper material has been received. A product certification should be provided with each shipment.

B. Material shall be stored above -20° F

C. Contractor shall prevent excessive mud, wet cement, epoxy and like substances which may affix themselves to the material from coming in contact with the material.

D. Material may be laid flat and stored outside for 30 days. For extended storage, material shall be stored in or beneath a trailer or covered with a colored tarpaulin to prevent long-term exposure.

636.08 Wall Excavation The excavation and use as fill disposal of all excavated material shall meet the requirements of Section 203 - Excavation and Embankment, except as modified herein. Temporary excavation support as required shall be the responsibility of the contractor.

636.09 Foundation Preparation. The foundation for the structure shall be graded level for a width equal to the length of reinforcement elements plus 5 ft, or as shown on the plans. Prior to wall construction the foundation shall be compacted with at least 10 passes of a smooth wheel vibratory roller weighing at least 10,000 lbs. Any foundation soils found to be unsuitable or incapable of sustaining the required compaction shall be removed and replaced with 703.20, Gravel Borrow. The foundation for the structure shall be approved by the Resident before erection is started.

A concrete leveling pad shall be constructed as indicated on the submitted plans. The leveling pad shall be cast to the design elevations as shown on the plans. Allowable elevation tolerances are +0.01 ft and -0.02 ft from the design elevations. Placement of wall panels may begin after 24 hours curing time of the concrete leveling pad.

636.10 Wall Erection A field representative from the proprietary wall system being used shall be available, as needed, during the erection of the wall. The services of the representative shall be at no additional cost to the project.

Precast concrete panels shall be placed so that their final position is vertical or battered as shown on the plans. The vendor representative shall specify the required back-batter so that the final position of the wall is vertical. Earth berms at the footing shall be placed to maintain the desired position of panels. For erection, panels are handled by means of lifting devices connected to the upper edge of the panel. Panels should be placed in successive horizontal lifts in the sequence shown on the approved shop drawings as backfill placement proceeds. As backfill material is placed behind the panels, the panels shall be maintained in position by means of temporary wedges or bracing according to the wall supplier's recommendations.

Concrete facing vertical tolerances and horizontal alignment tolerances shall not exceed $\frac{3}{4}$ inch when measured with a 10 ft straightedge ($\frac{1}{4}$ in/yd). During construction, the maximum allowable offset in any panel joint shall be $\frac{3}{4}$ in. The overall vertical tolerance of the wall (from top to bottom) shall not exceed $\frac{1}{2}$ inch per 10 ft of wall height.

636.11 Backfill Placement Backfill shall not be placed between November 1st and April 1st. Backfill placement shall closely follow erection of each course of panels. Backfill shall be placed and compacted in such a manner as to avoid any damage or disturbance of the wall materials or misalignment of the facing panels or reinforcing elements. Any wall materials which become damaged during backfill placement shall be removed and replaced at the Contractor's expense. Any misalignment or distortion of the wall facing panels due to placement of backfill outside the limits of this specification shall be corrected by the Contractor at his expense. Prior to the placement of the soil reinforcement, the backfill elevation after compaction shall be at the required elevation of the reinforcements. At each reinforcement level, the backfill shall be placed to the level of the connection. Backfill placement methods near the panels shall assure that no voids exist directly beneath the reinforcing element.

Gravel borrow backfill shall be compacted in accordance with Subsection 203.12 except that the minimum required compaction shall be 92 percent of maximum density as determined by AASHTO T 180, Method C or D (with oversize correction, as outlined in Note 7 of that test). If 30 percent or more of the backfill material is greater than 19 mm [$\frac{3}{4}$ in] in size, AASHTO T 180 is not applicable, and the acceptance criterion for control of compaction shall be either a minimum of 70 percent of the relative density of the material as determined by ASTM D4253 and D4254, or a method of compaction consisting of at least 4 (four) passes by a heavy roller.

Where spread footings support bridge or other structural loads, the top 5 ft below the bottom of footing elevation shall be compacted to 98 percent of the maximum density as determined by AASHTO T 180, Method C or D (with oversize correction, as outlined in Note 7 of that test).

The moisture content (determined in accordance with AASHTO T 180, Method C or D) of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Backfill materials shall be placed at a moisture content not more than 2 percentage points less than or equal to the optimum moisture content. Backfill material with a placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniformly acceptable throughout the entire lift.

At each reinforcing level, backfill shall be leveled before placing and bolting the reinforcing. The maximum lift thickness after compaction shall not exceed 12 in. The Contractor shall decrease this lift thickness, if necessary, to obtain the specified density.

Heavy compaction equipment shall not be used to compact backfill within 3 ft of the wall face. Compaction within 3 ft of the back face of the wall shall be achieved by at least three (3) passes of lightweight mechanical tamper, lightweight roller, or vibratory system. The specified lift thickness shall be adjusted as warranted by the type of compaction equipment actually used. No vehicular equipment shall be operated within 3 ft of the panels.

The frequency of sampling of the backfill material necessary to assure gradation control throughout construction shall be as directed by the Resident.

At the end of each day's operation, the Contractor shall slope the last level of the backfill away from the wall facing to rapidly direct runoff away from the wall face. In addition, the Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

636.12 Reinforcement Placement Prior to placing the first layer of reinforcements (strips, mats or grids), backfill shall be placed and compacted in accordance with Subsection 677.11, Backfill Placement.

Bending of reinforcements in the horizontal plane resulting in a permanent deformation in their alignment shall not be allowed. Gradual bending in the vertical direction that does not result in permanent deformations is allowable.

Cutting of longitudinal or transverse reinforcement bars to avoid conflicts with utility obstructions or piles will not be allowed. A structural connection (yokes) from the wall panel to the reinforcement shall be used whenever it is necessary to avoid cutting or excessive skewing of reinforcement due to pile or utility conflicts.

Soil reinforcements shall be placed normal to the face of the wall, unless otherwise shown on the plans or directed by the Resident. If skewing of the soil reinforcements is required due to obstructions in the reinforced fill, rotatable bolted connections shall be used and the maximum skew angle shall not exceed 15° from the normal position except in the case of acute corner where redundant reinforcements are used. The tensile capacity of splayed reinforcement shall be reduced by the cosine of the splay angle.

636.13 Method of Measurement Mechanically Stabilized Earth Retaining Wall will be measured by the square foot of face area computed using the plan dimensions. No adjustment in the pay quantity will be made if the computed quantity, based on the working drawings, varies from the plan quantity.

Vertical dimension limits will be from the top of leveling pad to the top of the wall facing units, as shown on the plans. The horizontal dimension limits will be from the edges of the facing units at each end of a wall, as shown on the plans. No field measurements will be made unless the Resident specifies, in writing, a change to the limits indicated on the plans.

The wall surface area, as shown on the plans, includes the surface area of nominal panel joint openings and wall penetrations such as pipes and other utilities.

636.14 Basis of Payment The accepted quantity of Mechanically Stabilized Earth Retaining Wall will be paid for at the contract unit price per square foot. Payment shall be full compensation for design, fabrication and erection of MSE retaining walls, furnishing all labor, equipment and materials including concrete face panels, fasteners, reinforcing mesh, reinforcing strips, tie strips, hardware, joint fillers, coping, woven drainage geotextile, impervious membrane, select granular backfill and technical field representative. Cost of cast-in-place concrete for leveling pad will not be paid for separately but will be considered incidental to the Mechanically Stabilized Earth Retaining Wall.

Excavation, including extra excavation due to unsuitable foundation material, will be measured and paid for under Item 203.20 - Common Excavation. Foundation material and select backfill material in the reinforced zone will be considered incidental to the Mechanically Stabilized Earth Retaining Walls.

The unit price for Mechanically Stabilized Earth Wall shall include costs for:

1. All design work, preparation of written submittals and plans, revision of submittals, sample submittals and any other necessary preliminary work prior to and after acceptance of the retaining wall by the Resident.
2. All materials, including transportation, for the MSE walls, including facing panels, MSE reinforcing elements, attachment devices, fasteners, bearing blocks and shims, joint materials, copings, vertical corner elements, concrete masonry, reinforcing steel, crushed stone, select backfill and incidentals.
3. All labor and equipment required to excavate and prepare the wall foundation, form and cast the leveling pad, erect the MSE wall to the lines and grades shown on the plans, place and compact backfill, place and compact the drainage layer, and construct any other items necessary to complete the MSE wall.
4. All temporary sheeting, temporary excavation, and temporary dewatering necessary to perform the other work in this section.

There will be no allowance for excavating and backfilling for the Mechanically Stabilized Earth Retaining Wall beyond the limits shown on the approved submitted plans, except for excavation required to remove unsuitable subsoil in preparation for the foundation.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
636.40 Mechanically Stabilized Earth Retaining Wall foot	Square

SPECIAL PROVISION
SECTION 203
CRUSHED STONE

Description This work shall consist of constructing a leveling pad of crushed stone in accordance with these specifications and in reasonably close conformity with the width, grade and thickness shown on the plans or established by the Resident.

MATERIALS

Aggregate Crushed stone material shall meet the requirements of ASTM Standard Specification C33, Standard Specification for Concrete Aggregates.

The aggregate shall meet the following gradation requirements:

Particle size	Percent by Weight Passing
1 inch	100
$\frac{3}{4}$ inch	90 – 100
$\frac{1}{2}$ inch	20 – 55
$\frac{3}{8}$ inch	0 – 15
No. 4	0 - 5

Construction Requirements The crushed stone shall be placed and graded as shown on the plans or as directed by the Resident. The crushed stone shall be compacted as required to ensure that all voids in the stone are filled, as approved by the Resident.

Method of Measurement Aggregate for crushed stone will be measured by the cubic yard complete in place.

Basis of Payment The accepted quantity of crushed stone will be paid for at the contract unit price per cubic yard of aggregate complete in place.

Payment will be under

Pay Item

Unit

203.35 Crushed Stone

Cubic Yard