

To: Gary Laroche, P.E., Structures Project Manager
SPM CEE

From: Stephen Madden, P.E, Geotechnical Engineer via Callie Ewald, P.E., Senior Geotechnical Engineer

Date: August 29th, 2025

Subject: Sunderland BM 20102 – Geotechnical Design Parameters Report

1.0 INTRODUCTION

As requested, we have completed geotechnical analyses of the proposed spread footing foundations as part of the Sunderland BM 20102 project. The project consists of the replacement of Bridge No. 19-5 (culvert) carrying US Route 7 over an unnamed brook in the town of Sunderland, VT. The project is located approximately 1.1 miles south of the intersection of US Route 7 and Vermont Route 313 (VT-313). The project will include replacement of the existing metal pipe arch culvert with a precast concrete box culvert with new headwalls and wingwalls. Contained herein are geotechnical recommendations for use in the design of the proposed replacement structure, as determined using the 2024 AASHTO LRFD Bridge Design Specifications.

2.0 FIELD INVESTIGATION

A field investigation was conducted by WSP USA, Inc. (WSP) in April, 2023 to evaluate the subsurface profiles for design and construction of the proposed replacement structure. The findings of this investigation are detailed in the Geotechnical Data Memorandum from WSP dated June 2nd, 2023 (attached as **Appendix A**). Refer to this report for a detailed description of the field sampling and testing, laboratory analysis of soil samples, generalized subsurface profile, and boring logs.

3.0 SHALLOW FOUNDATION ANALYSIS

AASHTO's LRFD Bridge Design Specifications Manual (2024) was used as the reference for settlement and bearing resistance equations. Section 10.6.3.1.2 contains the equation used for bearing resistance. Neither depth factors nor load inclination factors were used in the analysis as they were not considered pertinent due to the designed embedment of the structure, per Section C.10.6.3.1.2a. Hough's Method, used to calculate settlement in normally consolidated cohesionless soils, can be found in Section 10.6.2.4.2.

It is recommended that the bottom of the wingwall footings be at least 4 ft below the ground surface based on frost susceptibility and bearing stratum at the site. An embedment value of 4 ft was used for the strength limit state analysis and an embedment value of 0 ft was used for the service limit state analysis, which tends to control the design, to account for potential scour conditions at the design flood elevation per Section 2.6.4.4.2. A conservative groundwater elevation at the bottom of footing elevation was used in design.

As per section 10.5.5.1 of the 2024 AASHTO LRFD Bridge Design Specifications, a resistance factor of 1.0 should be applied to the unfactored bearing resistance for use in service limit state

design. Service limit state design includes, but is not limited to, settlement and scour. Section 10.5.5.2.2 specifies that a resistance factor of 0.45 should be applied to the unfactored bearing resistance for use in strength limit state design for spread footings on rock and soil. Strength limit state design includes, but is not limited to, checks for bearing resistance, sliding, and constructability. Potential for overturning is limited by controlling the location of the resultant of the reaction forces (eccentricity). Eccentricity, e , shall be limited as follows:

$$\begin{aligned} \text{Foundations on soil:} & \quad |e| < b/3 \\ \text{Foundations on rock:} & \quad |e| < 0.45b \end{aligned}$$

Eccentricity should be considered for settlement and bearing resistance design of spread footings by using effective footing widths based on AASHTO Section 10.6.1.3. All footing widths presented in this report are *effective* footing widths. The soil profiles used in these analyses were adapted from the subsurface investigation and can be found below in Table 3-1 and Table 3-2.

Table 3-1 Soil Profile Located at Inlet (B-102)

| Approximate Elevation (ft) | Soil Profile |
|----------------------------|----------------------------------|
| 942.5 – 927.5 ft | Medium Dense Gravelly Sandy SILT |
| 927.5 – 912.5 ft | Dense Gravelly SAND |
| 912.5 – 897.5 ft | Very Dense SANDY GRAVEL |

Table 3-2 Soil Profile Located at Outlet (B-101)

| Approximate Elevation (ft) | Soil Profile |
|----------------------------|-------------------------------|
| 944.5 – 924.5 ft | Dense Gravelly Silty SAND |
| 924.5 – 899.5 ft | Very Dense Silty Sandy GRAVEL |

3.1 Bearing Resistance (Inlet Bearing Stratum)

The maximum length of wingwalls used in the analysis was 14 ft, based on the Culvert Layout Plan sheet from the Final Plans dated July 23rd, 2025. The Substructure Details I sheet specifies a bottom of footing elevation of 923.96 ft at the inlet of the proposed culvert. Based on the geometry and elevations shown in the plans it appears as though the footings will bear on dense gravelly sand at the inlet. Based on boring information and subsequent calculations, the soil in this layer was assigned a friction angle, $\phi = 38^\circ$ and density, $\gamma = 130 \text{ lb/ft}^3$. The embedment was assumed to be 4 ft below the ground surface.

For effective footing widths of 3 ft through 10 ft, the maximum factored bearing resistances for the strength and service limit states are given in Table 3-3. Soil settlement values were calculated for various footing widths based on the nominal bearing pressure at the service limit state using Hough’s Method, as stated above in Section 3.0. Based on the calculations, bearing pressures that result in 1.0 inch of settlement are higher than the anticipated pressures, and therefore not included in this report. Considering the granular nature of the foundation soils, any settlement is expected to occur during or immediately after construction. Attached to this report are graphs that detail the corresponding bearing resistances for various effective footing widths (**Appendix B**).

Table 3-3 Factored Bearing Resistances at Various Effective Footing Widths (Inlet)

| Maximum Wingwall Length (ft) | Effective Footing Width (ft) | Factored Bearing Resistance, Strength Limit State (ksf) | Factored Bearing Resistance, Service Limit State (ksf) |
|------------------------------|------------------------------|---|--|
| 14 | 3 | 9.8 | 6.8 |
| | 4 | 11.0 | 8.8 |
| | 5 | 12.2 | 10.5 |
| | 6 | 13.3 | 12.2 |
| | 7 | 14.3 | 13.7 |
| | 8 | 15.3 | 14.8 |
| | 9 | 16.2 | 16.0 |
| | 10 | 17.0 | 17.0 |

3.2 Bearing Resistance (Outlet Bearing Stratum)

The maximum length of wingwalls used in the analysis was 12 ft, based on the Culvert Layout Plan sheet from the Final Plans dated July 23rd, 2025. The Substructure Details I sheet specifies a bottom of footing elevation of 917.52 ft at the outlet of the proposed culvert. Based on the geometry and elevations shown in the plans it appears as though the footings will bear on very dense silty sandy gravel at the outlet. Based on the boring information and subsequent calculations, the soil in this layer was assigned a friction angle, $\phi = 38^\circ$ and density, $\gamma = 135 \text{ lb/ft}^3$. The embedment was assumed to be 4 ft below the ground surface.

For effective footing widths of 3 ft through 10 ft, the maximum factored bearing resistances for the strength and service limit states are given in Table 3-4. Soil settlement values were calculated for various footing widths based on the nominal bearing pressure at the service limit state using Hough's Method, as stated above in Section 3.0. Based on the calculations, bearing pressures that result in 1.0 inch of settlement are higher than the anticipated pressures, and therefore not included in this report. Considering the granular nature of the foundation soils, any settlement is expected to occur during or immediately after construction. Attached to this report are graphs that detail the corresponding bearing resistances for various effective footing widths (**Appendix B**).

Table 3-4 Factored Bearing Resistances at Various Effective Footing Widths (Outlet)

| Maximum Wingwall Length (ft) | Effective Footing Width (ft) | Factored Bearing Resistance, Strength Limit State (ksf) | Factored Bearing Resistance, Service Limit State (ksf) |
|------------------------------|------------------------------|---|--|
| 12 | 3 | 10.3 | 6.9 |
| | 4 | 11.6 | 8.8 |
| | 5 | 12.8 | 10.5 |
| | 6 | 13.9 | 12.0 |
| | 7 | 15.1 | 13.3 |
| | 8 | 15.9 | 14.3 |
| | 9 | 16.9 | 15.2 |
| | 10 | 17.7 | 15.8 |

4.0 CULVERT WINGWALL STABILITY ANALYSIS

The overall stability of the proposed wingwalls was analyzed using the SLIDE 2018 limit equilibrium slope stability analysis program developed by Rocscience. The wingwalls at the inlet and outlet of the culvert were analyzed at a critical cross-section representing the full height of the wingwalls. The wingwall geometries and cross sections used were based on the Final Plans dated July 23rd, 2025. Per Section 11.6.3.7 of the *AASHTO LRFD Bridge Design Specifications*, a maximum resistance factor of 0.65 is allowable where the geotechnical parameters and subsurface stratigraphy are highly variable or based on limited information and a resistance factor of 0.75 is allowable where the geotechnical parameters and subsurface stratigraphy are well defined. The resistance factor of the slope is the inverse of the factor of safety as determined from the stability analysis.

Computer models were generated using SLIDE for Stations 1056+50 (Inlet) and 1057+00 (Outlet) and were analyzed using the Spencer Method. According to the VTrans Geotechnical Engineering Instruction on Soil Slope Stability Investigation & Evaluation Manual (GEC 14-01), the Spencer Method is recommended to be used for the analysis of failure surfaces of any shape. Soil parameters used in the analysis were equivalent to those developed for the shallow foundation analyses, as described in Section 3.0, and a conservative water table elevation was modeled. The maximum heights of the wingwalls were used based on the geometries shown in the Final Plans, corresponding to a height of 14 feet at both the inlet and the outlet.

Based on the analysis it appears that no deep-seated global stability issues will exist given the proposed conditions, and the overall stability of the wingwalls is acceptable. The resistance factors for slip surfaces beneath the wingwalls are less than AASHTO’s maximum recommended value of 0.75. Refer to **Appendix C** for outputs of the completed analysis at Stations 1056+50 and 1057+00, respectively.

5.0 RECOMMENDATIONS

Shallow foundations appear to be feasible for the proposed wingwalls as detailed in the Preliminary Plans. Factored bearing resistances for various footing widths were calculated for the

wingwalls and can be found in Tables 3-3 and 3-4. These calculations are based on the geometric and geotechnical assumptions outlined in Section 3.0 of this report. The bearing resistances presented in this report at the service limit state were calculated assuming a conservative scour condition (0 ft embedment). Sections 10.5.2 and 10.5.3 of AASHTO outline all design states relevant to spread footing design and their respective resistance factors. Eccentricity should be considered for settlement and bearing resistance design of spread footings by using effective footing widths based on AASHTO Section 10.6.1.3. Table 5-1 shows the appropriate resistance factors for various design states.

Table 5-1: Summary of Resistance Factors

| Design State | Resistance Factor, ϕ |
|---------------------|---|
| Settlement | 1.0 |
| Scour | 1.0 |
| Bearing Resistance | 0.45 |
| Sliding | 0.80 |

5.1 Plan Notes & Details

Based on the variability of the soils encountered during the subsurface investigation, and locations of the borings with relation to the inlet and outlet, we recommend including the following information on the plans:

- For strength limit state, using a resistance factor of 0.45, the factored bearing resistance is 9.8 ksf
- For service limit state, using a resistance factor of 1.0, the factored bearing resistance is 6.8 ksf

5.2 Design Parameters

Table 5-2 highlights engineering properties assigned to the in-situ soils. Engineering properties of common construction materials are shown in Table 5-3. These values should be used when designing any substructure units. It is recommended that values of K_o be used for calculating earth pressures where the structure is not allowed to deflect longitudinally, away from or into the retained soil mass. Values for K_a should be utilized for an active earth pressure condition where the structure is moving away from the soil mass and K_p where the structure is moving toward the soil mass. The design earth pressure coefficients are based on horizontal surfaces (non-sloping backfill) and a vertical wall face.

Table 5-2: Engineering Properties of Bearing Stratum Soils

| | Dense Gravelly SAND (Inlet) | Very Dense Silty Sandy GRAVEL (Outlet) |
|---|------------------------------------|---|
| Unit Weight, γ (lbs/ft ³): | 130 | 135 |
| Internal Friction Angle, ϕ (degrees): | 38 | 38 |
| Coefficient of Friction, f | | |
| - mass concrete cast against soil: | 0.45 | 0.55 |
| - soil against precast/formed concrete: | 0.31 | 0.40 |
| Active Earth Pressure Coef., K_a : | 0.24 | 0.24 |
| Passive Earth Pressure Coef., K_p : | 4.20 | 4.20 |
| At-Rest Earth Pressure Coefficient, K_o : | 0.38 | 0.38 |

Table 5-3: Engineering Properties of Construction Materials

| | 703.04 – Granular Borrow | 704.08 – Granular Backfill for Structures |
|---|---------------------------------|--|
| Unit Weight, γ (lbs/ft ³): | 130 | 140 |
| Internal Friction Angle, ϕ (degrees): | 32 | 34 |
| Coefficient of Friction, f | | |
| - mass concrete cast against soil: | 0.45 | 0.55 |
| - soil against precast/formed concrete: | 0.40 | 0.48 |
| Active Earth Pressure Coef., K_a : | 0.31 | 0.28 |
| Passive Earth Pressure Coef., K_p : | 3.26 | 3.57 |
| At-Rest Earth Pressure Coefficient, K_o : | 0.47 | 0.44 |

5.3 Construction Considerations

5.3.1 Cofferdams/Temporary Earthwork Support

The Contractor should be reminded that Section 208.06 of VTrans' 2018 *Standard Specifications for Construction* indicates that "The Contractor shall prepare detailed plans and a schedule of operations for each cofferdam specified in the Contract. Construction drawings shall be submitted in accordance with Section 105 (Control of the Work)."

5.3.2 Construction Dewatering

The bottom of footing elevations for the culverts are estimated to be beneath the water table based on where water was encountered during the subsurface investigation therefore temporary construction dewatering will likely be required to construct the foundations. Temporary dewatering will also be necessary to limit disturbance to and maintain the integrity of the bearing surface.

Temporary dewatering can likely be accomplished by open pumping from shallow sumps, temporary ditches, and trenches within and around the excavation limits. Sumps should be provided with filters suitable to prevent pumping of fine-grained soil particles. The water trapped by the temporary dewatering controls should be discharged to settling basins or an approved filter “sock” so that the fine particles suspended in the discharge have adequate time to “settle out” prior to discharge. All effluent water, or discharge, should comply with all applicable permits and regulations.

Sumps and trenches should lie outside a 1V:1H line extending downward and outward from the edge of footing. Installation and operation of the Contractor’s dewatering system should be integrated with other earthwork operations and sequence of cutting, filling, foundation construction, and backfilling.

5.3.3 Placement and Compaction of Soils

Fills should be placed systematically in horizontal layers not more than 12 inches in thickness, prior to compaction. Cobbles larger than 8 inches should be removed from the fill prior to placement. Compaction equipment should preferably consist of large, self-propelled vibratory rollers. Where hand-guided equipment is used, such as a small vibratory plate compactor, the loose lift thickness shall not exceed 6 inches. Cobbles larger than 4 inches should be removed from the fill prior to placement.

Embankment fills should be compacted to a dry density of no less than 95% of the maximum dry density determined in accordance with AASHTO T-99, Method C. Granular Backfill for Structures, or other select materials placed within the roadway base section shall be compacted to a dry density equal to 95% of the maximum dry density as determined in accordance with AASHTO T-99.

6.0 CONCLUSION

If you have any questions or would like to discuss this report, please contact the Geotechnical Engineering Section via email.

Reviewed by: Callie Ewald, P.E., Senior Geotechnical Engineer

Enclosures: Appendix A: WSP Geotechnical Data Memorandum (24 Pages)
Appendix B: Effective Footing Width vs. Bearing Resistance Graph (1 Page)
Appendix C: Global Stability Evaluation Outputs (2 Pages)

cc: Electronic Read File/MG
Project File/CEE
SPM

Appendix A
WSP Geotechnical Data Memorandum



TECHNICAL MEMORANDUM

TO: Mr. Stephen P. Madden

FROM: Mirsad Alihodzic, EIT, Karen Roth, EIT, and Jay R. Smerekanicz, PG, CPG

SUBJECT: Summary of Geotechnical Investigation and Subsurface Conditions, Vermont Agency of Transportation, Sunderland BM 20102

DATE: June 2, 2023

WSP Project No.: 31405712.002

INTRODUCTION

WSP USA Inc., (WSP), formerly Golder Associates USA Inc. (WSP Golder), is pleased to provide the Vermont Agency of Transportation (VTrans) this Technical Memorandum summarizing our geotechnical investigation for the proposed replacement of the Bridge 19-5 Culvert carrying U.S. Route 7 over an unnamed brook in Sunderland, VT (see Figure 1). This memorandum presents a summary of the geotechnical investigation we performed in April 2023, consisting of soil geotechnical information obtained from field characterization and observations of geotechnical borings conducted at the proposed culvert replacement location, and geotechnical laboratory results of select soil samples, conducted by VTrans' geotechnical laboratory.

This Technical Memorandum constitutes the completion of Task 1 – Subsurface Investigation, Task 2 – Geotechnical Laboratory Analysis and Interpretation, and Task 3 – Technical Memorandum from our proposed scope of work under contract with VTrans.

PROJECT BACKGROUND

The existing culvert was constructed in 1978 as part of original construction of U.S. Route 7, and consists of a steel pipe arch culvert with an eight-foot span.¹ Based on the Preliminary Geotechnical Report² completed by VTrans, we understand that VTrans is evaluating replacement options for the existing culvert, including a reinforced concrete box culvert with new headwalls and wingwalls, and a precast or steel arch bridge with spread footings founded on soil or bedrock. To support the scoping phase, VTrans requested WSP to drill two (2) geotechnical borings within the roadway shoulders at cross corners of the existing culvert.³

SUBSURFACE INVESTIGATION

WSP drilled the two (2) test borings, designated B-101 and B-102, between April 10, 2023 and April 12, 2023. B-101 lies in the U.S. Route 7 shoulder closest to the southwest corner of the culvert, and B-102 lies in the U.S. Route 7 shoulder closest to the northeast corner of the culvert. The approximate as-drilled locations of the borings are shown on Figure 1. WSP subcontracted Platform Environmental Drilling and Remediation Services LLC (Platform) of Montpelier, Vermont to complete the borings. Platform drilled the borings with a Geoprobe 7822DT track-mounted drill rig. A WSP geologist monitored drilling activities, logged the subsurface conditions encountered, and obtained soil samples for use in visual description and classification. As requested by VTrans, each boring was drilled to a target depth of 45 feet below ground surface (bgs). The WSP geologist used swing-tie measurements from

¹ Vermont Agency of Transportation. December 13, 2021. Inspection Report: Bridge #19-5 (Routine), US7 over Brook.

² Vermont Agency of Transportation. January 4, 2023. Office Memorandum: Sunderland BM 20102 Preliminary Geotechnical Information.

³ Vermont Agency of Transportation. January 26, 2023. Work Order Request (WOR) for Geotechnical Engineering Services, Sunderland BM 20102.



known civil site features to record the approximate as-drilled locations of the borings. The as-drilled boring locations of borings B-101 and B-102 were surveyed by VTrans early in May 2023 and provided to WSP on May 18, 2023.

Boring logs are provided in Appendix A, including details of the sampling methods used, field data obtained, soil conditions encountered during the investigation, geotechnical laboratory data, and borehole backfilling details. An explanation of the boring log symbols and terms used for the soil descriptions precedes the boring logs.

WSP delivered select soil samples to the VTrans Central Laboratory for grain size and moisture content testing on April 25, 2023. The laboratory test results are summarized in Table 1 and on the boring logs in Appendix A. Full laboratory test results are provided in Appendix B.

SUBSURFACE CONDITIONS

Soils encountered during our subsurface investigation include: fill materials placed during construction of U.S. Route 7; sand and silt interpreted as fluvial terrace deposits; and gravel and sand interpreted as glacial till. The borings were drilled to the target depth of 45 feet and did not encounter bedrock. The following descriptions summarize the major stratigraphic units and groundwater conditions encountered.

Pavement: Asphalt pavement thickness of 6 inches was encountered in each boring.

Fill: A two-foot thick nested cobble zone, interpreted as aggregate subbase, was encountered directly below the asphalt in each boring.

Fluvial Terrace Deposits: A layer interpreted as fluvial terrace deposits⁴ was encountered beneath the fill in each boring. In boring B-101, this layer generally consists of medium dense to very dense gravelly sand with some silt. In boring B-102, the layer generally consists of medium dense to dense silt with some gravel and some sand; a zone of loose sand was noted near the bottom of the layer. The fluvial terrace deposit thickness ranges from approximately 13 feet in B-101 to approximately 18 feet in B-102.

Glacial Till: A layer interpreted as glacial till⁴ was encountered beneath the fluvial terrace deposits in each boring. The layer generally consists of medium dense to very dense gravel with some sand and some silt, and dense to very dense sand with some gravel and some silt. The glacial till thickness ranges from at least 25 feet in B-102 to at least 30 feet in B-101. Both borings terminated within the glacial till layer.

Groundwater: WSP measured groundwater levels in boring B-101 during drilling and in boring B-102 upon completion of the hole. Measurements were made with temporary steel casing in the ground. Groundwater levels were measured as 13.6 feet bgs in B-101 and 10.8 feet bgs in B-102. We note that groundwater levels will vary seasonally from those measured.

CLOSING

WSP prepared this Technical Memorandum for the exclusive use of VTrans for specific application to the replacement of Bridge 19-5 Culvert carrying U.S. Route 7 in Sunderland, Vermont. We performed the geotechnical site investigation and compiled our subsurface interpretations in accordance with generally accepted soil and foundation engineering practices in this geographical area and under similar time and financial constraints. Our interpretations are based, in part, on information obtained from the referenced subsurface explorations completed at the discrete locations described in the memorandum. Variations in the nature and extent of subsurface conditions between explorations should be expected. WSP makes no other warranty, either express or implied.

The professional services provided by WSP for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible surface and/or subsurface contamination resulting from previous activities or

⁴ DeSimone, David. 2000. Surficial Geologic Map of the Arlington and Vermont Portion of the Shushan Quadrangles. Vermont Geological Survey Open-File Report VG00-2. Map Scale 1:24,000.



uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this report and have not been investigated or addressed.

WSP appreciates the opportunity to provide our geotechnical services to VTrans for this project. Please contact us if you have any questions.

Sincerely,

WSP USA Inc.

A handwritten signature in blue ink, appearing to read 'Mirsad Alihodzic'.

Mirsad Alihodzic
Senior Consultant, Geotechnical Engineer

A handwritten signature in blue ink, appearing to read 'Jay R. Smerekanicz'.

Jay R. Smerekanicz PG, CPG
Engineering Geologist, Technical Principal, Vice President

- Attachments:** Table 1: Summary of Soil Index and Classification Laboratory Testing Results
Figure 1: Boring Location Plan
Appendix A: Boring Logs
Appendix B: Laboratory Testing Results

Table

**Table 1: Summary of Soil Index and Classification Laboratory Testing Results
Bridge 19-5 Culvert carrying U.S. Route 7 over Unnamed Brook
Sunderland BM 20102**

| Test Boring Designation ¹ | Ground Surface Elevation ² (feet) | Sample Number | Sample Depth Below Ground Surface (feet) | Approximate Sample Elevation (feet) | Laboratory Testing ³ | | Soil Classification | |
|--------------------------------------|--|---------------|--|-------------------------------------|--------------------------------------|-----------------------------------|---------------------|------|
| | | | | | Sieve Minus No. 200 ⁴ (%) | Moisture Content ⁵ (%) | AASHTO | USCS |
| B-101 | 944.54 | S-2 | 10.0 - 12.0 | 934.54 - 932.54 | 20.2 | 10.6 | A-1-b | SM |
| | | S-4 | 20.0 - 22.0 | 924.54 - 922.54 | 24.9 | 10.7 | A-1-b | SM |
| | | S-6 | 30.0 - 32.0 | 914.54 - 912.54 | 31.2 | 10.1 | A-2-4 | SM |
| | | S-7 | 35.0 - 37.0 | 909.54 - 907.54 | 20.5 | 8.4 | A-1-b | GM |
| | | S-8 | 40.0 - 42.0 | 904.54 - 902.54 | 35.1 | 11.2 | A-4 | SM |
| B-102 | 942.45 | S-1 | 5.0 - 7.0 | 937.45 - 935.45 | 36.9 | 12.6 | A-4 | SM |
| | | S-3 | 15.0 - 17.0 | 927.45 - 925.45 | 19.0 | 17.2 | A-2-4 | SM |
| | | S-5 | 25.0 - 27.0 | 917.45 - 915.45 | 26.1 | 10.8 | A-2-4 | SM |
| | | S-7 | 35.0 - 37.0 | 907.45 - 905.45 | 32.3 | 9.3 | A-2-4 | GM |
| | | S-8 | 43.0 - 45.0 | 899.45 - 897.45 | 32.6 | 10.6 | A-2-4 | SM |

Notes:

1. Test boring locations are shown on Figure 1 - Boring Location Plan.
2. As-drilled boring elevations were provided to WSP by VTrans on May 18, 2023.
3. Laboratory testing was performed by the VTrans Central Laboratory in Berlin, VT.
4. Grain size testing was performed in accordance with AASHTO T-88, Standard Method of Test for Particle Size Analysis of Soils.
5. Moisture content testing was performed in accordance with AASHTO T-265, Standard Method of Test for Laboratory Determination of Moisture Content of Soils.

Prepared by: KAR
Checked by: FCT
Reviewed by: JRS

Figure

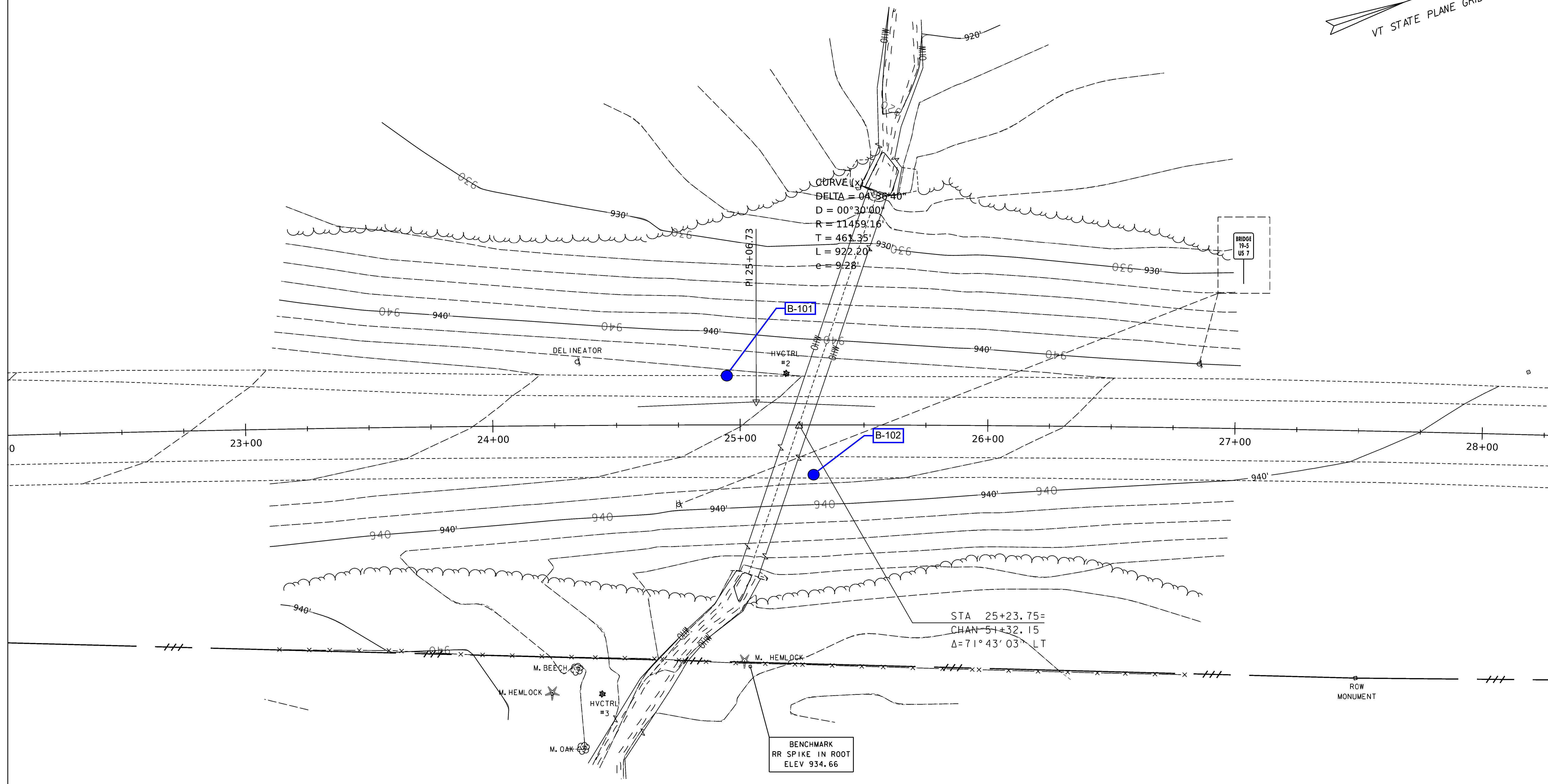
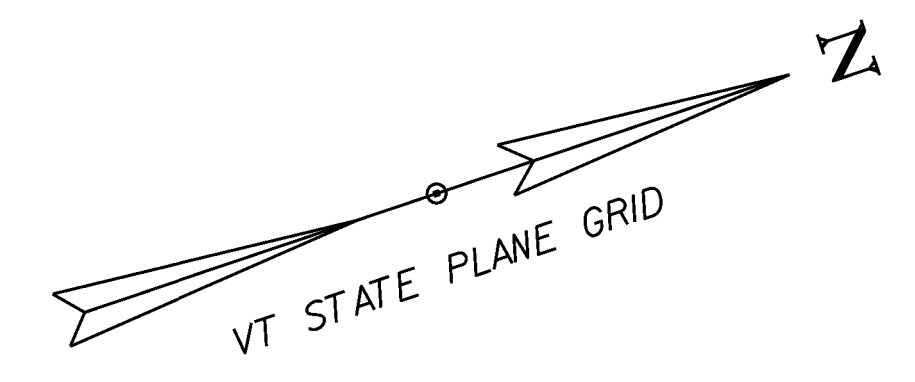


Figure 1 - Boring Location Plan


EXISTING CONDITIONS

SCALE 1" = 20'-0"
 20 0 20

| | |
|------------------------------------|------------------------|
| PROJECT NAME: SUNDERLAND | PLOT DATE: 31-OCT-2022 |
| PROJECT NUMBER: BM 20102 | DRAWN BY: D.D.BEARD |
| FILE NAME: s20b155BDR_Existing.dgn | CHECKED BY: ----- |
| PROJECT LEADER: L.J.STONE | SHEET 1 OF 6 |
| DESIGNED BY: ----- | |
| EXISTING CONDITIONS LAYOUT | |



Appendix A

| UNIFIED SOIL CLASSIFICATION SYSTEM | | | | TERMS DESCRIBING DENSITY/CONSISTENCY | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|--|--------------------------------------|--|--|---|---|-------------------------|--------------------------------------|-----------------------------------|---------------|-----------|-------------------|--------------------|--------------------------------|-----------|--------------------------------------|--|-------|---------------------------------|------------|--------|-------------|------------|--------------|-------------|-------|---------|------------|------|
| MAJOR DIVISIONS | | GROUP SYMBOLS | | TYPICAL NAMES | | | | | | | | | | | | | | | | | | | | | | | | | |
| COARSE-GRAINED SOILS (more than half of material is larger than No. 200 sieve size) | GRAVELS (more than half of coarse fraction is larger than No. 4 sieve size) | CLEAN GRAVELS | GW | Well-graded gravels, gravel-sand mixtures, little or no fines. | <p>Coarse-grained soils (more than half of material is larger than No. 200 sieve): Includes (1) clean gravels; (2) silty or clayey gravels; and (3) silty, clayey or gravelly sands. Consistency is rated according to standard penetration resistance.</p> <p style="text-align: center;">Modified Burmister System</p> <table border="0"> <tr> <td style="text-align: center;"><u>Descriptive Term</u></td> <td style="text-align: center;"><u>Portion of Total</u></td> </tr> <tr> <td>trace</td> <td>0% - 10%</td> </tr> <tr> <td>little</td> <td>11% - 20%</td> </tr> <tr> <td>some</td> <td>21% - 35%</td> </tr> <tr> <td>adjective (e.g. sandy, clayey)</td> <td>36% - 50%</td> </tr> </table> <table border="0"> <tr> <td style="text-align: center;"><u>Density of Cohesionless Soils</u></td> <td style="text-align: center;"><u>Standard Penetration Resistance</u></td> </tr> <tr> <td></td> <td style="text-align: center;"><u>N-Value (blows per foot)</u></td> </tr> <tr> <td>Very loose</td> <td>0 - 4</td> </tr> <tr> <td>Loose</td> <td>5 - 10</td> </tr> <tr> <td>Medium Dense</td> <td>11 - 30</td> </tr> <tr> <td>Dense</td> <td>31 - 50</td> </tr> <tr> <td>Very Dense</td> <td>> 50</td> </tr> </table> | <u>Descriptive Term</u> | <u>Portion of Total</u> | trace | 0% - 10% | little | 11% - 20% | some | 21% - 35% | adjective (e.g. sandy, clayey) | 36% - 50% | <u>Density of Cohesionless Soils</u> | <u>Standard Penetration Resistance</u> | | <u>N-Value (blows per foot)</u> | Very loose | 0 - 4 | Loose | 5 - 10 | Medium Dense | 11 - 30 | Dense | 31 - 50 | Very Dense | > 50 |
| | | <u>Descriptive Term</u> | <u>Portion of Total</u> | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | trace | 0% - 10% | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | little | 11% - 20% | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | some | 21% - 35% | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | adjective (e.g. sandy, clayey) | 36% - 50% | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <u>Density of Cohesionless Soils</u> | <u>Standard Penetration Resistance</u> | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | <u>N-Value (blows per foot)</u> | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Very loose | 0 - 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Loose | 5 - 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Medium Dense | 11 - 30 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Dense | 31 - 50 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Very Dense | > 50 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | GP | Poorly-graded gravels, gravel sand mixtures, little or no fines. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | GM | Silty gravels, gravel-sand-silt mixtures. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | GC | Clayey gravels, gravel-sand-clay mixtures. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | SANDS (more than half of coarse fraction is smaller than No. 4 sieve size) | CLEAN SANDS | SW | Well-graded sands, gravelly sands, little or no fines | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | SP | Poorly-graded sands, gravelly sand, little or no fines. | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | SM | Silty sands, sand-silt mixtures | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | SC | Clayey sands, sand-clay mixtures. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FINE-GRAINED SOILS (more than half of material is smaller than No. 200 sieve size) | SILTS AND CLAYS (liquid limit less than 50) | ML | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity. | <p>Fine-grained soils (more than half of material is smaller than No. 200 sieve): Includes (1) inorganic and organic silts and clays; (2) gravelly, sandy or silty clays; and (3) clayey silts. Consistency is rated according to shear strength as indicated.</p> <table border="0"> <tr> <td></td> <td style="text-align: center;"><u>Approximate Undrained Shear Strength (psf)</u></td> <td style="text-align: center;"><u>Field Guidelines</u></td> </tr> <tr> <td style="text-align: center;"><u>Consistency of Cohesive soils</u></td> <td style="text-align: center;"><u>SPT N-Value blows per foot</u></td> <td></td> </tr> <tr> <td>Very Soft</td> <td>WOH, WOR, WOP, <2</td> <td>0 - 250</td> </tr> <tr> <td>Soft</td> <td>2 - 4</td> <td>250 - 500</td> </tr> <tr> <td>Medium Stiff</td> <td>5 - 8</td> <td>500 - 1000</td> </tr> <tr> <td>Stiff</td> <td>9 - 15</td> <td>1000 - 2000</td> </tr> <tr> <td>Very Stiff</td> <td>16 - 30</td> <td>2000 - 4000</td> </tr> <tr> <td>Hard</td> <td>>30</td> <td>over 4000</td> </tr> </table> | | <u>Approximate Undrained Shear Strength (psf)</u> | <u>Field Guidelines</u> | <u>Consistency of Cohesive soils</u> | <u>SPT N-Value blows per foot</u> | | Very Soft | WOH, WOR, WOP, <2 | 0 - 250 | Soft | 2 - 4 | 250 - 500 | Medium Stiff | 5 - 8 | 500 - 1000 | Stiff | 9 - 15 | 1000 - 2000 | Very Stiff | 16 - 30 | 2000 - 4000 | Hard | >30 | over 4000 | |
| | | | <u>Approximate Undrained Shear Strength (psf)</u> | | <u>Field Guidelines</u> | | | | | | | | | | | | | | | | | | | | | | | | |
| | | <u>Consistency of Cohesive soils</u> | <u>SPT N-Value blows per foot</u> | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Very Soft | WOH, WOR, WOP, <2 | 0 - 250 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Soft | 2 - 4 | 250 - 500 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Medium Stiff | 5 - 8 | 500 - 1000 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stiff | 9 - 15 | 1000 - 2000 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Very Stiff | 16 - 30 | 2000 - 4000 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hard | >30 | over 4000 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | OL | Organic silts and organic silty clays of low plasticity. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | SILTS AND CLAYS (liquid limit greater than 50) | MH | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | CH | Inorganic clays of high plasticity, fat clays. | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | OH | Organic clays of medium to high plasticity, organic silts. | | | | | | | | | | | | | | | | | | | | | | | | | |
| | HIGHLY ORGANIC SOILS | Pt | Peat and other highly organic soils. | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>Desired Soil Observations: (in this order)</p> <p>Color (Munsell color chart) Moisture (dry, damp, moist, wet, saturated) Density/Consistency (from above right hand side) Name (sand, silty sand, clay, etc., including portions - trace, little, etc.) Gradation (well-graded, poorly-graded, uniform, etc.) Plasticity (non-plastic, slightly plastic, moderately plastic, highly plastic) Structure (layering, fractures, cracks, etc.) Bonding (well, moderately, loosely, etc., if applicable) Cementation (weak, moderate, or strong, if applicable, ASTM D 2488) Geologic Origin (till, marine clay, alluvium, etc.) Unified Soil Classification Designation Groundwater level</p> | | | | <p>Rock Quality Designation (RQD):</p> <p>RQD = $\frac{\text{sum of the lengths of intact pieces of core}^* > 100 \text{ mm}}{\text{length of core advance}}$</p> <p>*Minimum NQ rock core (1.88 in. OD of core)</p> <p style="text-align: center;">Correlation of RQD to Rock Mass Quality</p> <table border="0"> <tr> <td style="text-align: center;"><u>Rock Mass Quality</u></td> <td style="text-align: center;"><u>RQD</u></td> </tr> <tr> <td>Very Poor</td> <td><25%</td> </tr> <tr> <td>Poor</td> <td>26% - 50%</td> </tr> <tr> <td>Fair</td> <td>51% - 75%</td> </tr> <tr> <td>Good</td> <td>76% - 90%</td> </tr> <tr> <td>Excellent</td> <td>91% - 100%</td> </tr> </table> <p>Desired Rock Observations: (in this order)</p> <p>Color (Geological Society of America Rock Color Chart) Texture (aphanitic, fine-grained, etc.) Strength (ISRM Classification per Table A-2) Lithology (igneous, sedimentary, metamorphic, etc.) Hardness (very hard, hard, mod. hard, etc.)</p> | | <u>Rock Mass Quality</u> | <u>RQD</u> | Very Poor | <25% | Poor | 26% - 50% | Fair | 51% - 75% | Good | 76% - 90% | Excellent | 91% - 100% | | | | | | | | | | | | |
| <u>Rock Mass Quality</u> | <u>RQD</u> | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Very Poor | <25% | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Poor | 26% - 50% | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fair | 51% - 75% | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Good | 76% - 90% | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Excellent | 91% - 100% | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>Desired Soil Observations: (in this order)</p> <p>Color (Munsell color chart) Moisture (dry, damp, moist, wet, saturated) Density/Consistency (from above right hand side) Name (sand, silty sand, clay, etc., including portions - trace, little, etc.) Gradation (well-graded, poorly-graded, uniform, etc.) Plasticity (non-plastic, slightly plastic, moderately plastic, highly plastic) Structure (layering, fractures, cracks, etc.) Bonding (well, moderately, loosely, etc., if applicable) Cementation (weak, moderate, or strong, if applicable, ASTM D 2488) Geologic Origin (till, marine clay, alluvium, etc.) Unified Soil Classification Designation Groundwater level</p> | | | | <p>Weathering (fresh, very slight, slight, moderate, mod. severe, severe, etc.) Geologic discontinuities/jointing: -dip (horiz - 0-5, low angle - 5-35, mod. dipping - 35-55, steep - 55-85, vertical - 85-90) -spacing (very close - <5 cm, close - 5-30 cm, mod. close 30-100 cm, wide - 1-3 m, very wide >3 m) -tightness (tight, open or healed) -infilling (grain size, color, etc.) Formation (Waterville, Ellsworth, Cape Elizabeth, etc.) RQD and correlation to rock mass quality (very poor, poor, etc.) ref: AASHTO Standard Specification for Highway Bridges 17th Ed. Table 4.4.8.1.2A Recovery</p> | | | | | | | | | | | | | | | | | | | | | | | | | |
|  <p>Key to Soil and Rock Descriptions Including Boring Log Terms and Field Identification Information</p> | | | | <p>Sample Container Labeling Requirements:</p> <table border="0"> <tr> <td>Project Name / Town</td> <td>Blow Counts</td> </tr> <tr> <td>Boring Number</td> <td>Sample Recovery</td> </tr> <tr> <td>Sample Number</td> <td>Date</td> </tr> <tr> <td>Sample Depth</td> <td>Personnel Initials</td> </tr> </table> | | Project Name / Town | Blow Counts | Boring Number | Sample Recovery | Sample Number | Date | Sample Depth | Personnel Initials | | | | | | | | | | | | | | | | |
| Project Name / Town | Blow Counts | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Boring Number | Sample Recovery | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sample Number | Date | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sample Depth | Personnel Initials | | | | | | | | | | | | | | | | | | | | | | | | | | | | |



STATE OF VERMONT
 AGENCY OF TRANSPORTATION
 CONSTRUCTION AND
 MATERIALS BUREAU
 CENTRAL LABORATORY

BORING LOG

**Sunderland
 BM 20102
 Bridge 19-5 Culvert US Route 7**

Boring No.: **B-101**
 Page No.: **1 of 2**
 Pin No.: **20b155**
 Checked By: **MA**

Boring Crew: Michael Jordan (Platform), Kaitlin Berube (WSP)
 Date Started: 4/10/23 Date Finished: 4/11/23
 VTSPG NAD83: N 194749.34 ft E 1469816.28 ft
 Station: 25+20 Offset: 17.5 ft L
 Ground Elevation: 944.54 ft

Casing Sampler
 Type: HSA & WB SS
 I.D.: 4 in 1.5 in
 Hammer Wt: 140 lb. 140 lb.
 Hammer Fall: 30 in. 30 in.
 Hammer/Rod Type: Auto/NWJ
 Rig: Geoprobe 7822DT C_E = 1.68

| Groundwater Observations | | |
|--------------------------|------------|--------------------|
| Date | Depth (ft) | Notes |
| 04/11/23 | 13.6 | 8:45 AM (AD 16hrs) |
| | | |
| | | |

| Depth (ft) | Strata (1) | CLASSIFICATION OF MATERIALS (Description) | Blows/6" (N Value) | Moisture Content % | Gravel % | Sand % | Fines % |
|-------------|------------|---|--------------------|--------------------|----------|--------|---------|
| 0.0 - 0.5 | | Asphalt | | | | | |
| 0.5 - 2.5 | | Nested cobble zone | | | | | |
| 5.0 - 7.0 | | A-1-b, SM, reddish-brown, dry, medium dense gravelly fine to coarse SAND, some silt, well-graded., Rec. = 1.1 ft | 1-7-8-6 (15) | | | | |
| 10.0 - 12.0 | | A-1-b, SM, reddish-brown, dry, very dense gravelly fine to coarse SAND, some silt, well-graded., Rec. = 1.0 ft | 70-44-30-20 (74) | 10.6 | 38.8 | 41.0 | 20.2 |
| 15.0 - 17.0 | | A-1-b, SM, reddish-brown, moist, dense gravelly fine to coarse SAND, some silt, well-graded., Rec. = 0.5 ft | 8-11-35-39 (46) | | | | |
| 20.0 - 22.0 | | A-1-b, SM, reddish-brown, moist, medium dense GRAVEL, some sand, some silt, well-graded., Rec. = 0.8 ft | 17-13-9-7 (22) | 10.7 | 41.3 | 33.8 | 24.9 |
| 25.0 - 27.0 | | A-1-b, SM, reddish-brown, moist, medium dense GRAVEL, some sand, some silt, well-graded., Rec. = 0.8 ft | 15-11-10-10 (21) | | | | |
| 27.0 - 28.0 | | During boring advancement driller used a roller bit to advance through a boulder from approximately 27 feet to 28 feet bgs. | | | | | |
| 30.0 - 32.0 | | A-2-4, SM, reddish-brown, moist to wet, medium dense GRAVEL, some sand, some silt., Rec. = 0.85 ft | 16-10-17-28 (27) | 10.1 | 38.4 | 30.4 | 31.2 |

Notes: 1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
 2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
 3. Water level readings have been made at times and under conditions stated. Fluctuations may occur due to other factors than those present at the time measurements were made.

BORING LOG 31405712.002 VTRANS SUNDERLAND (1).GPJ VERMONT AOT.GDT 6/2/23



STATE OF VERMONT
 AGENCY OF TRANSPORTATION
 CONSTRUCTION AND
 MATERIALS BUREAU
 CENTRAL LABORATORY

BORING LOG

**Sunderland
 BM 20102
 Bridge 19-5 Culvert US Route 7**

Boring No.: **B-101**
 Page No.: 2 of 2
 Pin No.: 20b155
 Checked By: MA

Boring Crew: Michael Jordan (Platform), Kaitlin Berube (WSP)
 Date Started: 4/10/23 Date Finished: 4/11/23
 VTSPG NAD83: N 194749.34 ft E 1469816.28 ft
 Station: 25+20 Offset: 17.5 ft L
 Ground Elevation: 944.54 ft

Casing Sampler
 Type: HSA & WB SS
 I.D.: 4 in 1.5 in
 Hammer Wt: 140 lb. 140 lb.
 Hammer Fall: 30 in. 30 in.
 Hammer/Rod Type: Auto/NWJ
 Rig: Geoprobe 7822DT C_E = 1.68

| Groundwater Observations | | |
|--------------------------|------------|--------------------|
| Date | Depth (ft) | Notes |
| 04/11/23 | 13.6 | 8:45 AM (AD 16hrs) |
| | | |
| | | |

| Depth (ft) | Strata (1) | CLASSIFICATION OF MATERIALS (Description) | Blows/6" (N Value) | Moisture Content % | Gravel % | Sand % | Fines % |
|------------|------------|---|-----------------------|--------------------|----------|--------|---------|
| 35 | | 35.0 ft - 37.0 ft, A-1-b, GM, reddish-brown, moist to wet, very dense, GRAVEL, some sand, some silt., Rec. = 0.55 ft | 46-47-43-44 (90) | 8.4 | 51.8 | 27.7 | 20.5 |
| 40 | | 40.0 ft - 41.75 ft, A-4, SM, reddish-brown, dry, very dense, GRAVEL, some sand, some silt., Rec. = 0.8 ft | 114-48-76-50/3" (124) | 11.2 | 37.1 | 27.8 | 35.1 |
| 45 | | 42.0 ft - 45.0 ft, Roller bit and casing refusal at 42 ft bgs. Advanced core barrel through cobbles and boulders 42 to 45 ft bgs. | | | | | |
| 45 | | Hole stopped @ 45.0 ft Boring backfilled with drill cuttings. | | | | | |
| 50 | | Remarks: - Groundwater level recorded 16 hours after drilling (AD), at the time the groundwater level was recorded the steel casing was advanced 25 feet below the ground surface (bgs). - AASHTO and USCS classifications are based on visual description of sample recovery at depths where lab testing not performed. - Boring was backfilled with drill cuttings and capped with cold-patch asphalt to the existing ground surface by Platform. - Boring coordinates and elevation were provided to WSP by VTrans on 5/18/2023. | | | | | |
| 55 | | | | | | | |
| 60 | | | | | | | |

BORING LOG 31405712.002 VTRANS SUNDERLAND (1).GPJ VERMONT AOT.GDT 6/2/23

Notes:
 1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
 2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
 3. Water level readings have been made at times and under conditions stated. Fluctuations may occur due to other factors than those present at the time measurements were made.



STATE OF VERMONT
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 CENTRAL LABORATORY

BORING LOG

**Sunderland
 BM 20102
 Bridge 19-5 Culvert US Route 7**

Boring No.: **B-102**
 Page No.: **1 of 2**
 Pin No.: **20b155**
 Checked By: **MA**

Boring Crew: Michael Jordan (Platform), Kaitlin Berube (WSP)
 Date Started: 4/12/23 Date Finished: 4/12/23
 VTSPG NAD83: N 194771.67 ft E 1469865.12 ft
 Station: 25+30 Offset: 20 ft R
 Ground Elevation: 942.45 ft

Casing Sampler
 Type: HSA & WB SS
 I.D.: 4 in 1.5 in
 Hammer Wt: 140 lb. 140 lb.
 Hammer Fall: 30 in. 30 in.
 Hammer/Rod Type: Auto/NWJ
 Rig: Geoprobe 7822DT C_E = 1.68

| Groundwater Observations | | |
|--------------------------|------------|---------------------|
| Date | Depth (ft) | Notes |
| 04/12/23 | 10.8 | 4:40 PM (ATD 3 min) |
| | | |
| | | |

| Depth (ft) | Strata (1) | CLASSIFICATION OF MATERIALS (Description) | Blows/6" (N Value) | Moisture Content % | Gravel % | Sand % | Fines % |
|--------------|------------|---|--------------------|--------------------|----------|--------|---------|
| 0.0 - 0.5 | | 0.0 ft - 0.5 ft, Asphalt | | | | | |
| 0.5 - 2.5 | | 0.5 ft - 2.5 ft, Nested cobble zone | | | | | |
| 5.0 - 7.0 | | 5.0 ft - 7.0 ft, A-4, SM, reddish-brown, moist, medium dense, SILT, some gravel, some sand, Rec. = 1.0 ft | 5-8-7-10 (15) | 12.6 | 30.9 | 32.2 | 36.9 |
| 10.0 - 12.0 | | 10.0 ft - 12.0 ft, A-4, SM, reddish-brown, dry to moist, dense, SILT, some gravel, some sand, Rec. = 1.5 ft | 39-15-18-25 (33) | | | | |
| 14.0 | | 14.0 ft, Driller switched from hollow stem augers to drive and wash. | | | | | |
| 15.0 - 17.0 | | 15.0 ft - 17.0 ft, A-2-4, SM, brownish-grey, moist, loose, SAND, little silt, trace gravel, Rec. = 0.3 ft | 5-3-2-5 (5) | 17.2 | 8.9 | 72.1 | 19.0 |
| 20.0 - 22.0 | | 20.0 ft - 22.0 ft, A-2-4, GP-GM, reddish-brown, moist, very dense, SAND, some gravel, some silt, Rec. = 0.45 ft | 19-34-29-18 (63) | | | | |
| 25.0 - 27.0 | | 25.0 ft - 27.0 ft, A-2-4, SM, reddish-brown, moist, dense, SAND, some gravel, some silt, Rec. = 0.65 ft | 36-16-15-13 (31) | 10.8 | 34.4 | 39.5 | 26.1 |
| 29.0 - 30.0 | | 29.0 ft, During boring advancement driller noted gravel in the wash water from approximately 29 feet to 30 feet below ground surface (bgs). | | | | | |
| 30.0 - 31.25 | | 30.0 ft - 31.25 ft, A-2-4, GP-GM, reddish-brown, wet, very dense, GRAVEL, trace sand, trace silt, trace quartzite pieces, Rec. = 0.5 ft | 30-45-50/3" (R) | | | | |

Notes:
 1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
 2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
 3. Water level readings have been made at times and under conditions stated. Fluctuations may occur due to other factors than those present at the time measurements were made.

BORING LOG 31405712.002 VTRANS SUNDERLAND (1).GPJ VERMONT AOT.GDT 6/2/23



STATE OF VERMONT
 AGENCY OF TRANSPORTATION
 CONSTRUCTION AND
 MATERIALS BUREAU
 CENTRAL LABORATORY

BORING LOG

**Sunderland
 BM 20102
 Bridge 19-5 Culvert US Route 7**

Boring No.: B-102
 Page No.: 2 of 2
 Pin No.: 20b155
 Checked By: MA

Boring Crew: Michael Jordan (Platform), Kaitlin Berube (WSP)
 Date Started: 4/12/23 Date Finished: 4/12/23
 VTSPG NAD83: N 194771.67 ft E 1469865.12 ft
 Station: 25+30 Offset: 20 ft R
 Ground Elevation: 942.45 ft

Casing Sampler
 Type: HSA & WB SS
 I.D.: 4 in 1.5 in
 Hammer Wt: 140 lb. 140 lb.
 Hammer Fall: 30 in. 30 in.
 Hammer/Rod Type: Auto/NWJ
 Rig: Geoprobe 7822DT C_E = 1.68

| Groundwater Observations | | |
|--------------------------|------------|---------------------|
| Date | Depth (ft) | Notes |
| 04/12/23 | 10.8 | 4:40 PM (ATD 3 min) |
| | | |
| | | |

| Depth (ft) | Strata (1) | CLASSIFICATION OF MATERIALS (Description) | Blows/6" (N Value) | Moisture Content % | Gravel % | Sand % | Fines % |
|------------|------------|---|--------------------|--------------------|----------|--------|---------|
| 35 | | 35.0 ft - 37.0 ft, A-2-4, GM, reddish-brown, moist, very dense, GRAVEL, some sand, some silt, well-graded, Rec. = 0.9 ft | 21-64-49-20 (113) | 9.3 | 39.8 | 27.9 | 32.3 |
| 40 | | 38.0 ft - 40.0 ft, During boring advancement driller used a roller bit to advance through a cobble zone from approximately 38 feet to 40 feet bgs. | | | | | |
| 45 | | 43.0 ft - 45.0 ft, A-2-4, SM, reddish-brown, dry, very dense, GRAVEL, some sand, some silt, well-graded, Rec. = 1.0 ft | 12-86-42-37 (128) | 10.6 | 35.1 | 32.3 | 32.6 |
| 45 | | Hole stopped @ 45.0 ft Boring backfilled with drill cuttings. Remarks: - Groundwater level recorded 3 minutes after drilling (AD), at the time the groundwater level was recorded the steel casing was advanced 43 feet below the ground surface (bgs). - AASHTO and USCS classifications are based on visual description of sample recovery at depths where lab testing not performed. - Boring was backfilled with drill cuttings and capped with cold-patch asphalt to the existing ground surface by Platform. - Boring coordinates and elevation were provided to WSP by VTtrans on 5/18/2023. | | | | | |
| 50 | | | | | | | |
| 55 | | | | | | | |
| 60 | | | | | | | |

BORING LOG 31405712.002 VTRANS SUNDERLAND (1).GPJ VERMONT AOT.GDT 6/2/23

Notes:
 1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
 2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
 3. Water level readings have been made at times and under conditions stated. Fluctuations may occur due to other factors than those present at the time measurements were made.



Appendix B



**State of Vermont
Agency of Transportation
Construction and Materials Bureau
Central Laboratory**

Report on Soil Sample

Lab Number: E21 134 **Report Date:** 4/25/2023
Project: Sunderland BM 20102 **Site:** **Tested By:** B. Fletcher
Date Sampled: 4 / 10 / 23 **Date Received:** 4 / 17 / 23 **Date Tested:** 4 / 19 / 23
Station: 0 + 0 **Offset:** 0 **Hole:** B-101 **Depth:** 20 ft to: 22 ft **Examined For:** Class
Field Description: Silty Gr well graded, Moist, red/brn **Submitted By:** KMB **Sample Type:** SS

Test Results

T-88 Sieve Analysis

T-265 Moisture Content

| | TOTAL: | Wt Retained | Wt Passing | % Passing |
|---------|---------|-------------|------------|-----------|
| | | 503.3 | | |
| 75mm | 3in | 0.0 | 503.3 | 100.0 |
| 37.5mm | 1.5in | 0.0 | 503.3 | 100.0 |
| 19mm | 3/4in | 66.5 | 436.8 | 86.8 |
| 9.5mm | 3/8in | 29.3 | 407.5 | 81.0 |
| 4.75mm | No.4 | 82.9 | 324.6 | 64.5 |
| Reduced | 4.75mm | 261.3 | | |
| 2.00mm | No.10 | 23.6 | 237.7 | 58.7 |
| 850um | No.20 | 24.1 | 213.6 | 52.7 |
| 425um | No.40 | 22.2 | 191.4 | 47.2 |
| 250um | No.60 | 18.0 | 173.4 | 42.8 |
| 150um | No.100 | 21.8 | 151.6 | 37.4 |
| 75um | No.200 | 50.8 | 100.8 | 24.9 |
| <75um | <No.200 | | | |

Mass of can and WET SOIL: 826.70 g
Mass of can and DRY SOIL: 772.61 g
Mass of can: 269.33 g
Moisture content: 10.7 %
T-90 PL = **PI =** 0
T-89 LL =
Gr: 41.3 %
Sa: 33.8 %
Si: 24.9 %
100.0 %
M145: AASHTO Class: A-1-b
D2487: Soil Description: SiSaGr

Comments: 0

Reviewed By: Stephen Madden, Geotechnical Engineer



**State of Vermont
Agency of Transportation
Construction and Materials Bureau
Central Laboratory**

Report on Soil Sample

Lab Number: E21 135 **Report Date:** 4/25/2023

Project: Sunderland BM 20102 **Site:** **Tested By:** B. Fletcher

Date Sampled: 4 / 10 / 23 **Date Received:** 4 / 17 / 23 **Date Tested:** 4 / 19 / 23

Station: 0 + 0 **Offset:** 0 **Hole:** B-101 **Depth:** 30 ft to: 32 ft **Examined For:** Class

Field Description: Silty Sand trace Gr, MTW, red/brn **Submitted By:** KMB **Sample Type:** SS

Test Results

T-88 Sieve Analysis

T-265 Moisture Content

| | TOTAL: | Wt Retained | Wt Passing | % Passing |
|---------|---------|-------------|------------|-----------|
| | | 649.7 | | |
| 75mm | 3in | 0.0 | 649.7 | 100.0 |
| 37.5mm | 1.5in | 0.0 | 649.7 | 100.0 |
| 19mm | 3/4in | 39.5 | 610.2 | 93.9 |
| 9.5mm | 3/8in | 70.1 | 540.1 | 83.1 |
| 4.75mm | No.4 | 95.1 | 445.0 | 68.5 |
| Reduced | 4.75mm | 257.3 | | |
| 2.00mm | No.10 | 25.8 | 231.5 | 61.6 |
| 850um | No.20 | 26.0 | 205.5 | 54.7 |
| 425um | No.40 | 18.0 | 187.5 | 49.9 |
| 250um | No.60 | 13.0 | 174.5 | 46.5 |
| 150um | No.100 | 14.0 | 160.5 | 42.7 |
| 75um | No.200 | 43.4 | 117.1 | 31.2 |
| <75um | <No.200 | | | |

Mass of can and WET SOIL: 986.11 g
Mass of can and DRY SOIL: 920.17 g
Mass of can: 270.44 g
Moisture content: 10.1 %

T-90 PL = **PI =** 0
T-89 LL =

Gr: 38.4 %
Sa: 30.5 %
Si: 31.2 %
100.0 %

M145: AASHTO Class: A-2-4
D2487: Soil Description: SaSiGr

Comments: 0

Reviewed By: Stephen Madden, Geotechnical Engineer



**State of Vermont
Agency of Transportation
Construction and Materials Bureau
Central Laboratory**

Report on Soil Sample

Lab Number: E21 136 **Report Date:** 4/25/2023

Project: Sunderland BM 20102 **Site:** **Tested By:** B. Fletcher

Date Sampled: 4 / 10 / 23 **Date Received:** 4 / 17 / 23 **Date Tested:** 4 / 19 / 23

Station: 0 + 0 **Offset:** 0 **Hole:** B-101 **Depth:** 35 ft to: 37 ft **Examined For:** Class

Field Description: Sandy Gr trace Silt, MTW, red/bn **Submitted By:** KMB **Sample Type:** SS

Test Results

T-88 Sieve Analysis

T-265 Moisture Content

| | TOTAL: | Wt Retained | Wt Passing | % Passing |
|---------|---------|-------------|------------|-----------|
| | | 404.6 | | |
| 75mm | 3in | 0.0 | 404.6 | 100.0 |
| 37.5mm | 1.5in | 0.0 | 404.6 | 100.0 |
| 19mm | 3/4in | 37.1 | 367.5 | 90.8 |
| 9.5mm | 3/8in | 51.8 | 315.7 | 78.0 |
| 4.75mm | No.4 | 88.8 | 226.9 | 56.1 |
| Reduced | 4.75mm | 225.8 | | |
| 2.00mm | No.10 | 31.8 | 194.0 | 48.2 |
| 850um | No.20 | 21.9 | 172.1 | 42.7 |
| 425um | No.40 | 16.7 | 155.4 | 38.6 |
| 250um | No.60 | 14.1 | 141.3 | 35.1 |
| 150um | No.100 | 17.0 | 124.3 | 30.9 |
| 75um | No.200 | 41.6 | 82.7 | 20.5 |
| <75um | <No.200 | | | |

| | | |
|----------------------------------|--------|---------------|
| Mass of can and WET SOIL: | 710.15 | g |
| Mass of can and DRY SOIL: | 676.33 | g |
| Mass of can: | 271.74 | g |
| Moisture content: | 8.4 | % |
| T-90 PL = | | PI = 0 |
| T-89 LL = | | |
| Gr: | 51.8 | % |
| Sa: | 27.6 | % |
| Si: | 20.5 | % |
| | 100.0 | % |
| M145: AASHTO Class: | A-1-b | |
| D2487: Soil Description: | SiSaGr | |

Comments: 0

Reviewed By: Stephen Madden, Geotechnical Engineer



**State of Vermont
Agency of Transportation
Construction and Materials Bureau
Central Laboratory**

Report on Soil Sample

Lab Number: E21 137 **Report Date:** 4/25/2023
Project: Sunderland BM 20102 **Site:** **Tested By:** B. Fletcher
Date Sampled: 4 / 10 / 23 **Date Received:** 4 / 17 / 23 **Date Tested:** 4 / 19 / 23
Station: 0 + 0 **Offset:** 0 **Hole:** B-101 **Depth:** 40 ft to: 42 ft **Examined For:** Class
Field Description: Silty Sand trace Gr, Dry, red/brn **Submitted By:** KMB **Sample Type:** SS

Test Results

T-88 Sieve Analysis

T-265 Moisture Content

| | TOTAL: | Wt Retained | Wt Passing | % Passing |
|---------|---------|-------------|------------|-----------|
| | | 697.5 | | |
| 75mm | 3in | 0.0 | 697.5 | 100.0 |
| 37.5mm | 1.5in | 0.0 | 697.5 | 100.0 |
| 19mm | 3/4in | 67.2 | 630.3 | 90.4 |
| 9.5mm | 3/8in | 57.5 | 572.8 | 82.1 |
| 4.75mm | No.4 | 99.6 | 473.2 | 67.8 |
| Reduced | 4.75mm | 313.0 | | |
| 2.00mm | No.10 | 22.6 | 290.4 | 62.9 |
| 850um | No.20 | 21.0 | 269.4 | 58.4 |
| 425um | No.40 | 18.3 | 251.1 | 54.4 |
| 250um | No.60 | 14.9 | 236.2 | 51.2 |
| 150um | No.100 | 17.2 | 219.0 | 47.5 |
| 75um | No.200 | 57.2 | 161.8 | 35.1 |
| <75um | <No.200 | | | |

Mass of can and WET SOIL: 1047.08 g
Mass of can and DRY SOIL: 968.66 g
Mass of can: 271.17 g
Moisture content: 11.2 %
T-90 PL = **PI =** 0
T-89 LL =
Gr: 37.1 %
Sa: 27.9 %
Si: 35.1 %
100.0 %
M145: AASHTO Class: A-4
D2487: Soil Description: SaGrSi

Comments: 0

Reviewed By: Stephen Madden, Geotechnical Engineer



**State of Vermont
Agency of Transportation
Construction and Materials Bureau
Central Laboratory**

Report on Soil Sample

Lab Number: E21 138 **Report Date:** 4/25/2023
Project: Sunderland BM 20102 **Site:** **Tested By:** B. Fletcher
Date Sampled: 4 / 10 / 23 **Date Received:** 4 / 17 / 23 **Date Tested:** 4 / 19 / 23
Station: 0 + 0 **Offset:** 0 **Hole:** B-102 **Depth:** 5 ft to: 7 ft **Examined For:** Class
Field Description: Silty Sand trace Gr, Moist, red/bn **Submitted By:** KMB **Sample Type:** SS

Test Results

T-88 Sieve Analysis

T-265 Moisture Content

| | TOTAL: | Wt Retained | Wt Passing | % Passing |
|---------|---------|-------------|------------|-----------|
| | | 640.6 | | |
| 75mm | 3in | 0.0 | 640.6 | 100.0 |
| 37.5mm | 1.5in | 0.0 | 640.6 | 100.0 |
| 19mm | 3/4in | 107.2 | 533.4 | 83.3 |
| 9.5mm | 3/8in | 18.2 | 515.2 | 80.4 |
| 4.75mm | No.4 | 53.4 | 461.8 | 72.1 |
| Reduced | 4.75mm | 213.8 | | |
| 2.00mm | No.10 | 8.8 | 205.0 | 69.1 |
| 850um | No.20 | 9.1 | 195.9 | 66.1 |
| 425um | No.40 | 11.2 | 184.7 | 62.3 |
| 250um | No.60 | 11.1 | 173.6 | 58.5 |
| 150um | No.100 | 15.4 | 158.2 | 53.3 |
| 75um | No.200 | 48.7 | 109.5 | 36.9 |
| <75um | <No.200 | | | |

| | | |
|----------------------------------|-------------|---|
| Mass of can and WET SOIL: | 992.88 | g |
| Mass of can and DRY SOIL: | 912.23 | g |
| Mass of can: | 271.62 | g |
| Moisture content: | 12.6 | % |
| T-90 PL = | PI = | 0 |
| T-89 LL = | | |
| Gr: | 30.9 | % |
| Sa: | 32.2 | % |
| Si: | 36.9 | % |
| | 100.0 | % |
| M145: AASHTO Class: | A-4 | |
| D2487: Soil Description: | GrSaSi | |

Comments: 0

Reviewed By: Stephen Madden, Geotechnical Engineer



**State of Vermont
Agency of Transportation
Construction and Materials Bureau
Central Laboratory**

Report on Soil Sample

Lab Number: E21 139 **Report Date:** 4/25/2023
Project: Sunderland BM 20102 **Site:** **Tested By:** B. Fletcher
Date Sampled: 4 / 10 / 23 **Date Received:** 4 / 17 / 23 **Date Tested:** 4 / 19 / 23
Station: 0 + 0 **Offset:** 0 **Hole:** B-102 **Depth:** 15 ft to: 17 ft **Examined For:** Class
Field Description: Sand poorly graded, Moist, gry/brn **Submitted By:** KMB **Sample Type:** SS

Test Results

T-88 Sieve Analysis

T-265 Moisture Content

| | TOTAL: | Wt Retained | Wt Passing | % Passing |
|---------|---------|-------------|------------|-----------|
| | | 106.6 | | |
| 75mm | 3in | 0.0 | 106.6 | 100.0 |
| 37.5mm | 1.5in | 0.0 | 106.6 | 100.0 |
| 19mm | 3/4in | 0.0 | 106.6 | 100.0 |
| 9.5mm | 3/8in | 0.0 | 106.6 | 100.0 |
| 4.75mm | No.4 | 2.9 | 103.7 | 97.3 |
| Reduced | 4.75mm | 103.3 | | |
| 2.00mm | No.10 | 6.6 | 96.7 | 91.1 |
| 850um | No.20 | 9.5 | 87.2 | 82.1 |
| 425um | No.40 | 13.1 | 74.1 | 69.8 |
| 250um | No.60 | 13.0 | 61.1 | 57.5 |
| 150um | No.100 | 13.8 | 47.3 | 44.5 |
| 75um | No.200 | 27.1 | 20.2 | 19.0 |
| <75um | <No.200 | | | |

| | | |
|----------------------------------|--------|---------------|
| Mass of can and WET SOIL: | 394.33 | g |
| Mass of can and DRY SOIL: | 375.95 | g |
| Mass of can: | 269.32 | g |
| Moisture content: | 17.2 | % |
| T-90 PL = | | PI = 0 |
| T-89 LL = | | |
| Gr: | 8.9 | % |
| Sa: | 72.0 | % |
| Si: | 19.0 | % |
| | 100.0 | % |
| M145: AASHTO Class: | A-2-4 | |
| D2487: Soil Description: | Sa | |

Comments: 0

Reviewed By: Stephen Madden, Geotechnical Engineer



**State of Vermont
Agency of Transportation
Construction and Materials Bureau
Central Laboratory**

Report on Soil Sample

Lab Number: E21 140 **Report Date:** 4/25/2023

Project: Sunderland BM 20102 **Site:** **Tested By:** B. Fletcher

Date Sampled: 4 / 10 / 23 **Date Received:** 4 / 17 / 23 **Date Tested:** 4 / 19 / 23

Station: 0 + 0 **Offset:** 0 **Hole:** B-102 **Depth:** 25 ft to: 27 ft **Examined For:** Class

Field Description: Silty Sand trace Gr, Moist, red/bn **Submitted By:** KMB **Sample Type:** SS

Test Results

T-88 Sieve Analysis

T-265 Moisture Content

| | TOTAL: | Wt Retained | Wt Passing | % Passing |
|---------|---------|-------------|------------|-----------|
| | | 412.7 | | |
| 75mm | 3in | 0.0 | 412.7 | 100.0 |
| 37.5mm | 1.5in | 0.0 | 412.7 | 100.0 |
| 19mm | 3/4in | 46.8 | 365.9 | 88.7 |
| 9.5mm | 3/8in | 31.7 | 334.2 | 81.0 |
| 4.75mm | No.4 | 38.9 | 295.3 | 71.6 |
| Reduced | 4.75mm | 294.4 | | |
| 2.00mm | No.10 | 24.6 | 269.8 | 65.6 |
| 850um | No.20 | 25.8 | 244.0 | 59.3 |
| 425um | No.40 | 23.7 | 220.3 | 53.5 |
| 250um | No.60 | 20.5 | 199.8 | 48.6 |
| 150um | No.100 | 28.5 | 171.3 | 41.6 |
| 75um | No.200 | 63.9 | 107.4 | 26.1 |
| <75um | <No.200 | | | |

| | | |
|----------------------------------|--------|---------------|
| Mass of can and WET SOIL: | 730.60 | g |
| Mass of can and DRY SOIL: | 686.06 | g |
| Mass of can: | 273.33 | g |
| Moisture content: | 10.8 | % |
| T-90 PL = | | PI = 0 |
| T-89 LL = | | |
| Gr: | 34.4 | % |
| Sa: | 39.5 | % |
| Si: | 26.1 | % |
| | 100.0 | % |
| M145: AASHTO Class: | A-2-4 | |
| D2487: Soil Description: | SiGrSa | |

Comments: 0

Reviewed By: Stephen Madden, Geotechnical Engineer



**State of Vermont
Agency of Transportation
Construction and Materials Bureau
Central Laboratory**

Report on Soil Sample

Lab Number: E21 141 **Report Date:** 4/25/2023

Project: Sunderland BM 20102 **Site:** **Tested By:** B. Fletcher

Date Sampled: 4 / 10 / 23 **Date Received:** 4 / 17 / 23 **Date Tested:** 4 / 19 / 23

Station: 0 + 0 **Offset:** 0 **Hole:** B-102 **Depth:** 33 ft to: 37 ft **Examined For:** Class

Field Description: Sandy Gr well graded, Moist, red/brn **Submitted By:** KMB **Sample Type:** SS

Test Results

T-88 Sieve Analysis

T-265 Moisture Content

| | TOTAL: | Wt Retained | Wt Passing | % Passing |
|---------|---------|-------------|------------|-----------|
| | | 385.8 | | |
| 75mm | 3in | 0.0 | 385.8 | 100.0 |
| 37.5mm | 1.5in | 0.0 | 385.8 | 100.0 |
| 19mm | 3/4in | 38.1 | 347.7 | 90.1 |
| 9.5mm | 3/8in | 20.3 | 327.4 | 84.9 |
| 4.75mm | No.4 | 74.3 | 253.1 | 65.6 |
| Reduced | 4.75mm | 251.9 | | |
| 2.00mm | No.10 | 20.8 | 231.1 | 60.2 |
| 850um | No.20 | 21.2 | 209.9 | 54.7 |
| 425um | No.40 | 17.1 | 192.8 | 50.2 |
| 250um | No.60 | 12.4 | 180.4 | 47.0 |
| 150um | No.100 | 12.8 | 167.6 | 43.7 |
| 75um | No.200 | 43.5 | 124.1 | 32.3 |
| <75um | <No.200 | | | |

| | | |
|----------------------------------|-------------|---|
| Mass of can and WET SOIL: | 532.06 | g |
| Mass of can and DRY SOIL: | 496.23 | g |
| Mass of can: | 110.41 | g |
| Moisture content: | 9.3 | % |
| T-90 PL = | PI = | 0 |
| T-89 LL = | | |
| Gr: | 39.8 | % |
| Sa: | 27.9 | % |
| Si: | 32.3 | % |
| | 100.0 | % |
| M145: AASHTO Class: | A-2-4 | |
| D2487: Soil Description: | SaSiGr | |

Comments: 0

Reviewed By: Stephen Madden, Geotechnical Engineer



**State of Vermont
Agency of Transportation
Construction and Materials Bureau
Central Laboratory**

Report on Soil Sample

Lab Number: E21 142 **Report Date:** 4/25/2023

Project: Sunderland BM 20102 **Site:** **Tested By:** B. Fletcher

Date Sampled: 4 / 10 / 23 **Date Received:** 4 / 17 / 23 **Date Tested:** 4 / 19 / 23

Station: 0 + 0 **Offset:** 0 **Hole:** B-102 **Depth:** 43 ft to: 45 ft **Examined For:** Class

Field Description: Sandy Gr well graded, Dry, red/bm **Submitted By:** KMB **Sample Type:** SS

Test Results

T-88 Sieve Analysis

T-265 Moisture Content

| | TOTAL: | Wt Retained | Wt Passing | % Passing |
|---------|---------|-------------|------------|-----------|
| | | 637.3 | | |
| 75mm | 3in | 0.0 | 637.3 | 100.0 |
| 37.5mm | 1.5in | 0.0 | 637.3 | 100.0 |
| 19mm | 3/4in | 21.2 | 616.1 | 96.7 |
| 9.5mm | 3/8in | 35.8 | 580.3 | 91.1 |
| 4.75mm | No.4 | 107.6 | 472.7 | 74.2 |
| Reduced | 4.75mm | 235.5 | | |
| 2.00mm | No.10 | 29.3 | 206.2 | 64.9 |
| 850um | No.20 | 23.6 | 182.6 | 57.5 |
| 425um | No.40 | 18.2 | 164.4 | 51.8 |
| 250um | No.60 | 13.1 | 151.3 | 47.7 |
| 150um | No.100 | 14.7 | 136.6 | 43.0 |
| 75um | No.200 | 33.1 | 103.5 | 32.6 |
| <75um | <No.200 | | | |

| | | |
|----------------------------------|-------------|---|
| Mass of can and WET SOIL: | 814.00 | g |
| Mass of can and DRY SOIL: | 746.31 | g |
| Mass of can: | 109.05 | g |
| Moisture content: | 10.6 | % |
| T-90 PL = | PI = | 0 |
| T-89 LL = | | |
| Gr: | 35.1 | % |
| Sa: | 32.3 | % |
| Si: | 32.6 | % |
| | 100.0 | % |
| M145: AASHTO Class: | A-2-4 | |
| D2487: Soil Description: | SaSiGr | |

Comments: 0

Reviewed By: Stephen Madden, Geotechnical Engineer

Appendix B

Effective Footing Width vs. Bearing Resistance

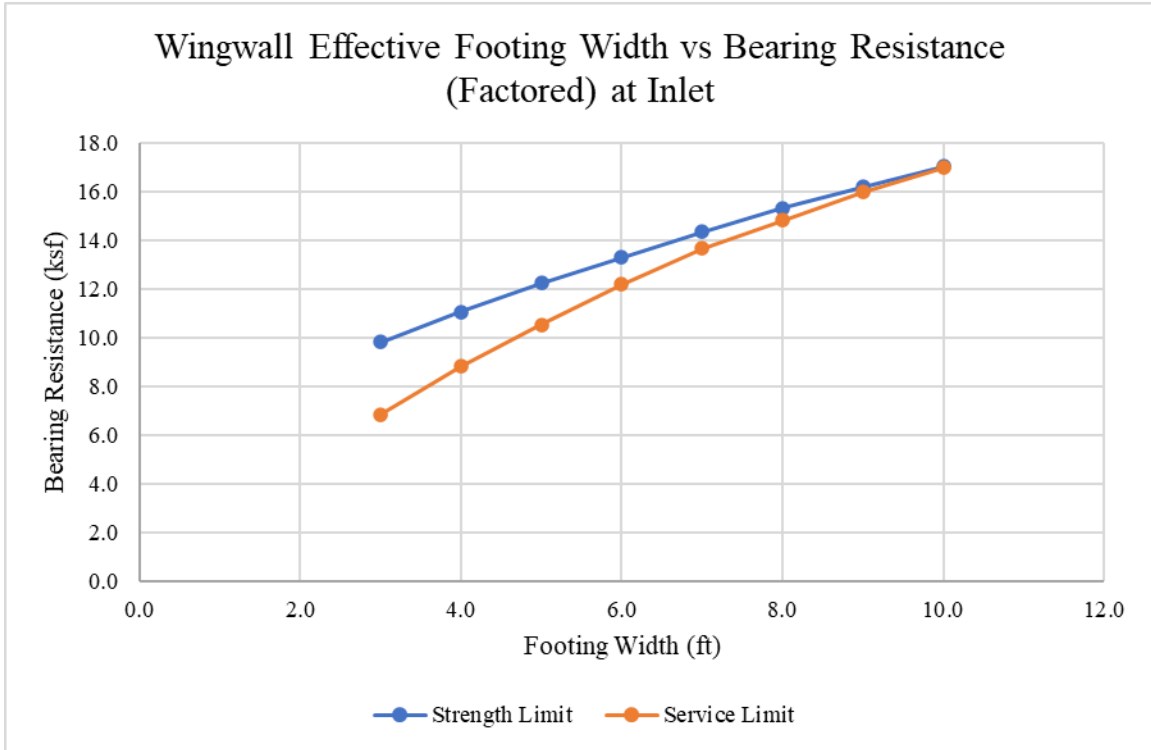


Figure B.1 Factored bearing resistance of soil at inlet with respect to effective footing width

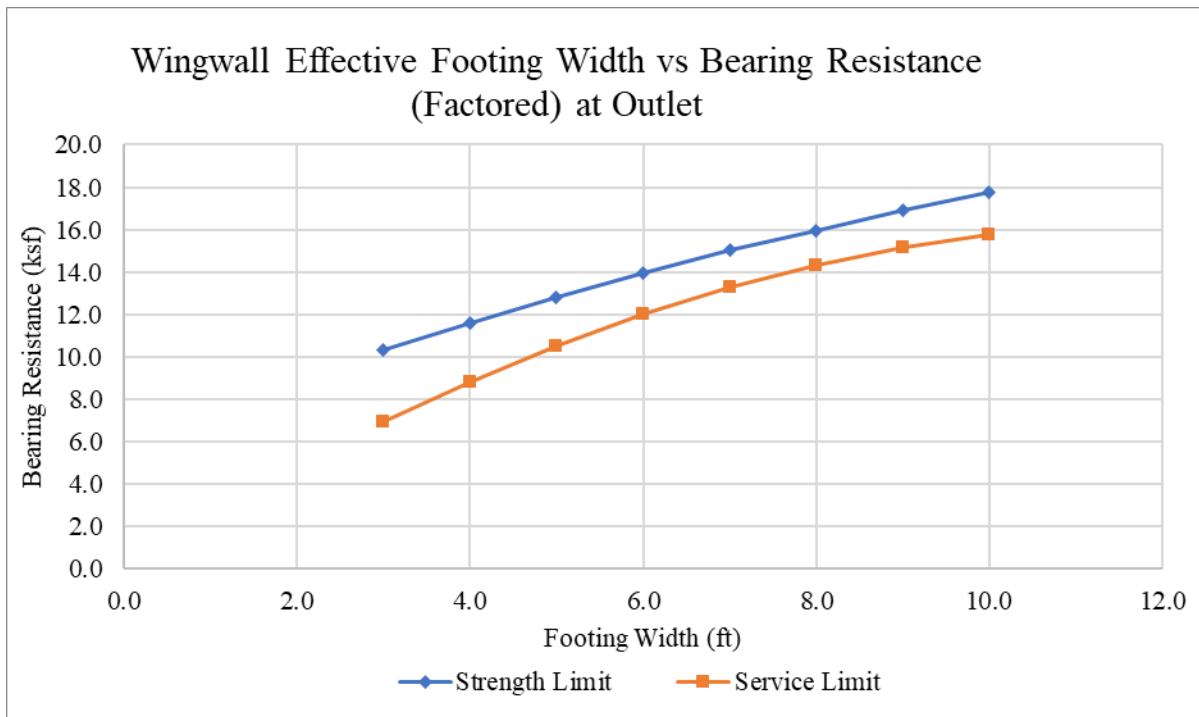
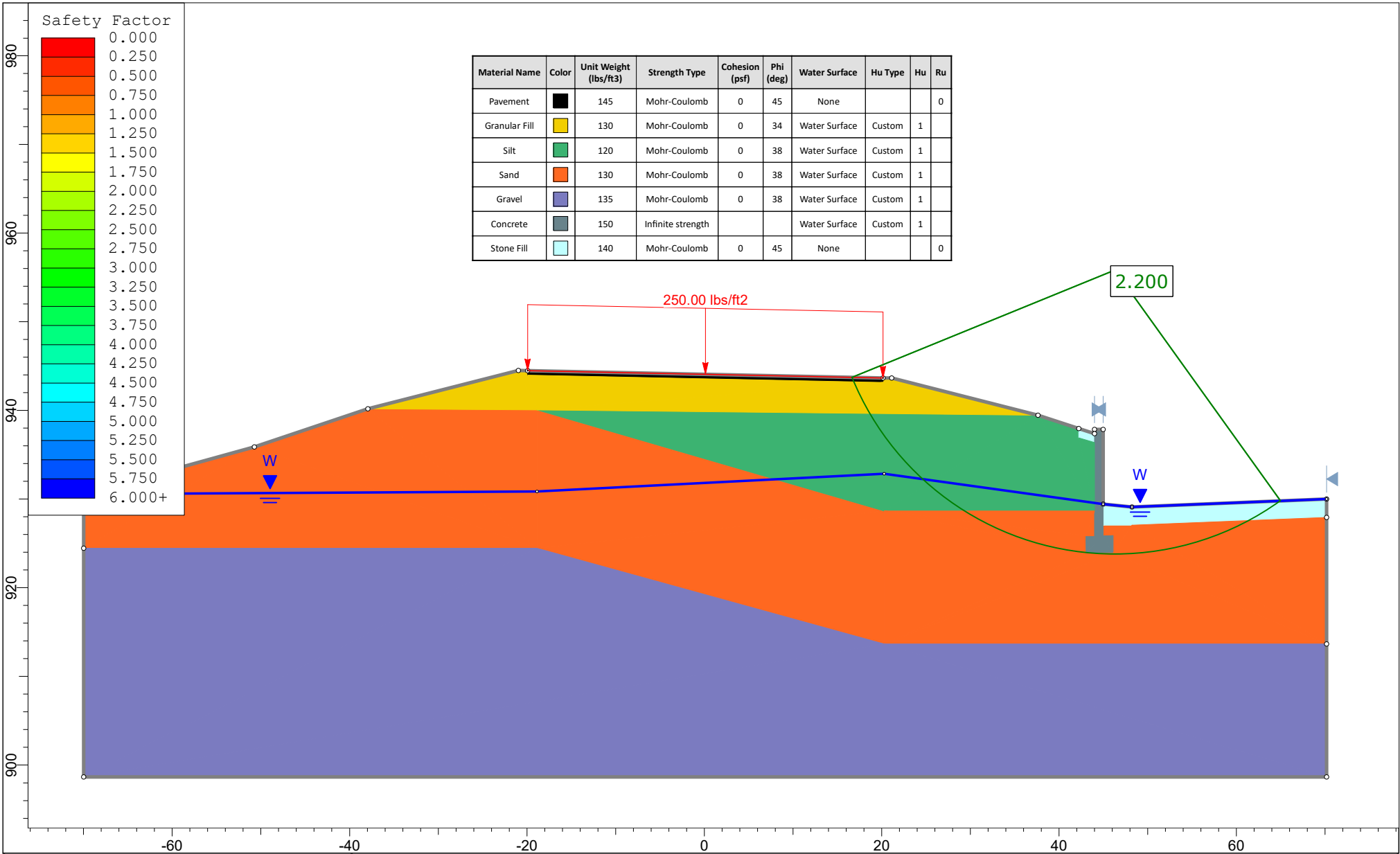


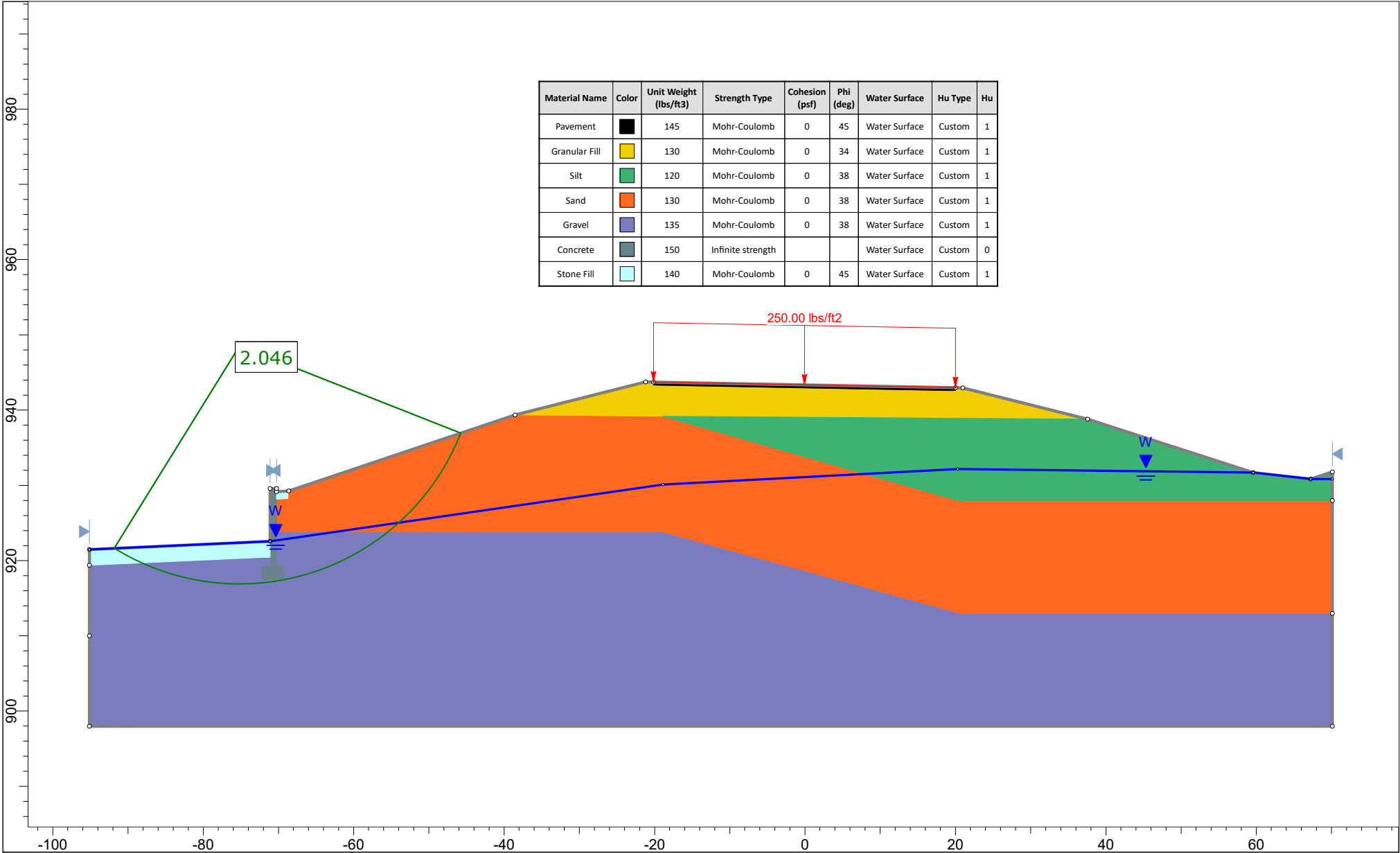
Figure B.2 Factored bearing resistance of soil at outlet with respect to effective footing width

Appendix C

Global Stability Analyses Output



| | | | | | | |
|--|----------------------|-----------|-----------|---------------------------|---------|---|
| | Project | | | Sunderland BM 20102 | | |
| | Analysis Description | | | 1056+50 Inlet GS Analysis | | |
| | Drawn By | SPM | Scale | 1:180 | Company | VTrans Geotechnical Engineering Section |
| | Date | 8/28/2025 | File Name | 1056+50.slmd | | |



| Material Name | Color | Unit Weight (lbs/ft ³) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---------------|------------|------------------------------------|-------------------|----------------|-----------|---------------|---------|----|
| Pavement | Black | 145 | Mohr-Coulomb | 0 | 45 | Water Surface | Custom | 1 |
| Granular Fill | Yellow | 130 | Mohr-Coulomb | 0 | 34 | Water Surface | Custom | 1 |
| Silt | Green | 120 | Mohr-Coulomb | 0 | 38 | Water Surface | Custom | 1 |
| Sand | Orange | 130 | Mohr-Coulomb | 0 | 38 | Water Surface | Custom | 1 |
| Gravel | Purple | 135 | Mohr-Coulomb | 0 | 38 | Water Surface | Custom | 1 |
| Concrete | Grey | 150 | Infinite strength | | | Water Surface | Custom | 0 |
| Stone Fill | Light Blue | 140 | Mohr-Coulomb | 0 | 45 | Water Surface | Custom | 1 |

| | | | | | | |
|--|----------------------|------------|-------|----------------------------|-------------|---|
| | Project | | | Sunderland BM 20102 | | |
| | Analysis Description | | | 1057+00 Outlet GS Analysis | | |
| | Drawn By | SPM | Scale | 1:212 | Company | VTrans Geotechnical Engineering Section |
| | Date | 08/28/2025 | | File Name | 1057+00.slm | |