

To: Amos Kempton, P.E. Roadway Design Project Manager

From: Megan Messina, Geotechnical Engineer, via, Callie Ewald, P.E., Senior Geotechnical Engineer

Date: January 28th, 2026

Subject: Hardwick ER P23-1(716) – Geotechnical Data Report

1.0 INTRODUCTION

As requested, we have completed our subsurface investigation and geotechnical analyses of the spread footing foundations for the proposed pipe arch and wingwalls as part of the Hardwick ER P23-1(716) project. The project consists of the full replacement of the existing culvert located on VT Route 15 over an unnamed tributary in the town of Hardwick, VT. The project is located approximately 1.0 miles east of the intersection of VT Route 14 and VT Route 15. Contained herein are the results of our field sampling and testing, laboratory analysis of soil samples, and design parameter 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

The field investigation was conducted between July 29th and September 15th, 2025. Three standard penetration borings were advanced to evaluate the subsurface profile for the design and construction of the replacement structure. Boring locations were provided by Amos Kempton, Roadway Section, in a Geotechnical Request Form dated December 23rd, 2024. Boring locations were located in the field by personnel from the Geotechnical Section using the Geotechnical Section's handheld Trimble TDC600 and Trimble DA2 GNSS GPS receiver with submeter accuracy during a site visit on April 28th, 2025. A summary of the final location of each boring and corresponding ground surface elevation can be found in Table 2.1. The values for the Northings and Eastings are based on the Vermont State Plane Grid Coordinate System NAD 83. Elevations for the borings, based on the North American Vertical Datum, NAVD 88, were estimated using the design file x24d005sv.dgn. The locations and elevations for the borings should be considered accurate only to the degree implied by the method used to determine them.

Table 2.1 Boring Locations and Elevations.

Boring No.	Northing (ft)	Easting (ft)	Station	Offset (ft)	Approximate Ground Surface Elevation (ft)
B-101	729683.2	1679378.5	227+95	16.5	887
B-102	729649.1	1679436.4	228+54	-20.6	888.2
B-102A	729654.0	1679439.8	228+57	15.4	888.3

The borings were performed in general accordance with AASHTO T206, *Standard Method of Test for Penetration Test and Split-Barrel Sampling of Soils*. During boring operations, split-spoon samples and standard penetration tests (SPT) were performed for each boring. For Boring B-101, samples were conducted at 5 foot (ft) intervals to a depth of 10 ft below ground surface (bgs), then sampled continuously to a depth of 24 ft bgs, and then 5 ft intervals to a depth of 49 ft bgs. For Boring B-102, samples were conducted at 5 ft intervals to 10 ft bgs and then continuously conducted to a depth of 20 ft bgs, where B-102 was terminated due to a drilling equipment malfunction. For Boring B-102A, casing was advanced to 20 ft bgs where two continuous samples were performed from 20 ft to 24 ft bgs, followed by samples collected at 5 ft intervals from 25 ft to 50 ft bgs. Bedrock was not encountered to depth in any of the borings.

During drilling operations soil samples were visually identified in the field and SPT blow counts were recorded on the boring logs when applicable. Soil samples were preserved and returned to the VTrans Construction and Materials Bureau Central Laboratory for testing and further evaluation. Upon completion of the laboratory testing, the boring logs were revised to reflect the results of the laboratory classification analysis. The attached boring logs in Appendix A display the types of soil strata encountered and include the laboratory test data, SPT data, and any pertinent observations made by the boring crew.

3.0 FIELD AND LABORATORY TESTINGS

The standard penetration resistance of the in-situ soil is determined by the number of blows required to drive a 2-inch outside diameter (OD) split-barrel sampler into the soil with a 140-pound hammer dropped from a height of 30 inches, in accordance with procedures specified in AASHTO T206. The number of blows required to drive the sampler each 6-inch increment is recorded, and the Standard Penetration Resistance (N-Value) is calculated as the sum of the blows over the second and third 6-inch intervals. The SPT N-value is commonly used with established correlations to estimate several soil parameters, particularly the shear strength and density of cohesionless soils. The N-values provided on the boring logs are raw values and have not been corrected for energy, borehole diameter, rod length, or overburden pressure.

The Vermont Agency of Transportation has determined a hammer correction value, C_E , to account for the efficiency of the SPT hammers on its drill rigs. Both borings were advanced with an Acker Renegade track rig. Because this is a new drill rig, a hammer energy correction factor has yet to be determined. As a result, a conservative C_E value of 1.3, based on a standard value for an automatic hammer, should be used in all soil parameter calculations.

Geotechnical laboratory tests were performed on select samples to assist with soil classification and evaluate engineering properties of the soil. Grain size analyses were performed on representative soil samples in accordance with AASHTO T 88, *Standard Method of Test for Particle Size Analysis of Soils*. Results from this testing can be found on the attached boring logs.

4.0 SOIL PROFILE

The following soil strata have been identified based on our review of the boring logs and laboratory testing. It should be noted that groundwater elevations are subject to change given the fact that boreholes were generally left open for a short period of time. Because groundwater elevations can fluctuate seasonally and are affected by temperature and precipitation, groundwater may be encountered during construction when not previously noted on the logs.

4.1 Boring B-101 (Outlet)

The ground surface elevation at B-101 was approximately 887 ft. Groundwater was observed after drilling operations on August 5th, 2025, at a depth of 9.4 ft bgs, corresponding to an approximate elevation of 877.6 ft.

Approximate Elevation (ft)	Soil Profile
887 – 867 ft	Dense SAND and GRAVEL, little Silt
867 – 836 ft	Dense SILT, little Gravel, trace Sand

4.2 Boring B-102/B-102A (Inlet)

The ground surface elevations at B-102 and B-102A were approximately 888.2 and 888.3 ft, respectively. Groundwater was observed after drilling operations in B-102A on September 15th, 2025, at a depth of 9.8 ft bgs, corresponding to an approximate elevation of 878.5 ft.

Approximate Elevation (ft)	Soil Profile
888.2 – 868	Dense GRAVEL and SAND, little Silt
868 – 866 ft	Medium Dense GRAVEL and SILT, little Sand
866 – 837 ft	Dense SILT, little Gravel, trace Sand

5.0 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 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 of 878.8 ft and 877.6 ft were used in design at the inlet and outlet, respectively.

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:

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

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 can be found below in Section 4.1 and 4.2.

5.1 Bearing Resistances

The maximum length of wingwalls used in the analysis was 11.0 ft and 10.0 ft at the inlet and outlet, respectively, based on the Detail Sheet from the Preliminary Plans dated July 9th, 2025. The bottom of footing elevation was also provided as 877.38 ft at the inlet and 874.41 ft at the outlet of the proposed culvert. Based on the geometry and elevations, it appears that the footings will bear on the dense Sandy Gravel layer at the inlet and the dense Gravelly Sand layer at the outlet. Based on the boring information and subsequent calculations, both of these strata were assigned a friction angle of $\phi = 38^\circ$ and a unit weight of $\gamma = 135 \text{ lb/ft}^3$.

For effective footing widths of 3 ft through 8 ft, the maximum factored bearing resistances for the strength and service limit states are given in Table 5.1.1 and Table 5.1.2 for the inlet and outlet, respectively. 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 5.0. Bearing pressure values were applied to the same footing widths as used to calculate bearing resistance. Considering the granular nature of the foundation soils, any settlement is expected to occur during or immediately after construction. Attached to this report, as Appendix B and Appendix C, are graphs that detail the corresponding bearing resistances for various effective footing widths and settlement graphs based on various bearing pressures, respectively

Table 5.1.1 Factored Bearing Resistances at Various Effective Footing Widths at the Inlet

Maximum Wingwall Length (ft)	Effective Footing Width (ft)	Factored Bearing Resistance, Strength Limit State (ksf)	Factored Bearing Resistance, Service Limit State (ksf)
11.0	3.0	10.4	7.0
	4.0	11.6	9.0
	5.0	12.9	10.8
	6.0	14.0	12.3
	7.0	15.1	13.8
	8.0	16.1	15.0

Table 5.1.2 Factored Bearing Resistances at Various Effective Footing Widths at the Outlet

Maximum Wingwall Length (ft)	Effective Footing Width (ft)	Factored Bearing Resistance, Strength Limit State (ksf)	Factored Bearing Resistance, Service Limit State (ksf)
10.0	3.0	10.4	6.9
	4.0	11.6	8.8
	5.0	12.9	10.5
	6.0	14.0	12.0
	7.0	15.1	13.3
	8.0	16.1	14.3

Soil settlement values were calculated for each wingwall at both the inlet and outlet for various footing widths at the service limit state using Hough's Method, as stated above in Section 5.0. 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.

6.0 RECOMMENDATIONS

Shallow foundations appear to be feasible for the proposed wingwalls as detailed in correspondence with the project engineers and the Preliminary Plans dated July 2025. Factored bearing resistances for various footing widths were calculated for the wingwalls and can be found in Table 5.1.1 and Table 5.1.2. These calculations are based on the geometric and geotechnical assumptions outlined in Section 5.0 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 6.1 shows the appropriate resistance factors for various design states.

Table 6.1: Summary of Resistance Factors

Design State	Resistance Factor, ϕ
Settlement	1.0
Scour	1.0
Bearing Resistance	0.45
Sliding*	0.90

*Assumes precast concrete placed on sand

6.1 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 10.4 ksf

- For service limit state, using a resistance factor of 1.0, the factored bearing resistance is 6.9 ksf

6.2 Design Parameters

Table 6.2.1 highlights engineering properties assigned to the in-situ soils as well as the engineering properties of common construction materials. 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 6.2.1: Engineering Properties of In-Situ and Construction Materials

	703.04 – Granular Borrow	704.08 – Granular Backfill for Structures	Dense Sandy Gravel (Inlet) Dense Gravelly Sand (Outlet) Bearing Stratum
Unit Weight, γ (lbs/ft ³):	130	140	135
Internal Friction Angle, ϕ (degrees):	32	34	38
Coefficient of Friction, f			
- mass concrete cast against soil:	0.45	0.55	0.55
- soil against precast/formed concrete:	0.50	0.54	0.45
Active Earth Pressure Coef., K_a :	0.31	0.28	0.24
Passive Earth Pressure Coef., K_p :	3.26	3.57	4.20
At-Rest Earth Pressure Coefficient, K_o :	0.47	0.44	0.38

6.3 Construction Considerations

6.3.1 Cofferdams/Temporary Earthwork Support

The Contractor should be reminded that Section 208.06 of VTrans' 2024 *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 Subsection 105.06."

6.3.2 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.

6.3.3 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.

7.0 CONCLUSION

If you have any questions or would like to discuss this report, please contact the Geotechnical Engineering Section via email. Computer generated boring logs are attached and available in the *M:\Projects\24d005\MaterialsResearch* folder.

Reviewed by: August Arles, Geotechnical Engineer *ASA*
Eric Denardo, P.E., Senior Geotechnical Engineer *END*

Enclosures: Appendix A: Boring Layout and Boring Logs (6 Pages)
Appendix B: Bearing Resistance (1 Page)
Appendix C: Settlement Graphs (1 Page)

cc: Project File
 END/CEE
 MNM

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Appendix A

Boring Layout and Boring Logs

STEEL BEAM GUARDRAIL
STA 225+75 - 228+37.5 LT

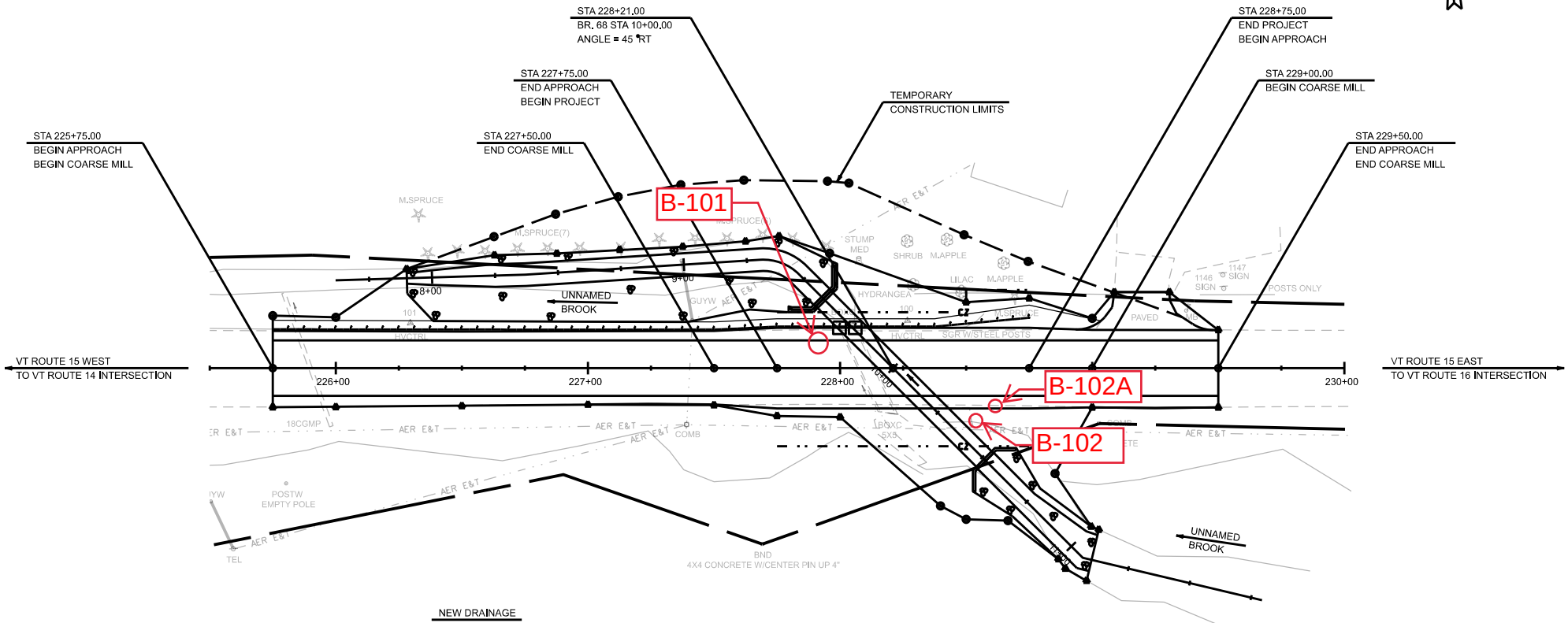
MTS, MGS, FLARED, TL-3
STA 228+37.5 - 228+75 LT

REMOVAL OF GUARDRAIL
STA 225+75 - 228+57 LT

DRIVEWAY APRON
STA 229+20 LT

REMOVE AND RELOCATE LANDSCAPE ITEMS (WOODEN FENCE)
STA 228+29 - 229+07 LT

CONTRACTOR-FABRICATED PRECAST CONCRETE STRUCTURE
(GUARDRAIL MOMENT SLAB)
STA 228+00 LT
STA 228+06 LT



NEW DRAINAGE

STA 228+21 C/L SKEW 45°
NEW CSSP BURIED BRIDGE
PIPE ARCH (103" X 71") X 92', S = 3.23%
W/ WINGWALLS (SEE DETAILS)
E-STONE FILL, TYPE I AT INLET, OUTLET
AND THROUGHOUT CULVERT. REMOVE
EXISTING CONCRETE BOX BULVERT.



PROJECT NAME: HARDWICK
PROJECT NUMBER: ER P23-1(716)

FILE NAME: d24d005bdr.dgn
PROJECT LEADER: A. KEMPTON
DESIGNED BY: A. KEMPTON
PLAN SHEET

PLOT DATE: \$\$\$DATE\$\$\$
DRAWN BY: A. KEMPTON
CHECKED BY: P. WHALLEY
SHEET \$\$# OF \$T#\$



VERMONT

AGENCY OF TRANSPORTATION

HIGHWAY DIVISION
CONSTRUCTION MATERIALS BUREAU
GEOTECHNICAL ENGINEERING SECTION

SOIL BORING

Hardwick
ER P23-1(716)
VT Route 15 PID 9206

Boring No.: B-101

Page No.: 1 of 2

Pin No.: 24D005

Checked By: MNM

Boring Crew: Thurston, Lubas, Degener

Date Started: 08/04/2025 Date Finished: 08/05/2025

Coordinates: N:729683.2, E:1679378.5

Station: 227+95 Offset: 10.5 ft

Ground Elevation: 887.0 ft

Type: Wash Bore
I.D.: 4 in
Hammer Wt: N.A.
Hammer Fall: N.A.
Hammer/Rod type: Auto / AWJ
Rig: Acker Renegade
C_E = 1.3

Sampler SS

1.5 in

140 lb

30 in

Groundwater Observations

Date	Depth (ft)	Status
08/05/2025	9.4'	After Drilling (AD)

Depth (ft)	Graphic Log	AASHTO Classification	Material Description and Notes	Field Data		Lab Data			
				Recovery (ft)	Blow Counts (N-Value)	Moisture Content (%)	Gravel (%)	Sand (%)	Fines (%)
5	NR		0.0 ft - 0.7 ft, Field Note: ASPHALT						
			0.7 ft - 2.7 ft, Field Description: Dry to Moist, Gray, Very Dense, Coarse Grained GRAVEL, some Sand, 2.7 ft - 4.7 ft, Field Note: Roller cone clean out	1.3	37-28-16-13 (44)				
			5.0 ft - 7.0 ft, Field Note: NO RECOVERY, Wash in sampler	0	4-3-3-4 (6)				
			10.0 ft - 10.9 ft, Field Note: NO RECOVERY, Wash in sampler. Refusal at 10.9 ft, 50 blows in 6.0 in	0	33-50/5" (R)				
15	NR		12.0 ft - 14.0 ft, Field Description: Moist, Grayish Brown, Very Dense, Coarse Grained GRAVEL, some Fine Grained Sand, Lab Note: Sample similar to 14.0 ft- 15.8 ft	0.7	3-24-26-22 (50)				
			14.0 ft - 15.8 ft, Lab Classification: Dry to Moist, Grayish Brown, Very Dense, SAND and GRAVEL, little Silt, Field Note: Refusal at 15.8 ft, 50 blows in 6 in	1.2	16-19-23-50/3" (42)	10.9	39.2	43.9	16.9
			14.0 ft - 16.0 ft, Field Note: Roller cone clean out						
			16.0 ft - 18.0 ft, Field Description: Dry to Moist, Grayish Brown, Very Dense, Fine Grained SAND and Coarse Grained GRAVEL, Lab Note: Sample similar to 14.0 ft- 15.8 ft	0.8	2-11-28-47 (39)				
20	NR		17.0 ft -18.0 ft Field Note: Roller cone clean out.	0.9	7-48-50-29 (98)				
			18.0 ft - 20.0 ft, Field Description: Moist, Grayish Brown, Very Dense, Coarse Grained SAND and GRAVEL, trace Silt, Lab Note: Sample similar to 14.0 ft - 15.8 ft						
			20.0 ft - 22.0 ft, Lab Classification: Moist, Grayish Brown, Very Dense, SILT, some Gravel, trace Sand	1.2	8-16-14-18 (30)	15.9	32.0	6.2	61.8
			22.0 ft - 24.0 ft, Lab Classification: Moist, Grayish Brown, Very Dense, SILT, little Gravel, trace Sand	1.6	9-12-13-19 (25)	27.5	14.3	3.5	82.2
25		A-4	24.0 ft - 26.0 ft, Lab Classification: Moist, Gray, Very Dense, SILT, trace Sand	1.7	9-14-14-18 (28)	28.8	0.0	3.1	96.9

Notes:

1. Stratification lines represent approximate boundary between material types. Transitions may be gradual.
2. N-values have not been corrected for hammer energy. CE is the hammer energy correction factor.
3. Water level readings have been made at times and under conditions stated. Water levels are likely to vary.



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SOIL BORING

Hardwick
ER P23-1(716)
VT Route 15 PID 9206

Boring No.: B-101

Page No.: 2 of 2

Pin No.: 24D005

Checked By: MNM

Boring Crew: Thurston, Lubas, Degener

Date Started: 08/04/2025 Date Finished: 08/05/2025

Coordinates: N:729683.2, E:1679378.5

Station: 227+95 Offset: 10.5 ft

Ground Elevation: 887.0 ft

Type:	Casing Wash Bore	Sampler SS
I.D.:	4 in	1.5 in
Hammer Wt:	N.A.	140 lb
Hammer Fall:	N.A.	30 in
Hammer/Rod type:	Auto / AWJ	
Rig:	Acker Renegade	C _E = 1.3

Groundwater Observations

Date	Depth (ft)	Status
08/05/2025	9.4'	After Drilling (AD)

Depth (ft)	Graphic Log	AASHTO Classification	Material Description and Notes	Field Data		Lab Data			
				Recovery (ft) (%)	Blow Counts (N-Value)	Moisture Content (%)	Gravel (%)	Sand (%)	Fines (%)
30			29.0 ft - 31.0 ft, Field Description: Moist, Grayish Brown, Very Dense, SILT, little Fine Grained Gravel	1.7	8-12-15-19 (27)				
35			34.0 ft - 36.0 ft, Field Description: Moist, Brown, Dense, SILT, some Fine Grained Gravel	1.6	7-18-26-34 (44)				
40			39.0 ft - 41.0 ft, Field Description: Dry to Moist, Brown, Dense, SILT, little Fine Grained Gravel, trace Clay	1.8	9-15-22-27 (37)				
45			44.0 ft - 46.0 ft, Field Description: Dry to Moist, Brown, Dense, SILT, little Fine Grained Sand, little Fine Grained Gravel	1.6	10-16-28-36 (44)				
50			49.0 ft - 51.0 ft, Field Description: Moist, Brown, Dense, SILT, little Medium Grained Sand	1	10-14-17-18 (31)				
End of Boring at 51.0 ft Hole Collapse at 9.3 ft									

Notes:

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2. N-values have not been corrected for hammer energy. CE is the hammer energy correction factor.
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SOIL BORING

Hardwick
ER P23-1(716)
VT Route 15 PID 9206

Boring No.: B-102

Page No.: 1 of 1

Pin No.: 24D005

Checked By: MNM

Boring Crew: Thurston, Lubas, Degener

Date Started: 07/29/2025 Date Finished: 07/29/2025

Coordinates: N:729649.1, E:1679436.4

Station: 228+54 Offset: -20.6 ft

Ground Elevation: 888.2 ft

Type: Wash Bore
I.D.: 4 in
Hammer Wt: N.A.
Hammer Fall: N.A.
Hammer/Rod type: Auto / AWJ
Rig: Acker Renegade
C_E = 1.3

Sampler
SS

1.5 in

140 lb

30 in

Groundwater Observations

Date	Depth (ft)	Status
07/29/2025		No Water Observed After Drilling (AD)

Depth (ft)	Graphic Log	AASHTO Classification	Material Description and Notes	Field Data		Lab Data			
				Recovery (ft) (%)	Blow Counts (N-Value)	Moisture Content (%)	Gravel (%)	Sand (%)	Fines (%)
5			0.0 ft - 0.8 ft, Field Note: ASPHALT						
			0.8 ft - 2.8 ft, Field Description: Dry to Moist, Dark Gray, Dense, Coarse Grained GRAVEL, some Medium Grained Sand	0.3	31-18-8-9 (26)				
			5.0 ft - 7.0 ft, Field Description: Dry to Moist, Gray, Dense, Coarse Grained GRAVEL and Medium Grained SAND	0.6	16-12-10-6 (22)				
			7.0 ft - 9.0 ft, Field Note: Clean out barrel used, suspected boulder						
10		A-1-b	10.0 ft - 11.4 ft, Lab Classification: Moist, Brown, Very Dense, GRAVEL and SAND, little Silt, Field Note: Refusal at 11.4 ft, 50 blows in 6 in	0.8	40-48-50/5" (R)	11.9	45.8	38.2	16.1
15	NR		12.0 ft - 14.0 ft, Field Description: Moist, Gray, Very Dense, Coarse Grained GRAVEL, little Coarse Grained Sand, Lab Note: Sample similar to 10.0 ft- 11.4 ft	0.4	45-41-35-33 (76)	0.5			
			14.0 ft - 14.9 ft, Field Note: NO RECOVERY, Refusal at 14.9 ft, 50 blows in 6.0 in.	0	44-50/5" (R)				
			16.0 ft - 18.0 ft, Field Description: Moist, Grayish Brown, Very Dense, Coarse Grained GRAVEL, some Medium Grained Sand, Fractured rock at end of sampler, Lab Note: Sample similar to 10.0 ft- 11.4 ft	0.8	23-17-16-20 (33)				
20		A-1-b	18.0 ft - 20.0 ft, Lab Classification: Moist, Gray, Very Dense, GRAVEL, little Silt, trace Sand,	0.8	19-15-19-13 (34)	3.8	73.0	7.6	19.4
		A-4	20.0 ft - 22.0 ft, Lab Classification: Dry to Moist, Dark Gray, Dense, GRAVEL and SILT, little Sand	0.8	32-13-14-10 (27)	8.4	43.2	17.3	39.5

Casing advancer failure.
End of Boring at 22.0 ft due to advancer retrieval.
Hole Collapse at 9.7 ft.

Notes:

1. Stratification lines represent approximate boundary between material types. Transitions may be gradual.
2. N-values have not been corrected for hammer energy. CE is the hammer energy correction factor.
3. Water level readings have been made at times and under conditions stated. Water levels are likely to vary.



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SOIL BORING

Hardwick
ER P23-1(716)
VT Route 15 PID 9206

Boring No.: B-102A

Page No.: 1 of 2

Pin No.: 24D005

Checked By: MNM

Boring Crew: McGinley, Thurston, Lubas, Messina

Date Started: 09/15/2025 Date Finished: 09/15/2025

Coordinates: N:729654, E:1679439.8

Station: 228+57 Offset: 15.4 ft

Ground Elevation: 888.3 ft

Type:	Casing Wash Bore	Sampler SS
I.D.:	4 in	1.5 in
Hammer Wt:	N.A.	140 lb
Hammer Fall:	N.A.	30 in
Hammer/Rod type:	Auto / AWJ	
Rig:	Acker Renegade	C _E = 1.3

Groundwater Observations

Date	Depth (ft)	Status
09/15/2025	9.8'	After Drilling (AD)

Depth (ft)	Graphic Log	AASHTO Classification	Material Description and Notes	Field Data		Lab Data			
				Recovery (ft) (%)	Blow Counts (N-Value)	Moisture Content (%)	Gravel (%)	Sand (%)	Fines (%)
0			0.0 ft - 20.0 ft, Field Note: No sampling, spun casing to 20.0 ft. NXDX Cleanout 18.7 ft - 20.0 ft						
5									
10									
15									
20		A-1-a	20.0 ft - 22.0 ft, Lab Classification: Moist to Wet, Brownish Gray, Very Dense, GRAVEL, some Sand, little Silt	0.3	15-23-28-25 (51)	4.7	55.6	30.2	14.2
22		A-1-b	22.0 ft - 24.0 ft, Lab Classification: Moist to Wet, Brownish Gray, Very Dense, SAND and GRAVEL, little Silt	0.9	12-15-18-16 (33)	7.9	43.0	45.3	11.6
25			25.0 ft - 26.4 ft, Field Description: Moist to Wet, Brownish Gray, Very Dense, SAND and GRAVEL, Field Note: Refusal at 26.4 ft. 10 blows, no movement. Lab Note: Sample similar to 22.0 ft- 24.0 ft. Lost water at 27.0 ft	0.8	17-16-10/5" (R)				
30			30.0 ft - 30.2 ft, Field Note: NO RECOVERY, Refusal at 31.2 ft. 10 blows, no movement	0	10/2" (R)				
35		A-4	35.0 ft - 37.0 ft, Lab Classification: Moist, Gray, Very Dense, SILT, little Gravel, trace Sand	1.4	12-18-26-45 (44)	25.2	11.2	2.9	85.8

Notes:

1. Stratification lines represent approximate boundary between material types. Transitions may be gradual.
2. N-values have not been corrected for hammer energy. CE is the hammer energy correction factor.
3. Water level readings have been made at times and under conditions stated. Water levels are likely to vary.



VERMONT
AGENCY OF TRANSPORTATION

HIGHWAY DIVISION
CONSTRUCTION MATERIALS BUREAU
GEOTECHNICAL ENGINEERING SECTION

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Groundwater Observations

Date	Depth (ft)	Status
09/15/2025	9.8'	After Drilling (AD)

Depth (ft)	Graphic Log	AASHTO Classification	Material Description and Notes	Field Data		Lab Data			
				Recovery (ft) (%)	Blow Counts (N-Value)	Moisture Content (%)	Gravel (%)	Sand (%)	Fines (%)
40			40.0 ft - 42.0 ft, Field Description: Moist, Gray, Very Dense, SILT, little Sand, Lab Note: Sample similar to 35.0 ft- 37.0 ft	1.7	9-15-22-22 (37)				
45			45.0 ft - 47.0 ft, Field Description: Moist to Wet, Grayish Brown, Very Dense, Fine Grained SAND, some Silt	1.8	16-20-21-28 (41)				
50			50.0 ft - 50.9 ft, Field Note: NO RECOVERY, Gravel at end of sampler. Refusal at 50.9 ft. 50 blows in 6 in.	0	41-50/5" (R)				

End of Boring at 50.9 ft
Hole Collapse at 39.0 ft

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Appendix B

Bearing Resistance Graphs

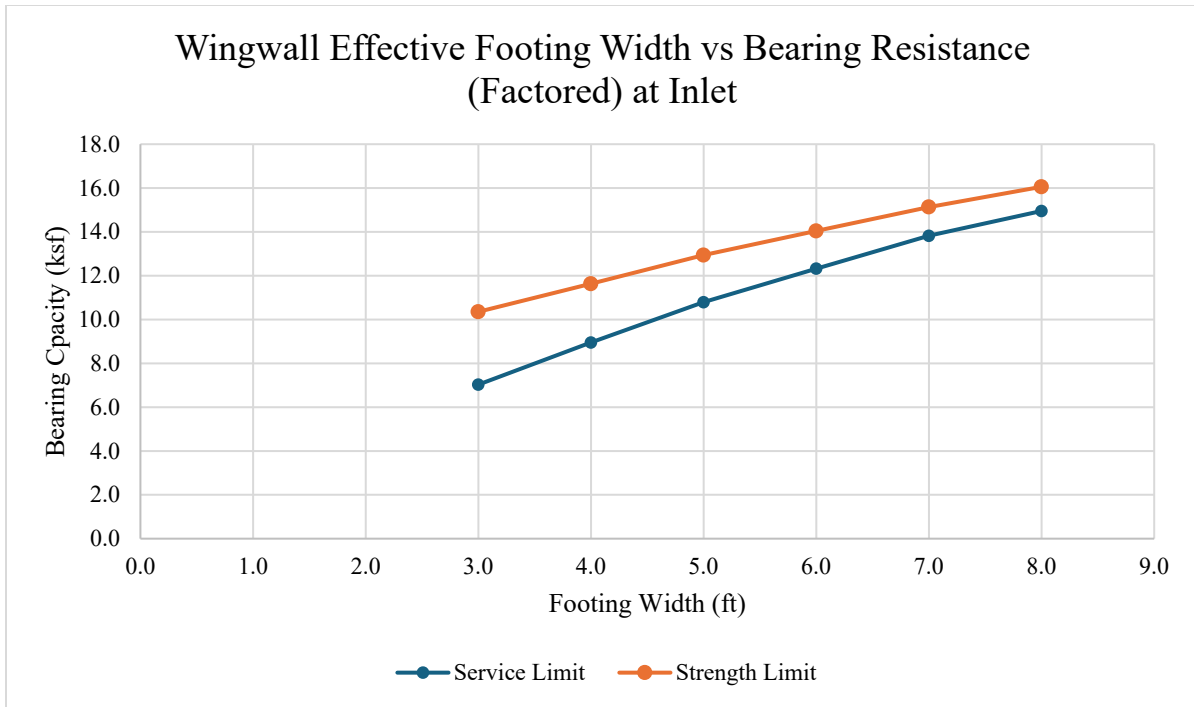


Figure B.1 Factored bearing resistance of soil at inlet with respect to effective footing width.

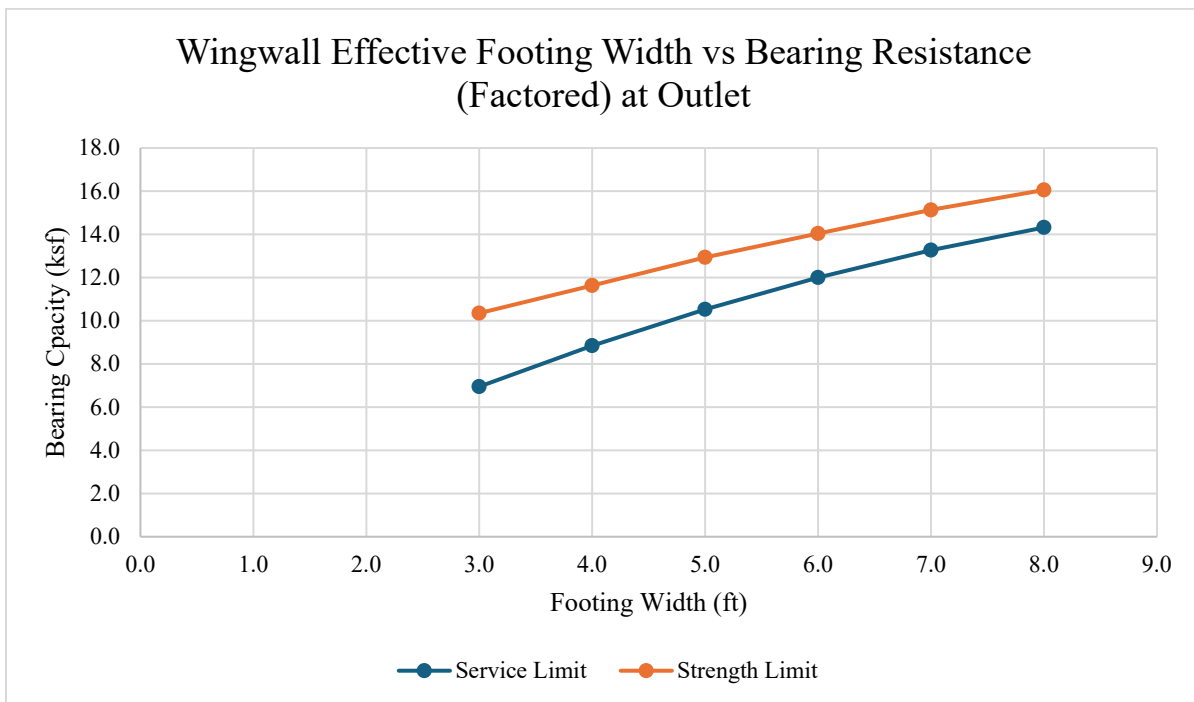


Figure B.2 Factored bearing resistance of soil at outlet with respect to effective footing width.

Appendix C

Settlement Graphs

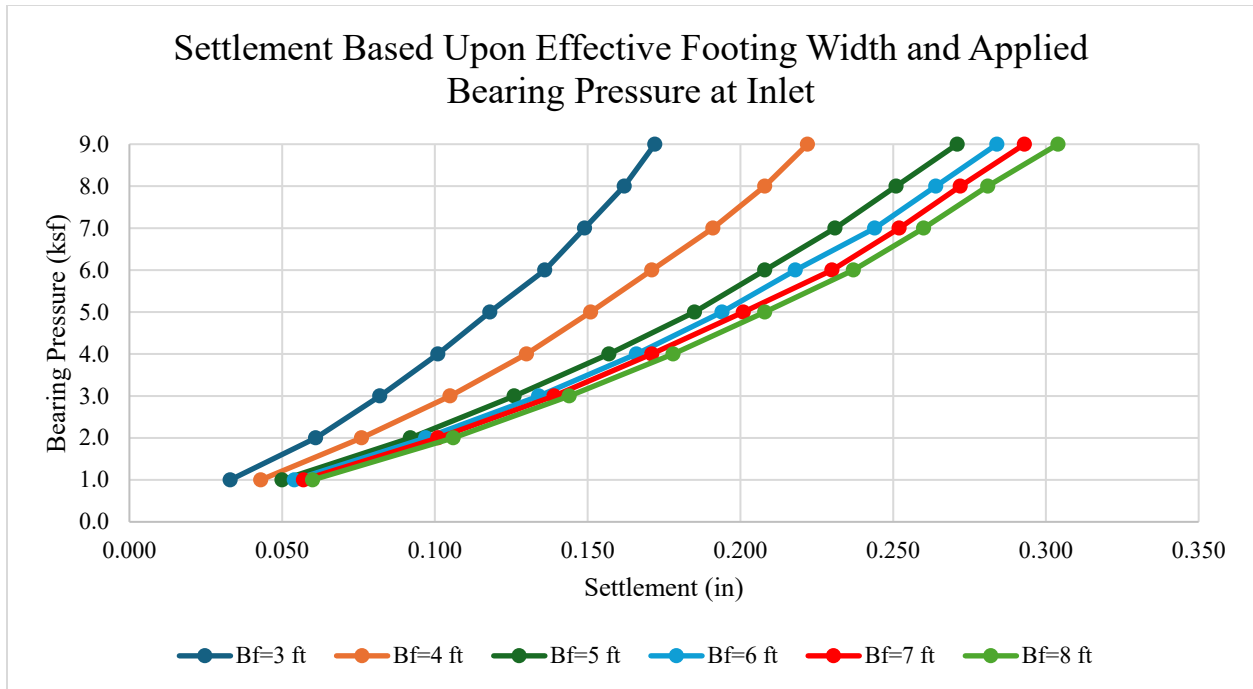


Figure C.1 Settlement based on effective footing width and applied bearing pressure at inlet.

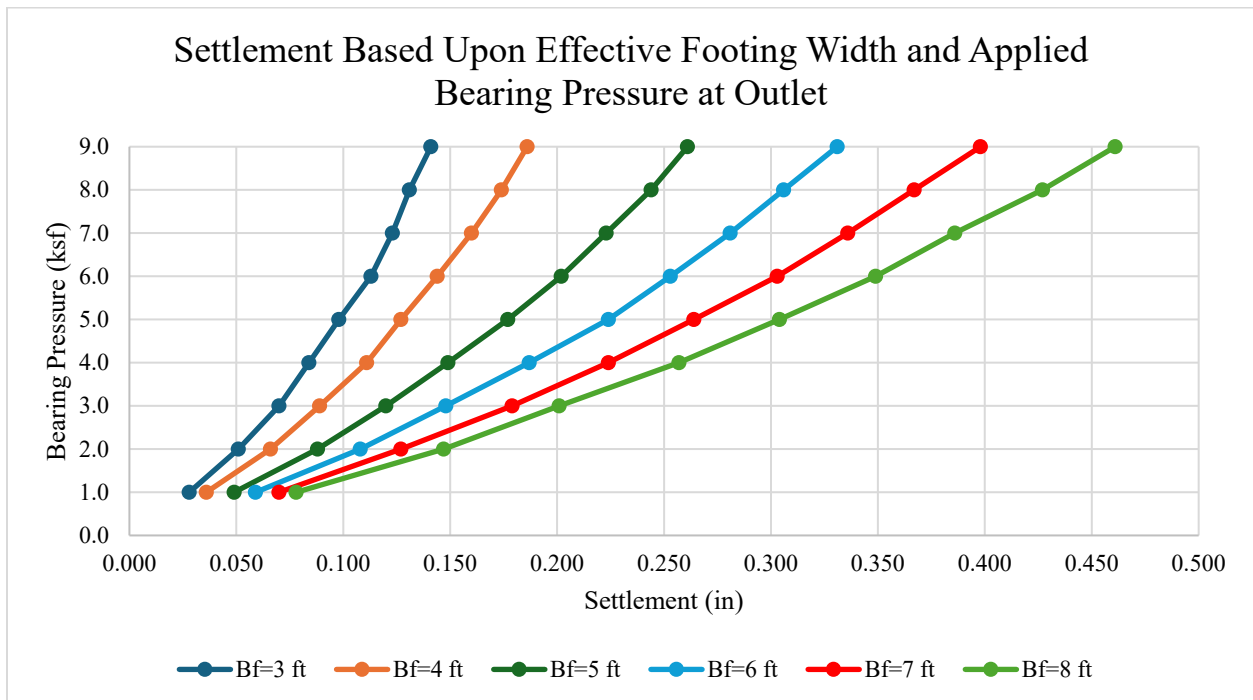


Figure C.2 Settlement based on effective footing width and applied bearing pressure at outlet.