AGENCY OF TRANSPORTATION **OFFICE MEMORANDUM**

To: Mahendra Thilliyar, P.E., Structures Project Manager

END CEE

From: Eric Denardo, P.E., Geotechnical Engineer, via, Callie Ewald, P.E., Senior Geotechnical Engineer

Date: March 26, 2025

Subject: Weston ER P23-1(230) – Geotechnical Report

1.0 INTRODUCTION

As requested, we have completed our subsurface investigation and geotechnical analyses of the spread footing foundations for the proposed box culvert, headwall, and wingwalls as part of the Weston ER P23-1(230) project. The project consists of the replacement of the existing culvert located on VT Route 100 over an unnamed stream in the town of Weston, VT. The project is located approximately 0.4 miles north of the intersection of VT Route 100 and TH 36 (Boynton Rd). 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 December 12th 2024 and February 12th 2025. Two standard penetration borings and two bedrock cores were advanced to evaluate the subsurface profile for design and construction of the replacement structure. Boring locations were provided by Amy Spera of Gill Engineering Associates (Gill) in an email dated August 21st, 2024. The borings 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. 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. The boring elevations for the, based on the North American Vertical Datum, NAVD 88, were estimated using the design file z24b003sv.dgn, dated July 2024. 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.	Station	Offset (ft)	Northing (ft)	Easting (ft)	Approximate Ground Surface Elevation (ft)
B-101	103+96	-16.3	277681.9	1563905.9	1293.3
B-102	104+25	12.0	277701.1	1563942.1	1295.1
B-103	103+59	-11.0	277646.6	1563898.1	1294.0
B-104	105+60	11.0	277735.1	1563950.7	1295.3

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 for B-101 and B-102, split spoon samples and standard penetration tests (STP) were taken for each boring. Samples were taken at 5 foot(ft) intervals to a depth of 10 ft below ground surface (bgs) then continuously sampled until bedrock was encountered at depths of 20.5 ft bgs and 25 ft bgs in B-101 and B-102, respectively. In B-103 and B-104, the borings were advanced to bedrock without sampling to depths of 19 ft bgs and 21.5 ft bgs, respectively. When refusal was encountered, two 5 ft core runs were advanced to recover 10 ft of rock core to confirm the presence of bedrock

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 Drilling Crew.

Details of the bedrock coring were recorded on the boring logs. Cores were then placed in core boxes and returned to the VTrans Construction and Materials Bureau Laboratory for further evaluation and testing, where applicable. The boring logs were revised to reflect the classification and description of the bedrock.

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, CE, to account for the efficiency of the SPT hammers on its drill rigs. B-101 was advanced with a Diedrich D25 with a hammer energy correction factor of 1.45 and B-102 was advanced with a CME 45 skid rig, with a hammer energy correction factor of 1.56. These values, included on the boring logs, should be used in calculations to estimate soil parameters.

Geotechnical laboratory tests were performed on samples to assist with soil classification and evaluate engineering properties of the soil. Grain size analyses were performed on 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-102 (Inlet)

The ground surface elevation at B-102 was approximately 1295.1 ft. Groundwater was encountered after drilling on December 18th, 2024 at a depth of 11 ft bgs, corresponding to an approximate elevation of 1284.1 ft.

Approximate Elevation (ft)	Soil Profile
1295.1 – 1294 ft	Asphalt
1294 – 1291 ft	Medium Dense GRAVEL, some Sand
1291 – 1270 ft	Dense Fine SAND, some Silt, some Gravel
<1270 ft	Bedrock(Gneiss)

4.2 Boring B-101 (Outlet)

The ground surface elevation at B-101 was approximately 1293.3 ft. Groundwater was measured before drilling on December 31st, 2024 at a depth of 8.2 ft bgs, corresponding to an approximate groundwater elevation of 1285.1 ft.

Approximate Elevation (ft)	Soil Profile
1293.3 – 1285 ft	Medium Dense GRAVEL and SAND, trace Silt
1285 – 1273 ft	Dense SAND, some Gravel, trace Silt
<1273ft	Bedrock(Gneiss)

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 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. Groundwater elevations of 1284.1 ft and 1285.1 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:

Foundations on soil:	$\|e\| < b/3$
Foundations on rock:	$\|e\| < 0.45b$

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 in Table 4.1 and Table 4.2.

5.1 Bearing Resistance

The maximum length of wingwalls used in the analysis was 10 ft, based on an email from Caitlin Burner of Gill dated November 18th, 2024. The bottom of footing elevations were also provided as 1282.83 ft and 1276.52 ft at the inlet and outlet of the proposed culvert, respectively. Based on the geometry and elevations it appears as though the footings will bear on the Dense SAND, some Gravel, trace Silt layer, which based on the boring information and subsequent calculations was assigned a friction angle, $\phi = 38^{o}$ and density, $\gamma = 135$ 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. 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. Analyses showed that 1 inch of settlement would require loading in excess of the anticipated loading, therefore settlement does not govern the design and results of the analyses have not been reported in Table 5.1.1. 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 are graphs that detail the corresponding bearing resistances for various effective footing widths.

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)
10.0	3	17.7	7.7
	4	19.5	10.1
	5	21.3	12.5
	6	22.9	14.8
	7	24.4	17.1
	8	25.8	19.4

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 October, 2024. Factored bearing resistances for various footing widths were calculated for the wingwalls and can be found in Table 5.1.1. 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

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 18 ksf
- For service limit state, using a resistance factor of 1.0, the factored bearing resistance is 8 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 SAND, some Gravel, trace Silt (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	0.78
- soil against precast/formed concrete:	0.40	0.48	0.54
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.

Reviewed by: August Arles, Geotechnical Engineer AJA

Enclosures: Appendix A: Boring Locations and Boring Logs (5 Pages)
Appendix B: Bearing Resistance and Settlement Graphs (3 Pages)

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

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Appendix A: Boring Locations and Boring Logs

SOIL CLASSIFICATION

AASHTO

A1	Gravel and Sand
A3	Fine Sand
A2	Silty or Clayey Gravel and Sand
A4	Silty Soil - Low Compressibility
A5	Silty Soil - Highly Compressible
A6	Clayey Soil - Low Compressibility
A7	Clayey Soil - Highly Compressible

ROCK QUALITY DESIGNATION

R.Q.D. (%)	ROCK DESCRIPTION
<25	Very Poor
25 to 50	Poor
51 to 75	Fair
76 to 90	Good
>90	Excellent

SHEAR STRENGTH

UNDRAINED SHEAR STRENGTH IN P.S.F.	CONSISTENCY
<250	Very Soft
250-500	Soft
500-1000	Med. Stiff
1000-2000	Stiff
2000-4000	Very Stiff
>4000	Hard

CORRELATION GUIDE OF "N" TO DENSITY/CONSISTENCY

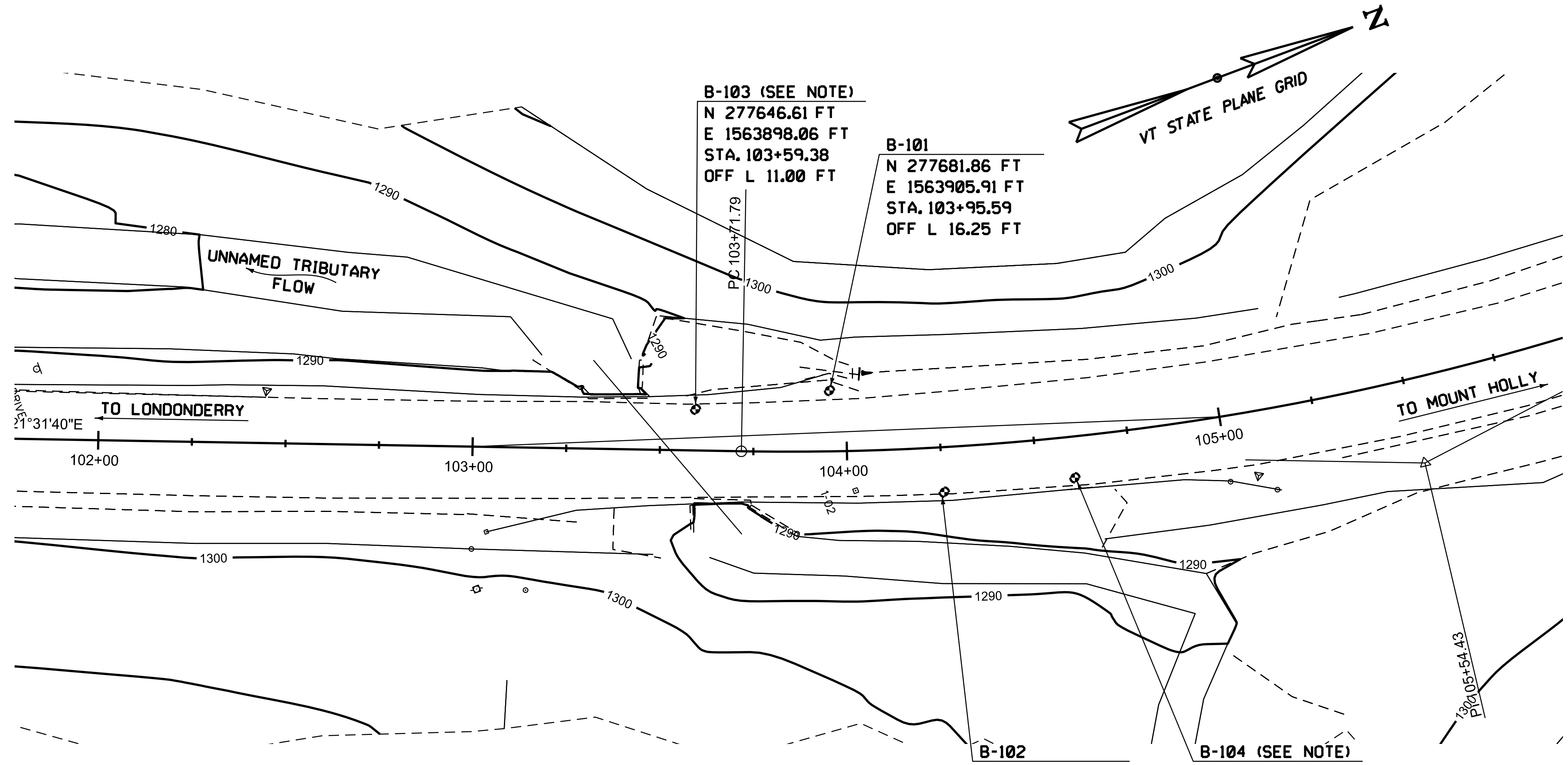
DENSITY (GRANULAR SOILS)		CONSISTENCY (COHESIVE SOILS)	
N	DESCRIPTIVE TERM	N	DESCRIPTIVE TERM
<5	Very Loose	<2	Very Soft
5-10	Loose	2-4	Soft
11-24	Med. Dense	5-8	Med. Stiff
25-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very Stiff
		31-60	Hard
		>60	Very Hard

COMMONLY USED SYMBOLS

▼	Water Elevation
◇	Standard Penetration Boring
⊕	Auger Boring
⊙	Rod Sounding
S	Sample
N	Standard Penetration Test Blow Count Per Foot For: 2" O. D. Sampler 1 3/8" I. D. Sampler Hammer Weight Of 140 Lbs. Hammer Fall Of 30"
VS	Field Vane Shear Test
US	Undisturbed Soil Sample
B	Blast
DC	Diamond Core
MD	Mud Drill
WA	Wash Ahead
HSA	Hollow Stem Auger
AX	Core Size 1 1/8"
BX	Core Size 1 5/8"
NX	Core Size 2 1/8"
M	Double Tube Core Barrel Used
LL	Liquid Limit
PL	Plastic Limit
PI	Plasticity Index
NP	Non Plastic
w	Moisture Content (Dry Wgt. Basis)
D	Dry
M	Moist
MTW	Moist To Wet
W	Wet
Sat	Saturated
Bo	Boulder
Gr	Gravel
Sa	Sand
Si	Silt
Cl	Clay
HP	Hardpan
Le	Ledge
NLTD	No Ledge To Depth
CNPF	Can Not Penetrate Further
TLOB	Top of Ledge Or Boulder
NR	No Recovery
Rec.	Recovery
%Rec.	Percent Recovery
RQD	Rock Quality Designation
CBR	California Bearing Ratio
<	Less Than
>	Greater Than
R	Refusal (N > 100)
VTSPG	NAD83 - See Note 7

COLOR

blk	Black	pnk	Pink
bl	Blue	pu	Purple
brn	Brown	rd	Red
dk	Dark	tn	Tan
gry	Gray	wh	White
gn	Green	yel	Yellow
lt	Light	mltc	Multicolored
or	Orange		



BORING PLAN

SCALE 1"=20'-0"

BORING LOCATIONS						
BORING	NORTHING	EASTING	STATION	OFFSET	GROUND ELEV.	BEDROCK ELEV.
B-101	277681.86	1563905.91	103+95.59	-16.25	1293.3	1272.8
B-102	277701.05	1563942.08	104+25.33	12.00	1295.1	1270.1
B-103	277646.61	1563898.06	103+59.38	-11.00	1294.0	1275.0
B-104	277735.07	1563950.73	104+59.87	11.00	1295.3	1273.8

NOTE:
BORINGS B-103 AND B-104 ARE SUPPLEMENTAL BORINGS TO BE TAKEN IF BEDROCK IS ENCOUNTERED DURING THE DRILLING OF BORINGS B-101 AND B-102.

DEFINITIONS (AASHTO)

BEDROCK (LEDGE) Rock in its native location of indefinite thickness.

BOULDER - A rock fragment with an average dimension > 12 inches.

COBBLE - Rock fragments with an average dimension between 3 and 12 inches.

GRAVEL - Rounded particles of rock < 3" and > 0.0787" (#10 sieve).

SAND - Particles of rock < 0.0787" (#10 sieve) and > 0.0029" (#200 sieve).

SILT - Soil < 0.0029" (#200 sieve), non or slightly plastic and exhibits no strength when air-dried.

CLAY - Fine grained soil, exhibits plasticity when moist and considerable strength when air-dried.

VARVED - Alternate layers of silt and clay.

HARDPAN - Extremely dense soil, cemented layer, not softened when wet.

MUCK - Soft organic soil (containing > 10% organic material.

MOISTURE CONTENT - Weight of water divided by dry weight of soil.

FLOWING SAND - Granular soil so saturated (loose) that it flows into drill casing during extraction of wash rod.

STRIKE - Angle from magnetic north to line of intersection of bed with a horizontal plane.

DIP - Inclination of bed with a horizontal plane.

GENERAL NOTES

1. The subsurface explorations shown herein were made between 12/27/2024 and 02/15/2025 by the Agency.
2. Soil and rock classifications, properties and descriptions are based on engineering interpretation from available subsurface information by the Agency and may not necessarily reflect actual variations in subsurface conditions that may be encountered between individual boring or sample locations.
3. Observed water levels and/or conditions indicated are as recorded at the time of exploration and may vary according to the prevailing rainfall, methods of exploration and other factors.
4. Engineering judgment was exercised in preparing the subsurface information presented herein. Analysis and interpretation of subsurface data was performed and interpreted for Agency design and estimating purposes. Presentation of the information in the Contract is intended to provide the Contractor access to the same data available to the Agency. The subsurface information is presented in good faith and is not intended as a substitute for personal investigation, independent interpretation, independent analysis or judgment by the Contractor.
5. Pictorial structure details shown on the boring plan layout or soils profile are for illustrative purposes only and may not accurately portray final contract details.
6. Terminology used on boring logs to describe the hardness, degree of weathering, and spacing of fractures, joints and other discontinuities in the bedrock is defined in the AASHTO Manual on Subsurface Investigations, 1988.
7. Northing and Easting coordinates are shown in Vermont State Plane Grid North American Datum 1983 in meters and survey feet.

PROJECT NAME: WESTON	
PROJECT NUMBER: ER P23-1(230)	
FILE NAME: $FILE$$	PLOT DATE: $$$$DATE$$$
PROJECT LEADER: LEAD	DRAWN BY: C.BURNER
DESIGNED BY: C.BURNER	CHECKED BY: BR CHECK
BORING LAYOUT SHEET	SHEET $S*$ OF $T*$

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

BORING LOG

Weston
ER P23-1(230)
VT 100

Boring No.: **B-101**

Pin No.: 24B003
Checked By: LHD

Boring Crew: McGinley, Thurston, Lubas, Degener
Date Started: 12/27/24 Date Finished: 12/31/24
VTSPG NAD83: N 277681.90 ft E 1563905.90 ft
Station: 103+96 Offset: -16.30
Ground Elevation: 1293.3 ft

	Casing	Sampler
Type:	WB	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:	Diedrich 25	C_E = 1.45

Groundwater Observations

Date	Depth (ft)	Notes
12/27/24	6.2	WT After Drilling
12/31/24	8.2	WT Before Drilling

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Run (Dip deg.)	Core Rec. % (RQD %)	Drill Rate minutes/ft	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
0		A-1-a, Lab Classification: GRAVEL and SAND, trace Silt, gry-brn, MTD, Rec. = 1.2 ft, Frozen ground. Rollercone cleanout 4.3-5.0'				19-11-12-13 (23)	8.7	55.7	43.2	1.1
5		Field Note:, No recovery, Advanced casing to 10'				15-13-10-14 (23)				
10		A-1-b, Lab Classification: GRAVEL and SAND, trace Silt, brn/gry, MTD, Rec. = 1.1 ft, Refusal at 11.5' - 50 blows per 6"				15-36-R@6" (R)	9.3	50.4	47.8	1.8
		A-2-4, Lab Classification: SAND, some Gravel, little Silt, brn, Moist, Rec. = 1.2 ft, Rollercone cleanout 13.3'-10.4'				31-35-R@5" (R)	11.1	28.3	55.0	16.7
15		A-1-b, Lab Classification: SAND, some Gravel, trace Silt, Lt brn, MTD, Rec. = 1.4 ft				14-19-24-20 (43)	14.2	33.8	63.1	3.1
		A-3, Lab Classification: SAND, some Gravel, trace Silt, Lt brn, MTD, Rec. = 1.2 ft, Rollercone cleanout 17.3'-18.0'				19-21-27-R@3" (48)	16.1	27.0	66.9	6.1
		Field Note:, No recovery, Tried to advance casing to 23' refusal at 20.5'				R@2" (R)				
20		20.5 ft - 25.5 ft, Light to medium gray, Biotite-muscovite-quartz-plagioclase GNEISS, with Amphibolite. Joint surfaces rough, faint tan to brown discoloration on joints. Hard, Very slightly weathered, Good rock, NX, RMR = 76	R1 (5-30)	82 (82)	5 6 7.75 8 8	Top of Bedrock @ 20.5 ft				
25		25.5 ft - 28.5 ft, White, QUARTZITE, Joint surfaces rough. Faint tan staining on fractured surface. Hard, Very slightly weathered, Good rock, NX, RMR = 62	R2 (5-30)	33 (33)	6 5.5 3.5					
30		Hole stopped @ 28.5 ft								
35		Remarks: Hole collapsed @ 4'								

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
AGENCY OF TRANSPORTATION
CONSTRUCTION AND
MATERIALS BUREAU
CENTRAL LABORATORY

BORING LOG

Weston
ER P23-1(230)
VT 100

Boring No.:	**B-102**
Page No.:	1 of 1
Pin No.:	24B003
Checked By:	LHD

Boring Crew: McGinley, Thurston, Lubas, Arles, Degener
Date Started: 12/12/24 Date Finished: 12/18/24
VTSPG NAD83: N 277701.10 ft E 1563942.10 ft
Station: 104+25 Offset: 12.00
Ground Elevation: 1295.1 ft

	Casing	Sampler
Type:	WB	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:	CME 45C SKID	C_E = 1.56

Groundwater Observations

Date	Depth (ft)	Notes
12/16/25		No WT Before Drilling
12/18/25	11.0	WT After Drilling

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Run (Dip deg.)	Core Rec. % (RQD %)	Drill Rate minutes/ft	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		Field Note:, Asphalt 0.0'-0.8'								
		Field Description:, GRAVEL, some Sand, brn, Dry, Rec. = 0.9 ft, NX cleanout 3.9'-5.0'				11-9-10-8 (19)				
5		Field Note:, No recovery, Refusal at 5.5' 10 blows no movmement. Rollercone cleanout 5.5'-10.0'				R@6" (R)				
10		Field Description:, Fine SAND, some Silt, trace Gravel, brn, MTD, Rec. = 1.5 ft				22-22-26-25 (48)				
		Field Description:, Fine SAND, some Silt, trace Gravel, brn, MTD, Rec. = 1.2 ft, Refusal at 13.4' - 50 blows per 6". Rollercone cleanout 13.5'-14.5'				29-42-R@5" (R)				
15		Field Description:, Fine SAND, some Silt, trace Gravel, brn, Moist, Rec. = 1.0 ft, Refusal at 15.4' - 50 blows per 6"				30-R@5" (R)				
		Field Description:, Fine SAND, some Silt, some Gravel, Lt/brn-gry, Moist, Rec. = 1.0 ft, Refusal at 17.3' - 10 blows no movement. Rollercone cleanout 19'-20'				33-40-R@3" (R)				
20		Field Description:, Fine SAND, some Silt, trace Gravel, Lt/brn-gry, Moist, Rec. = 0.2 ft, Refusal at 20.3' - 10 blows no movement. Advanced casing to 25'				R@3" (R)				
25		25.0 ft - 30.0 ft, Light gray to gray, biotite-muscovite-quartz-plagioclase GNEISS, with Amphibolite. Joints rough, faint tan to brown discoloration on joints. Hard, Very slightly weathered, Good rock, NX, RMR = 75	R1 (5-30)	92 (72)	11.5 6.3 4.6 3.6 5.5	Top of Bedrock @ 25.0 ft				
30		30.0 ft - 35.0 ft, Light gray to gray, Biotite-muscovite-quartz-plagioclase GNEISS, with Amphibolite. Joints rough, faint tan to brown discoloration on joints. Hard, Very slightly weathered, Good rock, NX, RMR = 79	R2 (5-30)	100 (100)	4 4.5 4.2 4 4.6					
35										
40		Hole stopped @ 40.0 ft								

Remarks:
Switched to Diedrich D25 to core.

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 AGENCY OF TRANSPORTATION CONSTRUCTION AND MATERIALS BUREAU CENTRAL LABORATORY	**BORING LOG** **Weston** **ER P23-1(230)** **VT 100**	Boring No.: **B-103** Page No.: 1 of 1 Pin No.: 24B003 Checked By: LHD

Boring Crew: Lubas, Thurston, Degener, Tung
Date Started: 1/14/25 Date Finished: 1/14/25
VTSPG NAD83: N 277646.60 ft E 1563898.10 ft
Station: 103+59 Offset: -11.00
Ground Elevation: 1294.0 ft

	Casing	Sampler
Type:	WB	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:	Diedrich 25	C_E = 1.45

Groundwater Observations

Date	Depth (ft)	Notes

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Run (Dip deg.)	Core Rec. % (RQD %)	Drill Rate minutes/ft	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
0.0		Field Note:, Asphalt 0.0'-0.5'								
0.5		Advanced boring to bedrock without sampling, 0.5 ft - 19.0 ft								
9.5		BXDC cleanout 9.5'-10.5', 9.5 ft - 10.5 ft, Advanced casing to refusal at 19'								
19.0		19.0 ft - 24.0 ft, Light gray to gray, Biotite-muscovite-quartz-plagioclase GNEISS, Joint surfaces rough, faint tan to brown discoloration on joints. Moderately hard, Very slightly weathered, Fair rock, BX, RMR = 58	R1 (10-20)	74 (34)	3 11.5 4 2.9 5.8	Top of Bedrock @ 19.0 ft				
24.0		24.0 ft - 29.0 ft, Light gray to gray, Biotite-muscovite-quartz-plagioclase GNEISS, Joint surfaces rough, faint tan to brown discoloration on joints. Moderately hard, Very slightly weathered, Fair rock, BX, RMR = 52	R2 (10-20)	90 (17)	2.4 2 3.8 2.6 4					
29.0		Hole stopped @ 29.0 ft								

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
AGENCY OF TRANSPORTATION
CONSTRUCTION AND
MATERIALS BUREAU
CENTRAL LABORATORY

BORING LOG

Weston
ER P23-1(230)
VT 100

Boring No.: **B-104**
Page No.: 1 of 1
Pin No.: 24B003
Checked By: LHD

Boring Crew: McGinley, Thurston, Lubas, Degener
Date Started: 2/11/25 Date Finished: 2/12/25
VTSPG NAD83: N 277735.10 ft E 1563950.70 ft
Station: 105+60 Offset: 11.00
Ground Elevation: 1295.3 ft

	Casing	Sampler
Type:	WB	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: Diedrich 25 C_E = 1.45

Groundwater Observations

Date	Depth (ft)	Notes
02/11/25	5.9	WT After Drilling

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Run (Dip deg.)	Core Rec. % (RQD %)	Drill Rate minutes/ft	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
0.0–20.0		Casing advanced to 20' to refusal, 0.0 ft - 20.0 ft								
21.5–26.5		21.5 ft - 26.5 ft, Light gray to gray, Biotite-muscovite-quartz-plagioclase GNEISS, Joint surfaces rough, faint tan to brown discoloration on joints. Moderately hard, Very slightly weathered, Fair rock, BX, RMR = 56	R1 (10-20)	60 (34)	11 4.6 4.75 2 4	Top of Bedrock @ 21.5 ft				
26.5–28.9		26.5 ft - 28.9 ft, Light gray to gray, Biotite-muscovite-quartz-plagioclase GNEISS, Joint surfaces rough, faint tan to brown discoloration on joints. Moderately hard, Very slightly weathered, Fair rock, BX, RMR = 55	R2 (10-25)	104 (40)	2.5 6.5 8.4					

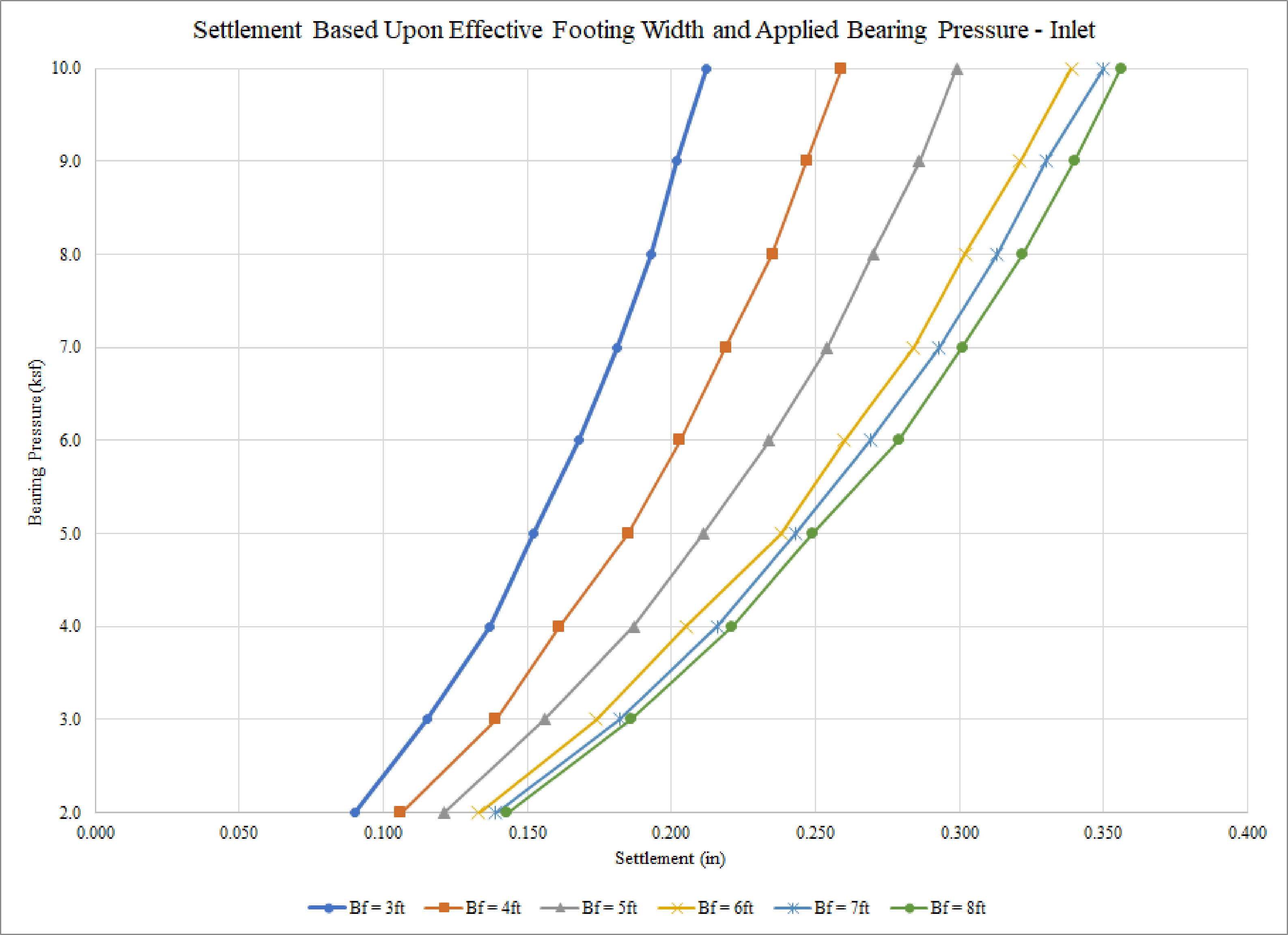
Hole stopped @ 31.5 ft

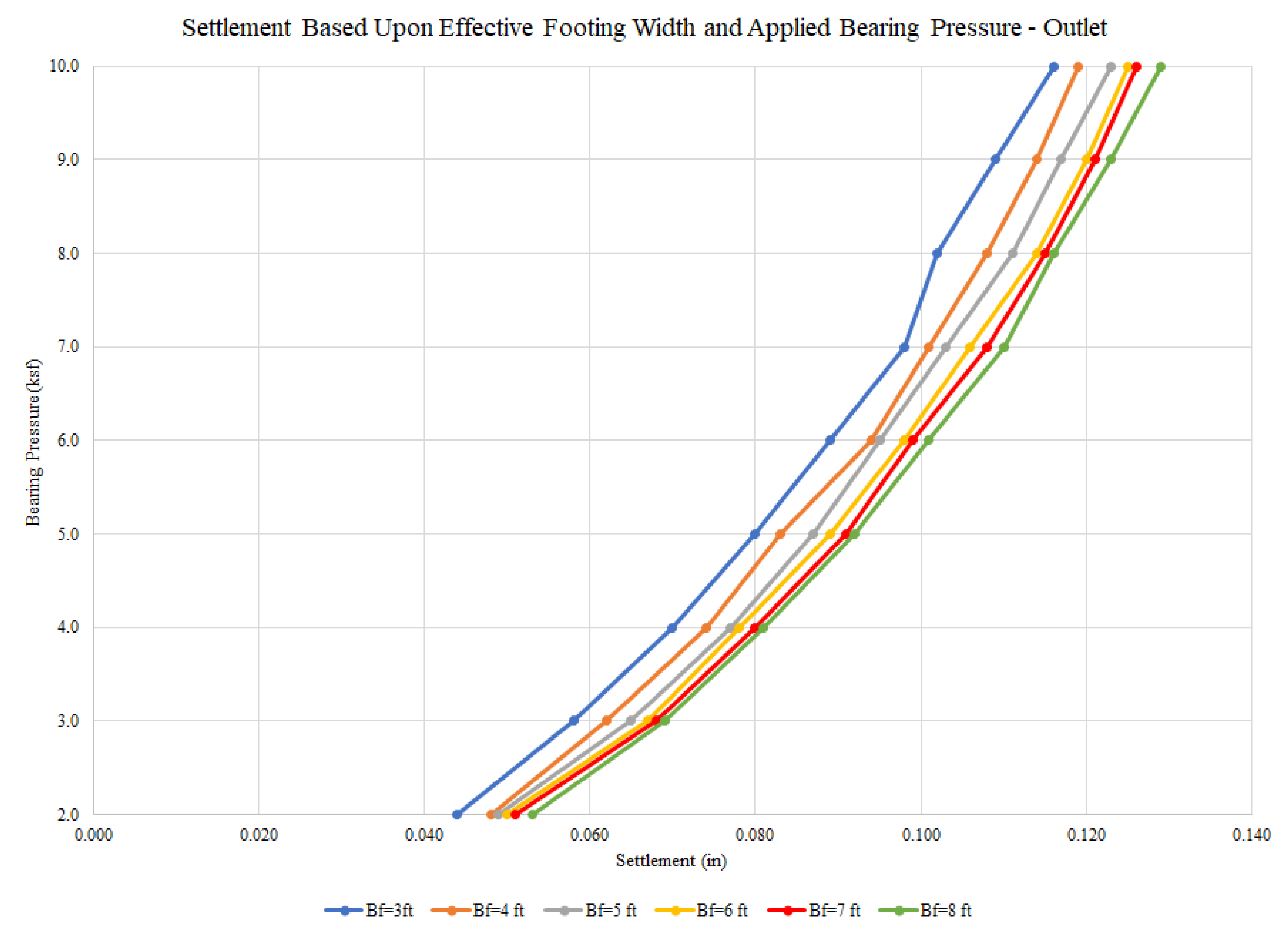
Remarks:
Core barrel clogged beyond 28.9' no recovery 28.9' -31.5'

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: Bearing Resistance and Settlement Graphs


Wingwall Effective Footing Width vs Bearing Resistance (Factored) at Inlet/Outlet
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Bearing Resistance (ksf)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
Footing Width (ft)
Strenght Limit
Service Limit


Settlement Based Upon Effective Footing Width and Applied Bearing Pressure - Inlet
Bearing Pressure (ksf)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
0.400
Settlement (in)
Bf = 3ft
Bf = 4ft
Bf = 5ft
Bf = 6ft
Bf = 7ft
Bf = 8ft


Settlement Based Upon Effective Footing Width and Applied Bearing Pressure - Outlet
Bearing Pressure (ksf)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
0.000
0.020
0.040
0.060
0.080
0.100
0.120
0.140
Settlement (in)
Bf=3ft
Bf=4 ft
Bf=5 ft
Bf=6 ft
Bf=7 ft
Bf=8 ft