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: December 12th, 2024, Revised June 12th, 2025

Subject: Londonderry ER P23-1(225) – 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 Londonderry ER P23-1(225) project. The project consists of the replacement of the existing culvert located on VT Route 100 over an unnamed stream in the town of Londonderry, VT. The project is located approximately 2.9 miles south of the intersection of VT Route 11 and VT Route 100. 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 2020 AASHTO LRFD Bridge Design Specifications.

2.0 FIELD INVESTIGATION

The field investigation was conducted between September 4th and October 12th, 2024. Two standard penetration borings 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. Northings, Eastings, and elevations for the borings, based on the North American Vertical Datum, NAVD 88, were estimated using the design file z23b829sv.dgn, dated September 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	104+13	12.0	250519.5	1556885.3	1147.3
B-102	104+20	-13.0	250526.2	1556860.3	1144.8

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 (STP) were taken for each boring. Boring B-101 was sampled in 5-foot intervals to 20 feet (ft) below ground surface (bgs), continuously sampled from 20 ft to 35 ft bgs, and then at 5-foot intervals to 50 ft bgs. B-102 was sampled at 5 ft intervals to 10 ft bgs, continuously sampled 10 ft to 22 ft bgs, then at 5-foot intervals to 30 ft bgs. Bedrock was not encountered to depth in either boring.

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, CE, to account for the efficiency of the SPT hammers on its drill rigs. Both borings were advanced with a CME 45 skid rig, with a hammer energy correction factor of 1.56. This value, 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 1144.8 ft. Groundwater was not encountered to the depth of the boring.

Approximate Elevation (ft)	Soil Profile
1143.8 – 1134 ft	Dense GRAVEL and SAND, some Silt
1134 – 1128 ft	Medium Dense SAND, some Gravel, some Silt
1128 – 1124 ft	Dense SILT and SAND, some Gravel
1124 – 1115 ft	Dense SAND and GRAVEL, some Silt

4.2 Boring B-101 (Outlet)

The ground surface elevation at B-101 was approximately 1147.3 ft. Groundwater was measured after drilling on October 10th, 2024, at a depth of 17.2 ft, corresponding to approximate groundwater elevations of 1130.1 ft.

Approximate Elevation (ft)	Soil Profile
1147.3 – 1146 ft	Asphalt
1146 – 1139 ft	Medium Dense SAND, and GRAVEL, some Silt
1139 – 1135 ft	Dense SILT, some Gravel, some Sand
1135 – 1130 ft	Very Loose GRAVEL and SAND, little Silt
1130 – 1121 ft	Dense SAND, some Gravel, some Silt
1121 – 1099 ft*	Dense SILT, some Gravel, trace Sand

**Cobbles noted from 37-42 ft bgs*

5.0 SHALLOW FOUNDATION ANALYSIS

AASHTO's LRFD Bridge Design Specifications Manual (2020) 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 of 1129.4 ft and 1114.4 ft was used in design at the inlet and outlet, respectively.

As per section 10.5.5.1 of the 2020 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 below in Table 4.1 and Table 4.2.

5.1 Bearing Resistance (Inlet Bearing Stratum, B-102)

The maximum length of wingwalls used in the analysis was 10 ft, based on an email from Caitlin Burner of Gill dated November 15th, 2024. The bottom of footing elevation was also provided as 1129.4 ft at the inlet of the proposed culvert. Based on the geometry and elevations it appears as though the footings will bear on the medium dense SAND, some Gravel, some Silt layer, which based on the boring information and subsequent calculations was assigned a friction angle, $\phi = 38^o$ and density, $\gamma = 120\ lb/ft^3$.

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 at the inlet 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	15.8	6.8
	4	17.4	9.0
	5	18.9	11.1
	6	20.3	13.2
	7	21.7	15.2
	8	22.9	17.2

5.2 Bearing Resistance (Outlet Bearing Stratum, B-101)

The maximum length of wingwalls used in the analysis was 10 ft, based on an email from Caitlin Burner of Gill dated November 15th, 2024. The bottom of footing elevation was also provided as 1114.4 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 the dense SILT, some Gravel, trace Sand layer, which based on the boring information and subsequent calculations, was assigned a friction angle, $\phi = 38^{o}$ and density, $\gamma = 130\ lb/ft^3$.

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 5.2.1. 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 at the inlet 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 5.2.1. 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 5.2.1 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	3	17.1	7.4
	4	18.8	9.7
	5	20.5	12.0
	6	22.0	14.3
	7	23.5	16.5
	8	24.9	18.7

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 November, 2024. Factored bearing resistances for various footing widths were calculated for the wingwalls and can be found in Table 5.1.1 and Table 5.2.1. 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

*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 15 ksf
- For service limit state, using a resistance factor of 1.0, the factored bearing resistance is 6 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**	**Medium Dense SAND, some Gravel, some Silt (Inlet Bearing Stratum)**	**Dense SILT, some Gravel, trace Sand (Outlet Bearing Stratum)**
Unit Weight, γ (lbs/ft^3):	130	140	120	135
Internal Friction Angle, φ (degrees):	32	34	38	38
Coefficient of Friction, f				
- mass concrete cast against soil:	0.45	0.55	0.57	0.50
- soil against precast/formed concrete:	0.40	0.54	0.35	0.35
Active Earth Pressure Coef., K_a:	0.31	0.28	0.24	0.24
Passive Earth Pressure Coef., K_p:	3.26	3.57	4.20	4.20
At-Rest Earth Pressure Coefficient, K_o:	0.47	0.44	0.38	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 (4 Pages)
Appendix B: Bearing Resistance and Settlement Graphs (4 Pages)

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

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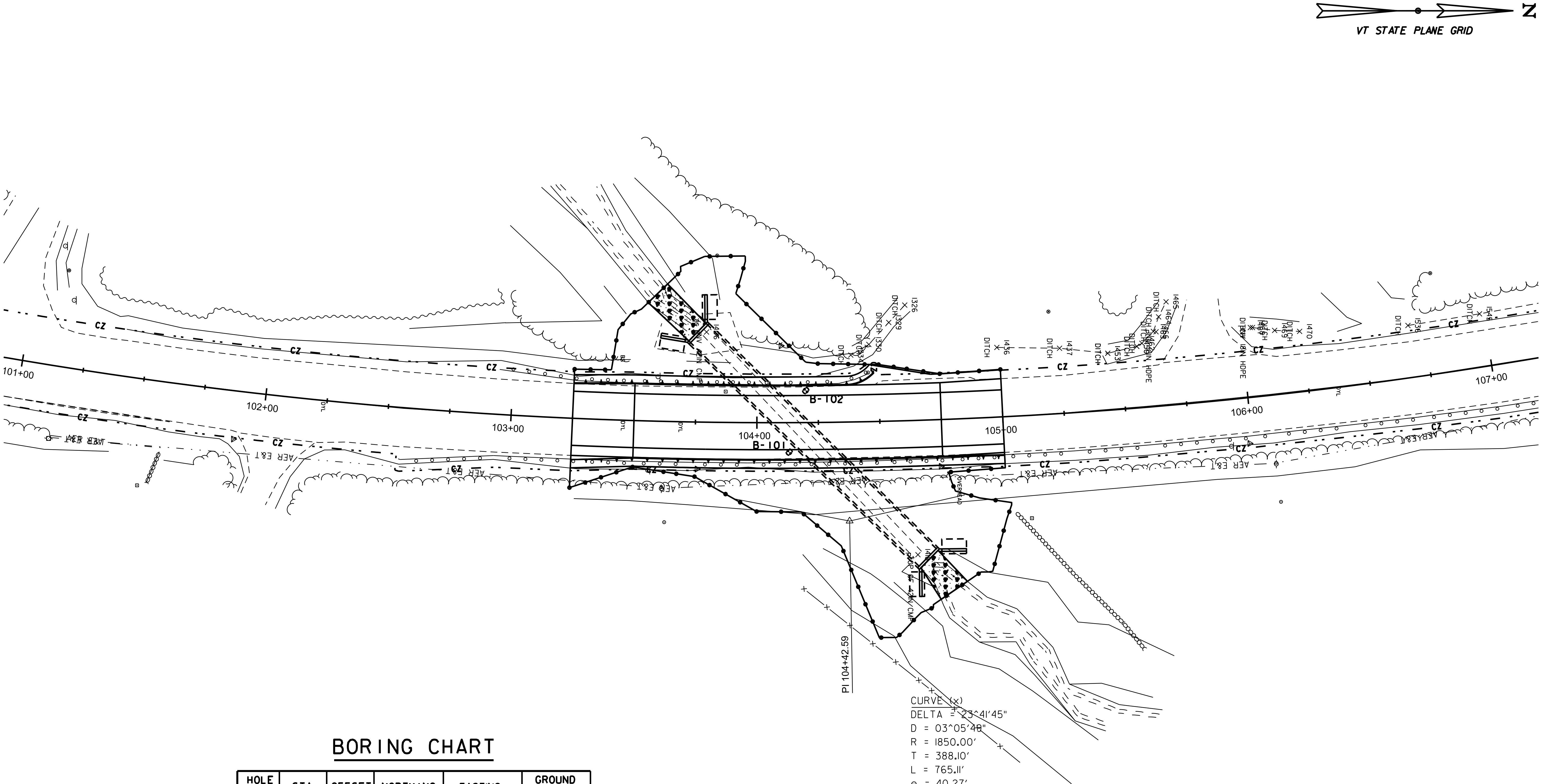
Appendix A: Boring Locations and Boring Logs



BORING CHART

HOLE NO.	STA.	OFFSET	NORTHING	EASTING	GROUND ELEVATION
B-101	104+13	12.0	250519.5	1556885.3	1147.3
B-102	104+20	-13.0	250526.2	1556860.3	1144.8

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

GILL ENGINEERING

PROJECT NAME: LONDONDERRY
PROJECT NUMBER: ER P23-1(225)
FILE NAME: $FILE$
PROJECT LEADER:
DESIGNED BY:
BORING LAYOUT
PLOT DATE: $$$DATE$$$
DRAWN BY:
CHECKED BY:
SHEET OF

STATE OF VERMONT AGENCY OF TRANSPORTATION CONSTRUCTION AND MATERIALS BUREAU CENTRAL LABORATORY	BORING LOG	
VTrans Working to Get You There — Vermont Agency of Transportation	**Londonderry** **ER P23-1(225)** **VT 100**	Boring No.: **B-101** Page No.: 1 of 2 Pin No.: 23B829 Checked By: END

Boring Crew: McGinley, Thurston, Lubas, Arles
Date Started: 9/12/24 Date Finished: 10/10/24
VTSPG NAD83: N 250519.50 ft E 1556885.30 ft
Station: 104+13 Offset: 12.00
Ground Elevation: 1147.3 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:	CME 45C SKID	C_E = 1.56

Groundwater Observations

Date	Depth (ft)	Notes
10/10/24	17.2	WT after drilling

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		ASPHALT, 0.0 ft - 0.75 ft					
		A-1-b, Lab Classification: GRAVEL and SAND, little Silt, brn, Dry, Rec. = 0.9 ft	5-9-9-7 (18)	8.5	49.8	35.9	14.3
5		A-2-4, Lab Classification: SAND, some Silt, some Gravel, brn/gry, Dry, Rec. = 0.8 ft	6-8-8-7 (16)	13.1	23.0	42.4	34.6
10		A-4, Lab Classification: SILT, some Gravel, some Sand, gry, Wet, Rec. = 0.75 ft	13-12-34-10 (46)	12.0	33.6	28.7	37.7
15		A-1-b, Lab Classification: GRAVEL and SAND, little Silt, gry, Wet, Rec. = 0.2 ft, Lab note: wood was within sample.	1-1-1-1 (2)	25.8	47.7	40.0	12.3
		Field Note:, No recovery, Refusal, 10 blows no movement. Attempted core 19.0-19.5' believed to be cobbles.	R@0"				
20		Field Note:, Attempted core 20-21' believed to be cobbles.					
		Field Description:, GRAVEL, gry, Moist, Rec. = 0.2 ft, Field note: Gravel in end of sampler.	6-12-11-18 (23)				
		Field Description:, Fine to medium SAND, some Gravel, some Silt, brn, Wet, Rec. = 1.3 ft	WoH-WoH-16-24 (16)				
25		Field Note:, No recovery, Refusal at 25.5'. Gravel in end of sampler.	R@5"				
		A-4, Lab Classification: SILT, trace Sand, Lt brn, MTW, Rec. = 1.5 ft	13-19-19-40 (38)	18.0	0.5	9.4	90.1
30		Field Description:, Fine SAND, some Gravel, little Silt, Rec. = 1.7 ft	27-31-41-48 (72)				
		Field Description:, Fine SAND, trace Gravel, Lt brn, MTW, Rec. = 0.5 ft, Refusal at 31.5'. 10 blows no movement.	R@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.

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

BORING LOG

Londonderry
ER P23-1(225)
VT 100

Boring No.: **B-101**

Pin No.: 23B829
Checked By: END

Boring Crew: McGinley, Thurston, Lubas, Arles
Date Started: 9/12/24 Date Finished: 10/10/24
VTSPG NAD83: N 250519.50 ft E 1556885.30 ft
Station: 104+13 Offset: 12.00
Ground Elevation: 1147.3 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:	CME 45C SKID	C_E = 1.56

Groundwater Observations

Date	Depth (ft)	Notes
10/10/24	17.2	WT after drilling

Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		Field Note:, No recovery, Refusal at 35.7'. 10 blows no movement. Weathered rock in end of sampler.	42-R@2" (R)				
40		Field Note:, Cobbles, Rollercone cleanout 37-42'					
		Field Note:, No recovery, Refusal at 42.3'. 10 blows no movement. Rollercone cleanout 42.3-47.0'	R@4"				
45							
		Field Note:, No recovery, Refusal at 48.3'	10-35-R@3" (R)				

Hole stopped @ 48.3 ft

50

Remarks:
Hole Collapse @ 22.3'.

55

60

65

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 LONDONDERRY ER P23-1(225).GPJ VERMONT AOT.GDT 11/12/24

STATE OF VERMONT
AGENCY OF TRANSPORTATION
CONSTRUCTION AND
MATERIALS BUREAU
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BORING LOG

Londonderry
ER P23-1(225)
VT 100

Boring No.: **B-102**
Page No.: 1 of 1
Pin No.: 23B829
Checked By: END

Boring Crew: McGinley, Thurston
Date Started: 9/04/24 Date Finished: 9/12/24
VTSPG NAD83: N 250526.20 ft E 1556860.30 ft
Station: 104+20 Offset: -13.00
Ground Elevation: 1144.8 ft

	Casing	Sampler
Type:	H.S.A. & 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
09/12/24		No WT to Collaspe

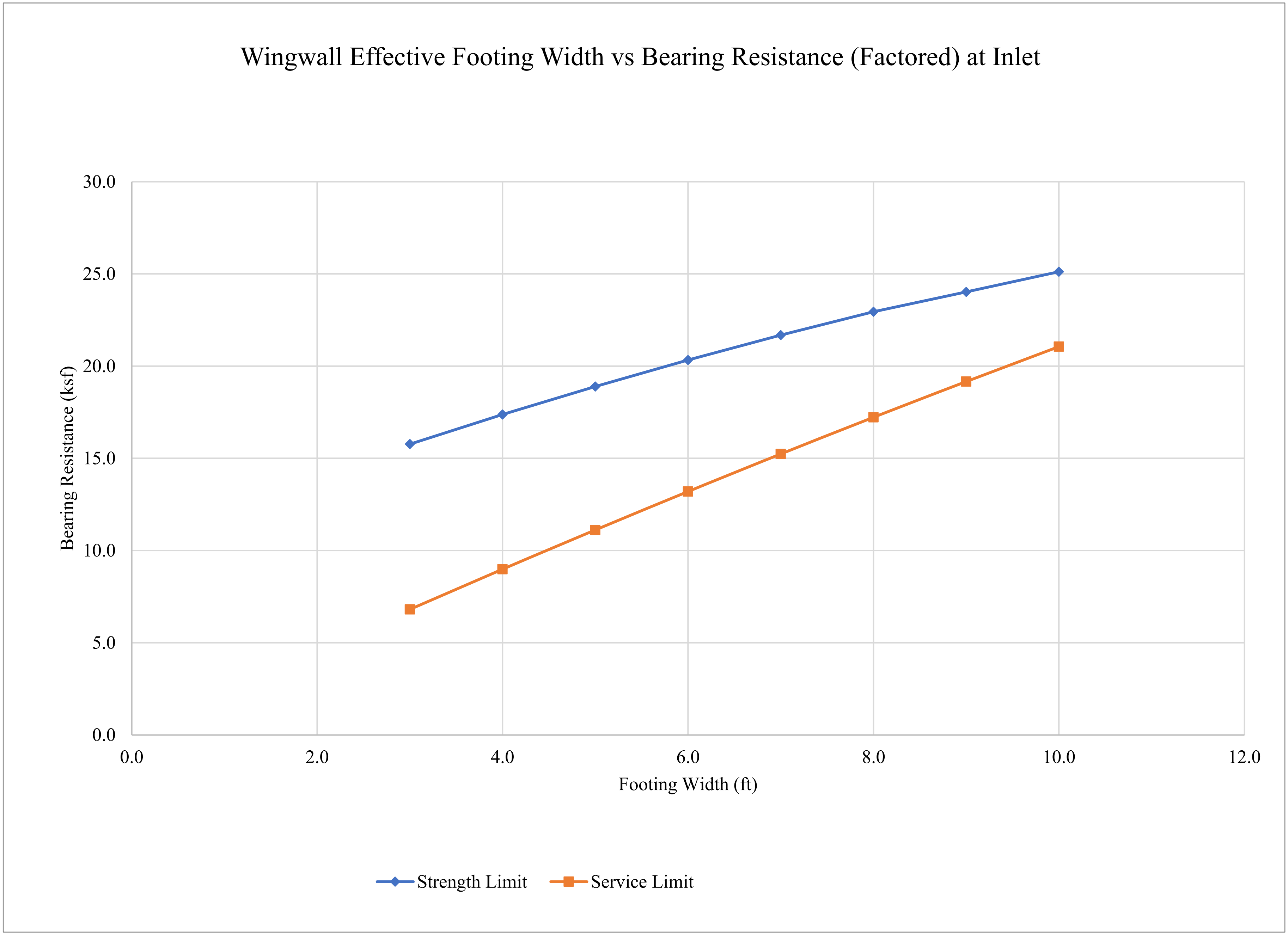
Depth (ft)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		ASPHALT, 0.0 ft - 0.9 ft					
		A-1-b, Lab Classification: GRAVEL and SAND, little Silt, brn, Dry, Rec. = 0.9 ft, Lab note: Asphalt was within sample.	14-13-15-14 (28)	16.1	48.8	36.0	15.2
5		A-1-b, Lab Classification: GRAVEL, some Sand, some Silt, brn, Dry, Rec. = 0.6 ft	28-19-14-13 (33)	9.4	47.3	29.3	23.4
10		Field Note:, No recovery	39-34-10-7 (44)				
		A-2-4, Lab Classification: GRAVEL, some Silt, some Sand, brn/gry, Wet, Rec. = 0.9 ft	13-7-23-16 (30)	8.7	45.9	24.9	29.2
		A-2-4, Lab Classification: SAND, some Silt, some Gravel, brn, Wet, Rec. = 0.4 ft	20-6-5-7 (11)	10.7	26.0	41.5	32.5
15		A-2-4, Lab Classification: SAND, some Silt, some Gravel, brn, Wet, Rec. = 1.0 ft	8-12-15-27 (27)	11.8	23.2	48.5	28.3
		A-4, Lab Classification: SILT and SAND, little Gravel, brn, Wet, Rec. = 1.0 ft	9-23-37-53 (60)	11.1	18.3	40.7	41.0
20		A-4, Lab Classification: SILT, some Sand, some Gravel, brn, Wet, Rec. = 1.5 ft, Refusal 100 blows. Broken rock was within sample.	36-40-63 (R)	9.7	30.4	31.9	37.7
		A-2-4, Lab Classification: SAND and GRAVEL, some Silt, brn, Wet, Rec. = 0.2 ft, Refusal 100 blows. Broken rock was within sample.	49-11-40 (R)	9.1	35.4	37.0	27.6
25		Field Note:, No recovery, Refusal, 10 blows no movement.	R@0"				
30		A-1-b, Lab Classification: SAND, some Gravel, some Silt, brn, Wet, Rec. = 0.4 ft, Refusal, 50 blows/5". Broken rock was within sample.	R@5"	8.0	34.2	51.5	14.3

Hole stopped @ 29.5 ft

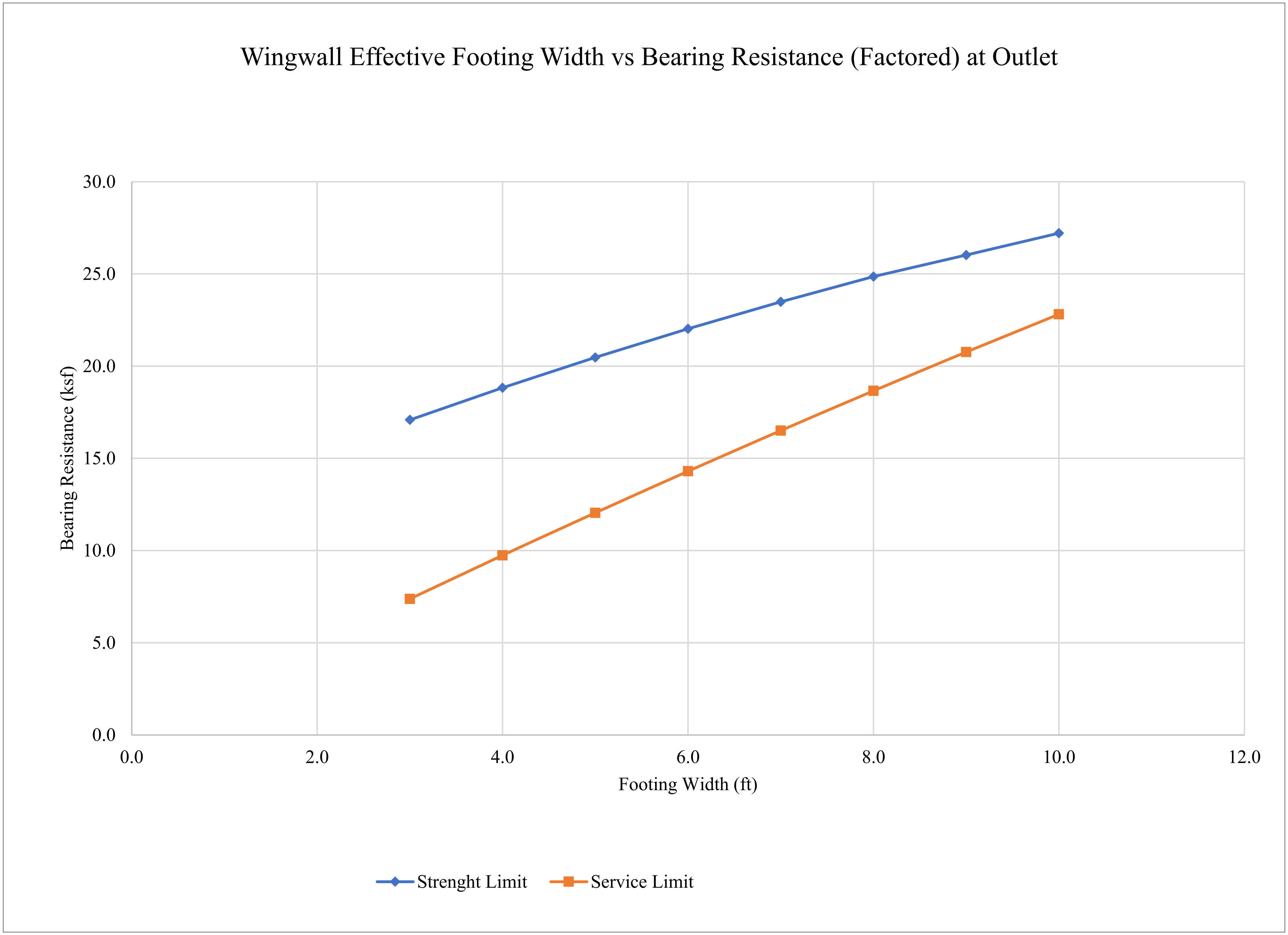
Remarks:
Hole Collapse @ 4'.

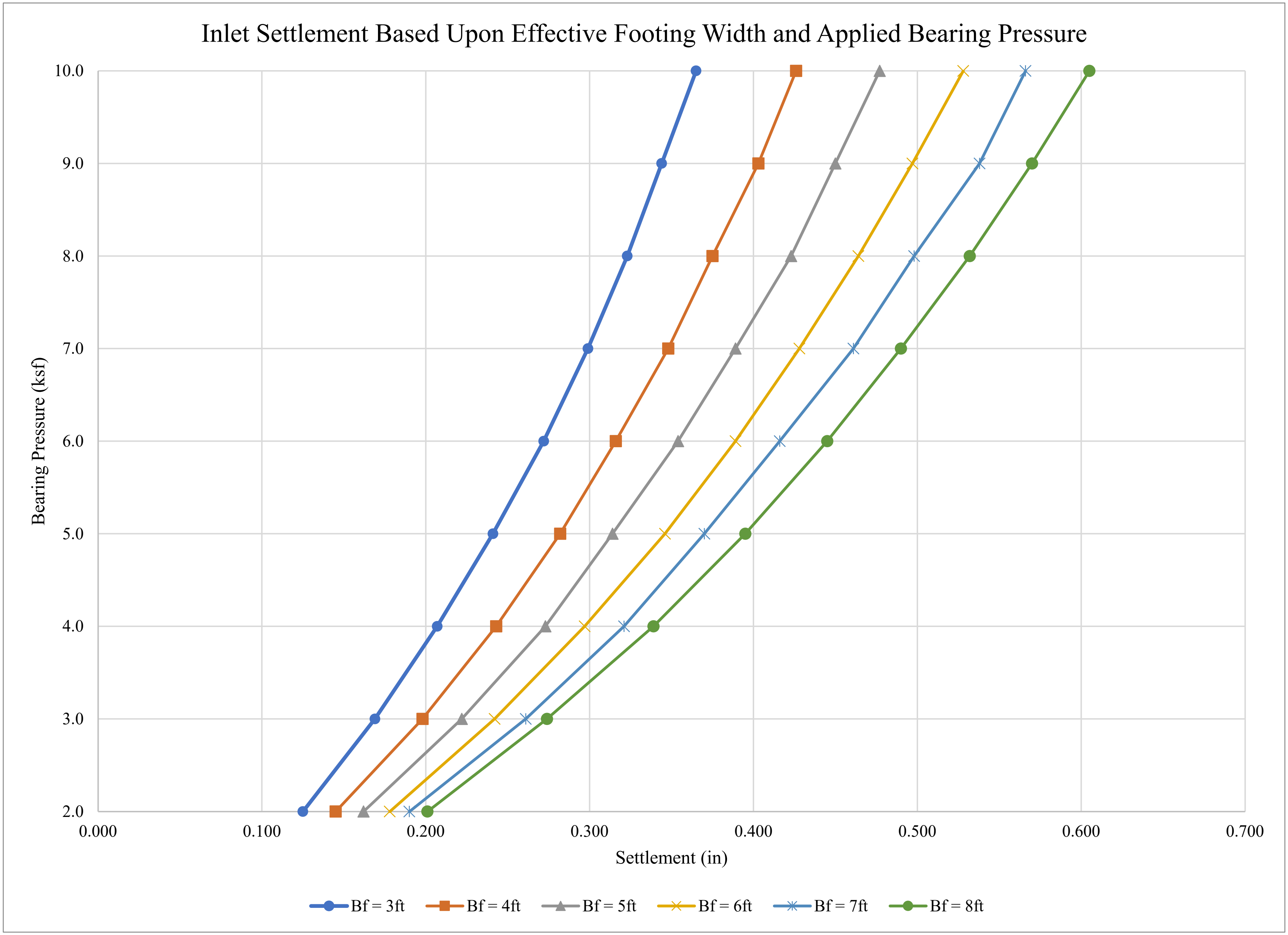
Notes:
1. Stratification lines represent approximate boundary between material types. Transition may be gradual.
2. N Values have not been corrected for hammer energy. C_E is the hammer energy correction factor.
3. Water level readings have been made at times and under conditions stated. Fluctuations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

Appendix B: Bearing Resistance and Settlement Graphs

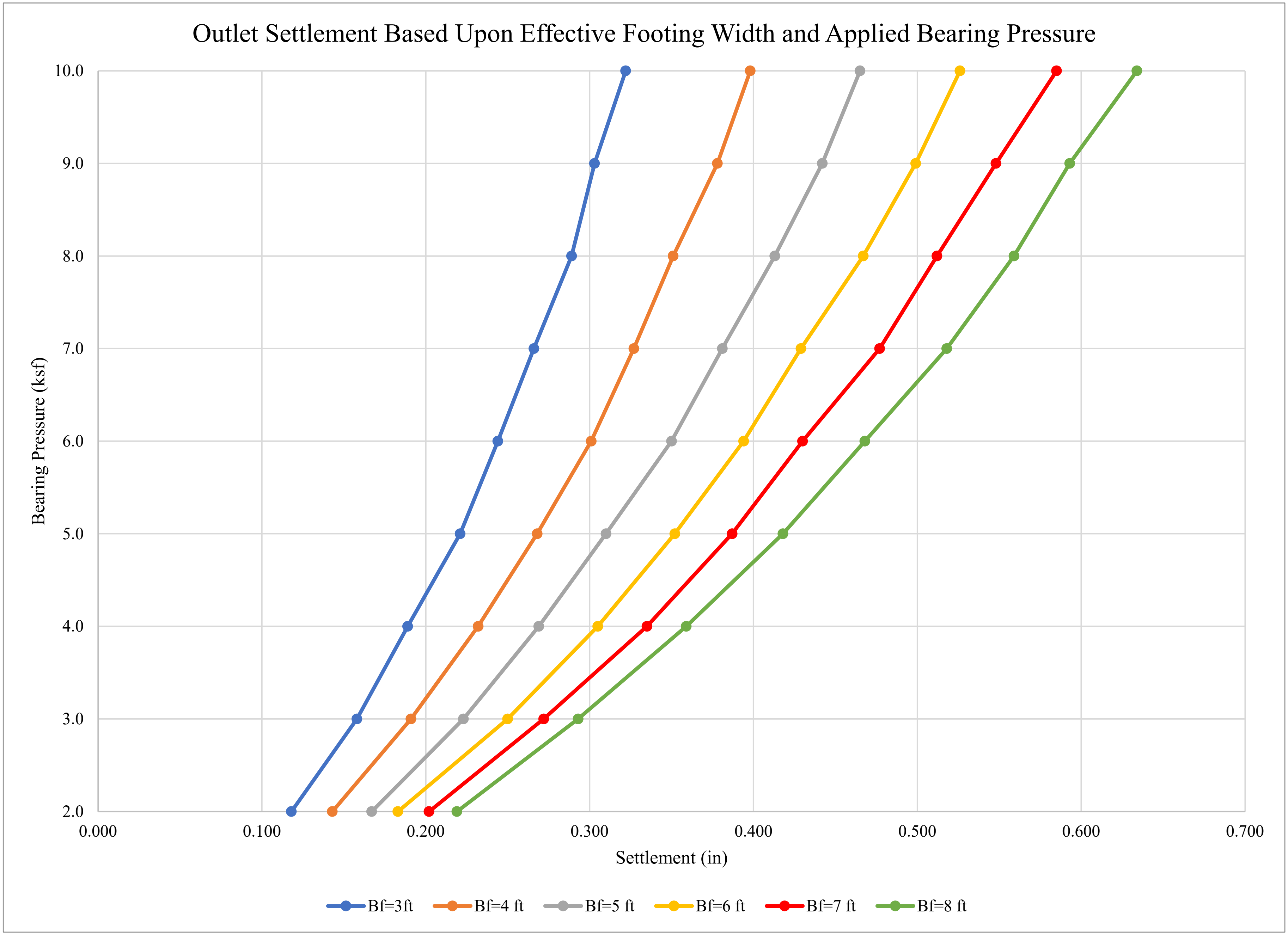


Wingwall Effective Footing Width vs Bearing Resistance (Factored) at Inlet
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Bearing Resistance (ksf)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
Footing Width (ft)
Strength Limit
Service Limit


Wingwall Effective Footing Width vs Bearing Resistance (Factored) at 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



Inlet Settlement Based Upon Effective Footing Width and Applied Bearing Pressure
Bearing Pressure (ksf)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
Settlement (in)
Bf = 3ft
Bf = 4ft
Bf = 5ft
Bf = 6ft
Bf = 7ft
Bf = 8ft


Outlet Settlement Based Upon Effective Footing Width and Applied Bearing Pressure
Bearing Pressure (ksf)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
Settlement (in)
Bf=3ft
Bf=4 ft
Bf=5 ft
Bf=6 ft
Bf=7 ft
Bf=8 ft