AGENCY OF TRANSPORTATION **OFFICE MEMORANDUM**

To: Bruce Martin, P.E., Roadway Design Project Manager

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

Date: June 18, 2019

Subject: Pittsford NH 019-3(491) – Geotechnical Recommendations

We have completed additional geotechnical analyses for the replacement of two culverts located on US Route 7. Bridges No. 106 and 107 are located approximately 1.3 miles and 0.6 miles south, respectively, of the junction with VT Route 3 in Pittsford, Vermont. As requested, we have developed soil parameters for the design of the wingwalls at the inlets and outlets of the culverts. These parameters should be included in the plans. Parameters for Granular Borrow and Granular Backfill for Structures shall meet the requirements of Subsections 703.04 and 704.08 of the *2018 Standard Specifications for the Construction*, respectively. Bottom of footing elevations were taken from the plans dated April 11, 2019 in order to determine the bearing strata identified below. The soil parameters for the bearing strata of the wingwalls, the factored bearing resistances for Strength and Service Limit States, as well as the bearing pressures resulting in 2.5 centimeters (cm) (1-inch) of settlement are located in Tables 1.1.1 through 2.2.3 below.

1.0 Bridge 106:

1.1 Inlet: B-301 (Wingwalls 1 and 2) The ground surface elevation at B-301 was approximately 179.1 meters (m). Groundwater was measured during drilling on May 29, 2019 at a depth of 1.06m below ground surface (bgs) corresponding to an approximate elevation of 178.04 m.

Table 1.1.1: B-301 Soil Profile

Depth (Below Ground Surface Elevation)	Soil Profile
0 – 2.4 m	Medium Dense Silty Gravelly Sand
2.4 – 4.9 m	Loose Silty Sand (Bearing Stratum)
4.9 – 7.6 m	Very Dense Sandy Gravel
7.6 – 10.1 m	Medium Dense Silt

Table 1.1.2: Engineering Properties of In-Situ Bearing Stratum

	Loose Silty Sand
Unit Weight, γ (kN/m^3):	17.28
Internal Friction Angle, ϕ (degrees):	31
Coefficient of Friction, f	
- mass concrete cast against soil:	0.31
- soil against precast/formed concrete:	0.25
Active Earth Pressure Coef., K_a:	0.320
Passive Earth Pressure Coef., K_p:	3.124
At-Rest Earth Pressure Coefficient, K_o:	0.485

Table 1.1.3 Factored Bearing Resistances at Various Effective Footing Widths at the Inlet

Maximum Wingwall Length (m)	Effective Footing Width (m)	Factored Bearing Resistance, Strength Limit State (kPa)	Factored Bearing Resistance, Service Limit State (kPa)	Bearing Pressure for 2.5-cm Settlement (kPa)
4.55	1.22	294.1	114.6	354.1
	1.83	366.0	155.5	287.1
	2.44	373.0	185.5	253.6
	3.05	405.1	204.6	234.4

1.2 Outlet: B-302 (Wingwalls 3 and 4) The ground surface elevation at B-302 was approximately 177.8 m. Groundwater was measured during drilling on May 30, 2019 at a depth of 0.94 m bgs corresponding to an approximate elevation of 176.86 m.

Table 1.2.1: B-302 Soil Profile

Depth (Below Ground Surface Elevation)	Soil Profile
0 – 1.8 m	Medium Dense Gravelly Sand
1.8 – 6.0 m	Medium Dense Silty Sand/Sandy Silt (Bearing Stratum)
6.0 – 7.6 m	Dense Sandy Gravel
7.6 – 10.1 m	Loose Silt

Table 1.2.2: Engineering Properties of In-Situ Bearing Stratum

	Medium Dense Silty Sand/Sandy Silt
Unit Weight, γ (kN/m^3):	17.28
Internal Friction Angle, ϕ (degrees):	33
Coefficient of Friction, f	
- mass concrete cast against soil:	0.31
- soil against precast/formed concrete:	0.25
Active Earth Pressure Coef., K_a:	0.295
Passive Earth Pressure Coef., K_p:	3.392
At-Rest Earth Pressure Coefficient, K_o:	0.455

Table 1.2.3 Factored Bearing Resistances at Various Effective Footing Widths at the Outlet

Maximum Wingwall Length (m)	Effective Footing Width (m)	Factored Bearing Resistance, Strength Limit State (kPa)	Factored Bearing Resistance, Service Limit State (kPa)	Bearing Pressure for 2.5-cm Settlement (kPa)
3.50	1.22	375.0	159.5	179.9
	1.83	430.1	219.8	148.3
	2.44	479.5	267.3	133.5
	3.05	523.0	301.8	123.4

2.0 Bridge 107:

2.1 Inlet: B-303 (Wingwalls 1 and 2) The ground surface elevation at B-303 was approximately 160.8 m. Groundwater was measured during drilling on June 10, 2019 at a depth of 0.5 m bgs corresponding to an approximate elevation of 160.3 m.

Table 2.1.1: B-303 Soil Profile

Depth (Below Ground Surface Elevation)	Soil Profile
0 – 0.2 m	Asphalt
0.2 – 0.5 m	Concrete
0.5 – 7.6 m	Medium Dense Sandy Gravel (Bearing Stratum)
7.6 – 11 m	Very Dense Silty Gravel/Gravelly Sandy Silt

Table 2.1.2: Engineering Properties of In-Situ Bearing Stratum

	M. Dense Sandy Gravel
Unit Weight, γ (kN/m^3):	18.07
Internal Friction Angle, ϕ (degrees):	34
Coefficient of Friction, f	
- mass concrete cast against soil:	0.57
- soil against precast/formed concrete:	0.44
Active Earth Pressure Coef., K_a:	0.283
Passive Earth Pressure Coef., K_p:	3.537
At-Rest Earth Pressure Coefficient, K_o:	0.441

Table 2.1.3 Factored Bearing Resistances at Various Effective Footing Widths at the Inlet

Maximum Wingwall Length (m)	Effective Footing Width (m)	Factored Bearing Resistance, Strength Limit State (kPa)	Factored Bearing Resistance, Service Limit State (kPa)	Bearing Pressure for 2.5-cm Settlement (kPa)
3.35	1.22	450.2	193.2	378.0
	1.83	518.3	265.1	306.2
	2.44	579.1	320.6	267.9
	3.05	632.4	359.6	244.0

2.2 Outlet: B-304 (Wingwalls 3 and 4) The ground surface elevation at B-304 was approximately 160.7 m. Groundwater was measured during drilling on June 7, 2019 at a depth of 0.1 m bgs corresponding to an approximate elevation of 160.6 m.

Table 2.2.1: B-304 Soil Profile

Depth (Below Ground Surface Elevation)	Soil Profile
0 – 0.3 m	Asphalt
0.3 – 2.7 m	Dense Sandy Gravel/Gravelly Sand
2.7 – 6.6 m	Medium Dense Silty sand/Gravelly Sandy Silt (Bearing Stratum)
7.1 – 10.1 m	Boulder

Table 2.2.2: Engineering Properties of In-Situ Bearing Stratum

	Medium Dense Silty Sand/Gravelly Sandy Silt (Bearing Stratum)
Unit Weight, γ (kN/m^3):	18.07
Internal Friction Angle, ϕ (degrees):	34
Coefficient of Friction, f	
- mass concrete cast against soil:	0.31
- soil against precast/formed concrete:	0.25
Active Earth Pressure Coef., K_a:	0.283
Passive Earth Pressure Coef., K_p:	3.537
At-Rest Earth Pressure Coefficient, K_o:	0.441

Table 2.2.3 Factored Bearing Resistances at Various Effective Footing Widths at the Outlet

Maximum Wingwall Length (m)	Effective Footing Width (m)	Factored Bearing Resistance, Strength Limit State (kPa)	Factored Bearing Resistance, Service Limit State (kPa)	Bearing Pressure for 2.5-cm Settlement (kPa)
3.66	1.22	445.5	195.9	382.8
	1.83	512.2	271.2	311.0
	2.44	572.1	331.5	272.7
	3.05	625.2	376.7	248.8

Based on the bearing resistances calculated in the Service Limit State, we recommend performing a feasibility analysis given the geometry of the wingwalls to determine if these resistances are sufficient for design. We can provide altered values assuming a one to two foot undercut with granular material if these determined values are found to be not feasible. If you have any questions, or you would like to discuss this report, please contact us at (802) 828-2561.

Enclosures: Boring Logs (4 Pages)

cc: Amos Kempton, P.E. Roadway Design Project Engineer
Electronic Read File/MG
Project File/CEE
END

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

BORING LOG

Pittsford
NH 019-3(491)
US-7 Culverts Br 106 Br 107

Boring No.: **B-301**
Page No.: 1 of 1
Pin No.: 85B008
Checked By: END

Boring Crew: Brochu, Emerson, Gonyaw
Date Started: 5/29/19 Date Finished: 5/29/19
VTSPG NAD83: N 132052.30 m E 460237.40 m
Station: 5+614 Offset: 17.00
Ground Elevation: 179.10 m

	Casing	Sampler
Type:	WB	SS
I.D.:	10.16 cm	3.81 cm
Hammer Wt:	N.A.	63.5 kg
Hammer Fall:	N.A.	0.762 m
Hammer/Rod Type:	Auto/AWJ	
Rig:	CME 45C SKID	C_E = 1.56

Groundwater Observations

Date	Depth (m)	Notes
05/29/19	1.06	W.T.during drilling

Depth (m)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Blows/15cm (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		A-1-b, GrSa, brn, Moist, Rec. = 0.30 m	6-5-8-6 (13)	7.1	37.3	44.9	17.8
1		Field Note:, No recovery	6-5-7-10 (12)				
		A-1-b, SiGrSa, brn, Moist, Rec. = 0.24 m	11-12-10-9 (22)	11.7	31.8	45.6	22.6
2		A-2-4, GrSiSa, brn, Moist, Rec. = 0.30 m, Cleanout NXDC 2.03-2.43m	9-12-7-8 (19)	15.7	20.1	58.3	21.6
		A-1-b, GrSa, brn, Moist, Rec. = 0.10 m, Cleanout NXDC 2.89-3.04m	4-3-2-3 (5)	154.6	41.4	48.2	10.4
3		A-2-4, SiSa, brn, MTW, Rec. = 0.14 m, Cleanout rollercone 3.53-3.65m	2-2-2-3 (4)	47.8	10.3	59.4	30.3
4		A-2-4, SiSa, gry, Moist, Rec. = 0.18 m, Cleanout rollercone 4.16-4.26m	2-4-5-7 (9)	20.9	3.9	73.2	22.9
		A-2-4, SiSa, brn, MTW, Rec. = 0.27 m	2-1-3-12 (4)	23.0	0.1	65.9	34.0
5		A-1-b, SaGr, brn, MTW, Rec. = 0.05 m, Cleanout rollercone 6.15-6.40m	18-34-19-8 (53)	13.9	56.6	30.0	13.4
6							
		Field Note:, No recovery, Cleanout rollercone 7.8-7.92m	17-14-15-12 (29)				
7							
8		A-4, Si, brn, MTW, Rec. = 0.27 m, Cleanout rollercone 9.34-9.44	4-5-4-5 (9)	30.0	2.4	8.5	89.1
9							
		A-4, Si, brn, MTW, Rec. = 0.23 m	5-4-5-5 (9)	33.6	1.3	1.0	97.7
10		Hole stopped @ 10.05 m					
11		Remarks: Hole collapsed at 1.82 meters.					

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.

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BORING LOG

Pittsford
NH 019-3(491)
US-7 Culverts Br 106 Br 107

Boring No.: **B-302**
Page No.: 1 of 1
Pin No.: 85B008
Checked By: END

Boring Crew: Brochu, Gonyaw, Gonyaw
Date Started: 5/30/19 Date Finished: 5/30/19
VTSPG NAD83: N 132034.20 m E 460217.00 m
Station: 5+613 Offset: -10.20
Ground Elevation: 177.80 m

	Casing	Sampler
Type:	WB	SS
I.D.:	10.16 cm	3.81 cm
Hammer Wt:	N.A.	63.5 kg
Hammer Fall:	N.A.	0.762 m
Hammer/Rod Type:	Auto/AWJ	
Rig:	CME 55 TRACK	C_E = 1.52

Groundwater Observations

Date	Depth (m)	Notes
05/30/19	0.94	W.T.during drilling

Depth (m)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Blows/15cm (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		A-1-b, GrSa, brn, Moist, Rec. = 0.16 m	2-3-4-4 (7)	14.8	22.3	65.8	11.9
1		A-1-b, SaGr, brn, Moist, Rec. = 0.06 m	5-3-4-3 (7)	8.3	51.7	38.7	9.6
		Field Note:, No recovery, Cleanout rollercone 1.52-1.8m	3-3-3-4 (6)				
2		A-2-4, SiSa, brn, Moist, Rec. = 0.28 m, Cleanout rollercone 2.17-2.43m	4-3-2-3 (5)	37.6	17.4	57.0	25.6
		A-4, SaSi, brn, MTW, Rec. = 0.13 m, Cleanout rollercone 2.89-3.04m	4-2-1-3 (3)	36.5	0.7	43.5	55.8
3		Field Note:, No recovery. Rock in end of sampler.	7-7-7-5 (14)				
4		A-4, SiSa, brn, MTW, Rec. = 0.19 m, Cleanout rollercone 4.17-4.26m	4-2-4-2 (6)	25.7	3.5	59.4	37.1
		A-4, SaSi, brn, MTW, Rec. = 0.18 m	WoH-1-2-2 (3)	27.9	2.0	24.6	73.4
5		A-4, GrSaSi, brn, MTW, Rec. = 0.17 m, Cleanout rollercone 5.7-6.3m	7-6-5-11 (11)	17.2	23.0	38.1	38.9
6							
7		A-1-b, SaGr, brn, MTW, Rec. = 0.14 m, Cleanout rollercone 7.3-7.8m	17-12-8-18 (20)	12.7	46.5	43.1	10.4
8		A-2-4, SiSa, brn, MTW, Rec. = 0.25 m, Cleanout NXDC 9.31-9.5m	6-2-3-3 (5)	31.9	0.6	65.3	34.1
9							
10		A-4, Si, brn, MTW, Rec. = 0.20 m	3-4-3-3 (7)	12.8	2.5	2.9	94.6
		Hole stopped @ 10.10 m					
11		Remarks: Hole collapsed at 4.92 meters.					

Notes:
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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 PITTSFORD NH019-3(491).GPJ VERMONT AOT.GDT 6/13/19

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BORING LOG

Pittsford
NH 019-3(491)
US-7 Culverts Br 106 Br 107

Boring No.: **B-303**
Page No.: 1 of 1
Pin No.: 85B008
Checked By: END

Boring Crew: Brochu, Gonyaw, Gonyaw
Date Started: 6/10/19 Date Finished: 6/10/19
VTSPG NAD83: N 132858.30 m E 459483.80 m
Station: 6+721 Offset: 3.70
Ground Elevation: 160.80 m

	Casing	Sampler
Type:	WB	SS
I.D.:	10.16 cm	3.81 cm
Hammer Wt:	N.A.	63.5 kg
Hammer Fall:	N.A.	0.762 m
Hammer/Rod Type:	Auto/AWJ	
Rig:	CME 45C SKID	C_F = 1.56

Groundwater Observations

Date	Depth (m)	Notes
06/10/19	0.50	W.T.during drilling

Depth (m)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Blows/15cm (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		Field Note:, Asphalt 0.0-0.2m					
		Field Note:, Concrete 0.2-0.5m					
1		A-1-b, SaGr, brn, Moist, Rec. = 0.10 m	3-5-3-4 (8)	11.5	53.5	38.8	7.7
		A-1-b, GrSa, brn, Moist, Rec. = 0.18 m	3-4-4-5 (8)	15.0	29.4	62.7	7.9
2		Field Note:, No recovery	5-4-3-2 (7)				
		Field Note:, No recovery. Rock in end of sampler	4-3-4-5 (7)				
3		A-1-b, SaGr Lab Note: Significant amount of wood in sample, brn, Moist, Rec. = 0.48 m, Cleanout rollercone 3.4-3.5m	10-18-18-48 (36)	28.9	55.5	37.2	7.3
		A-1-b, SaGr, brn, MTW, Rec. = 0.10 m, Cleanout rollercone 3.9-4.1m	2-2-3-11 (5)	30.8	48.1	39.0	12.9
4		Visual Description:, Gravelly Silty Sand Lab Note: Significant amount of wood in sample, gry, MTW, Rec. = 0.21 m, Cleanout rollercone 4.5-4.7m	7-6-6-6 (12)	31.3			
5		Field Note:, Wood, Rec. = 0.90 m, Cleanout rollercone 6.2-6.5m Bentonite added while drilling	4-4-4-4 (8)				
6							
7		A-1-b, Gr, brn, Moist, Rec. = 0.06 m, Cleanout rollercone 7.5-8.0m	6-8-5-6 (13)	4.9	63.9	16.2	19.9
8		A-1-b, SiGr, brn, Moist, Rec. = 0.26 m, Rollercone open hole to 9.5m	10-12-35-R@8.55m (47)	9.1	61.1	18.7	20.2
9							
10		A-4, GrSaSi, brn, Moist, Rec. = 0.45 m	8-24-16-22 (40)	21.5	24.9	35.0	40.1
11		Hole stopped @ 11.00 m					
12		Remarks: Hole collapsed at 2.0 meters.					

Notes:
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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 PITTSFORD NH019-3(491).GPJ VERMONT AOT.GDT 6/18/19

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BORING LOG

Pittsford
NH 019-3(491)
US-7 Culverts Br 106 Br 107

Boring No.: **B-304**
Page No.: 1 of 1
Pin No.: 85B008
Checked By: END

Boring Crew: Brochu, Gonyaw, Gonyaw
Date Started: 6/07/19 Date Finished: 6/07/19
VTSPG NAD83: N 132857.00 m E 459476.10 m
Station: 6+725 Offset: -3.00
Ground Elevation: 160.70 m

	Casing	Sampler
Type:	WB	SS
I.D.:	10.16 cm	3.81 cm
Hammer Wt:	N.A.	63.5 kg
Hammer Fall:	N.A.	0.762 m
Hammer/Rod Type:	Auto/AWJ	
Rig:	CME 45C SKID	C_F = 1.56

Groundwater Observations

Date	Depth (m)	Notes
06/07/19	0.10	W.T.during drilling

Depth (m)	Strata (1)	CLASSIFICATION OF MATERIALS (Description)	Blows/15cm (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
		Field Note:, Asphalt 0.0-0.3m					
		A-1-b, GrSa, brn, Moist, Rec. = 0.26 m	12-12-10-10 (22)	8.0	41.7	44.1	14.2
1		A-1-b, SaGr, brn, Moist, Rec. = 0.17 m	5-7-8-7 (15)	11.3	47.2	40.1	12.7
		A-1-b, GrSa, brn, Moist, Rec. = 0.36 m, Cleanout rollercone 1.72-2.13m	6-4-6-6 (10)	11.4	43.7	44.6	11.7
2		A-1-b, SaGr, brn, Moist, Rec. = 0.14 m, Cleanout rollercone 2.4-2.7m	9-7-6-5 (13)	11.2	52.9	35.6	11.5
		A-2-4, SiSa, gry, Moist	6-4-6-5 (10)	25.4	0.8	69.5	29.7
3		Field Note:, No recovery, Cleanout rollercone 3.7-3.9m	5-6-4-7 (10)				
		Field Note:, No recovery. Rock in end of sampler., Cleanout rollercone 4.3-4.5m	10-9-8-7 (17)				
4		A-4, GrSaSi, gry, MTW, Rec. = 0.10 m, Cleanout rollercone 6.2-6.6m	3-2-2-3 (4)	13.6	25.7	31.7	42.6
5							
6							
		Field Note:, No recovery	R (R)				
7		Field Note:, Boulder, NXMDC 7.1-10.1m Broke through boulder at 10.1m					
8							
9							
10		Hole stopped @ 10.10 m					
11		Remarks: Hole collapsed at 1.3 meters.					

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 PITTSFORD NH019-3(491).GPJ VERMONT AOT.GDT 6/18/19