AGENCY OF TRANSPORTATION **OFFICE MEMORANDUM**

To: Wendy Pelletier, P.E., Structures Project Manager

END CEE

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

Date: March 14, 2016

Subject: Johnson BF 0248(7) – Geotechnical Recommendations

1.0 INTRODUCTION

We have completed our geotechnical and geological investigation for the subject project located on VT Route 100C in Johnson, Vermont. The proposed project includes the replacement of the culvert with a three-sided frame located approximately 3.8 miles east of the intersection with VT Route 15. Contained herein are the results of our geotechnical analysis and design recommendations as determined using the 2014 AASHTO LRFD Bridge Design Specifications.

2.0 FIELD INVESTIGATION

The field investigation was conducted between December 18, 2015 and February 29, 2016. Two standard penetration borings were drilled to determine the subsurface profiles in order to aid in design and construction of the frame. Nine hand steel probes were also performed to better determine the bedrock profile at the inlet and outlet of the proposed rigid frame. Boring and probe locations were provided by Jeremy Salvatori in the geotechnical services request form dated December 11, 2015. Locations for both the borings and hand steel probes can be found in Tables 2.1 and 2.2, respectively, as well as in the attached boring location plan. The values for the Northings and Eastings are based on the Vermont State Plane Grid Coordinate System NAD 83, and were located by a handheld GPS. Elevations for the borings were then taken off a VTrans survey file. The locations and elevations of the borings should be considered accurate only to the degree implied by the method used to determine them.

Table 2.1 Boring Locations

Boring Number	Station	Offset (ft)	Northing (ft)	Easting (ft)	Elevation (ft)
B-103	185+48.6	10.9	788426.63	1609199.91	858.1
B-105	186+50.0	-10.8	788458.36	1609298.72	860.6

Table 2.2 Hand Steel Locations

Boring Number	Station	Offset (ft)	Northing (ft)	Easting (ft)	Elevation (ft)
B-101	184+81.3	39.2	788385.49	1609142.09	839.8
B-102	185+21.0	59.1	788374.47	1609182.79	828.6

Boring Number	Station	Offset (ft)	Northing (ft)	Easting (ft)	Elevation (ft)
B-102A	185+26.0	59.1	788375.38	1609187.36	833.1
B-104	186+30.4	-38.9	788485.43	1609277.00	847.5
B-104A	186+41.7	-39.4	788486.61	1609288.74	841.6
B-104B	186+37.7	-44.6	788491.61	1609284.29	847.0
B-106	186+70.5	-38.8	788486.79	1609319.00	844.5
B-106A	186+72.6	-43.3	788491.29	1609321.17	844.1
B-106B	186+67.8	-42.9	788490.92	1609316.18	843.9

The borings were performed in general accordance with AASHTO T206, *Standard Method of Test for Penetration Test and Split-Barrel Sampling of Soils.* For boring B-105, split spoon samples and standard penetration tests (SPT) were taken continuously to bedrock. For boring B-103, samples were taken at 5 foot intervals to bedrock. When refusal was encountered, two 5 foot core runs were taken in each boring to confirm the presence of bedrock. 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 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 nine hand steel probes were completed according to AAHSTO's 1988 Manual on Subsurface Investigation, Section 7.5.3.1, which states that exploratory probing can be defined when "small diameter, flush coupled, steel rods are pushed by hand to refusal in the underlying organic soil." The ¾ inch steel rods at this site were driven using a 10-pound sledge hammer. Exploratory probing is commonly used to determine depths to boulders or ledge in areas with easily penetrable soil.

3.0 FIELD AND LABORATORY TESTING

The standard penetration resistance of the in-situ soil is determined by the number of blows required to drive a 2 inch 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. During the standard penetration test (SPT), the sampler is driven for a total length of 2 feet, while counting the blows for each 6 inch increment. The SPT N-value, which is defined as the sum of the number of blows required to drive the sampler through the second and third increments, is commonly used with established correlations to estimate a number of 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 VT Agency of Transportation has determined a hammer correction value, C_E, to account for the efficiency of the SPT hammer on the drill rig. For this project a CME 45C Track Rig was used, with a hammer energy correction factor of 1.34. This value, included on the boring logs, was used in calculations to determine soil parameters. Laboratory tests were conducted on all samples to evaluate grain size, moisture content, and percent finer than No. 200 sieve. Results from this testing can be found on the attached boring logs.

A detailed description of the rock cores is presented on the boring logs including run length, drill times, recovery, and Rock Quality Designation (RQD). Recovery is defined as the length of core obtained expressed as a percentage of the total length cored. In accordance with ASTM D6032, RQD is the total length of core pieces, 4 inches or greater in length, expressed as a percentage of the total length cored. RQD provides an indication of the integrity of the rock mass and relative extent of seams, jointing, and bending planes. The Rock Mass Rating (RMR) is also included on the logs. RMR is AASHTO's (LRFD Bridge Design Specification) recommended method of classifying rock, and is based on five different parameters that all have relative ratings which combine to form the RMR. These parameters include rock strength, RQD, joint spacing, joint condition, and groundwater (AASHTO Section 10.4.6.4).

4.0 SOIL AND ROCK PROFILE

Review of laboratory data and boring logs revealed the following information pertaining to the soil strata. 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 in the logs

4.1 Depths to Bedrock: The depths to bedrock encountered in both the borings and hand steel probes are summarized below.

Boring	Depth to Bedrock (ft)	Approx. Top of Bedrock Elevation (ft)	Boring Type*
B-101	12.6	827.2	HS
B-102	1.4	827.2	HS
B-102A	3.0	830.1	HS
B-103	20.3	837.8	Boring
B-104	3.5	844.0	HS
B-104A	4.7	836.9	HS
B-104B	4.4	842.6	HS
B-105	23.3	837.3	Boring
B-106	4.2	845.3	HS
B-106A	5.2	838.9	HS
B-106B	6.7	837.2	HS

*HS – Hand Steel Probe

4.2 B-103/B-105 Soil Profile: This profile represents the material in the embankment. The ground surface elevation for borings B-103 and B-105 were 858.1 feet and 860.6 feet, respectively. Groundwater measurements were taken during drilling for B-103 and B-105 at 5.8 feet and 10.1 feet, respectively.

Depth (Below Ground Surface Elevation)	**Soil Profile**
0 – 0.5 feet	Asphalt
0.5 – 21.8 feet	Medium Dense Gravelly Sand
> 21.8 feet	Hard Phyllite

A summary of the rock core findings is listed in Table 4.1 and results are also available in the attached boring logs. Information from the cores indicated hard phyllite to be present at the boring locations. The bedrock had an average rock mass rating (RMR) of 52, indicating fair rock.

Table 4.1: Rock Core Sample Results

Boring	**Run Number**	**Core Size**	**Depth (ft Below GSE)**	**Recovery (%)**	**RQD (%)**	**Dip (deg)**	**Lithologic Description**	**RMR**
B-103	1	NX	20.3 – 25.3	93	53	75 – 80	Dark gray to black, graphitic pyrite bearing PHYLLITE with quartz laminae. Smooth joint surfaces with rust and orange staining. Hard, very slightly weathered.	49
	2	NX	25.3 – 30.3	88	100	75 - 80	Dark gray to black graphitic pyrite bearing PHYLLITE with quartz laminae. Rare calcite along quartze laminae. Smooth, clean joints. Hard, unweathered.	65
B-105	1	NX	23.3 – 28.3	100	28	70 - 80	Dark gray to black, vuggy, graphitic pyrite bearing PHYLLITE with quartz laminae. Rust staining along joint surfaces. Hard, slightly weathered.	44
	2	NX	28.3 – 33.7	100	50	70 – 80	Dark gray to black, graphitic pyrite bearing PHYLLITE with quartz laminae. Solution cavity forming in Calcite nodule at 29.7 – 29.8ft. Scarce $CaCO_3$ powder along joint surfaces and minor rust staining. Hard, slightly weathered.	49

5.0 ANALYSIS

Due to shallow bedrock, it is anticipated that the frame will be supported by spread footings on bedrock. As per section 10.5.5.1 of the 2014 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.

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:

$$\text{Foundations on rock: } |e| < 0.45b$$

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.

The bedrock at the location of the frame has fair rock quality designation. Classified as hard, slightly weathered to unweathered, graphitic pyrite bearing phyllite with quartz laminae, AASHTO recommends a presumptive bearing resistance of 70 ksf per Table C10.6.2.6.1-1 for this type of rock. Taken as the nominal bearing resistance, in combination with a resistance factor of 0.45 for spread footings on rock, per AASHTO 10.5.5.2.2-1, this yields a factored bearing resistance of 31.5 ksf. These values are summarized below in Table 5.1.

Table 5.1 Recommended Bearing Resistance Values

Nominal Bearing Resistance (ksf)	Resistance Factor, φ	Factored Bearing Resistance (ksf)
70	0.45	31.5

Due to the footings bearing directly on competent bedrock, settlement and scour are anticipated to be negligible. Similarly, a global stability analysis is typically performed for wingwalls, however due to the footings bearing directly on bedrock, global stability will not be an issue.

6.0 RECOMMENDATIONS

6.1 Spread Footings: A maximum factored bearing resistance of 31.5 ksf is recommended for design purposes for the spread footings on rock. It is recommended that any incompetent, weathered and fractured bedrock encountered during construction of the spread footing be removed until competent bedrock is encountered. During excavation, the Agency Geologist should inspect the ledge to determine the amount and extent of excavation needed. If uneven bedrock contours are encountered, the concrete subfooting should be stepped along the existing bedrock in order to transfer the footing pressure directly to the bedrock.

6.1.1 Resistance Factors: 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 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 Resistance Factors for Design States

Design State	Resistance Factor, φ
Service (Scour)	1.0
Strength (Bearing Resistance)	0.45
Sliding	0.80

Additional sliding resistance can be accomplished by doweling the footing into bedrock.

6.2 Construction Considerations

6.2.1 Cofferdams/Temporary Earthwork Support: The Contractor should be reminded that Section 208.07 of VTrans' *2011 Standard Specifications for Construction* indicates that "The Contractor shall prepare detailed plans and a schedule of its operation for each cofferdam specified in the Contract. The design and structural details of the cofferdam shall be signed, stamped, and dated by a Professional Engineer (Structural or Civil)."

6.2.2 Construction Dewatering: The bottom of footing elevation for the frame is estimated to be either at or below the expected water table. Therefore, temporary construction dewatering may be required to construct the foundation. 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, or discharge, should comply with all applicable permits and regulations.

6.2.3 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 (such as a small vibratory plate compactor) is used, the loose lift thickness shall not exceed 6 inches. Cobbles larger than 4 inches should be removed from the fill prior to placement.

General embankment fills should be compacted to a dry density of at least 95% of the maximum dry density determined in accordance with AASHTO T-99. The current specification calls for 90%, however we are in the process of revising it to be 95% as recommended above. Granular Backfill for Structures, or other select materials placed within the roadway base section shall be compacted to a dry density of 95% of the maximum dry density determined in accordance with AASHTO T-99.

6.3 Design Parameters: Table 6.2 highlights the geotechnical design parameters of regularly specified aggregates as well as the in-situ bedrock. These values should be used when designing the 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 and backfill) and a vertical wall face.

Table 6.2. Engineering Properties of Construction Materials

	703.01A - Granular Borrow	**704.08 - Granular Backfill for Structures**	**In-Situ Bedrock**
Density (lb/ft^3):	130	140	165
Internal Friction Angle, φ (degrees)	32	35	27
Coefficient of Friction, f			
- concrete cast against soil/rock:	0.50	0.55	0.70
- sand against formed concrete	0.40	0.45	-
Active Earth Pressure Coefficient, K_a:	0.31	0.27	-
Passive Earth Pressure Coefficient, K_p:	3.22	3.69	-
At-Rest Earth Pressure Coefficient, K_o:	0.47	0.43	-

7.0 CONCLUSION

If any further analysis is needed or you would like to discuss this report, please contact us at (802) 828-2561. Computer generated boring logs are attached and available in the *M:\Projects\12C590\MaterialsResearch* folder.

Attachments: Boring Location Plan (1 pages)
Boring Logs (2 pages)

cc: Electronic Read File/DJH
Project File/CEE

END

Z:\Highways\ConstructionMaterials\GeotechEngineering\Projects\Johnson BF 0248(7)\REPORTS\Johnson BF 0248(7) - Geotechnical Recommendations

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)

N	DESCRIPTIVE TERM
<5	Very Loose
5-10	Loose
11-24	Med. Dense
25-50	Dense
>50	Very Dense

CONSISTENCY (COHESIVE SOILS)

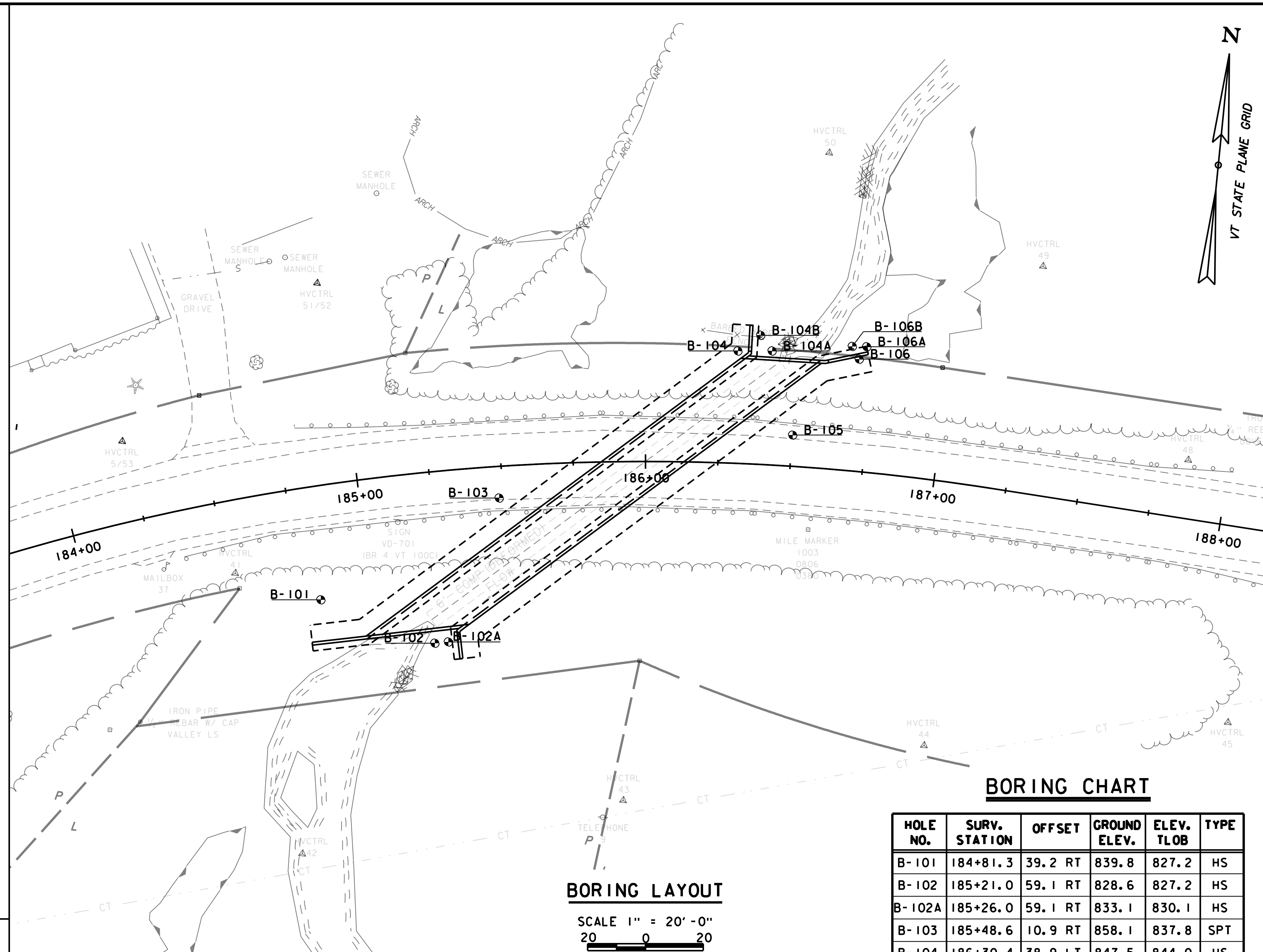
N	DESCRIPTIVE TERM
<2	Very Soft
2-4	Soft
5-8	Med. Stiff
9-15	Stiff
16-30	Very Stiff
31-60	Hard
>60	Very Hard

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
ROD	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 LAYOUT

SCALE 1" = 20'-0"

BORING CHART

HOLE NO.	SURV. STATION	OFFSET	GROUND ELEV.	ELEV. TLOB	TYPE
B-101	184+81.3	39.2 RT	839.8	827.2	HS
B-102	185+21.0	59.1 RT	828.6	827.2	HS
B-102A	185+26.0	59.1 RT	833.1	830.1	HS
B-103	185+48.6	10.9 RT	858.1	837.8	SPT
B-104	186+30.4	38.9 LT	847.5	844.0	HS
B-104A	186+41.7	39.4 LT	841.6	836.9	HS
B-104B	186+37.7	44.6 LT	847.0	842.6	HS
B-105	186+50.0	10.8 LT	860.6	837.3	SPT
B-106	186+70.5	38.8 LT	844.5	845.3	HS
B-106A	186+72.6	43.3 LT	844.1	838.9	HS
B-106B	186+67.8	42.9 LT	843.9	837.2	HS

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 xx-xx-xx and xx-xx-xx 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: JOHNSON
PROJECT NUMBER: BF 0248(7)

FILE NAME: s12c590bdr_bor.dgn
PROJECT LEADER: K. HIGGINS
DESIGNED BY: J. SALVATORI
BORING INFORMATION SHEET
PLOT DATE: $$$$DATE$$$
DRAWN BY: J. SALVATORI
CHECKED BY: ------
SHEET $S*$ OF $T*$

VTrans Working to Get You There, Vermont Agency of Transportation	STATE OF VERMONT AGENCY OF TRANSPORTATION CONSTRUCTION AND MATERIALS BUREAU CENTRAL LABORATORY	BORING LOG **Johnson** **BF 0248(7)** **Bridge #4 VT 100C**	Boring No.: **B-103** Page No.: 1 of 1 Pin No.: 12c590 Checked By: END

Boring Crew: Hook, Judkins, Nieto
Date Started: 2/22/16 Date Finished: 2/29/16
VTSPG NAD83: N 788426.63 ft E 1609199.91 ft
Station: 185+45.6 Offset: 12.00
Ground Elevation: 858.1 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 TRACK	C_E = 1.34

Groundwater Observations

Date	Depth (ft)	Notes
02/23/16	5.8	W.T. after drilling
02/29/16	17.1	W.T. 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 %
		Asphalt Pavement, 0.0 ft - 0.5 ft, Depth Unknown								
		A-1-a, SaGr, brn-blk, Moist, Rec. = 0.8 ft				44-R@3.5" (R)	10.8	56.9	38.0	5.1
		NXDC, Cleaned out casing, 4.1 ft - 5.0 ft								
5		A-2-4, Sa, brn, Moist, Rec. = 0.6 ft				5-3-3-3 (6)	15.8	16.2	72.0	11.8
		NXDC, Cleaned out casing, 9.0 ft - 10.0 ft								
10		A-1-b, GrSa, Lt/brn, Moist, Rec. = 0.6 ft				4-3-3-3 (6)	14.7	41.8	47.2	11.0
		NXDC, Cleaned out casing, 14.0 ft - 15.0 ft								
15		A-2-4, GrSiSa, Lt/brn-Lt/gry, Moist, Rec. = 1.2 ft				9-12-14-20 (26)	14.5	28.2	42.6	29.2
		NXDC, Cleaned out casing, 18.8 ft - 20.0 ft								
20		A-2-4, SiSa, gry, Moist, Rec. = 0.3 ft				R@3.5" (R)	14.1	19.8	49.5	30.7
		20.3 ft - 25.3 ft, Dark gray to black, Graphitic pyrite bearing PHYLLITE, with quartz laminae. Smooth joint surfaces with rust and orange staining.. Hard, Very slightly weathered, Fair rock, NX, RMR=49	1 (75-80)	93 (53)	7 6 6 9 9					
25		25.3 ft - 30.3 ft, Dark gray to black, Graphitic pyrite bearing PHYLLITE, with quartz laminae. Rare calcite along quartz laminae. Smooth clean joints.. Hard, Unweathered, Good rock, NX, RMR=65	2 (75-80)	88 (100)	11 10 9 9 10					
30		Hole stopped @ 30.3 ft								

Remarks:
Hole collapsed at 3.0 feet.
Top of Bedrock 20.3 feet.

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.

VTrans Working to Get You There — Vermont Agency of Transportation	STATE OF VERMONT AGENCY OF TRANSPORTATION CONSTRUCTION AND MATERIALS BUREAU CENTRAL LABORATORY	Boring No.: **B-105** Page No.: 1 of 1 Pin No.: 12c590 Checked By: END

BORING LOG

Johnson
BF 0248(7)
Bridge #4 VT 100C

Boring Crew:	Garrow, Judkins, Hook
Date Started:	2/01/16
Date Finished:	2/02/16
VTSPG NAD83:	N 788458.36 ft E 1609298.72 ft
Station:	186+50
Offset:	-12.00
Ground Elevation:	860.6 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 = Unknown

Groundwater Observations

Date	Depth (ft)	Notes
02/01/16	10.1	W.T. after drilling
02/02/16	19.5	W.T.

Depth (ft)	CLASSIFICATION OF MATERIALS (Description)	Run (Dip deg.)	Core Rec. % (RQD %)	Drill Rate minutes/ft	Blows/6" (N Value)	Moisture Content %	Gravel %	Sand %	Fines %
	Asphalt Pavement, 0.0 ft - 0.55 ft								
	A-1-b, GrSa, brn, Moist, Rec. = 0.9 ft				48-R@5" (R)	8.9	41.2	42.1	16.7
	NXDC, Cleaned out casing, 2.5 ft - 3.0 ft								
	A-1-b, GrSa, brn, Moist, Rec. = 1.2 ft				17-13-12-11 (25)	12.6	40.1	45.3	14.6
5	A-1-b, GrSa, brn, Moist, Rec. = 1.1 ft				9-7-9-17 (16)	9.7	40.7	45.9	13.4
	NXDC, Cleaned out casing, 6.5 ft - 7.0 ft								
	A-1-b, GrSa, brn, Moist, Rec. = 1.1 ft				12-11-9-10 (20)	13.5	39.3	46.4	14.3
	NXDC, Cleaned out casing, 8.6 ft - 9.0 ft								
10	A-2-4, GrSa, brn-Lt/brn, Moist, Rec. = 1.1 ft				10-7-4-6 (11)	18.3	22.7	59.9	17.4
	NXDC, Cleaned out casing, 10.5 ft - 11.0 ft								
	A-1-b, GrSa, gry-brn, Moist, Rec. = 0.8 ft				3-4-10-8 (14)	16.2	38.9	45.8	15.3
	NXDC, Cleaned out casing, 12.5 ft - 13.0 ft								
	A-1-a, SaGr, brn-gry, Moist, Rec. = 0.6 ft				2-4-5-27 (9)	11.4	53.3	36.6	10.1
15	NXDC, Cleaned out casing, 14.4 ft - 15.0 ft								
	A-1-b, GrSa, brn, Moist, Rec. = 1.0 ft				15-10-4-5 (14)	16.1	34.8	49.6	15.6
	A-1-a, SaGr, Dk/brn, Moist, Rec. = 0.4 ft				3-2-4-6 (6)	15.8	50.5	36.3	13.2
20	A-1-a, SaGr, Dk/gry, Moist, Rec. = 0.3 ft				6-7-2-2 (9)	17.5	64.3	26.5	9.2
	A-1-b, SaGr, gry, Moist, Rec. = 1.2 ft				5-30-30-R@1" (60)	15.4	43.7	39.5	16.8
	Cleaned out casing, 22.5 ft - 23.0 ft								
	A-1-b, SaGr, gry, Moist, Rec. = 0.2 ft				R@3.5" (R)	12.0	53.6	29.2	17.2
25	23.3 ft - 28.3 ft, Dark gray to black, Vuggy, graphitic pyrite bearing PHYLLITE, with quartz laminae. Rust staining along joint surfaces.. Hard, Slightly weathered, Fair rock, NX, RMR=44	1 (70-80)	100 (28)	3 4 4 6 5					
30	28.3 ft - 33.3 ft, Dark gray to black, Graphitic pyrite bearing PHYLLITE, with quartz laminae. Solution cavity forming in calcitenodule at 29.7-29.8 feet. Scarce CaCO3 powder along joint surfaces and minor rust staining.. Hard, Slightly weathered, Fair rock, NX, RMR=49	2 (70-80)	100 (50)	11 4 5 4 4					
35	Hole stopped @ 33.3 ft								

Remarks:
Hole Collapsed at 12.4 feet.
Top of Bedrock 23.3 feet.

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.