GEODESIGN INCORPORATED

GEOTECHNICAL | CONSTRUCTION | ENVIRONMENTAL
ENGINEERS and SCIENTISTS

MEMORANDUM

To: Callie Ewald, P.E. – VTrans

From: Daniel T. Howey, P.E.; Jason A. Gaudette, P.G. – Geo**Design**, Inc.

Date: October 21, 2016

Re: Geotechnical Design Recommendations Memo
Fairlee STP SCRP (15) - Geotechnical Recommendations Report

File No.: 750-09.21

INTRODUCTION

Geo**Design** is pleased to submit this memo providing culvert replacement foundation recommendations for Bridge #11 – VT Route 244 in the town of Fairlee, VT. The project entails replacing an existing culvert below Route 244 approximately 0.3 miles west of the intersection with Route 5 and just west of the I-91 overpass.

This memo includes recommendations for foundation design and construction in accordance with *AASHTO LRFD Bridge Design Specifications* as outlined in our proposal dated September 21st, 2016. Recommendations are based on subsurface information and boring logs included in a VTrans memo entitled Fairlee STP SCRP (15) – Geotechnical Report and dated August 26th, 2016. This memo incorporates VTrans' comments from our October 17, 2016 draft submission.

FIELD INVESTIGATION

A field investigation was performed between July 15th and 20th, 2016 by VTrans personnel. See the VTrans Geotechnical Report in Attachment 1 for details of the investigation.

LABORATORY TESTING

Laboratory tests consisting of grain size sieve analyses and moisture content determinations were performed on all recovered soil samples. Test results are shown on the boring logs included in the VTrans Geotechnical Report in Attachment 1.

SUBSURFACE CONDITIONS

Subsurface soils generally consisted of a layer of medium to very dense Sand and Gravel overlying bedrock. Bedrock was encountered between approximate depths of 14 and 19 feet (approximate elevations of 480 and 484 feet). Groundwater was typically encountered at approximately 6 feet deep. Refer to the VTrans Geotechnical Report regarding details of the subsurface conditions encountered in the borings and limitations related to the measured groundwater levels.

RECOMMENDATIONS

FOUNDATION DESIGN

The proposed bottom of footing elevations for the wing walls and culvert range from approximately 486 to 489 indicating the footings should bear within the natural Sand and Gravel layer encountered in the borings. A box culvert type mat foundation and spread footings for the wingwalls are appropriate foundation types for this site provided foundations bear within the medium dense to very dense natural Sand and Gravel soils or on compacted Granular Backfill for Structures (VAOT 704.08A) placed directly over those soils.

We recommend a factored net bearing resistance of 6 kips per square foot (ksf) for strength limit state and a factored net bearing resistance of 4 ksf for service limit state (based on estimated settlement of 1 inch). These design values are suitable for effective footing widths between 4 and 14 feet and should therefore be suitable for culvert and wingwall footing design. We assumed a friction angle (φ) of 33 degrees and a unit weight (γ) of 125 pounds per cubic foot.

We recommend founding wingwall spread footings at least 5 feet below grade for frost protection. Bottom of culvert concrete founded 3 feet below stream bed and underlain by 18 inches of Granular Backfill for Structures (as shown on the preliminary plans) will be reasonably frost protected.

LATERAL EARTH PRESSURE AND SLIDING FRICTION CRITERIA

We recommend the following earth pressure criteria for free draining compacted granular backfill (e.g., Granular Backfill for Structures - VAOT 704.08A):

- Use equivalent fluid unit weights provided for "dense sand or gravel" in Table 3.11.5.5-1 of *AASHTO LRFD Bridge Design Specifications*.
- Select values for either active or at-rest conditions depending on wall movement restraint.
- Select values for either level backfill, backfill slope of 25 degrees, or interpolate for slope angles between level and 25 degrees.
- Where the equivalent wall pressure is less than 240 pounds per square foot (i.e., near the top of wall), use a uniform pressure of 240 pounds per square foot until wall pressure reaches this value, to account for locked in compaction stresses.
- Reliance on passive pressure in front of wingwalls is not recommended due to scour potential.
- Load factors for earth pressures should be taken from Table 3.4.1-2 in *AASHTO LRFD Bridge Design Specifications*.

We recommend the following sliding resistance criteria for mass (cast-in-place) and formed (pre-cast) concrete placed on compacted granular backfill (e.g., Granular Backfill for Structures - VAOT 704.08A):

Coefficient of friction, (ultimate) ***f,***

- Formed (pre-cast) concrete: 0.4
- Mass (cast-in-place) concrete: 0.55
- Resistance factors for sliding resistance should be taken from Table 10.5.5.2.2-1 in *AASHTO LRFD Bridge Design Specifications*.

OVERALL STABILITY OF WINGWALLS

We evaluated the overall stability of the wingwalls using the SLIDE 7.0 limit equilibrium slope stability analysis program by Rocscience. Per Section 11.6.2.3 in *AASHTO LRFD Bridge Design Specifications*, a maximum resistance factor of 0.65 is acceptable for a slope which supports a structural element.

We computed the resistance factor as the inverse of the factor of safety determined in SLIDE 7.0 and determined that it is less than the maximum acceptable value of 0.65. Therefore, based on the wingwall configuration and grading shown on the preliminary plans, we conclude that overall stability of the proposed wingwalls is adequate. Refer to the SLIDE 7.0 output in Attachment 2.

SOIL MATERIAL

Geo**Design** recommends using Granular Backfill for Structures (as shown in Table 704.08A, VAOT 2011 Standard Specifications for Construction) as a base course below the culvert and as free-draining structural backfill within 5 feet of culvert walls and wing walls. The material should be compacted to requirements in the 2011 VTrans Standard Specifications for Construction.

Excavated on site material may be used as backfill beyond the free-draining structural backfill required behind the culvert and wingwalls and below the road base courses. The material should be compacted to requirements in the 2011 VTrans Standard Specifications for Construction.

CONSTRUCTION CONSIDERATIONS

Dewatering and stream diversion will be required to maintain a reasonably dry excavation and subgrade. It appears from the preliminary plans that the proposed replacement culvert alignment is offset approximately 30 feet from the existing alignment which will assist with the stream diversion aspect.

Maintaining relatively undisturbed foundation subgrades is important for suitable foundation performance and limiting settlement. Disturbed subgrade materials should be removed and replaced with compacted granular fill. We recommend proof-rolling final subgrades prior to placing the base layer of Granular Backfill for Structures that is shown on the preliminary plans.

CONSTRUCTION DOCUMENT REVIEW AND FIELD OBSERVATION

To maintain continuity between the design and construction phases, Geo**Design** recommends that we be given the opportunity to review the final construction documents. We also recommend that Geo**Design** provides construction observation for foundation subgrades preparation. This will provide us the opportunity to evaluate that the subgrades are as anticipated, and to recommend adjustments as warranted.

LIMITATIONS

This report is subject to limitations presented in Attachment 3.

ATTACHMENT 1

VTrans Fairlee STP SCRP (15) – Geotechnical Report

August 26, 2016

AGENCY OF TRANSPORTATION **OFFICE MEMORANDUM**

To: Ken Upmal, P.E., Roadway Project Manager

MLM CEE

From: Marcy Montague, Senior Geotechnical Engineer via Callie Ewald, P.E., Geotechnical Engineering Manager

Date: August 26th, 2016

Subject: Fairlee STP SCRP (15) – Geotechnical Report

1.0 INTRODUCTION

We have completed our geotechnical and geological investigation for the proposed culvert replacement as part of the Fairlee STP SCRP (15) project located on VT Route 244 in the Town of Fairlee, Vermont. The proposed project includes the replacement of the existing culvert located just west of the I-91 overpass approximately 0.3 miles west of the intersection with US Route 5. Provided herein are the results of our field sampling and testing, laboratory testing and analyses of soil and rock samples, as well as boring logs to aid in the design and construction of the new culvert.

2.0 FIELD INVESTIGATION

The initial field investigation was conducted between July 15th and July 20th, 2016. Four standard penetration borings were drilled to determine the subsurface profile in order to aid in design and construction of the new culvert. Either a boulder or shallow bedrock was encountered in B-101, so five additional probes were drilled during a subsequent investigation to help determine whether or not shallow bedrock exists at this location. The subsequent analysis was performed between July 20th and August 9th, 2016. Locations for both the borings and probes can be found below 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 NAD 83 coordinate system and were collected in the field using our Trimble GPS unit. Elevations were interpolated from the VTrans survey file based off of the Northings and Eastings. 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)	Bedrock Elevation (ft)
B-101	122+25	17.4	503715.33	1724562.34	497.9	483.6*
B-102	122+36	11.0	503714.54	1724575.29	498.4	481.5
B-103	122+07	-14.8	503752.04	1724564.58	500.1	481.0
B-104	122+23	-15.0	503743.81	1724577.91	498.6	480.1

*Note: After reviewing the depths to refusal encountered in the probes and a closer review of the rock cores sampled, it was determined that a boulder was encountered at an elevation of 473.3 feet and the actual top of bedrock elevation corresponds to 483.6 feet.

Table 2.2: Probe Locations

Boring Number	Station	Offset (ft)	Northing (ft)	Easting (ft)	Ground Elevation (ft)	TLOB* (ft)
P-1	122+17	5.5	503729.49	1724562.20	499.3	482.0
P-2	122+32	5.5	503721.36	1724574.94	499.1	482.6
P-3	122+11	-5.5	503741.80	1724563.35	500.1	483.1
P-4	122+27	-5.5	503733.46	1724576.45	498.7	483.9
P-5	122+19	13.3	503721.97	1724559.44	499.0	483.4

*TLOB – To Ledge or Boulder (Bedrock is not verified by sampling a core with these probes, only refusal of the drill casing.)

The borings were performed in general accordance with AASHTO T206, *Standard Method of Test for Penetration Test and Split-Barrel Sampling of Soils.* During boring operations, split spoon samples and standard penetration tests (SPT) were taken continuously to approximately 15 feet in B-102 and B-103 and at 5 foot intervals until bedrock for B-101 and B-104. When bedrock was encountered, a 10-foot NX rock core was sampled to confirm the presence of bedrock in B-102 and B-103 and a 5-foot NX rock core was sampled in B-101 and B-104 to confirm the presence of bedrock.

Soil samples were visually identified in the field and SPT blow counts were recorded on the boring logs. Soil and rock 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 analyses. The attached boring longs indicate the types of soils and strata encountered and include the laboratory test results, SPT data, and any pertinent observations made by the boring crew.

In order to determine the depth to ledge or boulder (TLOB), the boulder buster was attached to the bottom of the drill rod and then driven until refusal for the probes. In this scenario, a 15.25-inch-long boulder buster weighing 10.3 pounds was attached to the bottom of the AW drill rod and used to break through the soil stratum until refusal was encountered, indicating TLOB. After the rod was removed, the pavement thickness was measured. No soil samples were collected.

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 skid rig was used with a $C_E = 1.42$. This value, included on the boring logs, is recommended for use in soil parameter

calculations. Laboratory tests were conducted on all samples to evaluate grain size, moisture content, percent finer than No. 200 sieve, and liquid and plastic limits when applicable. 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 including rock material strength, RQD, discontinuity or joint spacing, joint condition, and groundwater condition, that all have relative ratings which combine to form the RMR (AASHTO Section 10.4.6.4).

4.0 SOIL PROFILE

Review of the 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 the 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 even when not previously noted on the boring logs.

4.1 Boring B-101 (Outlet)

The ground surface elevation at B-101 was approximately 497.9 feet. Groundwater was measured at 5.0 feet below the ground surface before drilling operations began on the second day. Auger refusal was encountered at 6.6 feet and a 4 foot NX rock core was sampled. The core barrel broke through rock at a depth of 10.6 feet and soil sampling resumed. Auger refusal was then encountered at 14.3 feet and a 5 foot NX rock core was sampled to confirm the presence of bedrock.

Depth (Below Ground Surface Elevation)	Soil Profile
0 - 5 feet	Very Loose Sand
5 – 14.3* feet	Very Dense Silty Gravelly Sand/Sandy Gravel
>14.3 feet	Bedrock

*****Note a boulder was encountered from 6.6 feet to 10.6 feet within this stratum.

4.2 Boring B-102 (Outlet)

The ground surface elevation at B-102 was approximately 498.4 feet. Groundwater was measured at 6.0 feet below the ground surface after drilling operations were completed. Auger refusal was encountered at 16.9 feet and a 10 foot NX rock core was sampled to confirm the presence of bedrock.

Depth (Below Ground Surface Elevation)	Soil Profile
0 – 16.9 feet	Dense Sandy Gravel
> 16.9 feet	Bedrock

4.3 Boring B-103 (Inlet)

The ground surface elevation at B-103 was approximately 500.1 feet. Groundwater was measured at 6.0 feet below the ground surface after drilling operations were completed. Auger refusal was encountered at 19.1 feet and a 10 foot NX rock core was sampled to confirm the presence of bedrock.

Depth (Below Ground Surface Elevation)	Soil Profile
0 – 19.1 feet	Medium Dense Gravelly Sand
> 19.1 feet	Bedrock

4.4 Boring B-104 (Inlet)

The ground surface elevation at B-104 was approximately 498.6 feet. Groundwater was measured at 6.4 feet below the ground surface after drilling operations were completed. Auger refusal was encountered at 18.5 feet and a 5 foot NX rock core was sampled to confirm the presence of bedrock.

Depth (Below Ground Surface Elevation)	Soil Profile
0 – 18.5 feet	Medium Dense Gravelly Sand
> 18.5 feet	Bedrock

4.5 Probe Information

Five auger probes were drilled to determine the depth TLOB around the proposed culvert. Results from the probes indicate the following information.

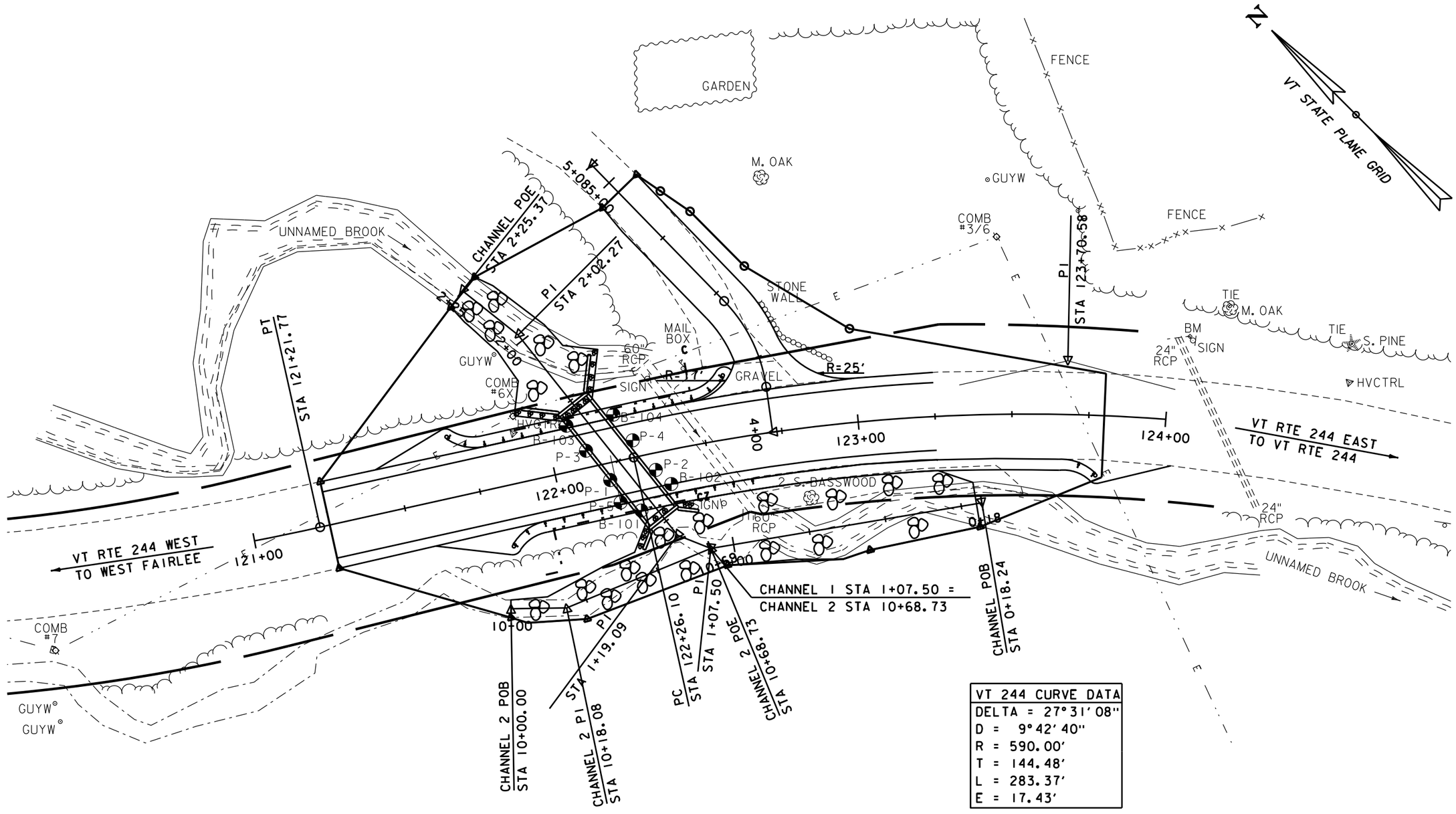
Probe	Asphalt Thickness (ft)	Depth TLOB (ft)
P-1	1.07	17.3
P-2	0.40	16.5
P-3	0.38	17.0
P-4	0.38	14.8
P-5	0.45	15.6

5.0 CONCLUSION

Once this project moves further along in the design phase, we would be happy to provide design parameters and assist with any foundation design required. Please feel free to contact us at (802) 828-2561 if you have any questions, or you would like to further discuss this report. Typed boring logs are attached and are available in the CADD design files:
M:\Projects\16d012\MaterialsResearch folder.

Attachments: Boring Location Plan (1 page)
Boring Logs (4 pages)

cc: Matt Gamelin, VTrans Roadway
Electronic Read File/DJH
Project File/CEE
MLM



VT 244 CURVE DATA
DELTA = 27°31'08"
D = 9°42'40"
R = 590.00'
T = 144.48'
L = 283.37'
E = 17.43'

0 20 40
SCALE IN FEET

PROJECT NAME: FAIRLEE
PROJECT NUMBER: STP SCRP(15)

FILE NAME:
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

Fairlee
STP SCRP(15)
VT 244 Br. #11

Boring No.: **B-101**
Page No.: 1 of 1
Pin No.: 16d012
Checked By: MLM

Boring Crew: Nieto, Judkins, Emerson
Date Started: 7/19/16 Date Finished: 7/20/16
VTSPG NAD83: N 503715.33 ft E 1724562.34 ft
Station: 122+25 Offset: 17.40
Ground Elevation: 497.9 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_F = 1.42

Groundwater Observations

Date	Depth (ft)	Notes
07/20/16	5.0	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 %
		A-2-4, Sa, blk, Moist, Rec. = 0.5 ft, Lab Note: Plant roots were within sample				WH-WH-1-1 (1)	23.7	10.6	74.7	14.7
2.5										
		Field Note:, NXDC, Cleaned out casing								
5.0		A-2-4, SiGrSa, blk, Moist, Rec. = 0.5 ft, Lab Note: Broken rock was within sample				5-6-R@5" (R)	15.1	34.7	36.0	29.3
		6.6 ft - 10.6 ft, Gray, Pyrite bearing PHYLLITE, with quartz veins. Rust and yellow staining along joints. Moderately hard, Moderately weathered, Poor rock, NX, RMR=26	1 (80)	38 (0)	6 9 7 14					
7.5										
10.0										
		Field Note:, NXDC, Cleaned out casing								
12.5		A-1-b, SaGr, gry, Moist, Rec. = 0.4 ft, Lab Note: Broken and weathered rock was within sample				R@5" (R)	13.3	60.7	23.7	15.6
		Field Note:, Appears to be a seam in bedrock								
		14.3 ft - 19.3 ft, Gray, Pyrite bearing PHYLLITE, with quartz veins. Rust and brown staining along joints. Moderately hard, Very slightly weathered, Good rock, NX, RMR=64	2 (80)	100 (95)	4 4 4 3 4	Top of Bedrock @ 14.3 ft				
15.0										
17.5										
		Hole stopped @ 19.3 ft								
20.0										
		Remarks: Hole collapsed at 8.9 feet.								
22.5										

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.

BORING LOG 2 FAIRLEE STP SCRP(15).GPJ VERMONT AOT.GDT 8/26/16

STATE OF VERMONT
AGENCY OF TRANSPORTATION
CONSTRUCTION AND
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CENTRAL LABORATORY

BORING LOG

Fairlee
STP SCRP(15)
VT 244 Br. #11

Boring No.: **B-102**
Page No.: 1 of 1
Pin No.: 16d012
Checked By: MLM

Boring Crew: Garrow, Judkins, Gomes
Date Started: 7/15/16 Date Finished: 7/15/16
VTSPG NAD83: N 503714.54 ft E 1724575.29 ft
Station: 122+36 Offset: 11.00
Ground Elevation: 498.4 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_F = 1.42

Groundwater Observations

Date	Depth (ft)	Notes
07/15/16	6.0	W.T. 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 %
		Asphalt Pavement, 0.0 ft - 0.88 ft								
		A-1-b, SiGrSa, gry-brn, Moist, Rec. = 1.2 ft, Lab Note: A small amount of asphalt pavement was within sample				11-8-6-6 (14)	11.4	26.0	52.5	21.5
		A-1-b, GrSa, brn, Moist, Rec. = 0.7 ft, Lab Note: Broken rock was within sample Field Note:, Rollercone, cleaned out casing				6-6-5-10 (11)	13.4	41.6	42.6	15.8
5		A-1-b, SaGr, brn, Moist, Rec. = 0.7 ft Field Note:, NXDC, Cleaned out casing				7-7-13-12 (20)	16.5	50.7	37.2	12.1
		A-1-a, SaGr, brn, Moist, Rec. = 0.4 ft, Lab Note: Broken rock was within sample Field Note:, NXDC, Cleaned out casing				8-7-11-3 (18)	12.3	52.3	37.0	10.7
10		Field Note:, No Recovery				4-1-5-10 (6)				
		A-1-b, SaGr, gry, Moist, Rec. = 1.1 ft, Lab Note: Broken and weathered rock was within sample Field Note:, NXDC, Cleaned out casing				4-11-20-17 (31)	11.0	47.4	34.7	17.9
		A-1-b, SaGr, gry, Moist, Rec. = 1.3 ft, Lab Note: Broken and weathered rock was within sample Field Note:, NXDC, Cleaned out casing				12-10-13-R@3.5" (23)	12.0	52.3	31.7	16.0
15		A-1-a, SaGr, gry, Moist, Rec. = 1.1 ft, Lab Note: Broken and weathered rock was within sample				30-16-7-R@3.5" (23)	14.7	59.6	27.8	12.6
		16.9 ft - 21.9 ft, Gray, Pyrite bearing PHYLLITE, with quartz veins. Rust and brown staining along joints. Moderately hard, Very slightly weathered, Fair rock, NX, RMR=50	1 (70)	96 (79)	7 7 6 8 8	Top of Bedrock @ 16.9 ft				
20										
		21.9 ft - 26.9 ft, Gray, Pyrite bearing PHYLLITE, with quartz veins. Massive quartz vein at 23.3-25.1 feet. Slight rust and brown staining along joints. Moderately hard, Unweathered, Good rock, NX, RMR=63	2 (70)	100 (87)	7 8 9 7 6					
25										
		Hole stopped @ 26.9 ft								
30		Remarks: Hole collapsed at 11.9 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.

BORING LOG 2 FAIRLEE STP SCRP(15).GPJ VERMONT AOT.GDT 8/26/16

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

Fairlee
STP SCRP(15)
VT 244 Br. #11

Boring No.: **B-103**
Page No.: 1 of 1
Pin No.: 16d012
Checked By: MLM

Boring Crew: Nieto, Judkins, Emerson
Date Started: 7/18/16 Date Finished: 7/18/16
VTSPG NAD83: N 503752.04 ft E 1724564.58 ft
Station: 122+07 Offset: -14.80
Ground Elevation: 500.1 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_F = 1.42

Groundwater Observations

Date	Depth (ft)	Notes
07/18/16	6.0	W.T. 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 %
		A-1-b, GrSa, brn, Moist, Rec. = 1.2 ft, Lab Note: A small amount of asphalt pavement was within sample				4-6-6-7 (12)	7.1	35.9	53.6	10.5
		A-2-4, GrSa, brn, Moist, Rec. = 0.8 ft, Lab Note: A small amount of asphalt pavement was within sample				6-4-3-3 (7)	10.1	20.4	60.1	19.5
5		A-2-4, SiSa, brn, Moist, Rec. = 1.3 ft, Lab Note: Pieces of wood were within sample				1-2-3-7 (5)	21.0	19.0	54.6	26.4
		A-2-4, SiGrSa, gry, Moist, Rec. = 1.2 ft, Lab Note: Pieces of wood and a small amount of asphalt pavement were within sample Field Note:, Rollercone, Cleaned out casing				1-2-5-7 (7)	24.7	29.6	49.5	20.9
		A-3, Sa, brn, Moist, Rec. = 0.8 ft				6-2-3-2 (5)	22.0	8.3	81.6	10.1
10		Visual Description:, Broken rock, Rec. = 0.2 ft				5-4-5-3 (9)	2.6			
		Field Note:, No Recovery, Appears to be sand				5-4-3-9 (7)				
		A-1-b, GrSa, brn, Moist, Rec. = 0.5 ft				10-15-10-R@0" (25)	12.2	42.1	46.2	11.7
15										
20		19.1 ft - 24.1 ft, Gray, PHYLLITE, with few quartz veins and rare pyrite. Moderately hard, Unweathered, Good rock, NX, RMR=71	1 (70-80)	100 (100)	5 5 6 6 6	Top of Bedrock @ 19.1 ft				
25		24.1 ft - 29.1 ft, Gray, Pyrite bearing PHYLLITE, with quartz veins. Moderately hard, Unweathered, Good rock, NX, RMR=66	2 (75-80)	90 (96)	5 6 7 8 7					
30		Hole stopped @ 29.1 ft								

Remarks:
Hole collapsed at 6.1 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.

BORING LOG 2 FAIRLEE STP SCRP(15).GPJ VERMONT AOT.GDT 8/26/16

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

BORING LOG

Fairlee
STP SCRP(15)
VT 244 Br. #11

Boring No.: **B-104**
Page No.: 1 of 1
Pin No.: 16d012
Checked By: MLM

Boring Crew: Nieto, Judkins, Emerson
Date Started: 7/19/16 Date Finished: 7/19/16
VTSPG NAD83: N 503743.81 ft E 1724577.91 ft
Station: 122+23 Offset: -15.00
Ground Elevation: 498.6 ft

	Casing	Sampler
Type:	WASH BORE	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_F = 1.42

Groundwater Observations

Date	Depth (ft)	Notes
07/19/16	6.4	W.T. 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 %
		A-1-b, GrSa, brn, Moist, Rec. = 1.4 ft, Lab Note: A small amount of asphalt pavement was within sample				3-5-6-5 (11)	5.8	39.0	50.3	10.7
		Field Note:, Rollercone, Cleaned out casing								
5		Field Note:, No Recovery, Appears to be sand				3-4-3-7 (7)				
		Field Note:, Rollercone, Cleaned out casing								
10		Field Note:, No Recovery, Appears to be sand				6-4-4-5 (8)				
		A-1-b, GrSa, brn, Moist, Rec. = 0.5 ft				4-7-12-12 (19)	12.6	35.4	46.7	17.9
15		A-1-b, GrSa, brn, Moist, Rec. = 0.8 ft, Lab Note: Broken rock was within sample				5-10-12-11 (22)	8.8	43.9	44.6	11.5
20		18.5 ft - 23.5 ft, Gray, Pyrite bearing PHYLLITE, with quartz veins. Moderately hard, Unweathered, Fair rock, NX, RMR=60	1 (80)	100 (78)	8 7 9 4 4	Top of Bedrock @ 18.5 ft				
25		Hole stopped @ 23.5 ft								

Remarks:
Hole collapsed at 8.6 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.

BORING LOG 2 FAIRLEE STP SCRP(15).GPJ VERMONT AOT.GDT 8/26/16

ATTACHMENT 2

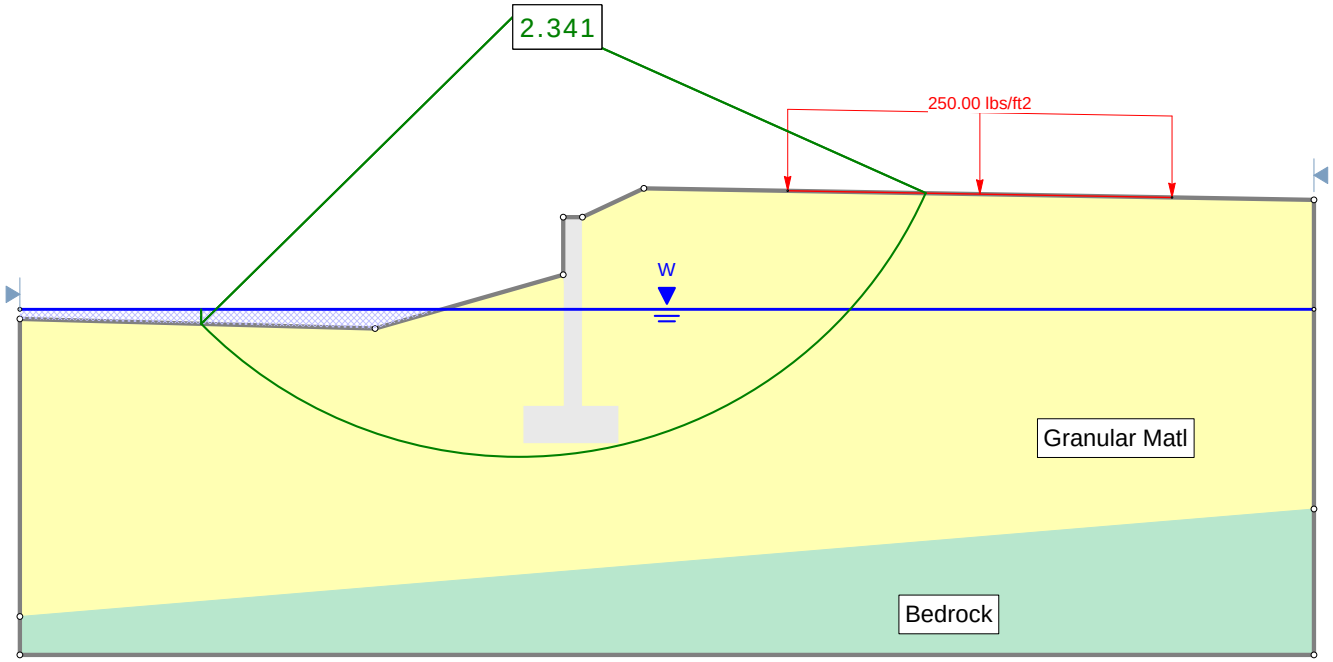
Overall Stability of Wingwalls

SLIDE 7.0 Output

#750-09.21 Fairlee STP SCRP(15)
Proposed Conditions
Method: spencer

By: DTH 10/11/16
Reviewed: JFW 10/13/16

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Granular Matl		125	Mohr-Coulomb	0	33
Bedrock		160	Infinite strength		
Footing		150	Infinite strength		



ATTACHMENT 3

Limitations

GEOTECHNICAL LIMITATIONS

Explorations

1. The analyses and recommendations submitted in this report are based in part upon the data obtained from widely spaced subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. For specific information, refer to the boring logs.

3. Water level readings and moisture conditions have been made in the explorations, and from the samples at times and under conditions stated on the logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater and moisture condition may occur due to variations in rainfall, temperature, and other factors occurring since the time measurements were made.

Review

4. In the event that any changes in the nature, design or location of the proposed structures is planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by Geo**Design**, Inc. We recommend that we be provided the opportunity to review and comment on the finalized project design and relevant construction specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design and specifications.

Use of Report

5. This report has been prepared for the exclusive use of Client, for specific application to the project, as described in Geo**Design**'s scope of services/ contract and related documents, in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made.

6. This report has been prepared for this specific project by Geo**Design**, Inc. This report is for design purposes only and is not sufficient to prepare an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to design considerations only, unless otherwise specified in the report.

7. Unless otherwise noted, the scope of our services did not include environmental assessment or investigation for the presence of hazardous or toxic materials in the soil, surface water, groundwater or air, on, below, or around this site.