GEO DESIGN

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# MEMORANDUM

**TO:** Callie Ewald, P.E.
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Vermont Agency of Transportation
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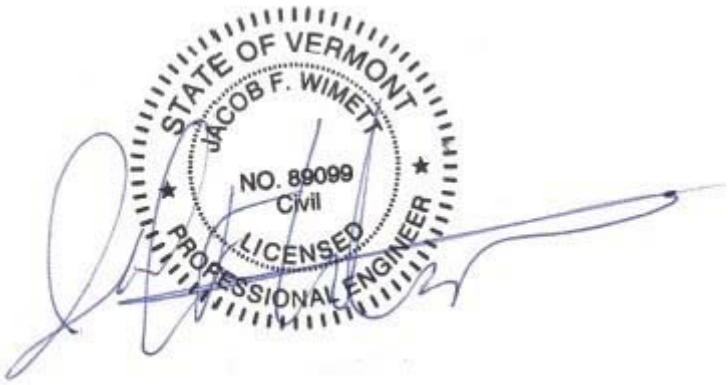
**Email:** callie.ewald@Vermont.gov




**FROM:** GEODesign, Inc.
(Jacob Wimett, P.E.)

**DATE:** January 4, 2024

**RE:** Subsurface Findings & Preliminary Recommendations
Washington ER P23-1(669)
Bridge No. 15 – VT Route 110 Washington
PIN: 23B742
Washington, VT

**FILE NO.:** 0750-22

**ATTACHMENTS:** Exploration Location Plan (Fig 1); Soil Boring Logs (B & P-Series); Laboratory Testing Results; Limitations

## SUMMARY

GEODesign completed soil borings and rock coring at the request of VTrans for Bridge No. 15 along Route 110 in Washington, Vermont. This memorandum transmits our subsurface findings and associated preliminary recommendations for the new bridge. Work was completed in accordance with the VTrans Emergency July 2023 Weather Event South Eastern contract (WAN #PS0837-WA00015).

## SOIL BORINGS

Soil borings and rock probes (B-Series and P-Series) were performed on August 7 and 8, 2023 by New England Boring Company using a GTechDrill GT8 drilling rig. Two borings (B-101 and B-102) consisted of soil sampling using the Standard Penetration Test (SPT) and rock coring. Three

borings (P-103, P-104 and P-105) consisted of probing for bedrock depth using wash and drive methods and a roller bit.

Refer to the attached Exploration Location Plan (Figure 1) and boring logs for additional information.

## SUBSURFACE CONDITIONS

We observed a generalized subsurface profile in our soil borings as outlined below.

***Non-Engineered Fill*** – Fill that has not been placed and compacted in a controlled and consistent manner to a specified density is considered non-engineered. We encountered approximately 9 to 10-feet of this material in the soil boring, consisting of primarily sand with varying amounts of silt, gravel, and organic matter.

***Glacial Till*** – Natural soil was first encountered approximately 9 to 10-feet below existing grade at a layer of very dense glacial till consisting of primarily silt and sand with varying amounts of gravel. This layer was only encountered in B-101 where the bedrock was deeper than the other borings.

***Inferred Weathered / Decomposed Bedrock*** – Weathered Bedrock was inferred to begin at approximately 7 to 8.5-feet below existing grade on the south side of the bridge (B-102, P-103 and P-105), and 13.5 to 18 feet below existing grade on the north side of the bridge (B-101 and P-104). Increased roller bit resistance at these depths support these approximate depths.

***Bedrock*** - Bedrock was inferred to begin at approximately 9 to 9.5-feet below existing grade on the south side of the bridge (B-102, P-103 and P-105), and 14 to 19-feet on the north side of the bridge (B-101 and P-104). Increased roller bit resistance along with poor to good quality rock cores support these approximate depths.

## GEOTECHNICAL IMPLICATIONS & PRELIMINARY RECOMMENDATIONS

Based on our subsurface findings, we recommend founding the wingwalls and bridge footings either:

- On spread footings bearing directly on bedrock or glacial till; or,
- On a micropile supported pile cap, with the micropiles deriving their capacity within the underlying bedrock.

For spread footings, we recommend a maximum allowable bearing pressure of 5,000 psf for foundations bearing directly on bedrock or glacial till.

For micropile supported foundation design, we recommend a preliminary grout-to-rock ultimate bond strength of 150 psi for initial pile design purposes. Ultimately, bond strength will need to be verified in the field through verification and proof tests performed in accordance with Publication No. FHWA NHI-05-039 (Micropile Design and Construction Reference Manual).

## OTHER DESIGN CONSIDERATIONS

*Subgrade Preparation*

Rock subgrade surfaces having an average slope greater than 10 percent across the width of the footing in any direction will need to be leveled. Alternatively, if leveling proves difficult it is acceptable to install dowels into the rock in lieu of leveling the subgrade by mechanical means. In our experience, 30-inch-long Grade 60 No. 8 size reinforcing dowel bars drilled into the subgrade at least 12 inches into the rock is sufficient, but we recommend the Structural Engineer review this option and specify the number of bars required based on the measured slope of the rock subgrade if this alternative is pursued.

Backfill for the wingwalls should consist of a free draining granular backfill, with drainage provided at the wall bottom to avoid the buildup of hydrostatic pressures. We recommend using Granular Backfill For Structures (VAOT 704.08), and suggest the following design parameters for this material:

**Granular Backfill for Structures Parameters (Assumes compacted to 95% Modified Proctor)**

| Parameter | Value |
|---|---|
| Unit Weight $\gamma$ | 140 pcf |
| Friction Angle $\Phi$ | 34° |
| Cohesion c | 0 psf |
| Active Earth Pressure Coefficient $K_a$ | 0.28 |
| At-Rest Earth Pressure Coefficient $K_0$ | 0.44 |
| Passive Earth Pressure Coefficient $K_p$ | 3.54 |

Note that active pressure coefficient should be used where walls are free to displace laterally, and at-rest pressure coefficient should be used when walls are constrained for lateral movement at the top or by multiple levels of bracing.

Note that to fully develop passive pressure resistance as part of a wall design, (1) sufficient soil extending laterally from of the wall is required as well as (2) significant movement of the wall into the soil (around 1% of the wall heigh) is required. Oftentimes the level of movement required to fully mobilize passive pressure will not be achieved. The actual distance soil is required to extend in front of the wall as well as the actual wall movement required to develop full passive pressure will depend on the individual details and geometric arrangement of a given wall. It is the wall designer's responsibility to verify sufficient conditions exist before relying on passive pressure (or

a portion thereof) for retaining wall design. Furthermore, GEODesign recommends passive resistance be completely neglected where the ground slopes away from the walls or within anticipated scour depths.

Lateral Loading Considerations

For lateral loading evaluation in micropile design, we recommend the following parameters for overburden materials:

**Fill:**

| Fill Parameter | Value |
|---|---|
| Unit Weight γ | 120 pcf |
| Friction Angle Φ | 30° |
| Cohesion c | 0 psf |
| At-Rest Earth Pressure Coefficient $K_0$ | 0.50 |
| Lateral Subgrade Modulus k (Above Water) | 35 pci |
| Lateral Subgrade Modulus k (Below Water) | 20 pci |

**Glacial Till:**

| Glacial Till Parameter | Value |
|---|---|
| Unit Weight γ | 135 pcf |
| Friction Angle Φ | 40° |
| Cohesion c | 0 psf |
| At-Rest Earth Pressure Coefficient $K_0$ | 0.36 |
| Lateral Subgrade Modulus k (Above Water) | 225 pci |
| Lateral Subgrade Modulus k (Below Water) | 125 pci |

## LIMITATIONS

This memorandum is subject to the attached limitations.

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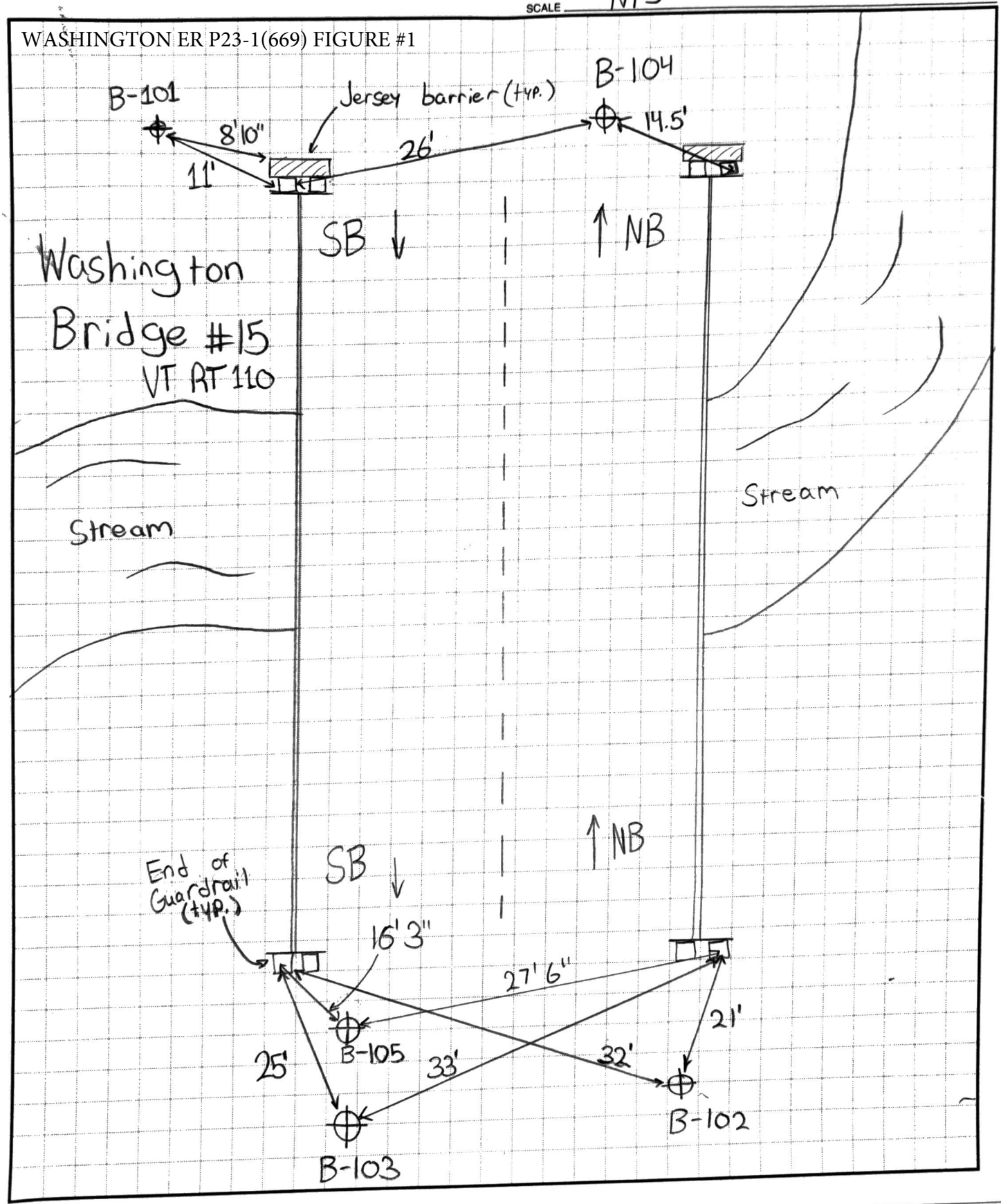
JOB 0750 - 012.22
SHEET NO. 1 OF 1
CALCULATED BY JAC DATE 12/28/23
CHECKED BY JFW DATE 12/28/23
SCALE NTS

WASHINGTON ER P23-1(669) FIGURE #1



# EXPLANATION OF THE FORM - BORING LOG

**The following provides an explanation of the various fields on the Boring Log form.**

## UPPER PORTION OF BORING LOG

**Project and Boring Details**

Within the upper portion of the Boring Log, details with regards to the Project Name and Location, Boring Number, and VTrans PIN number are provided. In addition, within the upper section of the Boring Log, the Boring Crew details - Driller (and name of the Drilling Company), together with the name of Geo**Design**'s representative, are presented. Details with regards to the dates when the boring was drilled, its coordinates or other location references and the corresponding surface elevation may also be provided.

**Casing and Sampler**

This section provides a summary of the typical size of samplers and casings used, together with the type of drilling rig See below for a description of samplers.
The type of drill rods and sampling hammer used is also provided in this section along with the hammer energy correction factor ($C_E$) to be used for converting N-values to $N_{60}$-Values.

**Groundwater Observations**

Water levels typically indicated on the Boring Log are levels measured in the boring at the date indicated. In permeable materials, the indicated levels may reflect the location of groundwater. In low permeability soils and/or due to effects of the casing, the accurate determination of groundwater levels may not be possible with only short term observations.

## CENTRAL PORTION OF BORING LOG

**DEPTH**

This column gives the depth scale of the boring, in feet or meters.

**STRATA**

This column provides a graphical representation of the soil and bedrock units, and inferred geological contacts. See Subsurface Profile Legend. Stratification lines represent approximate boundaries between material types, transitions may be gradual.

**SAMPLE INFORMATION**

The initial columns provide the sample number, sample type, penetration, recovery and sample depth. The Sample Type Coding is as follows:

| | | | |
|---|---|---|---|
| A - Auger Sample | PS- Undisturbed Piston - 3" (76 mm) | SSL - Large Split-Barrel - 3" (76 mm) | V - Vane Test |
| C - Core - Diamond Bit - NX double tube, unless otherwise noted. | SS - Split-Barrel (Split-Spoon) | ST - Shelby Tube - 3" (76 mm) | |

**Blows / 6 " (N Value)**

Representative soil samples were obtained in the boring by split-barrel sampling procedures in general accordance with ASTM D 1586. The split-barrel sampling procedure utilizes a standard 51 mm (2") outside diameter split-barrel sampler that is driven into the bottom of the boring with a 63.5 kg (140-pound) hammer falling a distance of 0.76 m (30"). The number of blows required to advance the sampler in 0.15 m (6") increments is recorded as part of the Standard Penetration Test (SPT). These values are indicated at their depth of occurrence.

The number of blows required to advance the split-barrel sampler the middle two - 0.15 m (6") increments is recorded as the Standard Penetration Resistance Value ("N") and is listed in parenthesis.

Where the sampler advanced by Weight of Rods or Weight of Hammer, the designation WOR and WOH, respectively, was used.

**Coring Time (Where Applicable)**

This column provides the rate in minutes at which the core barrel was advanced into the bedrock (or boulder) in one foot (0.3 m) intervals.

**Moisture Content % (Where Applicable)**

This column provides moisture content determination results for the samples tested.

**Gravel% / Sand% / Fines % (Where Applicable)**

These columns provides the grain size breakdown per AASHTO M145 for the samples tested.

**LL% / PI% (Where Applicable)**

This column provides Liquid Limit and Plasticity Index results for the samples tested.

**SAMPLE DESCRIPTION**

This column provides a description of the soil and bedrock units, based on visual observation of the samples, sometimes in conjunction with field and laboratory tests. Each sample was generally described according to the following classification and terminology. In general, description of the soil units followed the Burmister classification system. AASHTO M145 Classifications where given are based on the results of laboratory testing.

## SOIL PROPERTIES & DESCRIPTIONS

**TEXTURE***

| Component | Size (mm) |
|---|---|
| **CLAY** | < 0.002 mm |
| **SILT** | < #200 Sieve (0.075 mm) |
| **SAND** | #200 to #4 Sieve (0.075 mm to 4.75 mm) |
| Fine | #200 to #40 Sieve (0.075 mm to 0.425 mm) |
| Medium | #40 to #10 Sieve (0.425 mm to 2.00 mm) |
| Coarse | #10 to #4 Sieve (2.00 mm to 4.75 mm) |
| **GRAVEL** | #4 Sieve to 3 in (4.75 mm to 76 mm) |
| Fine | #4 Sieve to 3/4 in (4.75 mm to 19 mm) |
| Coarse | 3/4 in to 3 in (19 mm to 76 mm) |
| **COBBLES** | 3 in to 12 in (76 mm to 305 mm) |
| **BOULDERS** | > 12 in (305 mm) |

*textural classification as determined by sieve and hydrometer analyses

**COMPOSITION**

Principal Component in Upper Case i.e. >50%
CLAY, SILT, SAND, GRAVEL, COBBLES, BOULDERS

Minor Component Upper and Lower Case i.e.<50%
Clay, Silt, Sand, Gravel, Cobbles, Boulders

| DESCRIPTIVE ADJECTIVE | PERCENTAGE REQUIREMENT |
|---|---|
| trace | <10 % |
| little | 10 - 20 % |
| some | 20 - 35 % |
| and | 35 - 50 % |

**MOISTURE CONDITION**

| | |
|---|---|
| Dry | Absence of moisture, dusty |
| Moisture | Damp but no visible water |
| Wet | Visible free water |

**COHESIVE SOILS**

| ESTIMATED CONSISTENCY CLASSIFICATION *** | "N" Value |
|---|---|
| Very Soft | < 2 |
| Soft | 2 - 4 |
| Medium | 4 - 8 |
| Stiff | 8 - 15 |
| Very Stiff | 15 - 30 |
| Hard | > 30 |

*** empirical relationship

**COHESIONLESS SOILS**

| ESTIMATED COMPACTNESS DESCRIPTION *** | "N" Value |
|---|---|
| Very Loose | < 4 |
| Loose | 4 - 10 |
| Medium Dense | 10 - 30 |
| Dense | 30 - 50 |
| Very Dense | > 50 |

**PLASTICITY - Burmister**

| Degree of Plasticity | Soil Type | Smallest Diameter of Thread** |
|---|---|---|
| Non-Plastic | SILT | None |
| Slight | Clayey SILT | 1/4" (6 mm) |
| Low | SILT & CLAY | 1/8" (3 mm) |
| Medium | CLAY & SILT | 1/16" (1.6 mm) |
| High | Silty CLAY | 1/32" (0.8 mm) |
| Very High | CLAY | 1/64" (0.4 mm) |

** moisture at or near optimum

**STRUCTURE**

| | |
|---|---|
| Stratified, | >6 mm (1/4") |
| Laminated, | < 6 mm (1/4") |
| Parting, | 0 to 1.6 mm (1/16") |
| Seam, | 1.6 to 13 mm (1/2") |
| Layer, | 13 to 305 mm (12") |
| Stratum, | > 305 mm (12") |

## BEDROCK PROPERTIES & DESCRIPTIONS

**RECOVERY AND ROCK QUALITY DESIGNATION (RQD)**

**Recovery** is defined as the length of core obtained expressed as a percentage of the total length cored.

**RQD** is defined as the total length of sound core pieces, 4 inches (100 mm) or greater in length, excluding drilling breaks, 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 and bedding planes.

| Classification | RQD % |
|---|---|
| Very Poor Quality | 0 - 25 |
| Poor Quality | 25 - 50 |
| Fair Quality | 50 - 75 |
| Good Quality | 75 - 90 |
| Excellent Quality | 90 - 100 |

**HARDNESS**

| TYPICAL ROCK TYPES | | Moh's Hardness Scale |
|---|---|---|
| Hard | Cannot be scratched with knife | > 5.5 |
| Moderately Hard | Can scratch with knife but not fingernail | 5.5 - 2.5 |
| Soft | Can be scratched with fingernail | < 2.5 |
| **SANDSTONE** | | |
| Well Cemented | Capable of scratching a knife blade | 5.5 - 2.5 |
| Cemented | Can be scratched with knife | < 2.5 |
| Poorly Cemented | Can be broken apart easily with fingers | |

**WEATHERING**

| | |
|---|---|
| Fresh | No visible signs of weathering |
| Slightly Weathered | Slight discoloration of parent material in joints and seams |
| Moderately Weathered | Less than 35% of rock material is decomposed. Fresh or discolored rock is present. |
| Highly Weathered | More than 35% of rock material is decomposed. Fresh or discolored rock is present. |
| Extremely Weathered | All rock material is decomposed to soil. Rock mass structure may still be intact. |

**SPACING OF DISCONTINUITIES**

| Bedding | Jointing | Spacing (inches) | Spacing (mm) |
|---|---|---|---|
| Very Thick Bedded | Very Wide | >80 | >2000 |
| Thick Bedded | Wide | 24 - 80 | 600 - 2000 |
| Medium Bedded | Moderate | 8 - 24 | 200 - 600 |
| Thin Bedded | Close | 2.4 - 8 | 60 - 200 |
| Very Thin Bedded | Very Close | 0.8 - 2.4 | 20 - 60 |
| Laminated | Shattered | 0.24 - 0.8 | 6 - 20 |
| Thinly Laminated | Fissured | <0.24 | <6 |

When classification of rock materials has been estimated from disturbed samples, core samples and petrographic analysis may reveal other rock types.

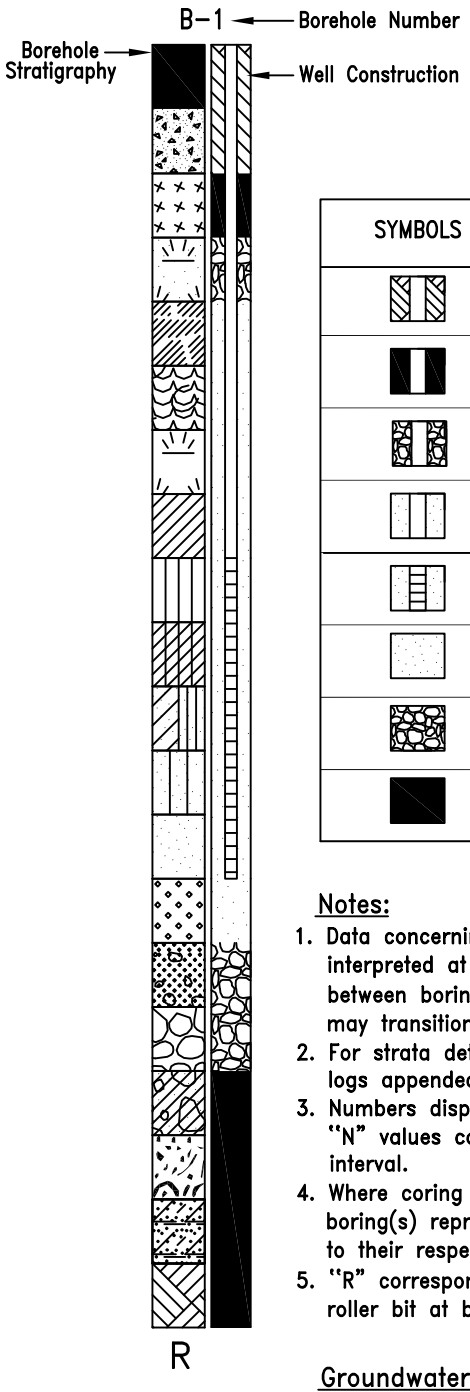
## BOTTOM PORTION OF BORING LOG

The lower portion of the log provides borehole termination depth, termination criteria, and additional drilling notes within the Remarks section.

# STRATIGRAPHY SYMBOLS

| SYMBOLS | TYPICAL DESCRIPTIONS OF PREDOMINENT MATERIAL TYPE |
|---|---|
| | ASPHALT |
| | CONCRETE |
| | FILL |
| | TOPSOIL |
| | SUBSOIL |
| | ORGANIC SILT OR CLAY WITH SHELLS |
| | PEAT |
| | CLAY |
| | SILT |
| | CLAY/SILT MIXTURE |
| | CLAY/SILT/SAND MIXTURE |
| | SANDY SILT |
| | SILTY SAND |
| | POORLY-GRADED SAND |
| | WELL-GRADED SAND |
| | SAND/SILT/GRAVEL MIXTURE |
| | BOULDERS AND/OR COBBLES |
| | GLACIAL TILL |
| | WEATHERED BEDROCK |
| | BEDROCK |

# EXPLANATION OF BORING




# WELL SYMBOLS

| SYMBOLS | TYPICAL DESCRIPTIONS |
|---|---|
| | CEMENT SEAL: 1 PIPE |
| | BENTONITE SEAL: 1 PIPE |
| | SLOUGH BACKFILL: 1 PIPE |
| | FILTER PACK: 1 PIPE |
| | SLOTTED PIPE WITH FILTER PACK: 1 PIPE |
| | FILTER PACK AT BOTTOM OF HOLE |
| | SLOUGH AT BOTTOM OF HOLE |
| | BENTONITE AT BOTTOM OF HOLE |

## Notes:

1. Data concerning the various strata have been interpreted at boring locations only. The stratigraphy between borings may vary from that shown, and may transition more gradually within borings.
2. For strata details, see Report and boring logs appended to this report.
3. Numbers displayed beside boring(s) represent SPT "N" values corresponding to their respective sampling interval.
4. Where coring was performed, numbers displayed beside boring(s) represent Recovery and RQD values corresponding to their respective sampling interval.
5. "R" corresponds to refusal of sampler, casing and/or roller bit at bottom of boring.

## Groundwater Observations (where applicable)

▽ Water Level Reading at time of drilling.

▼ Water Level Reading after completing drilling.


GEODESIGN INCORPORATED

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# BORING LOG / SUBSURFACE PROFILE LEGEND

ACAD FILE No. \\Field\VTrans Boring Log Legend.DWG

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

# BORING LOG

**VT Route 110 Washington Bridge #15**
**Washington ER P23-1(669)**

Boring No.: **B-101**
Page No.: 1 of 1
Pin No.: 23B742
Checked By: JFW

Boring Crew: Ken Smith (NEBC), Jack Cassara (GEODesign)
Date Started: 8/07/23 Date Finished: 8/07/23
VTSPG NAD83: Not Available
Station: Not Available Offset: Not Available
Ground Elevation: Not Available

| | Casing | Sampler |
|---|---|---|
| Type: | FJ | SS |
| I.D.: | 4 in | 2 in |
| Hammer Wt: | 140 lb. | 140 lb. |
| Hammer Fall: | 30 in. | 30 in. |
| Hammer/Rod Type: | | Auto |
| Rig: | GTechDrill GT8 | $C_E$ = 1.3 |

Groundwater Observations [3]

| Date | Depth (ft) | Notes |
|---|---|---|
| | | |
| | | |
| | | |

| Depth (ft) | Strata [1] | CLASSIFICATION OF MATERIALS (Description) | Run (Dip deg.) | Core Rec. % (RQD %) | Drill Rate minutes/ft | Blows/6" (N Value) [2] | Moisture Content % | Gravel % | Sand % | Fines % | LL % | PI % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | | S1) Very loose. Top 3": brown GRAVEL, gray, moist Bottom 7": SILT, little fine Sand, trace roots. Rec. = 0.1 ft | | | | 1-1-2-2 (3) | | | | | | |
| | | S2) Very loose, brown/gray fine to coarse SAND and SILT, trace fine Gravel, moist. Rec. = 0.8 ft | | | | 2-2-2-7 (4) | | | | | | |
| | | S3) Medium dense, brown/gray/red, SILT and ORGANICS, some fine to coarse SAND, trace Wood, trace Gravel, moist. Rec. = 0.6 ft | | | | 37-11-4-5 (15) | | | | | | |
| 10 | | S4) Very loose, brown/gray fine to medium SAND, some Silt, trace Wood, wet. Rec. = 1.0 ft (A-2-4.) | | | | 1-1/12"-3 (1) | 48.6 | 0.4 | 74.5 | 25.1 | NP | NP |
| | | S5) Medium dense Top 9": Light brown SILT and fine to coarse SAND, moist. Bottom 2": Gray SILT and fine to coarse SAND, trace fine Gravel, moist. Rec. = 0.9 ft | | | | 7-14-14-12 (28) | | | | | | |
| 15 | | S6) Very dense, Gray SILT and fine to coarse SAND, trace fine to coarse Gravel, wet. Rec. = 1.5 ft (A-4.) | | | | 27-44-37-34 (81) | 10.5 | 12.0 | 34.1 | 53.9 | NP | NP |
| | | | | | | | | | | | | |
| 20 | | 19.0 ft to 24.0 ft, C1) Light to dark gray, moderately hard, fresh, closely to moderately jointed, Fair Quality LIMESTONE (with PHYLLITE interbeds). | C1 | 100 (73) | 2.2<br>2.1<br>1.7<br>2.2<br>2.2 | | | | | | | |
| 25 | | 24.0 ft to 29.0 ft, C2) Light to dark gray, moderately hard, fresh, closely to moderately jointed, Good Quality LIMESTONE (with PHYLLITE interbeds). | C2 | 100 (85) | 1.3<br>1.3<br>1.3<br>1.1<br>1.2 | | | | | | | |
| 30 | | Hole stopped @ 29.0 ft<br>Inferred Bedrock | | | | | | | | | | |
| 35 | | | | | | | | | | | | |
| 40 | | Remarks:<br>1) S2, S5 not per ASTM D1586 standards (back to back with S1 and S4).<br>2) Switched to 300 lb safety hammer to pound casing through glacial till.<br>3) Driller noted inferred ledge at 18', Rollerbitted through to 19'prior to coring. Stone cuttings in wash.<br>4) Hammer energy is assumed. | | | | | | | | | | |
| 45 | | | | | | | | | | | | |

Top of Bedrock @ 18.0 ft

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

GEODESIGN LOG - NO LOCATION OR GSE WASHINGTON BRIDGE 15.GPJ VERMONT AOT.GDT 1/4/24

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

# BORING LOG

**VT Route 110 Washington Bridge #15**
**Washington ER P23-1(669)**

Boring No.: **B-102**
Page No.: 1 of 1
Pin No.: 23B742
Checked By: JFW

Boring Crew: Ken Smith (NEBC), Jack Cassara (GEODesign)
Date Started: 8/07/23 Date Finished: 8/07/23
VTSPG NAD83: Not Available
Station: Not Available Offset: Not Available
Ground Elevation: Not Available

| | Casing | Sampler |
|---|---|---|
| Type: | FJ | SS |
| I.D.: | 4 in | 2 in |
| Hammer Wt: | 140 lb. | 140 lb. |
| Hammer Fall: | 30 in. | 30 in. |
| Hammer/Rod Type: | | Auto |
| Rig: | GTechDrill GT8 | $C_E$ = 1.3 |

Groundwater Observations [3]

| Date | Depth (ft) | Notes |
|---|---|---|
| | | |
| | | |
| | | |

| Depth (ft) | Strata [1] | CLASSIFICATION OF MATERIALS (Description) | Run (Dip deg.) | Core Rec. % (RQD %) | Drill Rate minutes/ft | Blows/6" (N Value) [2] | Moisture Content % | Gravel % | Sand % | Fines % | LL % | PI % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Asphalt | | | | | | | | | | |
| | | S1) Dense, dark brown fine to coarse SAND and SILT, little fine to coarse Gravel, moist. Rec. = 0.8 ft | | | | 17-16-15-9 (31) | | | | | | |
| 5 | | S2) Medium dense, gray/brown fine to coarse SAND and SILT (ORGANICS), trace roots, trace to fine Gravel, moist. Rec. = 0.8 ft (A-2-4.) | | | | 6-8-7-6 (15) | | | | | | |
| | | S3) Medium dense, gray, fine to medium SAND and SILT, moist. Rec. = 0.9 ft | | | | 5-5-8-12 (13) | 33.4 | 1.9 | 65.4 | 32.6 | NP | NP |
| | | S4) Medium dense Top 11": Gray, fine to medium SAND and SILT, wet. Bottom 9": Orange-brown, fine to coarse SAND and SILT, trace fine to coarse Gravel, moist. Rec. = 1.8 ft | | | | 13-9-13-100/4" (22) | | | | | | |
| 10 | | 9.0 ft to 14.0 ft, C1) Light to dark gray, moderately hard, slightly weathered along fracture surfaces, very closely to closely jointed, Poor Quality LIMESTONE (with PHYLLITE interbeds). NX | C1 | 83 (22) | 1.5<br>1.6<br>1.2<br>1.4<br>2.2 | | | Top of Bedrock @ 9.0 ft | | | | |
| 15 | | 14.0 ft to 19.0 ft, C2) Light to dark gray, moderately hard, slightly weathered along fracture surfaces, very closely to closely jointed, Poor Quality LIMESTONE (with PHYLLITE interbeds). NX | C2 | 55 (35) | 1.2<br>1.2<br>0.9<br>0.8<br>0.8 | | | | | | | |
| 20 | | Hole stopped @ 19.0 ft<br>Inferred Bedrock | | | | | | | | | | |
| 25 | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | |
| 35 | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | |
| 45 | | | | | | | | | | | | |

Remarks:
1) Drilled through 8" of asphalt prior to sampling.
2) Driller inferred top of rock at 9'.
3) Hammer energy is assumed.

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 of groundwater may occur due to other factors than those present at the time measurements were made.

GEODESIGN LOG - NO LOCATION OR GSE WASHINGTON BRIDGE 15.GPJ VERMONT AOT.GDT 1/4/24

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

# BORING LOG

**VT Route 110 Washington Bridge #15**
**Washington ER P23-1(669)**

Boring No.: **P-103**
Page No.: 1 of 1
Pin No.: 23B742
Checked By: JFW

Boring Crew: Ken Smith (NEBC), Jack Cassara (GEODesign)
Date Started: 8/07/23 Date Finished: 8/07/23
VTSPG NAD83: Not Available
Station: Not Available Offset: Not Available
Ground Elevation: Not Available

| | Casing | Sampler |
|---|---|---|
| Type: | FJ | SS |
| I.D.: | 4 in | 2 in |
| Hammer Wt: | 140 lb. | 140 lb. |
| Hammer Fall: | 30 in. | 30 in. |
| Hammer/Rod Type: | | Auto |
| Rig: | GTechDrill GT8 | $C_E$ = 1.3 |

Groundwater Observations [3]

| Date | Depth (ft) | Notes |
|---|---|---|
| | | |
| | | |
| | | |

| Depth (ft) | Strata [1] | CLASSIFICATION OF MATERIALS (Description) | Blows/6" (N Value) [2] | Moisture Content % | Gravel % | Sand % | Fines % |
|---|---|---|---|---|---|---|---|
| | | 8" Asphalt | | | | | |
| | | Smooth drilling. | | | | | |
| 5 | | Medium rig chatter. | | | | | |
| 10 | | Smooth hard drilling (Inferred Bedrock). Top of Bedrock @ 9.5 ft<br>Hole stopped @ 9.5 ft<br>Inferred Bedrock | | | | | |

Remarks:
1) Exploration performed as a probe for top of bedrock. No soil sampling was performed.
2) Drove casing to 5'. Advance open-hole with rollerbit thereafter.
3) Wash water dark brown through inferred fill to 7' deep.
4) Rollerbit chatter at 7' deep on inferred gravelly soils.
5) Driller infers bedrock at 9.5' deep.

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 of groundwater may occur due to other factors than those present at the time measurements were made.

GEODESIGN LOG - NO LOCATION OR GSE WASHINGTON BRIDGE 15.GPJ VERMONT AOT.GDT 1/4/24

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

# BORING LOG

**VT Route 110 Washington Bridge #15**
**Washington ER P23-1(669)**

Boring No.: **P-104**
Page No.: 1 of 1
Pin No.: 23B742
Checked By: JFW

Boring Crew: Ken Smith (NEBC), Jack Cassara (GEODesign)
Date Started: 8/08/23 Date Finished: 8/08/23
VTSPG NAD83: Not Available
Station: Not Available Offset: Not Available
Ground Elevation: Not Available

| | Casing | Sampler |
|---|---|---|
| Type: | FJ | SS |
| I.D.: | 4 in | 2 in |
| Hammer Wt: | 140 lb. | 140 lb. |
| Hammer Fall: | 30 in. | 30 in. |
| Hammer/Rod Type: | | Auto |
| Rig: | GTechDrill GT8 | $C_E$ = 1.3 |

Groundwater Observations [3]

| Date | Depth (ft) | Notes |
|---|---|---|
| | | |
| | | |
| | | |

| Depth (ft) | Strata [1] | CLASSIFICATION OF MATERIALS (Description) | Blows/6" (N Value) [2] | Moisture Content % | Gravel % | Sand % | Fines % |
|---|---|---|---|---|---|---|---|
| | | 11" Asphalt | | | | | |
| | | Smooth drilling. | | | | | |
| 5 | | | | | | | |
| | | Medium rig chatter. | | | | | |
| 10 | | | | | | | |
| | | Smooth hard drilling (Inferred Bedrock). | | | | | |
| | | Top of Bedrock @ 13.5 ft | | | | | |
| 15 | | Hole stopped @ 13.5 ft<br>Inferred Bedrock | | | | | |
| 20 | | | | | | | |
| 25 | | | | | | | |
| 30 | | | | | | | |
| 35 | | | | | | | |
| 40 | | | | | | | |
| 45 | | | | | | | |

Remarks:
1) Exploration performed as a probe for top of bedrock. No soil sampling was performed.
2) Drove casing down to approximately 10'. Advance open hole with rollerbit thereafter.
3) Wash water brown.
4) Rollerbit chatter at 13.5', slowed advance at 14', stone chips in wash. Infer bedrock at 13.5' deep.

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 of groundwater may occur due to other factors than those present at the time measurements were made.

GEODESIGN LOG - NO LOCATION OR GSE WASHINGTON BRIDGE 15.GPJ VERMONT AOT.GDT 1/4/24

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

# BORING LOG

**VT Route 110 Washington Bridge #15**
**Washington ER P23-1(669)**

Boring No.: **P-105**
Page No.: 1 of 1
Pin No.: 23B742
Checked By: JFW

Boring Crew: Ken Smith (NEBC), Jack Cassara (GEODesign)
Date Started: 8/08/23 Date Finished: 8/08/23
VTSPG NAD83: Not Available
Station: Not Available Offset: Not Available
Ground Elevation: Not Available

| | Casing | Sampler |
|---|---|---|
| Type: | FJ | SS |
| I.D.: | 4 in | 2 in |
| Hammer Wt: | 140 lb. | 140 lb. |
| Hammer Fall: | 30 in. | 30 in. |
| Hammer/Rod Type: | | Auto |
| Rig: | GTechDrill GT8 | $C_E$ = 1.3 |

Groundwater Observations [3]

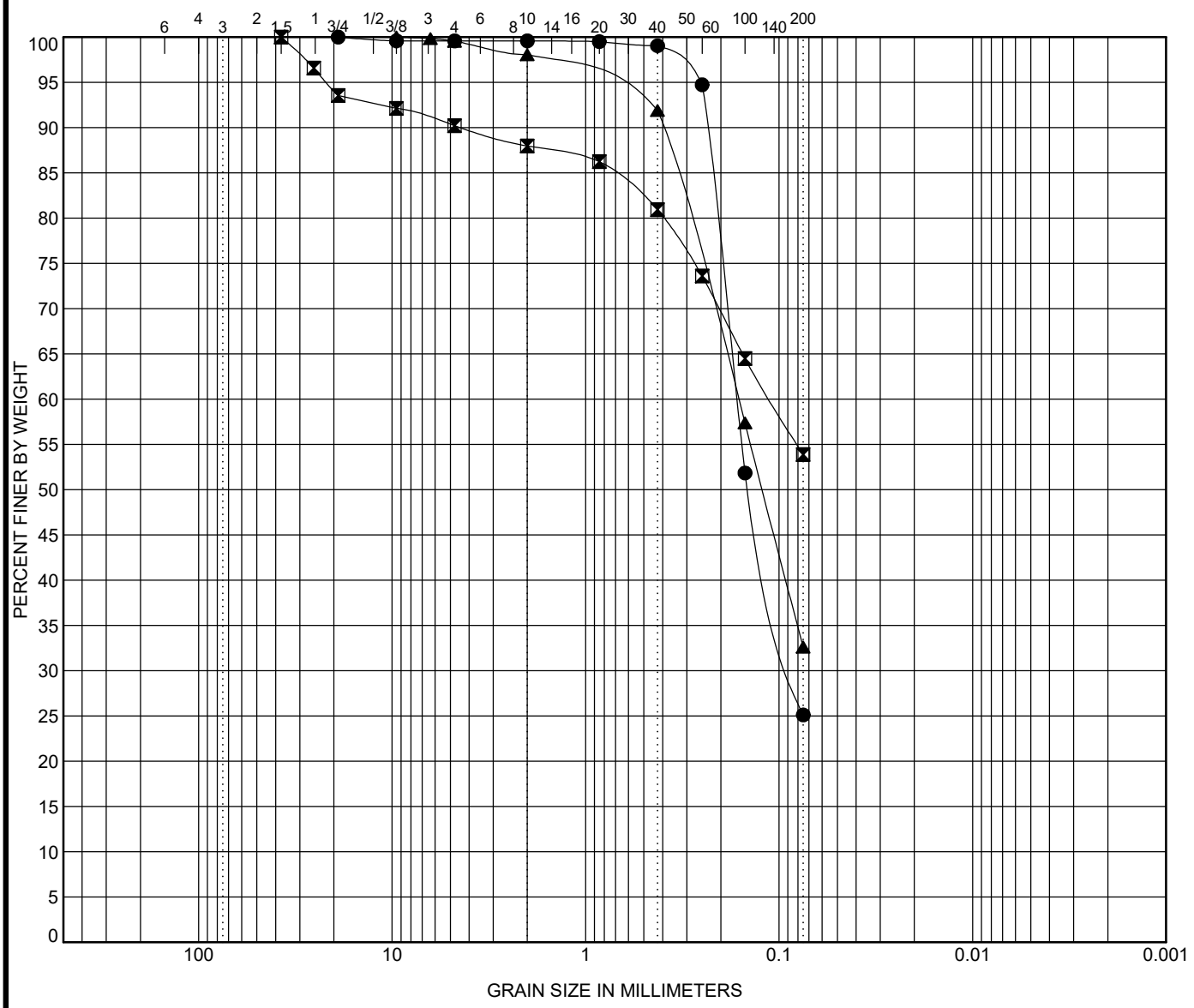
| Date | Depth (ft) | Notes |
|---|---|---|
| | | |
| | | |
| | | |

| Depth (ft) | Strata[1] | CLASSIFICATION OF MATERIALS (Description) | Blows/6" (N Value)[2] | Moisture Content % | Gravel % | Sand % | Fines % |
|---|---|---|---|---|---|---|---|
| | | Asphalt | | | | | |
| | | Smooth drilling. | | | | | |
| 5 | | | | | | | |
| | | Hard rig chatter (Inferred Decomposed Bedrock). | | | | | |
| | | Top of Bedrock @ 8.5 ft | | | | | |
| 10 | | Smooth hard drilling (Inferred Bedrock). | | | | | |
| | | Hole stopped @ 9.0 ft | | | | | |
| | | Inferred Bedrock | | | | | |
| 15 | | | | | | | |
| 20 | | | | | | | |
| 25 | | | | | | | |
| 30 | | | | | | | |
| 35 | | | | | | | |
| 40 | | | | | | | |
| 45 | | | | | | | |

Remarks:
1) Exploration performed as a probe for top of bedrock. No soil sampling was performed.
2) Driller drove casing to refusal on inferred bedrock at 9' deep
3) Wash water brown to gray.
4) Rollerbit chatter beginning at approximately 8.5'.

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 of groundwater may occur due to other factors than those present at the time measurements were made.

GEODESIGN LOG - NO LOCATION OR GSE WASHINGTON BRIDGE 15.GPJ VERMONT AOT.GDT 1/4/24




| COBBLES | GRAVEL | SAND | | SILT OR CLAY |
|---|---|---|---|---|
| | | coarse | fine | |

| | Boring | Start Depth (ft) | Classification (M145 , D2487) | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|
| ● | B-101 | 6.0 | A-2-4 , SM | NP | NP | NP | | |
| ⊠ | B-101 | 14.0 | A-4 , ML | NP | NP | NP | | |
| ▲ | B-102 | 4.5 | A-2-4 , SM | NP | NP | NP | | |
| | | | | | | | | |
| | | | | | | | | |

| | Boring | Start Depth (ft) | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|
| ● | B-101 | 6.0 | 19 | 0.165 | 0.085 | | 0.4 | 74.5 | 25.1 | |
| ⊠ | B-101 | 14.0 | 37.5 | 0.112 | | | 12.0 | 34.1 | 53.9 | |
| ▲ | B-102 | 4.5 | 9.5 | 0.162 | | | 1.9 | 65.5 | 32.6 | |
| | | | | | | | | | | |
| | | | | | | | | | | |

VTrans Working to Get You There — Vermont Agency of Transportation

GEO DESIGN

# GRAIN SIZE DISTRIBUTION

Project Name: VT Route 110 Washington Bridge #15 - Washington, VT
Number: Washington ER P23-1(669)
Testing Performed By: JAC
Testing Reviewed By: JFW
Testing Date: 12/28-29/2023
Testing performed in general accordance with AASHTO T27 & T11.

GEO SIEVE WASHINGTON BRIDGE 15.GPJ VT AOT.GDT 12/29/23

GEO DESIGN

GEODesign, Inc.
85 Granite Shed Lane
Suite #1
Montpelier, VT 05602
(802) 674-2033

# 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 GEODesign, 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 **VTrans**, for specific application to the **Washington ER P23-1(669)** project, as described in GEODesign'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 GEODesign, 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.