ADDENDUM #1
ITB/RFP NUMBER: 2016022-PW-B
Reservoir Street Project ITB

DATE: December 31, 2015

TO: All Potential Bidders/Offerors

City of Harrisonburg's Reservoir Street Project ITB, is modified as follows:

1. Question: Are you able to send the Geotech report info for the retaining walls on this project?

Answer: See attached pages for the two (2) geotech reports done for this project.

All other requirements, terms and conditions of the ITB/RFP remain unchanged.

Addendum page must be signed and returned with your bid/proposal to acknowledge receipt of this addendum.

_____
Authorized Signature

By: Pat Hilliard, CPPB
Procurement Manager

Report of Geotechnical Study

Reservoir Street Widening
Harrisonburg, Virginia
F&R Project No. 71R3013

Prepared For:
McCormick Taylor, Inc.
113 Mill Place Parkway
Verona, Virginia 24482

Prepared By:
Froehling & Robertson, Inc.
6181 Rockfish Gap Turnpike
Crozet, Virginia 23932-3330

December 4, 2013

SINCE 1881

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Engineering Stability Since 1881

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December 4, 2013

McCormick Taylor, Inc.
113 Mill Place Parkway
Verona, Virginia 24482

Attn: Mr. Gregory E. Krystyniak, P.E.

Reference: Report of Geotechnical Study
Reservoir Street Widening
Harrisonburg, Virginia
F&R Project No. 71R3013

Dear Mr. Krystyniak:

The purpose of this study is to present the results of the subsurface exploration program and geotechnical engineering evaluation undertaken by Froehling & Robertson, Inc. (F&R) in connection with the referenced project. Our services were performed in general accordance with F&R Proposal No. 1471-144G rev1 dated September 17, 2013. The attached report presents our understanding of the project, reviews our exploration procedures, describes existing site and general subsurface conditions, and presents our geotechnical evaluations and recommendations.

We have enjoyed working with you on this project, and we are prepared to assist you with the recommended quality assurance monitoring and testing services during construction. Please contact us if you have any questions regarding this report or if we may be of further service.

Sincerely,
FROEHLING & ROBERTSON, INC.

COMMONWEALTH OF VIRGINIA
CLYDE A. SIMMONS, III
Lic. No. 037906
12/4/13
PROFESSIONAL ENGINEER

Clyde A. Simmons, III, P.E.
Senior Engineer

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Geotechnical Engineer

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TABLE OF CONTENTS

SECTION		PAGE
1.0	PURPOSE & SCOPE OF SERVICES	1
2.0	PROJECT INFORMATION	2
2.1	SITE DESCRIPTION	2
2.2	PROPOSED CONSTRUCTION	2
3.0	EXPLORATION PROCEDURES	3
3.1	SOIL BORINGS	3
3.2	LABORATORY TESTING	5
4.0	REGIONAL GEOLOGY & SUBSURFACE CONDITIONS	5
4.1	REGIONAL GEOLOGY	5
4.2	SUBSURFACE CONDITIONS	6
4.2.1	General	6
4.2.2	Surficial Materials	7
4.2.3	Existing Fill Materials	7
4.2.4	Residual Soils	8
4.2.5	Auger Refusal Materials	8
4.2.6	Bedrock Materials	8
4.3	SUBSURFACE WATER	8
5.0	GEOTECHNICAL DESIGN RECOMMENDATIONS	9
5.1	GENERAL	9
5.2	RETAINING WALL E	10
5.3	GRAVITY WALLS RW-3	10
5.4	LARGE DIAMETER PIPE SUPPORT	11
5.5	ROADWAY SUBGRADES	11
5.6	TEMPORARY PAVEMENTS	12
5.7	MILLING AND OVERLAYING OF SIDE STREETS	12
6.0	CONTINUATION OF SERVICES	14
7.0	LIMITATIONS	15

APPENDICES

APPENDIX I

Site Vicinity Map (Drawing No. 1)
Boring Location Plan (Drawing No. 2)

APPENDIX II

Key to Soil Classification
Unified Soil Classification System
Key to Boring Log Rock Classification
Typical Diagram of Limestone Profile
Boring Logs
Subsurface Profiles

APPENDIX III

ASFE Document "Important Information about Your Geotechnical Engineering Report"

1.0 PURPOSE & SCOPE OF SERVICES

The purpose of the subsurface exploration and geotechnical engineering evaluation was to explore the subsurface conditions on the project site and provide geotechnical engineering evaluation and construction recommendations that can be used during planning process of the proposed structure and site work.

F&R's scope of services included the following:

- Visited the site to observe existing surface conditions;
- Coordinated utility clearance with Miss Utility;
- Reviewed readily available geologic and subsurface information relative to the project site;
- Completion of three soil test borings to depths of 20 feet to 40 feet below the existing ground surface and perform 5 feet of rock coring;
- Performed laboratory testing on selected soil samples, consisting of water content, wash sieve analysis, Atterberg Limits, and an unconfined compression test of a rock core;
- Preparation of typed Boring Logs and development of a Subsurface Profile;
- Performing a geotechnical engineering evaluation of the subsurface conditions with regard to their suitability for the proposed construction;
- Provided the requested LRFD parameters for retaining wall E.
- Provided comments regarding the feasibility of RW-3 walls for the other wall locations.
- Provided recommendations for support of the large diameter concrete pipes where poor soil conditions are present. This will include undercutting, increasing the thickness of bedding material, and the use of geosynthetics, as appropriate;
- Provided subgrade stabilization recommendations for the roadway;
- Provided recommendations regarding the design and construction of temporary pavements (i.e. pavement subjected to traffic for 1 year or less), including a recommended pavement section;
- F&R will provide comments regarding the feasibility of milling and overlaying the side streets, based on a visual examination of the pavement condition;
- Preparation of this geotechnical report by professional engineers.

Our scope of services did not include a survey of the boring locations, quantity estimates, preparation of plans or specifications, or the identification and evaluation of wetland or other environmental aspects of the project site.

2.0 PROJECT INFORMATION

2.1 Site Description

The project site is currently consists of an approximately 1.6 mile long section of Reservoir Street, just north of the city boundary to just north of the intersection with University Boulevard in Harrisonburg, Virginia (See Site Location Plan, Drawing No. 1, Appendix I). The existing roadway consists of two lanes (i.e. one lane in each direction) south of Neff Avenue, and four lanes (i.e. two lanes in each direction) north of Neff Avenue. The surrounding area is mostly residential to the south and commercial to the north.

2.2 Proposed Construction

Project information was provided in telephone and email correspondence with you, which included the following electronically provided plan and section drawings: "d101219_geotech plan_9-4-13.pdf" and "d101219_geotech xsn_9-4-13.pdf". F&R has also been provided the "Revised Geotechnical Engineering Report" for the Project by S&ME dated 7/27/12.

It is understood that road widening is planned for an approximately 1.6 mile length of Reservoir Street. Pavements will consist of new pavements, as well as some overlay, with overlay planned at the side streets where they tie into Reservoir Street. Seven retaining walls (designated Wall A through Wall G) are planned for the project. Each of the walls is planned to consist of a VDOT RW-3 concrete gravity wall, except for Wall E. Soldier piles and MSE is being considered for this wall, which will be about 10 feet tall. The project will also include new 42" diameter and 60" diameter culvert pipes. A summary of the retaining wall conditions is as follows:

Wall No.	Length (ft)	Starting Location (Station No.)	Maximum Height (ft)	Cut or Fill	Proposed Type
A	77.5	33+60	6	Cut	RW-3 (gravity)
B	264	34+63	8	Cut	RW-3 (gravity)
C	230	39+45	8	Cut	RW-3 (gravity)
D	91.4	48+33	8	Fill	RW-3 (gravity)
E	340.8	56+00	10	Fill	MSE or soldier pile
F	200	59+75	8	Cut	RW-3 (gravity)
G	400	11+00	7	Cut	RW-3 (gravity)

This report is intended to supplement the data and recommendations which were provided in the aforementioned S&ME report. The recommendations given herein are predicated on the assumption that the S&ME data is accurate. Unless stated otherwise herein, F&R takes no exceptions to the data or recommendations from the S&ME report.

3.0 EXPLORATION PROCEDURES

3.1 Soil Borings

The exploration program was performed on November 7 and 15, 2013, and consisted of three soil test borings designated B-101 through B-103. The borings were drilled to the planned termination depths of 20 to 40 feet each or prior auger refusal. The locations of the borings are shown on the attached Boring Location Plan (Drawing No. 2). The planned boring locations were determined and staked in the field by F&R by measuring from existing site features such as building corners, edges of pavement, etc. Surface elevations at the boring locations were estimated from the topography indicated on the provided site plans. In consideration of the methods used in their determination, the test boring locations shown on the attached boring location plan should be considered approximate.

The soil test borings were performed in accordance with generally accepted practice using a track-mounted CME-55 rotary drill rig equipped with an automatic safety hammer. Hollow-stem augers were advanced to pre-selected depths, the center plug was removed, and representative soil samples were recovered with a standard split-spoon sampler (1 3/8 in. ID, 2 in. OD) in general accordance with ASTM D 1586, the Standard Penetration Test. For these tests, a weight of 140 pounds was freely dropped from a height of 30 inches to drive the split-spoon sampler into the soil. The number of blows required to drive the split-spoon sampler three consecutive 6-inch increments was recorded, and the blows of the last two increments were summed to obtain the Standard Penetration Resistance (N-value). The N-value provides a general indication of in-situ soil conditions and has been correlated with certain engineering properties of soils.

Research has shown that the Standard Penetration Resistance (N-value) determined by automatic hammer is different than the N-value determined by the safety hammer method. Most corrections that are published in the technical literature are based on the N-value determined by the safety hammer method. This is commonly termed N_{60} as the rope and cathead with a safety hammer delivers about 60 percent of the theoretical energy delivered by a 140-pound hammer falling 30 inches. Several researchers have proposed correction factors for the use of hammers other than the safety hammer. The correction is made by the following equation:

$$N_{60} = N_{field} \times C_E$$

where N_{field} is the value recorded in the field, and C_E is the drill rod energy ratio for the hammer used. A correction factor (C_E) of 1.3 was utilized for the automatic hammer used during the drilling of borings for this site, based on previous energy measurements made for the automatic hammer system. Plotted N-values reported on Boring Logs are the actual, field-derived blow

counts (N_{field}). Drilling notes on each Boring Log indicates whether penetration resistances presented on the Boring Log were determined using automatic hammer or conventional hammer systems. Corrected N_{60} values were used for all analyses.

In some soils it is not always practical to drive a split-spoon sampler the full three consecutive 6-inch increments. Whenever more than 50 blows are required to drive the sampler over a 6-inch increment, or the sampler is observed not to penetrate after 10 blows, the condition is called split-spoon refusal. Split-spoon refusal conditions may occur because of obstructions or because the earth materials being tested are very dense or very hard. When split-spoon refusal occurs, often little or no sample is recovered. The SPT N-value for split-spoon refusal conditions is typically estimated as > 100 blows per foot (bpf). Where the sampler is observed not to penetrate after 10 blows, the N-value is reported as 10/0. Otherwise, the depth of penetration after 50 blows is reported in inches, i.e. 50/5, 50/2, etc.

The test borings were advanced through the soil overburden by soil drilling procedures until the planned termination depth or auger refusal material was encountered. Rock coring was performed in boring B-101.

Rock coring was accomplished in general accordance with ASTM D 2113 using a 2-inch nominal inside diameter diamond-impregnated drill attached to the end of a double-tube core barrel. Rock core specimens were measured for recovery immediately upon retrieval, placed in core boxes for protection, labeled and transported to the laboratory for further evaluation by our professional staff. In the laboratory, the rock core specimens were measured for Percent Recovery and Rock Quality Designation (RQD) by a member of our professional staff. Percent Recovery is the ratio of the recovered core length to the length of rock drilled, expressed by a percentage. RQD is the ratio of the cumulative length of all pieces of rock greater than or equal to four (4) inches to the total amount drilled, expressed as a percent of the total amount drilled. The RQD value is related to the soundness and quality of the rock mass and has been correlated with engineering properties of rock. Qualitative descriptions of the rock cored were also developed and are included on the boring logs.

Subsurface water level readings were taken in each of the borings during the drilling process. Upon completion of drilling, the boreholes were backfilled with auger cuttings (soil). Periodic observation of the boreholes should be performed to monitor subsidence at the ground surface, as the borehole backfill could settle over time.

Representative portions of the split-spoon soil samples obtained throughout the exploration program were placed in glass jars and transported to our laboratory. In the laboratory, the soil samples were evaluated by a member of our engineering staff in general accordance with techniques outlined in the visual-manual identification procedure (ASTM D 2488). The soil

descriptions and classifications discussed in this report and shown on the attached Boring Logs are based on visual observation and should be considered approximate. A copy of the boring logs are provided and classification procedures are further explained in Appendix II.

Split-spoon soil samples recovered on this project will be stored at F&R's office for a period of 60 days. After 60 days, the samples will be discarded unless prior notification is provided to us in writing.

3.2 Laboratory Testing

Representative soil samples were subjected to Water Content (ASTM D 2216), #200 Sieve Wash (ASTM D 1140), and Atterberg Limits (ASTM D 4318) to substantiate the visual classifications and assist with the estimation of the soils' pertinent engineering properties. In addition, one rock core sample was tested to determine its unconfined compressive strength. The results are shown in Section 4.4.

4.0 REGIONAL GEOLOGY & SUBSURFACE CONDITIONS

4.1 Regional Geology

The project site is located in Virginia's Valley and Ridge Geologic Province which is underlain by ancient faulted and folded limestones, dolomites, shales and sandstones of Paleozoic age. Information obtained from publication entitled Geology of Harrisonburg and Bridgewater, Quadrangles, Virginia (Commonwealth Division of Mineral Resources Publication 60, 1986) indicates that this area is located over the Ordovician age carbonate rocks which are a part of the Beekmantown Group middle limestone unit. The virgin soils encountered in this area are the residual product of in-place chemical and mechanical weathering of the parent bedrock formation that underlies the site. These materials consist of clayey soils near the surface where soil weathering is more advanced, underlain by silty material.

Often, these rocks weather to form a highly variable bedrock surface consisting of troughs and pinnacles that may greatly fluctuate in elevation within short lateral distances. Sometimes, the interbedded layers after weathering will result in alternating rock and soil seam layers that can be oriented near vertical. The varying susceptibility to weathering creates seams of soil sandwiched between weather-resistant rock pinnacles.

From an excavation and support point of view, this near vertical orientation can result in very hard layers that may require blasting to excavate, interbedded with soft clay seams that may require undercutting to some depth to provide adequate structural support. Where soil test borings encountered a vertical bed of auger refusal material, direct interpretation of the field data might lead one to envision a rock surface between the auger refusal points. Likewise, where vertical soil seams are encountered, a deep soft soil profile might be anticipated.

However, in the Valley and Ridge physiographic province our experience is that a combination of both conditions may exist. Therefore, the boring data should be viewed as a specific example of the subsurface condition at each explored location rather than a broad interpretation of conditions across the site area.

Limestone and dolomite are composed of calcium carbonate and calcium magnesium carbonate, respectively, with the relative proportion of magnesium to calcium being used to distinguish the two types of rock. Impurities (i.e., silicates, sulfides, and other mineral groups) within these rock formations occur either as distinct beds of shale or siltstone, or may be widely dispersed throughout the rock. Carbonate rocks are susceptible to dissolution in the presence of subsurface water. The mineral residues remaining after the carbonates are eroded are known as residual soils, and typically consist of medium to highly plastic silts and clays.

Continued subsurface dissolution of the carbonate bedrock may lead to development of a highly irregular rock profile that may include underground voids. Over time, the soils overlying a void may subside, in a continual process of subsurface chemical erosion of bedrock and infilling by overburden soils. The resulting ground surface depression is known as a sinkhole. Terrain characterized by sinkholes and other solutional features is known as karst. See attached conceptual model of carbonate geology provided by ATS International in Appendix II.

There are numerous other variations on sinkhole development. Regardless of the mode of development, it is important to note that changes in soil stress and water regime can greatly accelerate sinkhole development. Natural geologic processes that might otherwise occur over thousands of years can occur within several years or even months. Construction activities such as site grading, building construction, change in water flow and water impoundment have reportedly caused sinkholes to develop rapidly or to collapse suddenly. This site lies within a geologic formation known to contain solutional features; however, the potential for development of sinkholes, along with the rate at which a sinkhole will develop, are not easily determined or accurately predicted.

4.2 Subsurface Conditions

4.2.1 General

The subsurface conditions discussed in the following paragraphs and those shown on the attached Boring Logs represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. The transitions between different soil strata are usually less distinct than those shown on the boring logs. Sometimes the relatively small sample obtained in the field is insufficient to definitively describe the origin of the subsurface material. In these cases, we qualify our origin descriptions with “possible” before the word describing the material’s origin (i.e. possible fill, etc.). Although individual soil test borings are representative of the subsurface conditions at

the boring locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or at other times. Data from the specific soil test borings are shown on the attached Boring Logs in Appendix II.

A Subsurface Profile has been prepared from the boring data to graphically illustrate the subsurface conditions encountered at the site. The Subsurface Profile can be found after the boring logs in Appendix II. Strata breaks designated on the Boring Logs and Subsurface Profile represent approximate boundaries between soil types. The transition from one soil type to another may be gradual or occur between soil samples. This section of the report provides a general discussion of subsurface conditions encountered within areas of proposed construction at the project site.

Below the existing ground surface, the borings generally encountered pavements (borings B-101 and B-102), surficial organics (boring B-103), existing fill (boring B-102 and B-103), residual soils, auger refusal materials (boring B-101) and bedrock materials (boring B-101). These materials are generally discussed in the following paragraphs.

4.2.2 Surficial Materials

Borings B-101 and B-102 encountered a pavement section consisting of 6 inches of asphaltic concrete overlying 6 inches of gravel. Thicknesses of pavement layers were taken in the borehole, not from core samples, and should be considered approximate. Surficial soils were encountered in boring B-3 and extended to a depth of 4 inches. Surficial organic soil is typically a dark-colored soil material containing roots, fibrous matter, and/or other organic components, and is generally unsuitable for engineering purposes. F&R has not performed any laboratory testing to determine the organic content or other horticultural properties of the observed surficial organic soil materials. Therefore, the term surficial organic soil is not intended to indicate a suitability for landscaping and/or other purposes. The surficial organic soil depths provided in this report are based on driller observations and should be considered approximate. We note that the transition from surficial organic soil to underlying materials may be gradual, and therefore the observation and measurement of surficial organic soil depths is subjective. Actual surficial organic soil depths should be expected to vary.

4.2.3 Existing Fill Materials

Fill consists of any materials deposited by man. Existing fill materials were encountered in borings B-102 and B-103 and extended to depths of 4 feet to 13.5 feet below existing grades. Sampled fill materials consisted of lean CLAY (CL) and fat CLAY (CH) soils, with varying amounts of roots, sand, and gravel. The fill materials were brown and light gray in color, with moisture contents visually characterized as moist to very moist. The Standard Penetration Test values (N-Values) in the fill ranged from 6 bpf to 19 bpf.

4.2.4 Residual Soils

Residual soils, formed by the in-place weathering of the parent rock, were encountered at each boring location below the pavement section or fill, and extended to the boring termination or bedrock depths. The residual soil consisted of silty GRAVEL (GM), SILT (ML), elastic SILT (MH), and fat CLAY (CH). These soils were brown, light brown, orangish brown, light gray, and dark gray in color, with moisture contents visually characterized as moist to wet. The Standard Penetration Test values (N-Values) in the residuum ranged from 1 bpf to 31 bpf.

4.2.5 Auger Refusal Materials

Auger refusal occurs when materials are encountered that cannot be penetrated by the soil auger and is normally indicative of a very hard or very dense material, such as boulders, rock lenses, rock pinnacles, or the upper surface of rock. Auger refusal was encountered in boring B-101 at a depth of 31.5 feet below existing grades. Auger refusal conditions with a CME 55 do not necessarily indicate conditions impenetrable to other equipment. Auger refusal conditions will likely vary in unexplored areas of the site.

4.2.6 Bedrock Materials

Rock coring was performed in boring B-101 at a depth of 31.5 feet and was extended 5 feet below auger refusal elevations. The bedrock materials were classified as gray, slightly weathered, close to widely fractured LIMESTONE from the Beekmantown formation. The recovered sample recorded a recovery of 100% and a rock quality designation (RQD) of 65%. The compressive strength of a sample of the rock core was determined to be 4,580 psi.

4.3 Subsurface Water

The test borings were monitored during and after drilling operations to obtain short-term subsurface water information. Subsurface water was encountered during drilling in borings B-101 and B-102 at depths of 18 feet to 35 feet. It should be noted that the location of the subsurface water table could vary by several feet because of seasonal fluctuations in precipitation, evaporation, surface water runoff, local topography, and other factors not immediately apparent at the time of this exploration. Normally, the highest subsurface water levels occur in the late winter and spring and lowest levels occur in the late summer and fall.

4.4 Laboratory Test Results

As discussed in Section 3.2, laboratory testing was performed on representative soil samples collected during our subsurface exploration and the results are indicated in the tables below.

Boring No.	Sample Depth (Feet)	Natural Water Content (%)	Liquid Limit/ Plasticity Index	% Passing No. 200 Sieve	USCS Class.
B-101	1-2.5	37.3	--	--	--
B-101	4-5.5	44.1	--	--	--
B-102	1-2.5	25.7	--	--	--
B-102	4-5.5	15.7	--	--	--
B-103	1.5-3	16.1	43/25	73.0	CL
B-103	3.5-5	23.5	--	--	--
B-103	8.5-10	25.9	54/34	79.9	CH
B-103	13.5-15	34.3	--	--	--

5.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

5.1 General

The following evaluations and recommendations are based on our observations at the site, interpretation of the field obtained during this exploration, and our experience with similar subsurface conditions and projects. Soil penetration data has been used to evaluate relative consistency and compressibility of the underlying soil stratum using established correlations. Subsurface conditions in unexplored locations may vary from those encountered. If the structure locations, loadings, or elevations are changed, we should be notified and requested to confirm and, if necessary, re-evaluate our recommendations. As previously indicated, F&R also utilized the data from the S&ME report to formulate its recommendations. Unless noted otherwise, the S&ME recommendations are considered valid; the recommendations given here were intended to be supplemental in nature.

Determination of an appropriate foundation system for a given structure is dependent on the proposed structural loads, soil conditions, and construction constraints such as proximity to other structures, etc. The subsurface exploration aids the geotechnical engineer in determining the soil stratum appropriate for structural support. This determination includes considerations with regard to both allowable bearing capacity and compressibility of the soil strata. In

addition, since the method of construction greatly affects the soils intended for structural support, consideration must be given to the implementation of suitable methods of site preparation, fill compaction, and other aspects of construction, where applicable.

5.2 Retaining Wall E

We understand that due to site constraints, this retaining wall is likely to consist of a MSE wall or soldier pile wall, rather than the typical RW-3 gravity wall. Further, this project is being designed using the LRFD method, and specific soil/rock parameters have been requested to aid in the design. Therefore, some of the parameters given herein are not applicable for ASD methods.

- Strength reduction factor for bearing capacity- 0.45
- Strength reduction factor for sliding- 0.85; 0.5 for passive pressure component of sliding resistance
- Number of soil/rock layers- 3

The remaining values that were requested can be found in the table below:

Parameter	Soil Layer		
	Medium Stiff Clay	Soft Clay	Rock
Thickness (ft)	13.5	18	Infinite
Undrained Shear Strength (psf)	1000	250	N/A
Unsaturated Unit Weight (pcf)	115	110	130
Saturated unit weight (pcf)	125	120	135
Elastic Modulus (ksf)	200	50	20000
Poisson's Ratio	0.3	0.3	0.25
Cohesion (psf)	1000	250	N/A
Effective Friction Angle (degrees)	N/A	N/A	40

5.3 Gravity Walls RW-3

We understand that gravity walls are planned for each wall except Wall E. This type of gravity wall should be feasible at those locations. However, we do note that Wall G will require cutting into the embankment for the existing detention facility. Although the facility was not designed as a “wet” pond, it appears to be have silted in and is currently retaining a pool of water. Before making any excavations into the berm, we recommend that the pond be completely drained. Provided that the pond is drained prior to construction, it is F&R’s opinion that a gravity wall is feasible for Wall G. If the pond is not drained, we recommend that the excavation be shored. Other wall types (such as soldier piles, sheet piles, or soil nailing) would reduce the required excavation, but these are typically done by a specialty contractor and are likely to be more expensive.

Based on the F&R and S&ME boring data, we anticipate that the retaining wall excavations would be made into soils meeting the requirements of OSHA "Type B" soil, and per OSHA, the allowable excavation slope angle for this soil is 1H:1V. The soil type should be confirmed during construction based on materials encountered during excavation.

5.4 Large Diameter Pipe Support

We understand that there will be some large diameter pipe culverts (48 inches and 60 inches in diameter) associated with the SWM basin, located west of Reservoir Street, north and south of its intersection with Woodland Drive. Typical bedding materials, as required by the City of Harrisonburg or VDOT, should be adequate, provided that firm soils are present. Borings B-19 and B-20 are the closest borings to the proposed piping, and generally indicate stiff to very stiff soils which should be suitable for pipe support. However, it is possible that lesser quality soils could be encountered in excavations for the pipes, especially if the pipe is located in an existing swale or low-lying area. We recommend that pipe subgrades be observed by the geotechnical engineer to determine if suitable soil conditions are present. Should soft or otherwise unsuitable soils be encountered, we envision that they would be removed and replaced with additional bedding materials to reach firm soils. If the soft soils extend to a significant depth such that complete removal is not practical, F&R should be consulted to provide a recommendation. In general, this issue can be addressed by using geosynthetics and possibly widening the base of the excavation.

5.5 Roadway Subgrades

F&R has been requested to estimate the approximate stations where undercuts will be necessary to provide adequate pavement support, and this information is provided in the table below.

Boring Number	Location	Depth of Undercut (ft)
B-6	Station 24+00 to 27+25	1.5
B-9	Station 36+00 to 38+75	1.5
B-13	Station 47+80 to 50+50	2
B-24	Station 34+50 to 35+00	2
B-29	Station 59+50 to 61+00	2
B-31	Station 11+00 to 14+00 (University)	4
B-32		2
B-33		2

We have reviewed the soil types and SPT values from the boring logs to identify areas where unstable soils requiring undercut could be encountered on the site. In order to estimate a length of undercut, we have assumed that the data from a specific boring represents the conditions across the entire road width, along a length of road equal to half the spacing between the adjacent borings in each direction. In addition, some of the borings may have been performed just outside the limits of the proposed widening, but were considered to be

"representative" of the conditions for the road widening at that location. It must be understood that the actual soil conditions can and do vary over relatively short distances between boring locations. Please note that the provided undercut locations depths are for planning purposes only, and actual undercuts should be based on the soil conditions encountered during construction. It is also possible that geosynthetics can be utilized in conjunction with the undercutting to reduce the undercutting requirements. The need for undercutting or geosynthetics should be determined by the geotechnical engineer at the time of construction, based on the soil conditions which are encountered, and the results of the proofrolling.

5.6 Temporary Pavements

We understand that there may be occasions during construction when a temporary road is needed. We understand that these temporary roads will be in service for a maximum time period of 1 year. The following is a summary of the design parameters for temporary flexible pavements:

- Design CBR value of 6.0
- ADT of 9,450 vehicles per day
- 2.1% trucks (half single unit trucks and half tractor trailers)

Our flexible pavement design analysis was based on methodology from the American Association of State Highway and Transportation Officials' (AASHTO) *Guide of Design of Pavement Structures*, 1993. Based on the assumptions and methodologies presented above, we recommend the following pavement section:

Temporary Pavement Section

Layer	VDOT Specification (Superpave)	Thickness (Inches)
Surface course	Asphalt Concrete (SM-9.5A)	1.5
Intermediate Course	Asphalt concrete (IM-19)	2.0
Subbase Course	Type I Crushed Aggregate (No. 21A or No. 21B)	6.0

5.7 Milling and Overlaying of Side Streets

We understand that 1.5 inches of mill and overlay with SM-9.5A is proposed for the public roads which intersect Reservoir Street over the length of the planned improvements. F&R has been requested to provide general comments regarding the feasibility of this pavement repair. F&R's evaluation was based on visual examination of the existing pavement condition. No pavement cores were performed to aid in this evaluation. The mill and overlay is planned for the following

roads: Stonewall Drive, Ridgeville Lane, Foley Road, Woodland Drive, Neff Avenue (east and west), and University Boulevard (east and west), with the extent of the repairs indicated on the plans provided to F&R.

In general, for milling and overlaying to be a viable option, the existing pavements must be in fair condition. It is common for cracks in the existing pavement to also propagate in the overlay. Therefore, cracked asphalt should be milled down to sound asphalt prior to overlaying, or a nonwoven asphalt overlay fabric should be used to retard the formation of the reflective cracks. F&R's comments about the surface condition of the asphalt surface of each road are indicated in the table below:

Road	**Condition**
Stonewall Drive	moderate alligator cracking, cracks worse in westbound direction
Ridgeville Lane	asphalt in good condition
Foley Road	asphalt in fair condition- appeared old- but only minor cracking
Woodland Drive	asphalt in good condition
Neff Ave- West	moderate alligator cracking
Neff Ave- East	asphalt in good condition
University Blvd- West	asphalt in good condition
University Blvd- East	moderate alligator cracking

F&R recommends that areas which are indicated above to have moderate cracking be milled to sound asphalt, or that an overlay fabric be used.

6.0 CONTINUATION OF SERVICES

We recommend that we be given the opportunity to review the foundation plan, grading plan, and project specifications when construction documents approach completion. This review evaluates whether the recommendations and comments provided herein have been understood and properly implemented. We also recommend that Froehling & Robertson, Inc. be retained for professional and construction materials testing services during construction of the project. Our continued involvement on the project helps provide continuity for proper implementation of the recommendations discussed herein.

The Geotechnical Engineer of Record should be retained to monitor and test earthwork activities, and subgrade preparations for foundations, excavations and floor slabs. It should be noted that the actual soil conditions at the various subgrade levels and footing bearing grades will vary across this site and thus the presence of the Geotechnical Engineer and/or his representative during construction will serve to validate the subsurface conditions and recommendations presented in this report. We recommend that F&R be employed to monitor the earthwork and foundation construction, and to report that the recommendations contained in this report are completed in a satisfactory manner. Our involvement on the project will aid in the proper implementation of the recommendations discussed herein. The following is a recommended scope of services:

- Review of project plans and construction specifications to verify that the recommendations presented in this report have been properly interpreted and implemented;
- Observe all foundation excavations and footing bearing grades for compliance with the geotechnical recommendations.

These services are not included in our current scope of services and can be rendered for an additional cost.

7.0 LIMITATIONS

This report has been prepared for the exclusive use of the McCormick Taylor, Inc., or their agent, for specific application to the Reservoir Street Widening project, in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made. Our evaluations and recommendations are based on design information furnished to us; the data obtained from the previously described subsurface exploration program, and generally accepted geotechnical engineering practice. The evaluations and recommendations do not reflect variations in subsurface conditions which could exist intermediate of the boring locations or in unexplored areas of the site. Should such variations become apparent during construction, it will be necessary to re-evaluate our recommendations based upon on-site observations of the conditions.

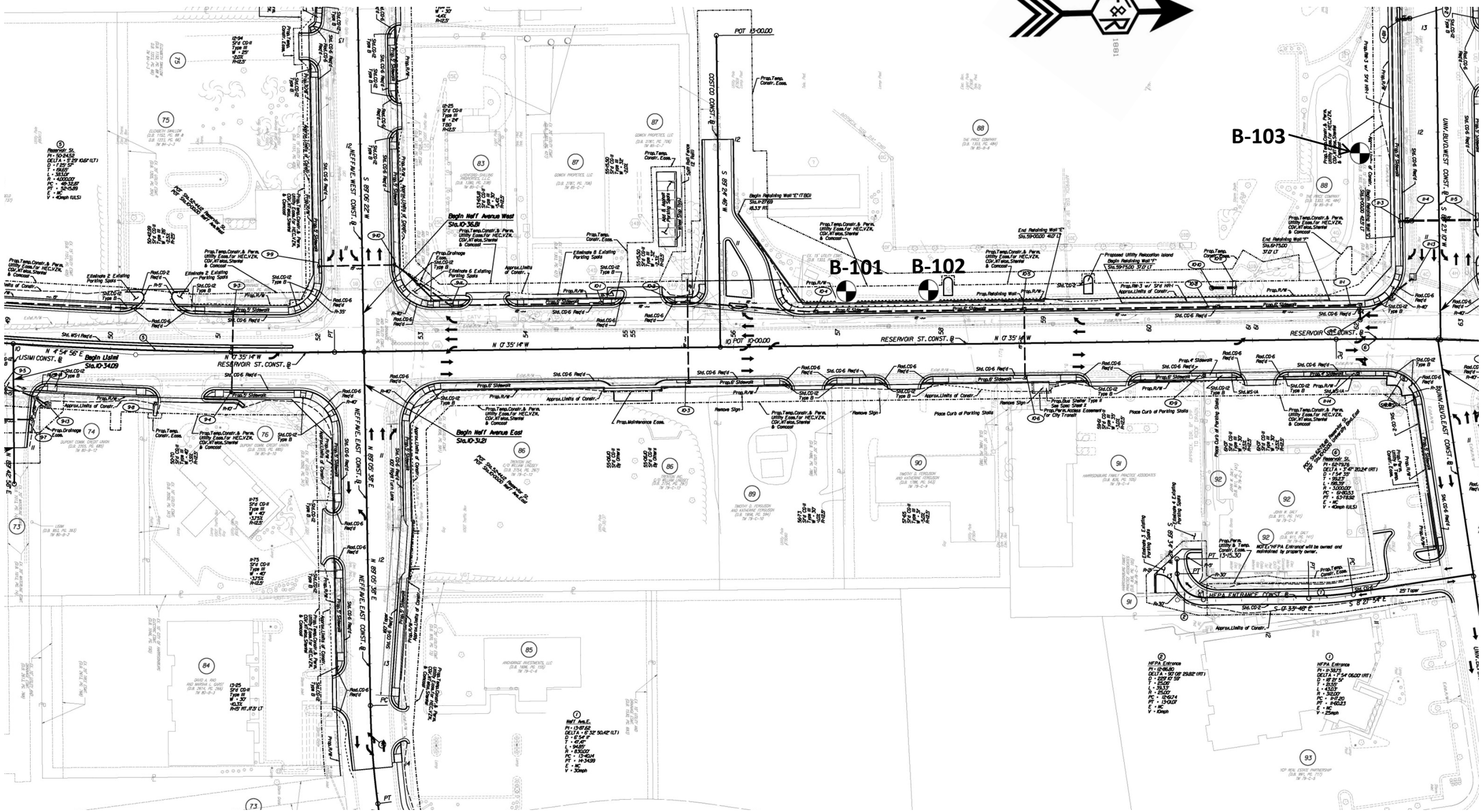
There are important limitations to this and all geotechnical studies. Some of these limitations are discussed in the information prepared by ASFE, which is included in Appendix III. We ask that you please review this ASFE information.

Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by the designers, or that the construction process has altered the soil conditions. Therefore, experienced geotechnical engineers should evaluate earthwork, pavement, and foundation construction to verify that the conditions anticipated in design actually exist. Otherwise, we assume no responsibility for construction compliance with the design concepts, specifications, or recommendations.

In the event that changes are made in the design or location of the proposed structure, the recommendations presented in the report shall not be considered valid unless the changes are reviewed by our firm and conclusions of this report modified and/or verified in writing. If this report is copied or transmitted to a third party, it must be copied or transmitted in its entirety, including text, attachments, and enclosures. Interpretations based on only a part of this report may not be valid.

APPENDIX I

FROEHLING & ROBERTSON, INC. *Engineering Stability Since 1881* 6181 Rockfish Gap Turnpike Crozet, Virginia 22932-3330 T 434.823.5154 I F 434.823.4764	Site Location Plan		
	Client: McCormick Taylor, Inc.		
	Project: Reservoir Street Widening		
	F&R Project No. 71R-3013		
	Date: Nov. 2013	Scale: NTS	Drawing No.: 1



FROEHLING & ROBERTSON, INC

Engineering Stability Since 1881

6181 Rockfish Gap Turnpike, Crozet, VA 22932
T 434.823.5154 | F 434.823.4764

Boring Location Plan

Client: McCormick Taylor, Inc.

Project: Reservoir Street Widening

F&R Project No.: 71R-3013

Date: Nov. 2013

Scale: 1"=100'

Drawing No.

2

APPENDIX II

KEY TO BORING LOG SOIL CLASSIFICATION

Particle Size and Proportion

Verbal descriptions are assigned to each soil sample or stratum based on estimates of the particle size of each component of the soil and the percentage of each component of the soil.

Particle Size Descriptive Terms		Proportion Descriptive Terms		
Soil Component	Particle Size	Component	Term	Percentage
Boulder	> 12 inch	Major	Uppercase Letters	>50%
Cobble	3 – 12 inch		(e.g., SAND, CLAY)	
Gravel-Coarse	¾ - 3 inch			
-Fine	#4 – ¾ inch	Secondary	Adjective	20%-50%
Sand-Coarse	#10 - #4		(e.g. sandy, clayey)	
-Medium	#40 - #10			
-Fine	#200 - #40	Minor	Some	15%-25%
Silt (non-cohesive)	< #200		Little	5%-15%
Clay (cohesive)	< #200		Trace	0%-5%

Notes:
1. Particle size is designated by U.S. Standard Sieve Sizes
2. Because of the small size of the split spoon sampler relative to the size of gravel, the true percentage of gravel may not be accurately estimated.

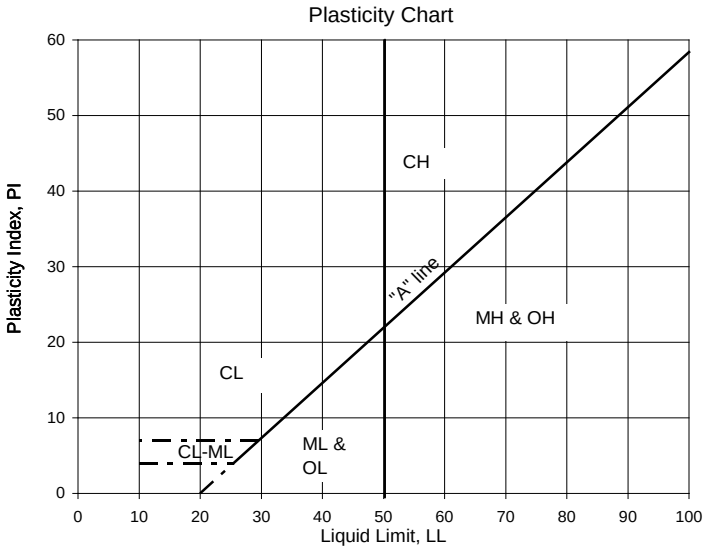
Density or Consistency

The standard penetration resistance values (N-values are used to describe the density of coarse-grained soils (GRAVEL, SAND) or the consistency of fine-grained soils (SILT, CLAY). Sandy silts of very low plasticity may be assigned a density instead of a consistency.

DENSITY		CONSISTENCY	
Term	N-Value	Term	N-Value
Very Loose	0 – 4	Very Soft	0 – 1
Loose	5 – 10	Soft	2 – 4
Medium-Dense	11 – 30	Medium Stiff	5 – 8
Dense	31 – 50	Stiff	9 – 15
Very Dense	> 50	Very Stiff	16 – 30
		Hard	>30

Notes:
1. The N-value is the number of blows of a 140 lb. hammer freely falling 30 inches required to drive a standard split-spoon sampler (2.0 in. O.D., 1-3/8 in. I.D.) 12 inches into the soil after properly seating the sampler 6 inches.
2. When encountered, gravel may increase the N-value of the standard penetration test and may not accurately represent the in-situ density or consistency of the soil sampled.

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

Major Divisions			Group Symbols	Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 Sieve), coarse-grained soils are classified as follows: Less than 5 per cent GW, GP, SW, SP; More than 12 per cent GM, GC, SM, SC; 5 to 12 per cent Borderline cases requiring dual symbols	$C_u=D_{60}/D_{10}$ greater than 4; $C_c=(D_{30})^2/(D_{10} x D_{60})$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line or PI greater than 7	
	Sands (More than half of coarse fraction is smaller than No.4 sieve size)	Clean sands (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines		$C_u=D_{60}/D_{10}$ greater than 6; $C_c=(D_{30})^2/(D_{10} x D_{60})$ between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line or PI greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 sieve	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity			
	Highly organic soils		Pt	Peat and other highly organic soils			

Key to Boring Log Rock Classification

Classification of rock is based on the following characteristics: color, weathering, discontinuities, attitude, grain size, voids, hardness, strength, density, water conditions, rock type, RQD, and RMR.

Weathering

Term	Symbol	Description
Fresh	F	Rock fresh, no visible signs of decomposition, or discoloration, crystals are bright.
Very Slight	VS	Rock generally fresh, joints stained, some joints may show clay or calcite coating.
Slightly	WS	Slight discoloration inwards from openings.
Moderately	WM	Discoloration throughout. Weaker minerals decomposed. Strength somewhat less than fresh rock but cores cannot be broken by hand or scraped by knife. Texture preserved. Joints may contain clay.
Highly	WH	Most minerals some what decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct but fabric preserved.
Completely	WC	Minerals decomposed to soil but fabric and structure preserved (saprolite). Speciments easily crumbled or penetrated.
Residual Soil	RS	Advanced state of decomposition resulting in plastic soils. Rock Fabric and structure completely destroyed.

Discontinuities

Spacing		Banding, Bedding and Foliation	Faults, Joints and Fractures	RMR
Feet	**Metric**			
Greater than 6.0 feet	Greater than 181cm	Very Thick	Very Wide	30
2.0 - 6.0 feet	60.4 – 181cm	Thick	Wide	25
8 - 24 inches	20.3 – 60.4cm	Medium	Moderately close	20
2.5 - 8 inches	6.3 – 20.3cm	Thin	Close	10
¾ - 2.5 inches	1.9 – 6.3cm	Very Thin	Very Close	5
Spacing [1]		**Lamination, Foliation, or Cleavage**		
¼ - ¾ inch	0.5 – 1.9cm	Intense	Extremely Close	0
Less than ¼ inch	Less than 0.5cm	Very Intense		

[1] Spacing is the perpendicular distance between discontinuities.

Type of Discontinuity

Term	Condition
Joint	A fracture along which no movement has occurred
Bedding Plane	A natural plane dividing sedimentary rock layers
Shear Plane	A fracture along which some movement has occurred
Fault	A zone of fractured rock containing one or more shear plane and areas of gouge

Attitude / Influence

Term	Existing Angle
Horizontal	0° - 5°
Low Angle	5° - 35°
Moderate Angle	35° - 55°
High Angle	55° - 85°
Vertical	85° - 90°

Rock Grain Size

Igneous and Metamorphic Rocks		Sedimentary Rocks	
Coarse Grained	Diameter > 5 mm	Coarse Grained	Diameter > 2 mm
Medium Grained	1 mm - 5 mm	Medium Grained	0.06 mm - 2 mm
Fine Grained	< 1 mm	Fine Grained	0.002 mm - 0.06 mm
Glassy	Grains not visible with unaided eye	Very Fine Grained	Grains not visible with unaided eye

Voids

Term	Size of Void
Pit	< 6 mm (1/4 inch)
Vug	6 mm – 50 mm (2 inches)
Cavity	50 mm – 0.6 m (2 feet)
Cave	> 0.6 m (2 feet)

Ground Water Conditions

General Condition	RMR
Completely Dry	10
Moist	7
Water Under Moderate Pressure	4
Severe Water Pressure	0

Estimated Density

Definition	Description
Very High	D > 25 kN/m^3
High	23.5 ≤ D < 25 kN/m^3
Moderate	22 ≤ D < 23.5 kN/m^3 (range of concrete)
Low	20.5 ≤ D < 22 kN/m^3
Very Low	D < 20.5 kN/m^3 (behaves like soil)

Field Test

Hardness	Field Test	Description	Strength	RMR
Very Soft	Material crumbles under moderate blow with sharp end of pick and can be peeled with a knife.	Moldable by hand; can be gouged with knife blade; unconfined compressive strength: q_u < 5 MPa (behaves like soil)	PSI = < 500 mn/m^2 = (< 1.25)	0
Soft	Can just be scraped or peeled with knife.	Geological hammer makes craters; can be cut with knife blade; unconfined compressive strength: 5 ≤ q_u < 20 MPa	PSI = 500 to 1,500 mn/m^2 = 1.25 – 5.0	1
Moderately Hard	Grooves to 5mm can be excavated with sharp blow of geologist pick.	Geological hammer makes dents; can be scratched with knife blade; unconfined compressive strength: 20 ≤ q_u < 50 MPa	PSI = 1,500 to 3,500 mn/m^2 = 5.0 – 12.5	2
Hard	Cannot be scraped or peeled with knife, hand-held specimen can be broken with single moderate blow with pick.	Geological hammer makes pits; cannot be scratched with knife blade; unconfined compressive strength: 50 ≤ q_u < 100 MPa	PSI = 3,500 to 7,250 mn/m^2 = 12.5 – 50	4
			PSI = 7,250 to 14,500 mn/m^2 = 50 – 100	7
Very Hard	Hand-held specimen breaks with hammer end of pick under more than one blow.	Geological hammer rebounds; can be chipped with heavy hammer blows; unconfined compressive strength: q_u >100 MPa	PSI = 14,500 to 29,000 mn/m^2 = 100 – 200	12
Extremely Hard	Many blows with a geologic hammer required to break intact specimen.		PSI = > 29,000 mn/m^2 = > 200	15

Rock Quality Designation (RQD)

Rock Quality Designation [1], %	Rock Mass Description	
90 - 100	Excellent	20
75 - 90	Good	17
50 - 75	Fair	13
25 - 50	Poor	8
< 25	Very Poor	3

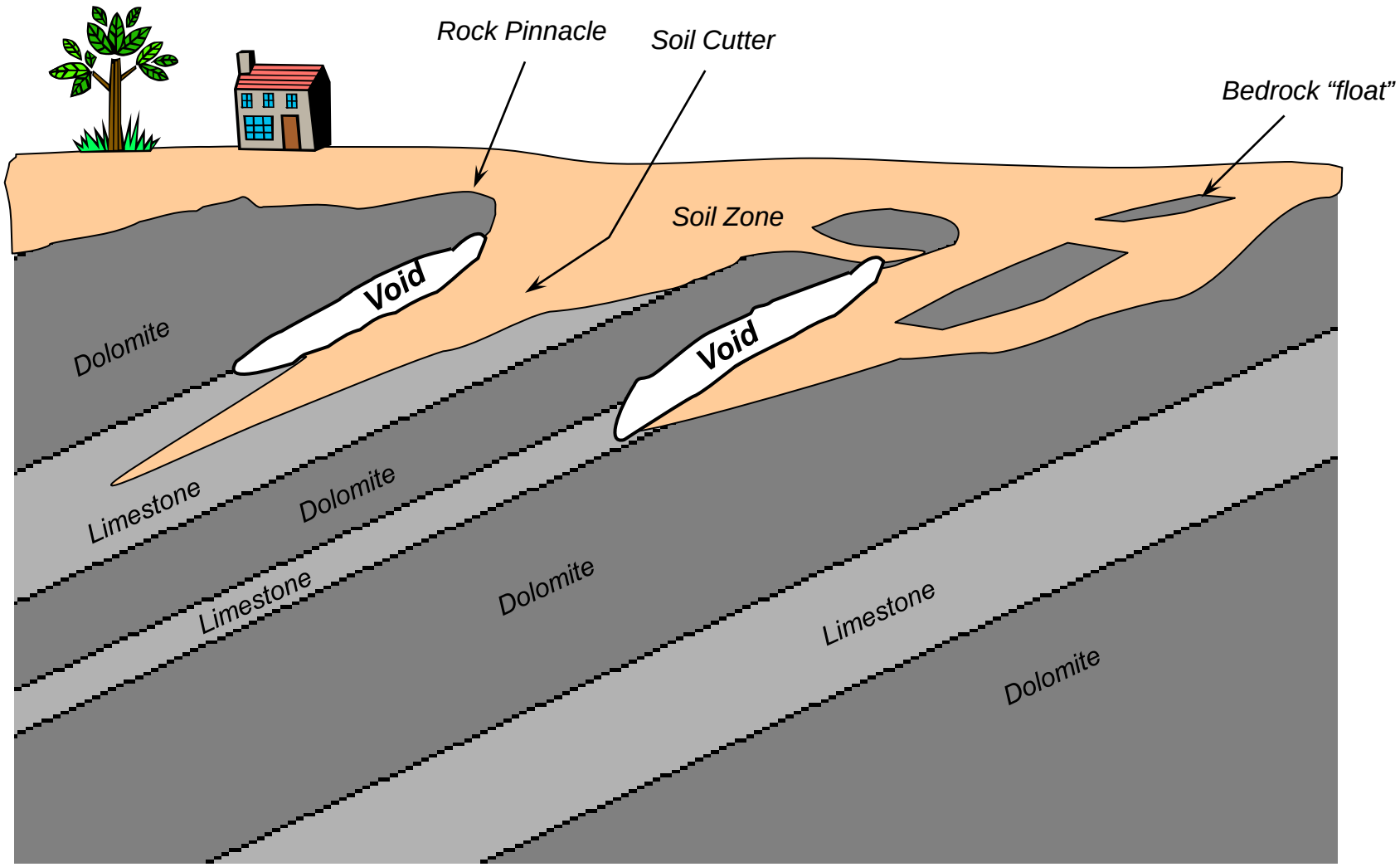
[1] RQD is the ration of the cumulative length of all pieces of rock greater than or equal to four inches to the total length drilled, expressed as a percentage.

Rock Mass Rating

Class	Description of Rock Mass	RMR Sum of Rating Increments
I	Very Good Rock	81 - 100
II	Good Rock	60 - 80
III	Fair Rock	41 - 60
IV	Poor Rock	21 - 40
V	Very Poor Rock	0 - 20

Rock Mass Rating for Increments for Joint Conditions

Description	RMR
Very rough surface of limited extent; hard wall rock	25
Slightly rough surfaces: aperture less than 1mm; hard wall rock	20
Slightly rough surfaces: aperture less than 1mm; soft wall rock	12
Smooth surfaces, OR gouge filling 1-5mm thick, OR aperture of 1-5mm; joints extend more than several meters	6
Open joints filled with more than 5mm of gouge, OR open more than 5mm; joints extend more than several meters	0



Conceptual model of the site geology including alternating limestone and dolomite beds undergoing differential weathering. The weathering results in deep soil cutters in the limestone, tabular pinnacles of dolomite, and detached rock fragments often called "float". Voids form primarily in the limestone beds at the interface with the dolomite beds.
(Adapted from report by ATS International)

FROEHLING & ROBERTSON, INC.

BORING LOG

Boring: B-101 (1 of 1)

Project No: 71R3013
Client: McCormick Taylor, Inc.
Project: Reservoir Street Widening
City/State: Harrisonburg, Virginia

Elevation: 1437 ±
Total Depth: 36.5'
Boring Location: See Boring Location Plan

Drilling Method: HSA
Hammer Type: Automatic
Date Drilled: 11/7/13
Driller: Gooden

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1436.0	1.0	6 Inches Asphaltic Concrete over 6 Inches Gravel				
		Orangish Brown, Very Moist, Medium Stiff to Stiff, Elastic SILT (MH), Little Sand **RESIDUUM**	4-4-3	1.0		
			4-6-3	2.5	7	
1433.0	4.0	Brown, Very Moist, Medium Stiff, Elastic SILT (MH), Little Sand **RESIDUUM**	3-4-4	4.0	9	
				5.5	8	
			3-3-2	6.0		
				7.5	5	
			3-3-4	8.5		
				10.0	7	
1423.5	13.5	Brown, Very Moist, Soft, Fat CLAY (CH), Trace Sand **RESIDUUM**	3-2-2	13.5		
				15.0	4	
1418.5	18.5	Light Brown, Wet, Soft, Sandy SILT (ML), Little Gravel **RESIDUUM**	2-2-1	18.5		Subsurface water recorded at a depth of 30 feet before removing augers and at 18 feet after removing the augers. Cave in recorded at 31.5 feet after removing the augers.
				20.0	3	
1413.5	23.5	Dark Gray, Very Soft, SILT (ML), Little Sand **RESIDUUM**	WOH-WOH-1	23.5		
				25.0	1	
1408.5	28.5	Gray, Moist, Very Dense, Silty GRAVEL (GM) **RESIDUUM**	3-14-50/3	28.5		
				29.8	100+	
1405.5	31.5	Gray, Slightly Weathered, Close to Widely Fractured LIMESTONE **BEDROCK FORMATION**	REC=100% RQD=65%	31.5		
1400.5	36.5	Boring Terminated at 36.5 Feet		36.5		

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N-Value.

BORING_LOG 71R3013.GPJ F&R.GDT 12/3/13

FROEHLING & ROBERTSON, INC.

BORING LOG

Boring: B-102 (1 of 1)

Project No: 71R3013
Client: McCormick Taylor, Inc.
Project: Reservoir Street Widening
City/State: Harrisonburg, Virginia

Elevation: 1435 ±
Total Depth: 40.0'
Boring Location: See Boring Location Plan

Drilling Method: HSA
Hammer Type: Automatic
Date Drilled: 11/7/13
Driller: Gooden

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1434.0	1.0	6 Inches Asphaltic Concrete over 6 Inches Gravel				
		Brown, Moist, Stiff to Very Stiff, Lean CLAY, Little to Some Sand **FILL**	6-6-8	1.0		
			12-9-8	2.5	14	
1431.0	4.0	Light Brown, Moist, Very Stiff, SILT (ML), Little Sand **RESIDUUM**	3-6-10	4.0	17	
			11-9-11	5.5 / 6.0	16	
				7.5	20	
1426.5	8.5	Brown, Moist, Very Stiff and Stiff, Fat CLAY (CH), Little Sand **RESIDUUM**	4-6-10	8.5		
				10.0	16	
			6-7-11	13.5		
				15.0	18	
			6-5-7	18.5		Subsurface water recorded at a depth of 35 feet before removing augers and the boring was caved and dry at a depth of 32 feet after removing the augers.
				20.0	12	
			7-7-9	23.5		
				25.0	16	
1406.5	28.5	Brown, Moist, Stiff to Medium stiff, Elastic SILT (MH), Little Sand **RESIDUUM**	7-6-9	28.5		
				30.0	15	
			4-3-4	33.5		
	▽			35.0	7	
1396.5	38.5	Tan, Wet, Very Stiff, Fat CLAY (CH), Little Sand **RESIDUUM**	9-9-7	38.5		
1395.0	40.0	Boring Terminated at 40 Feet		40.0	16	

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N-Value.

BORING_LOG 71R3013.GPJ F&R.GDT 12/3/13

FROEHLING & ROBERTSON, INC.

BORING LOG

Boring: B-103 (1 of 1)

Project No: 71R3013
Client: McCormick Taylor, Inc.
Project: Reservoir Street Widening
City/State: Harrisonburg, Virginia

Elevation: 1430 ±
Total Depth: 20.0'
Boring Location: See Boring Location Plan

Drilling Method: HSA
Hammer Type: Automatic
Date Drilled: 11/15/13
Driller: Gooden

Elevation	Depth	Description of Materials (Classification)	* Sample Blows	Sample Depth (feet)	N-Value (blows/ft)	Remarks
1429.7	0.3	4 Inches Surficial Organics	3-5-8	0.0		
		Brown, Moist, Stiff to Very Stiff, Lean CLAY (CL), Little Gravel and Sand **FILL**	8-9-10	1.5	13	
				3.0	19	
1426.5	3.5	Brown, Moist, Stiff, Fat CLAY (CH), Little Sand, Trace Roots **FILL**	5-7-6	3.5		
				5.0	13	
1424.0	6.0	Brown and Light Gray, Very Moist, Medium Stiff, Fat CLAY (CH), Little Sand **FILL**	3-3-5	6.0		
				7.5	8	
			2-2-4	8.5		
				10.0	6	
1416.5	13.5	Tan, Moist, Stiff to Hard, Fat CLAY (CH), Little Sand **RESIDUUM**	4-6-8	13.5		Subsurface water was not encountered during drilling or upon removal of the augers. Cave in recorded at a depth of 12 feet upon removal of the augers.
				15.0	14	
			12-16-15	18.5		
1410.0	20.0	little gravel at 19.5-20 ft		20.0	31	
		Boring Terminated at 20 Feet				

*Number of blows required for a 140 lb hammer dropping 30" to drive 2" O.D., 1.375" I.D. sampler a total of 18 inches in three 6" increments. The sum of the second and third increments of penetration is termed the standard penetration resistance, N-Value.

BORING_LOG 71R3013.GPJ F&R.GDT 12/3/13

FROEHLING & ROBERTSON, INC.

SUBSURFACE PROFILE

Plot Based on Elevation

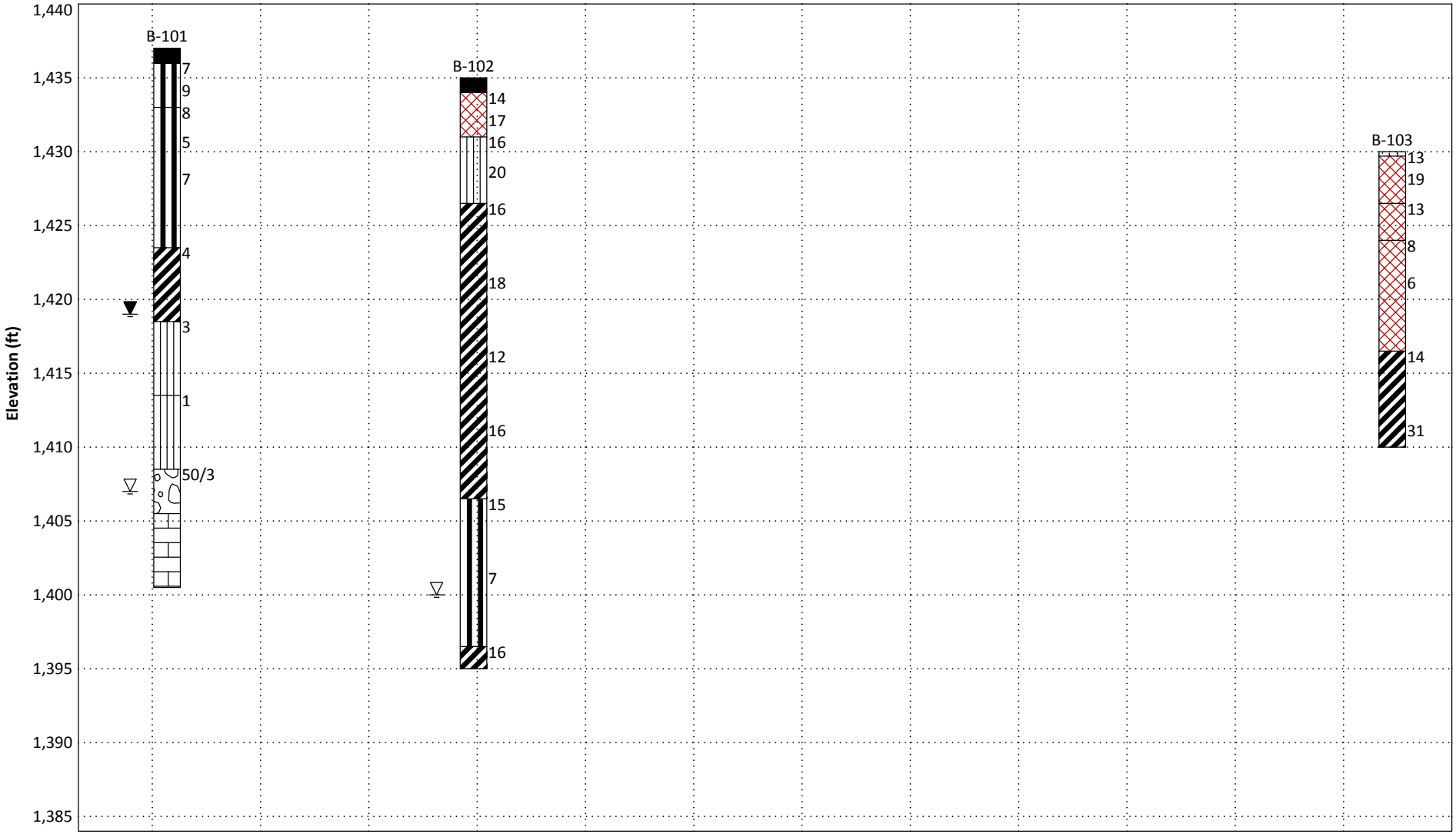
Profile Name:

Project No: 71R3013

Client: McCormick Taylor, Inc.

Project: Reservoir Street Widening

City/State: Harrisonburg, Virginia



ELEV_LANDSCAPE_8.5X11 71R3013.GPJ F&R.GDT 12/3/13

APPENDIX III

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

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REVISED GEOTECHNICAL ENGINEERING REPORT
Proposed Reservoir Street Improvements
Harrisonburg, Virginia
S&ME Project No. 1081-11-098

Prepared For:

McCormick Taylor
Engineers & Planners Since 1946

North Shore Commons A
4951 Lake Brook Drive, Suite 275
Glen Allen, Virginia 23060

Prepared By:

S&ME

S&ME, Inc.
8211 Hermitage Road
Henrico, Virginia 23228

July 27, 2012

July 27, 2012

McCormick Taylor, Inc.
North Shore Commons A
4951 Lake Brook Drive, Suite 275
Glen Allen, Virginia 23060

Attention: Mr. Christopher M. Young, E.I.T.

Reference: Revised Geotechnical Engineering Report
Proposed Reservoir Street Improvements
Harrisonburg, Virginia
S&ME Project 1081-11-098

Dear Mr. Young:

This report presents the findings of S&ME's geotechnical evaluation for the referenced project. The purpose of our services was to obtain subsurface information at the site with regard to developing geotechnical recommendations with regard to site grading, pavement thicknesses, and retaining wall support. This report is a revision to our original report dated April 11, 2012. The report has been revised based on your email to Mr. David Gordinier of S&ME on May 14, 2012.

This report describes our understanding of the project, presents the results of the field exploration and laboratory testing, and discusses our conclusions and recommendations. S&ME appreciates the opportunity to be of service to McCormick Taylor as your local geotechnical consultant. Please contact us if you have questions concerning this report or any of our services.

Respectfully submitted,

S&ME, Inc.

COMMONWEALTH OF VIRGINIA
7/27/12
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TABLE OF CONTENTS

1. AUTHORIZATION 1
2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT 1
3. OBJECTIVE AND SCOPE 1
4. FIELD EXPLORATION 2
5. SUBSURFACE CONDITIONS 2
5.1 Site Geology 2
5.2 Subsurface Summary 3
6. LABORATORY TESTING 4
7. GEOTECHNICAL RECOMMENDATIONS 5
7.1 Culvert Support 5
7.2 Proposed Stormwater Pond 6
7.2.1 Pond Embankments and Slopes 6
7.2.2 Pond Liner 6
7.2.3 Key Trench 6
7.2.4 Spillway Pipe 6
7.3 Retaining Walls 7
7.4 Permanent Slopes for Roadway 9
7.5 Pavements 9
7.5.1 Flexible Pavement 9
7.5.2 Pavements – General 10
8. GEOTECHNICAL CONSTRUCTION RECOMMENDATIONS 11
8.1 Anticipated Seasonal Impacts on Site Grading 11
8.2 Subgrade Preparation 11
8.3 Undercut Potential 12
8.4 Culvert Over-Excavation Recommendations 12
8.5 Excavations 13
8.6 Dewatering 13
8.7 Controlled Structural Fill 14
8.7.1 Materials 14
8.7.2 Compaction Requirements 14
8.8 Permanent Site Drainage 15
8.9 Evaluation of Retaining Wall Foundation Bearing Materials 15
8.10 Field Observation 15
9. LIMITATIONS OF REPORT 15

APPENDIX I – DRAWINGS
APPENDIX II – SUBSURFACE EXPLORATION
APPENDIX III – LABORATORY TESTING

1. AUTHORIZATION

Our services on this project were performed in general accordance with S&ME Proposal PR11163 (Revision 1) dated December 12, 2011. Our understanding of the requested services is based on a meeting between Christopher Young and David Gordinier of S&ME on October 13, 2011, email correspondence between Mr. Young, Mr. Gordinier and Nathan Reeves of S&ME, and a review of Site Plans provided to S&ME dated January 21, 2011.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

We understand the City of Harrisonburg plans to widen approximately 1.6 miles of Reservoir Street from just north of the city limit boundary to just north of its intersection with University Boulevard. Retaining walls, a stormwater management pond, and utilities will be incorporated into this project. The project will include new pavement areas along with overlaying areas of existing pavements. A Site Vicinity Plan (Drawing 1A) is provided in Appendix I.

The project is planned from Station 8+75.00 to Station 65+37.25 of the Reservoir Street alignment. Retaining walls are planned along Reservoir Street from Stations 33+60 to 34+18, 34+63 to 35+49, 56+69 to 59+00, and 59+75 to 61+75. We understand retaining walls will consist of VDOT RW-2 or RW-3 concrete gravity walls. We expect maximum wall heights will be about 8 feet. A new access road off University Boulevard around station 12+25 is planned for entry to adjacent businesses and medical facilities. New 42-inch and 60-inch reinforced concrete pipes associated with the planned storm water management basin will be installed near Woodland Drive.

According to the site plans provided, we understand that cut and fill depths will typically be less than 5 feet. We also understand that proposed embankment slopes will be graded at 3H:1V or flatter, with exception of several fill slopes possibly nearing 2H:1V grades.

3. OBJECTIVE AND SCOPE

The objective of our geotechnical services was to evaluate subsurface conditions at the project site and provide recommendations regarding geotechnical design and construction of the proposed roadway widening, including retaining walls, pavement thickness, storm-water utilities and management basin.. The general scope of services for the project included the following:

- Stake boring locations, coordinate underground utility clearance, obtain all permits required for performed fieldwork, and coordinate any necessary traffic control measures.
- Perform 33 soil test borings (boring B-21 was omitted due to access restraints) to depths ranging from approximately 10 to 15 feet and prepare their respective boring logs.
- Conduct laboratory testing on selected samples recovered from the borings to establish engineering design parameters for use in our analysis.

- Prepared this geotechnical engineering report providing our evaluation of existing subsurface conditions and our geotechnical conclusions and recommendations.

The following services were not provided by S&ME: surveying for line and grade, environmental services, foundation design recommendations of signal poles, chemical tests of soil sample, construction cost estimates, or preparation of detailed plans and specifications.

4. FIELD EXPLORATION

S&ME arranged a subsurface exploration program at the project site to collect data for geotechnical design. S&ME completed 33 soil test borings, designated B-1 through B-20 and B-22 through B-34. Boring B-21 was omitted due to difficult access. Approximate boring locations are shown on Drawings 1B through 1J in Appendix I (Figure 1I was purposely skipped for numbering clarity).

Soil test borings were performed to depths ranging from approximately 10 to 15 feet using 2¼-inch (inner diameter) hollow-stem auger techniques. Disturbed samples (split-spoon samples) were obtained using Standard Penetration Test (SPT) methods with an automatic hammer in general accordance with ASTM D1586. The SPT provides a split-spoon sample of the tested soil and a resulting standard penetration resistance value (N value), which gives an indication of the density or consistency of the in-place soils. In addition, multiple bulk samples of auger cuttings were also collected. Standard penetration resistance values can be utilized with empirical correlations to estimate physical properties and engineering characteristics for most soils. A more detailed explanation of the drilling and sampling method is provided in Appendix II.

Following completion of the borings, water levels were measured in open boreholes. Boreholes were then backfilled to the original ground surface with auger cuttings. Soil samples were transported to our laboratory for visual classification and testing.

Profiles of Generalized Subsurface Conditions (subsurface profiles) are attached in Appendix I as Drawings 2A through 2D. Specific observations, remarks, and logs of the borings are included in Appendix II. Surface elevations listed on the logs and profiles were interpolated from the topographic plans provided by McCormick Taylor.

5. SUBSURFACE CONDITIONS

The following sections contain a description of the geologic setting, the soils encountered during our subsurface exploration and subsurface water observations at the time of drilling completion.

5.1 Site Geology

The project site is located in the Valley and Ridge Physiographic Province of Virginia. This province is characterized by folded sedimentary rocks of Paleozoic age, weathered to form low, rounded ridges composed of resistant rocks, such as sandstone, and flat valleys composed of less resistant strata, such as shale or limestone. These rocks, formed

during the early Paleozoic, subsequently underwent intense compressional forces during several orogenic (mountain building) events that occurred over the next 200 million years, as evidenced by the large and small scale folding and faulting observed in the Valley and Ridge province. It is this combination of structural deformation with the lithologic properties that influence differential weathering that affected the regional topography, creating northeast-southwest trending sandstone ridges separated by valleys of carbonates and shales.

Locally, the site is underlain by the Ordovician-age middle limestone and dolomite unit of the Beekmantown Group.1 This unit consists of calcarenite interbedded with minor intraclastic flat-pebble limestone conglomerate, burrowed dark-gray calcilutite, and laminated light- to medium-gray dolomite. The land surface has gently rolling hills and linear ridges and generally is covered with deep, well-drained soil. Soil creep and erosion may occur in modified land areas. Soil thickness varies over short distances and according to Gathright and Frischmann (1986) the clay subsoil has a moderately high shrink-swell potential. Sinkholes and caves are known to exist in the Beekmantown Group.

5.2 Subsurface Summary

We encountered approximately 2 to 7 inches of topsoil at boring locations B-1 through B-3, B-5 through B-11, B-17 through B-23, B-25, B-30 through B-34. Approximately 3 to 8 inches of asphalt was encountered at boring locations B-12 through B-16, B-24, and B-26 through B-29. The typical asphalt thickness was approximately 6 inches. Asphalt was underlain by approximately 6 inches of gravel. Approximately 12 inches of surficial gravel was encountered at boring B-4.

Existing fill was encountered to depths of about 2 to 8 feet in borings B-6, B-7, B-15, B-16, B-23, B-24, B-28, and B-29. The fill consisted of brown sandy silt (ML), silty sand (SM, SP-SM), and fat clay (CH), all containing varying amounts of gravel. The fill exhibited Standard Penetration Test (SPT) N-value of 5 to 31 blows per foot (bpf), indicative of a loose to dense relative density for course grained fill soils and firm to hard consistency for fine grained fill soils. Our past experience indicates that well-compacted fill should exhibit SPT N-values (with an auto-hammer) of at least 7 to 9 blows per foot. As such, encountered fill appears moderately well to well compacted based on recorded SPT N-values.

Fill soils similar to those encountered in our borings may be encountered at other locations within the project area. These soils, as relevant to this site, are assumed to consist of roadway embankment fill and/or existing underground utility backfill material. Although encountered fill appeared moderately-well to well-compacted, fill will likely be encountered in other areas within the project corridor. Unexplored fill soils could exhibit poor strength characteristics. Existing fill should be carefully evaluated during

[1] Gathright, T. M. II and Frischmann, P. S., 1986, Geologic map of the Harrisonburg and Bridgewater Quadrangles, Virginia: Virginia Division of Mineral Resources Publication 60.

construction by the geotechnical engineer, or his/her representative, before placement of new fills or preparation of finished subgrades.

Residual soils (i.e., soils resulting from natural, in-place weathering of rock materials) were encountered below fill or surface materials at remaining boring locations. Encountered residual soils generally consisted of soft to hard clays (CL, CH) and loose to very dense sands (SC, SM). Residual soils extended to boring termination depths. SPT N-values in residual soils ranged from 4 to 69 blows per foot which corresponds to soft to very hard consistency for fine grained materials and very loose to very dense relative density. In some cases, it is difficult to distinguish between fill and residual soils based on observation of the split-spoon soil samples. Relatively low-consistency residual soils were encountered in borings B-9, B-18, and B-29 through B-32 (SPT N-values of 4 to 5 blows per foot). Given these relatively low SPT N-values, these softer materials may consist of fill.

Based on visual classification and laboratory testing, which is discussed later in this report, the typical soil type encountered in the borings was relatively highly plastic clay (CH). In several of the borings, mixed and interbedded sands were encountered.

Water was not encountered in the borings at the time of drilling. Subsurface water levels will tend to fluctuate due to season factors such as rainfall, temperature and others that are different from those prevailing at the time S&ME completed the subsurface exploration. Additionally, perched water could be encountered within sands overlying less permeable materials, such as fine-grained soils, particularly after recent rainfall.

6. LABORATORY TESTING

Our AASHTO-accredited soils laboratory in Richmond, Virginia performed laboratory testing on select split-spoon soil samples and bulk soil samples collected from the borings. Testing was performed to aid in the classification of soils encountered in the test borings and to aid in the development of engineering parameters for encountered soils. Laboratory testing consisted of natural moisture contents, grain size analysis, Atterberg limits, standard Proctor, and California Bearing Ratio (CBR). The laboratory tests were performed in general accordance with applicable ASTM and VDOT test methods. The results of the laboratory tests are presented in Appendix III. The following is a brief discussion of laboratory test results.

Atterberg limits tests of 3 soil samples from various borings and depths revealed liquid limits ranging from 61 to 81 percent and plasticity indices ranging from 41 to 57 percent. These values are indicative of highly plastic soils.

The standard Proctor maximum dry densities of 8 bulk samples of soils collected from the borings ranged from 95.8 to 119.3 pounds per cubic foot (pcf) with corresponding optimum moistures ranging from 12.2 to 24.6 percent. The natural moisture contents of these bulk samples ranged from 15.2 to 28.9 percent. <u>Based on comparison of natural moisture contents to the optimum moistures, the in-place moistures of the bulk samples were generally wet of optimum compaction moisture.</u>

Soaked CBR tests were performed on the 8 bulk samples remolded to densities ranging from approximately 97.7 to 101.0 percent of their standard Proctor maximum dry densities. The compaction moisture content of remolded specimens was ranged from about 2 percent dry of optimum moisture to one percent wet of optimum moisture. These samples exhibited soaked CBR values ranging from 4.1 to 13.2 percent with swell percentages ranging from 0.1 to 1.9 percent. Based on our experience, these swell percentages are relatively low to moderate. The variation in initial compaction moisture content was in an attempt to measure the change in soaked CBR versus initial compaction moisture. Generally, the data suggests an increase in soaked CBR number and a decrease in swell percent when the samples are compacted at optimum moisture or slightly higher than optimum.

7. GEOTECHNICAL RECOMMENDATIONS

The following recommendations are based on the results of our subsurface exploration, our understanding of proposed construction, and our experience with similar subsurface conditions in the general vicinity of the site. Should site grades differ from those assumed in this report, S&ME should be provided with that information so that our recommendations may be confirmed, extended, or modified as necessary. Additionally, if subsurface conditions different than those indicated by this report are encountered during construction, those differences should be reported to us for review and comment.

When reviewing our recommendations, please note that prior grading has been performed at the site. Existing fill was encountered in several of the borings. Our experience with previously graded sites indicates that unexpected conditions often exist. These conditions may consist of additional areas of low-consistency soils, debris-laden fill, abandoned utilities, and others. These conditions can be addressed by on-site engineering evaluation at the time of construction.

Recommendations for culverts, foundations, soil slopes, pavements, and site grading are provided in the following sections.

7.1 Culvert Support

New 42 and 60 inch pipe culverts are proposed near boring locations B-11, B-19, and B-20, which are located at approximately Station 43 to 44 along Reservoir Street and from east of the intersection of Reservoir Street and Woodland Drive to Station 12 of Woodland Drive. Culverts should be founded on firm and stable subgrade. Since soft alluvial soils are expected in the area of the culverts extensions (i.e., located within existing drainage features), over-excavation and replacement of existing soft soils in culvert and end walls locations may be required. Anticipated depths of over-excavation are discussed later in this report. During over-excavation, it is important that bearing soils beneath the existing culverts not be undermined. Recommendations for culvert end walls are provided in the Retaining Walls section of this report.

7.2 Proposed Stormwater Pond

We understand a storm-water pond will be constructed just west of Woodland Drive and in the vicinity of borings B-18 and B-19. The pond will be designed to temporarily store water, meaning it will be a "dry" pond. We assume maximum fill embankment heights will be about 5 feet, and maximum excavations will be less than 10 feet. The spillway pipe for the pond will extend beneath Woodland Drive. The spillway pipe will be installed by boring and jacking methods.

7.2.1 Pond Embankments and Slopes

We recommend that pond embankments be constructed of on-site clays that were typically encountered in the borings. Placement of embankment materials should be conducted in accordance with the fill placement recommendations of this report.

We recommend cut and fill slopes be constructed at inclinations of 3(H):1(V) or flatter. Erosion and shallow slope failure must be controlled by either promptly vegetating the slope surface or covering the slopes with an approved erosion control mat.

7.2.2 Pond Liner

Borings B-18 and B-19, which were performed in the proposed pond area, encountered clays to depths of approximately 15 feet below the existing ground surface. It is our opinion that the encountered clays are of relatively low permeability. As such, a clay liner or geosynthetic membrane does not appear to be needed to reduce infiltration through the pond bottom.

7.2.3 Key Trench

We recommend a key trench be constructed beneath fill embankments to reduce the potential of concentrated seepage beneath the embankments. The key trench should be excavated at least 3 feet into embankment foundation soils and should be at least 4 feet wide. The key trench excavation should be backfilled with on-site clays that are placed and compacted in accordance with the recommendations of this report.

7.2.4 Spillway Pipe

We understand that the spillway pipe will be installed below Woodland Drive by the "bore and jack" method. We anticipate this installation method could leave voids around the pipe exterior. Voids could be an avenue for concentrated seepage and piping failure; therefore, we recommend the following with regard to pipe construction:

- Inject pressurized grout around the pipe exterior in an effort to completely fill any voids caused by the installation process.
- A concrete cradle should be constructed below pipe sections which are installed by typical trenching methods on the inlet side of the dam, up to the inlet structure. Concrete should be used to fill any voids between the trench side-walls and pipe caused by the excavation process. Concrete should be placed up to the pipe spring-line. In addition, a minimum of 6-inches of concrete should be placed directly below the pipe. The concrete should have a minimum compressive strength of 3,000 psi after 28-days.

- Consideration should be given to constructing a concrete seepage collar at the down-gradient termination point of the concrete cradle (within the dam slope). The concrete collar should be at least 12 inches thick and extend outward a minimum distance of at least 3 feet beyond the pipe in each direction.
- A seepage diaphragm should be constructed around the downstream-most spillway pipe section (minimum of 8 feet in length) to the outlet structure (if any). The diaphragm should consist of a minimum 12-inch thick layer of VDOT No. 67 stone completely wrapped in a non-woven geotextile filter fabric (such as Mirifi 160N) on all sides. The purpose of the diaphragm is to collect and discharge seepage which could occur along the pipe section while retaining soil which may be transported with the seepage.

Once the retention pond drawings have been completed, S&ME can be retained to provide additional recommendations and/or details regarding seepage control around the spillway pipe.

7.3 Retaining Walls

We understand that VDOT RW-2 or RW-3 concrete gravity retaining walls are planned along Reservoir Street from Stations 25+75 to 25+37.25, 33+60 to 34+18, 34+63 to 35+49, 56+69 to 59+00, and 59+75 to 61+75 and also at University Boulevard from station 11+00 to station 15+00. In addition, end walls will be constructed at the culvert extensions. Pertinent information regarding the concrete gravity walls is provided in the table below.

Table 1: Retaining Wall Locations

Wall Number	Location and Stationing	Boring Locations
1	Reservoir St. 33+60 to 34+18	B-22, B-23
2	Reservoir St. 34+63 to 35+49	B-24, B-25
3	Reservoir St. 56+69 to 59+00	B-26, B-27, B-28
4	Reservoir St. 59+75 to 61+75	B-29, B-30
5	University Blvd. 11+00 to 15+00	B-31, B-32, B-33, B-34

Based on the results of our exploration and analysis, it is our opinion that the proposed retaining walls can be supported by foundations designed for a net allowable soil bearing pressure of 2,000 psf. We recommend a minimum foundation embedment depth of 24 inches for frost protection. We expect that undercutting and replacement of low-consistency soil will likely be required beneath the concrete gravity walls constructed near borings B-24, and B-30 through B-32, where relatively low-consistency soils were encountered to depths of about 2 to 4 feet. Also, since borings were not performed adjacent to culvert extensions, due to difficult access, it is important that the

recommended bearing pressure beneath culvert end wall foundations be confirmed in the field through engineering evaluation (i.e., hand augering with dynamic cone penetrometer tests).

The walls should be structurally designed to resist the forces imposed by the lateral earth pressures from the backfill soils. **We do not recommend that on-site fine-grained soils be used as wall backfill.** Granular backfill is recommended to reduce the build-up of hydrostatic forces behind the wall. As such, we recommend backfill consist of a select material, such as VDOT Type I, as defined in Section 207 of the VDOT 2007 Road and Bridge Specifications. This backfill material should extend a horizontal distance equal to the wall height behind the wall. Backfill placed behind the retaining wall should be compacted as recommended in this report. Operating heavy compaction equipment within 5 feet behind the retaining structures can create lateral earth pressures far in excess of those recommended for design. As such, we recommend that hand-operated equipment be used within 5 feet of the walls.

To aid in evaluating the active and passive forces imposed on the wall from the backfill, equivalent fluid unit weights presented in the table below may be used. The parameters in the table assume a level backfill surface. These parameters should be adjusted if the backfill surface will be inclined.

Table 2: Parameters for Retaining Backfill Soils

Soil Design Parameters	
Wall Number	1 through 5 and culvert end walls
Select Backfill Material	VDOT Type I
Active Equivalent Fluid Unit Weight (pcf)	35
Passive Equivalent Fluid Unit Weight (pcf)	300

In addition to using Type I backfill, we recommend placing a drainage medium, such as clean stone (VDOT No. 57) wrapped in a nonwoven geotextile fabric, directly behind retaining walls. The drainage medium should be connected to a foundation drain to reduce the potential for buildup of hydrostatic pressures due to surface water, perched water, or utility leaks.

In addition to the lateral stresses from backfill, the walls may be subjected to surcharge loading from adjacent traffic, stockpiled materials, or stresses from nearby footings or floor slabs. If present, these surcharge stresses should be resolved into appropriate lateral stress distributions and added to the earth pressures outlined above. Walls should have adequate factors of safety against overturning, sliding, and global failure.

7.4 Permanent Slopes for Roadway

Excavation and fill slopes up to 3 to 5 feet in height are anticipated to accommodate grade changes due to the proposed roadway widening. We recommend cut and fill slopes be constructed at inclinations of 2(H):1(V) or flatter when constructed in accordance with our recommendations. An exception is downstream pond embankment slopes retaining water, where these slopes should be constructed at inclinations of 3(H):1(V) or flatter.

Erosion and shallow slope failure must be controlled on all slopes by either promptly vegetating the exposed slopes or covering the slopes with an approved erosion control mat.

7.5 Pavements

As discussed previously, highly plastic soils were typically encountered in the borings. Higher CBR values and lower swell percentages were generally measured when the CBR specimens were initially compacted wet of optimum moisture. Our recommendation, as discussed later in this report, is that on-site soils used as structural fill be compacted at moisture levels of minus one to three percent points above optimum moisture (-1 to +3%) in an attempt to reduce the amount of swell exhibited by the subgrade soils during service life of the pavement.

Based on measured CBR data and the above compaction moisture recommendation, a design CBR value of 6 percent was used in our flexible pavement analysis. S&ME performed flexible pavement design analyses in accordance with VDOT design procedures (AASHTO design method modified for Virginia conditions). Our pavement design is based on traffic counts provided by McCormick Taylor.

7.5.1 Flexible Pavement

The following is a summary of design parameters for flexible pavements:

- Design CBR value of 6.0 percent for flexible pavement
- 20-year design life for Divided Primary Route
- Initial ADT of 9,540 vehicles per day in 2013 (based on 2006 ADT of 7,600)
- 2.1 percent trucks (assume half single unit truck and half tractor trailers with an average equivalent 18-kip single axle load of 0.77 per truck)
- 3.3 percent traffic growth rate (based on year 2006/2030 ADT values provided)
- Design traffic for shoulders is 2.5 percent of the main roadway design traffic

Tables 3 and 4 present our recommended flexible pavement sections for the main roadway and shoulders. Based on our experience with VDOT, an asphalt section consisting of a surface mix, intermediate course, and base course is preferred (rather than surface mix directly on base course).

Table 3: Flexible Pavement Options for Main Roadway Section

Layer	Material	Thickness (Inches)
Surface Mix	VDOT SM-9.5A	1.5
Intermediate Course	VDOT IM-19.0	2.0
Base Course	VDOT BM-25	2.5
Aggregate Base	VDOT 21B	8

Table 4: Flexible Pavement Options for Shoulders

Layer	Material	Thickness (Inches)
Surface Mix	VDOT SM-9.5A	1.5
Intermediate Course	VDOT IM-19.0	2.0
Aggregate Base	VDOT 21B	6.0

As previously mentioned the existing moisture contents of the existing subgrade soils are significantly wet than optimum moisture content for compaction. If the existing soils are unstable at the time of construction, lime amendment may be utilized for this project as a moisture adjustment additive to facilitate compaction.

7.5.2 Pavements – General

All materials and construction methods associated with paving, aggregate base, and lime stabilization (if needed) should meet the requirements of VDOT Road and Bridge Specifications (2007). Important factors regarding pavement performance are the condition of subgrade soils at time of construction, post construction drainage, and maintenance.

We recommend that all pavement subgrade areas be evaluated prior to aggregate base course placement. Any areas which deflect or rut during proofrolling must be repaired prior to aggregate base course placement. Sufficient testing and observation should be performed during pavement construction to confirm that the required thickness, density, and quality requirements of the specifications are followed.

Aggregate base material should be connected to a longitudinal pavement drain (UD-4) with outlets or day-lighted (to the face of a ditch) to provide positive lateral drainage. Combination underdrains (CD-1 or CD-2) beneath the roadway should be considered to

reduce the adverse impacts of subsurface water on the stability and strength of the pavement structure. The aggregate base thickness should be appropriate to allow for the underdrain system.

It is important to realize that maintenance will likely have a significant impact on the life of the pavement. For asphalt pavement sections, cracks should be sealed to reduce water infiltration and swelling of subgrade soils.

8. GEOTECHNICAL CONSTRUCTION RECOMMENDATIONS

The following sections provide general guidance for the development of project documents with respect to earthwork and construction activities.

8.1 Anticipated Seasonal Impacts on Site Grading

Site grading will be difficult during periods of extended rainfall that generally occur during the typically wetter winter months. On-site clay soils are typically highly plastic and very moisture sensitive. In addition, they were measured to be significantly wet of optimum moisture at the time of our exploration. To reduce potential earthwork problems, site preparation and grading should be scheduled during the drier summer and fall months, if possible. If winter grading is attempted, repair of near surface soils and possibly use of select off-site borrow, or use of chemical soil stabilization methods (i.e., lime), will be necessary to prepare subgrades adequately for new construction. Even during drier periods of the year, we recommend that the exposed subgrade be sloped and "sealed" at the end of each day to promote positive runoff and reduce infiltration from rainfall.

8.2 Subgrade Preparation

In general, we recommend the following activities take place prior to placement of any controlled structural fill, pavement, foundations, or utilities. These activities should be detailed in the project documents.

1. Strip all organic materials, debris and other detrimental material from the surface if detrimental material will be within five feet of finished subgrade elevation. Remove heavy root mat and stumps; hair-like roots may be left in place. Approximately 2 to 7 inches of topsoil was typically in existing grass areas. Deeper stripping depths could be encountered if wet weather grading is conducted.
2. Proofroll subgrades prior to controlled fill placement, and finished subgrades prior to aggregate base placement, in the presence of a qualified engineering representative of City of Harrisonburg. Use a fully loaded tandem-axle dump truck or other equipment approved by City of Harrisonburg. Areas that pump, rut or weave should be repaired using one of the following methods:
    - In favorable weather conditions, scarify and re-work subgrade soils until the proper level of moisture is obtained to achieve compaction in accordance with the project documents.

- Undercut and replace unstable subgrade materials with controlled structural fill adequate to support the proposed overlying construction. The use of stabilization geotextiles may be needed beneath the undercut area depending on the amount of subgrade instability that exists. Use of geotextiles should be a decision of the City of Harrisonburg designated engineering representative at the time of construction.

3. If fill placement is required where ponded water is present, we recommend the fill consist of VDOT No. 57 stone to a level of 12 inches above the water. The stone should be placed in maximum 24-inch lifts and each lift should be tamped with a backhoe bucket to "seat" the stone. The stone should be covered with a non-woven geotextile, such as Mirafi 160N, or the equivalent, prior to placement of overlying controlled fill.
4. Maintain construction access roads to reduce incidental traffic across subgrade. Construction sequencing should limit exposure of the asphalt base materials to traffic before the surface course is placed.
5. Subgrade that is disturbed by the Contractor's operations or weather should not be considered as unsuitable material and should not be compensated as undercut to repair subgrade. Damaged subgrade should be repaired in accordance with the project requirements.

8.3 Undercut Potential

Clayey soils were typically encountered at the boring locations. These soils were generally soft to very stiff based on the boring information. Several of the borings encountered soft near-surface soils which are expected to be unstable at the time of construction. Clay soils that are stiff to very stiff should not require undercut if properly maintained by the contractor. In deeper fill areas, it may be possible to bridge softer soils, as discussed previously.

As previously mentioned, we expect undercutting of retaining wall foundations soils could be required in the vicinities of borings B-24 and B-30 through B-32, where low-consistency soils were encountered to depths on the order of 2 to 4 feet. Near-surface, low-consistency soils, which may require undercutting, were also encountered in borings B-6, B-9, and B-13, located in proposed road widening areas.

We also expect low-consistency soils will be present in existing ditches which will be filled to widen the roadway. When placing fill within existing ditches, we recommend the ditch be widened sufficiently so that compaction equipment can enter the ditch.

8.4 Culvert Over-Excavation Recommendations

Alluvial soils are likely present near the drainage features where culverts will be extended due to standing water. These areas are likely to require a few feet of over-excavation to provide adequate support for the proposed culvert structures.

Over-excavation at culvert extension locations should be backfilled VDOT No. 57 stone. All culvert excavations should be dewatered prior to excavation to reduce disturbance of

the subgrade. Dewatering may be accomplished by diverting water away from the new excavation or with cofferdams or pumps around the new excavation.

Over-excavation should be performed using a smooth-bladed bucket to limit disturbance of the subgrade. The geotextile and No. 57 stone should extend continuously below the end wall and the culvert and a minimum of three feet beyond the outside limits of the culvert end walls. The geotextile may be laid out either parallel or perpendicular to the pipes. Adjacent sheets of woven geotextile should be overlapped a minimum of two feet. For locations where over-excavation and stabilization is necessary, the VDOT No. 57 stone bedding should be placed around the sides of the pipe culverts. We recommend the on-site clayey soils not be used as backfill for culvert sidewalls or the end walls.

8.5 Excavations

Excavations will be required for installation of utilities and construction of the new road and storm-water detention ponds. Excavation for new culverts and associated head walls will also be required. Soils encountered during our exploration within the anticipated excavation depth typically consisted predominantly of moderate to high consistency clay. Excavation of these soils will likely require the use of a large tracked excavator equipped with rock teeth. All excavations, including open excavation where shoring is not required, should be completed in accordance with applicable OSHA regulations.

Temporary lateral earth support might be required to facilitate culvert installation, construction of foundation elements, and general utility installation Temporary shoring must be designed by the contractor to resist lateral earth pressures. Temporary earth support systems must be designed to resist adjacent construction, traffic and other appropriate surcharge pressures. A qualified, Professional Engineer registered in Virginia must prepare shoring plans.

If difficult excavation is encountered we recommend it be defined as materials that cannot be excavated by a Caterpillar D-8 crawler tractor using a single-tooth ripper or a Caterpillar 325 hydraulically operated backhoe with ripper or rock teeth, or equivalent, without the use of drilling and blasting.

If rock blasting is required, an experienced and qualified blaster should design a blasting plan. A pre-blast survey of any nearby structures should also be performed. Rock was not encountered in our borings.

8.6 Dewatering

Some portions of utility trenches and storm water management ponds might require excavations deeper than subsurface water levels and special care must be taken to maintain a dewatered excavation. In these areas, dewatering might be required to prevent unstable subgrade conditions. Dewatering methods are the responsibility of the contractor.

8.7 Controlled Structural Fill

8.7.1 Materials

On-site soils, except topsoil and debris-laden soils, should be suitable for reuse as structural fill in roadway embankments provided that the moisture content is properly controlled during placement and compaction and their maximum particle size does not exceed 3 inches. As previously mentioned, we do not recommend that fine-grained soils be used as backfill for the reinforced zone behind retaining walls. As previously discussed, we recommend that on-site clays be used for construction of storm-water pond embankments and underlying key trench.

At the time of our exploration, encountered soils were typically wet of optimum moisture. As such, we expect that drying of on-site soils will likely be required prior to compaction.

We recommend that backfill along culvert sidewalls and end wall backfill consist of select free draining materials such VDOT No. 57, as described in the VDOT 2007 Road and Bridge Specifications. The backfill should extend behind the wall for horizontal distance equal to the wall height.

If any off-site borrow materials are used as structural fill, these materials should be of low plasticity (plasticity index less than 25), free of organics and debris, and have a maximum particle size of 3 inches. In addition, the off-site borrow should have a standard Proctor maximum dry density (VTM-1) of at least 100 pounds per cubic foot (pcf).

8.7.2 Compaction Requirements

We recommend roadway embankments and soils supporting structures or pavements be placed in general accordance with the following recommendations:

1. Moisture condition soils as required to compact controlled structural fill.
2. Place controlled structural fill in horizontal, loose lifts not exceeding 8 inches in thickness. Compact controlled structural fill to at least 95 percent of the standard Proctor maximum dry density (VTM-1). Within 6 inches of finished subgrade in pavement areas, this compaction requirement should be increase to 100 percent of the standard Proctor maximum dry density. Control moisture content within minus one <u>to three percent points above optimum moisture</u> content (-1 to +3%).
3. Place controlled structural fill only in the presence of a qualified representative of the City of Harrisonburg. Allow the qualified representative to field test controlled structural fill for dry density in accordance with either the sand cone method (ASTM D1556) or the nuclear method (ASTM D2922).
4. Place fill against existing slopes steeper than about 4(H):1(V) by benching into side slopes to reduce the potential of developing slip surfaces.
5. Do not place fill through water or on snow, ice, or frozen subgrade.
6. Backfill utility trenches within pavement areas with controlled structural fill or dense-graded aggregate such as VDOT No. 21A, No. 21B or No. 10 sand

screenings. Compact trench backfill in maximum 6-inch lifts, to at least 95% of the maximum dry density as determined by the Standard Proctor test (VTM-1). Within 6 inches of finished subgrade, the compact requirement should be increased to 100 percent of the standard Proctor maximum dry density. The soils moisture should be as described in Item 2 above.

8.8 Permanent Site Drainage

Adequate control of surface drainage is an important component of durable pavements and slope stability. We recommend that site grading provide runoff away from the pavement surface and beyond the limits of paved areas. We recommend that toe drainage ditches be constructed to intercept and divert surface water away from cut and fill slopes and pavement areas.

8.9 Evaluation of Retaining Wall Foundation Bearing Materials

A geotechnical engineer or his representative should observe foundation bearing conditions beneath retaining wall foundations prior to placement of reinforcing steel and concrete. This evaluation should include the performance of shallow hand auger borings with dynamic cone penetrometer testing to confirm the suitability of near surface bearing soils for foundation support. As previously mentioned, over-excavation of some footing bearing materials should be anticipated.

Exposure to the environment will cause the bearing soils to rapidly deteriorate. Excessively loose/soft soils, water and other unsuitable materials should be removed. Over-excavated soils can be replaced by suitable, well-compacted soils, VDOT No. 57 stone, or lean concrete. To further reduce the potential for deterioration of bearing soils, we recommend that foundation excavation and placement of concrete be conducted on the same day if practical. If placement of the foundation concrete is to be delayed, a lean concrete mud mat should be placed on exposed bearing soils.

8.10 Field Observation

We encourage the project team to retain S&ME to provide construction observation during earthwork and paving operations to observe compliance with the plans and specifications and to identify changes in the nature of the subsoils revealed during construction so we might review our recommendations promptly. Field observation comprises the second phase of a complete geoprofessional service, permitting S&ME (the report developer) to observe subsurface conditions during construction and thereby assess the reliability of our subsurface profile and the appropriateness of our recommendations.

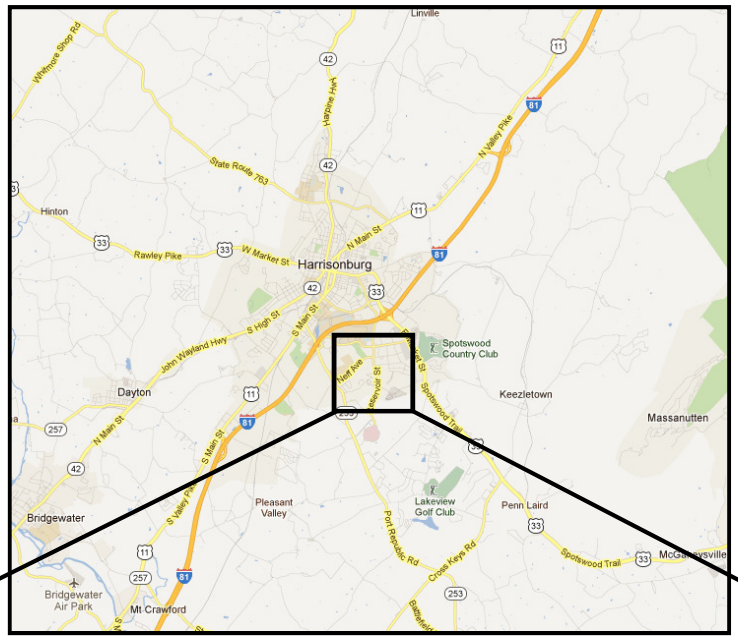
9. LIMITATIONS OF REPORT

This report has been prepared specifically for McCormick Taylor, Inc. in accordance with generally accepted engineering practice for specific application to the Reservoir Street widening in Harrisonburg, Virginia. Any wetland, environmental, or contaminant assessment efforts are beyond the scope of this geotechnical exploration; and therefore, those issues are not addressed in this geotechnical exploration report. The recommendations contained in this report are based on the applicable standards of our

profession at the time this report was prepared. No other warranty, express or implied, is made.

Conclusions and recommendations submitted in this report are based upon the data obtained from the geotechnical exploration and our understanding of the proposed construction. The nature and extent of variations between and outside of the boring locations may not become evident until construction. If variations appear evident, then it will be necessary to re-evaluate the recommendations of this report. In the event that any changes in the grades, nature, design, or location of the proposed construction are planned, the recommendations contained in this report should be reviewed and modified or verified in writing. We recommend that our firm be provided the opportunity for general review of preliminary design specifications to evaluate whether our recommendations are properly interpreted and implemented.

APPENDIX I - DRAWINGS



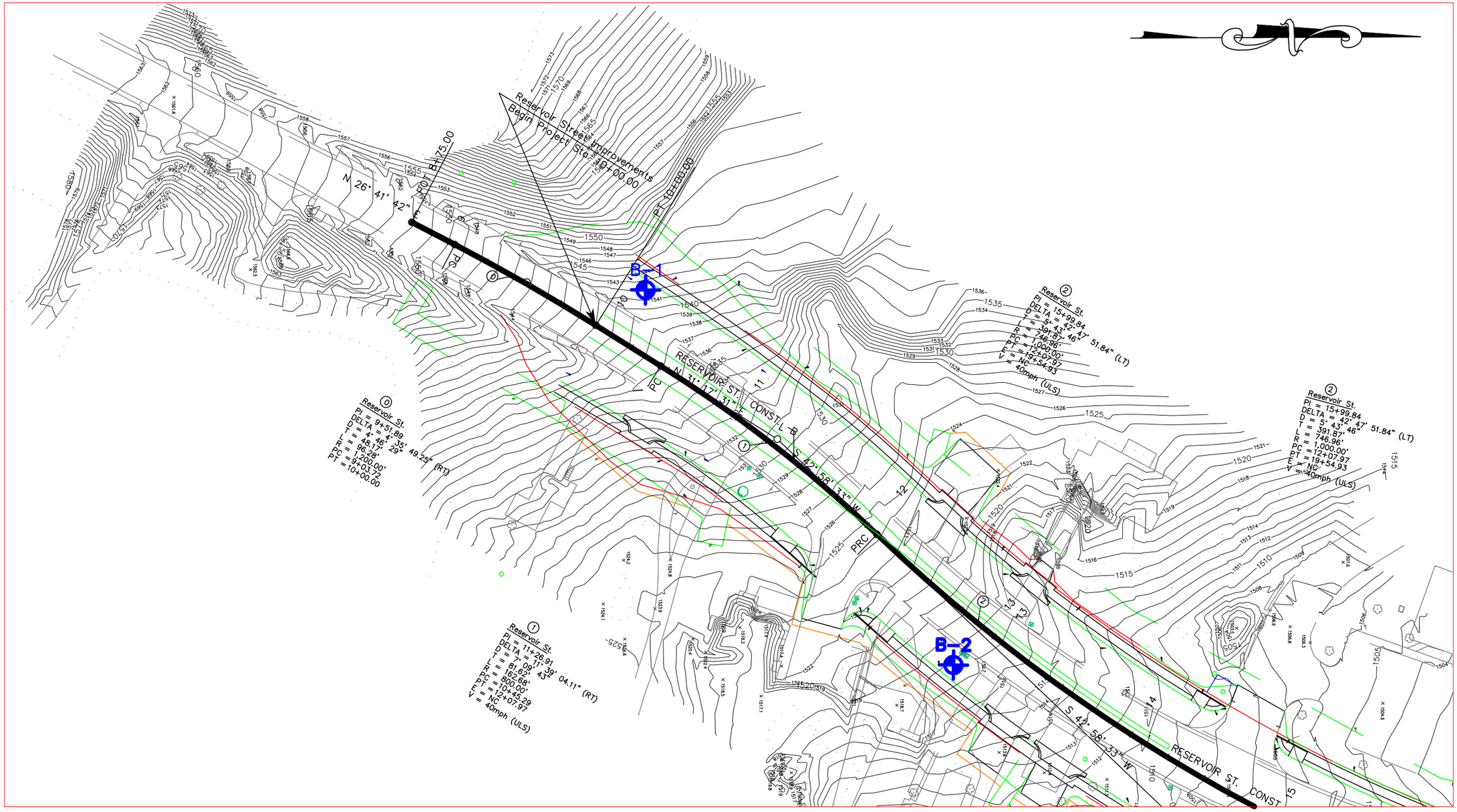
NOTE:
UPPER MAP CREATED USING GOOGLE MAPS.
LOWER MAP CREATED USING GOOGLE EARTH.

S&ME

1081-11-098
RESERVOIR STREET IMPROVEMENTS
HARRISONBURG, VIRGINIA

SITE VICINITY MAP

PREPARED BY: MBL	REVIEWED BY: JNR		DRAWING 1A
DRAFTER: MBL	SCALE: NTS	DATE: 3/8/2012	



Source: Created From Drawings Provided By McCormick Taylor

Legend

B-XX Soil Test Borings

GRAPHIC SCALE

0 30 60

SCALE: 1"=60'	DATE: 3/29/12
PROJECT NO. 1081-11-098	DRAWN BY: JNR
	CHECKED BY:

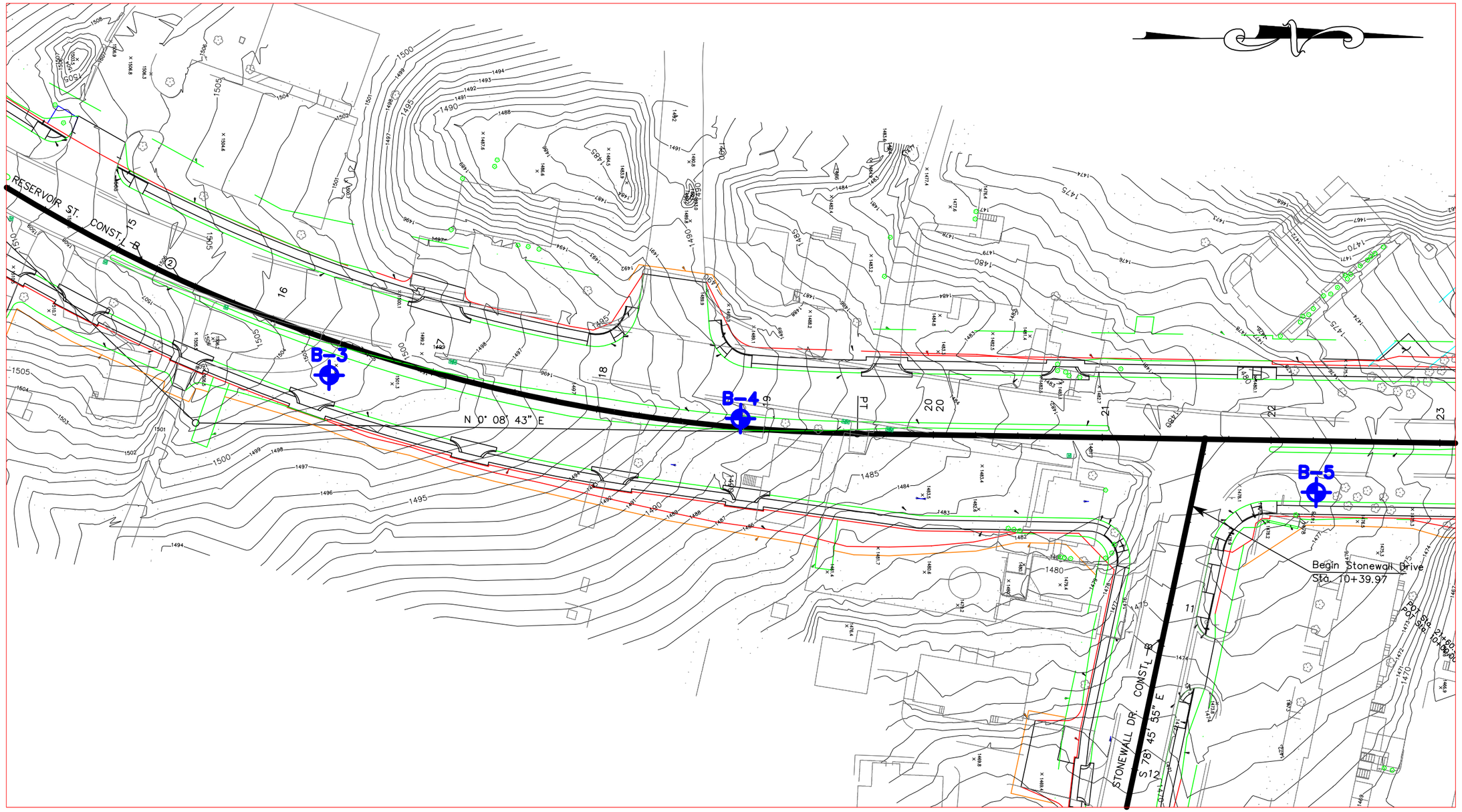
S&ME
WWW.SMEINC.COM

Boring Location Plan (Sta. 9 To 15)

Reservoir Street Widening
Harrisonburg, Virginia

GRAPHIC

DRAWING 1B



Source: Created From Drawings Provided By McCormick Taylor

Legend

B-XX Soil Test Borings

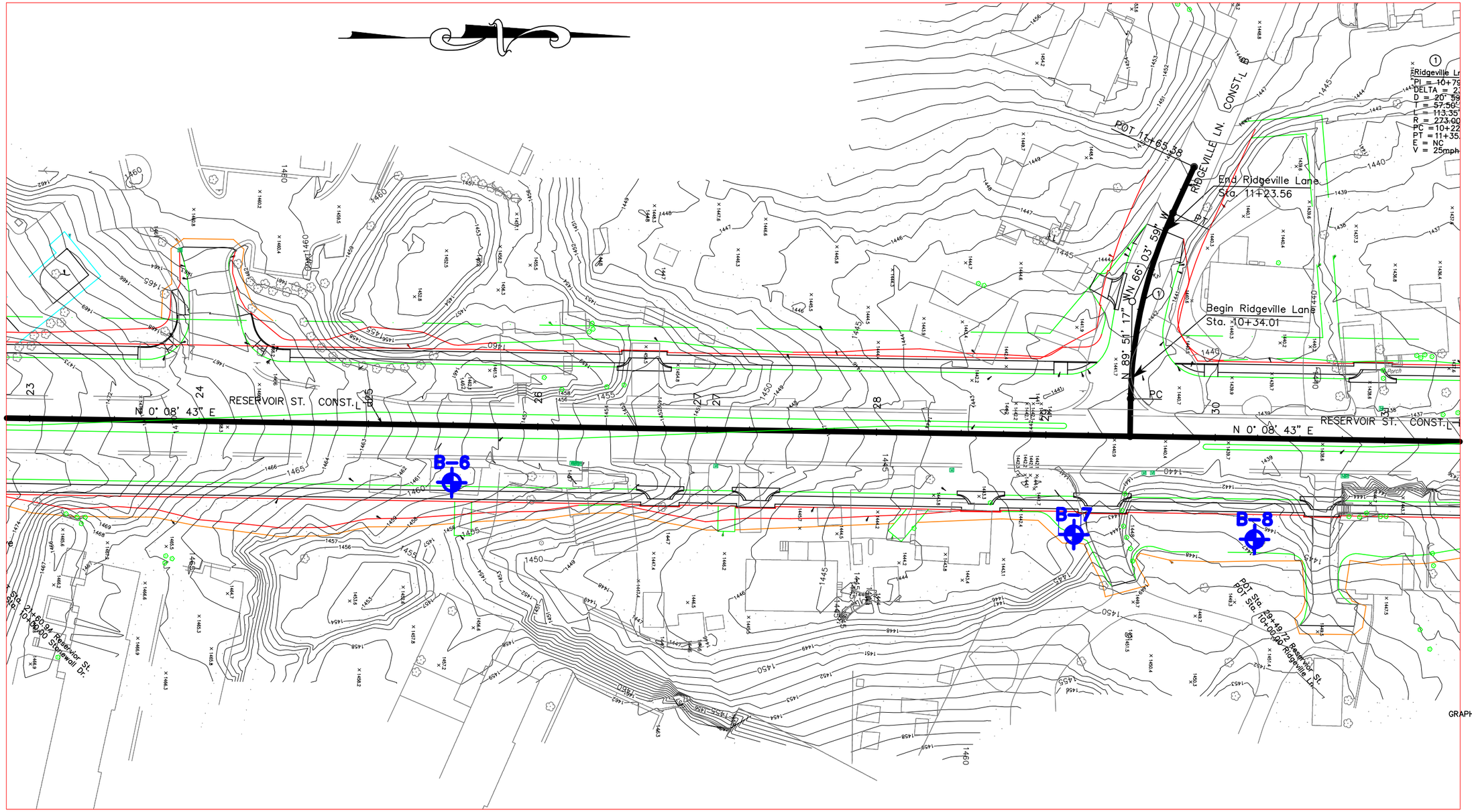
SCALE: 1"=60'	DATE: 3/29/12
PROJECT NO. 1081-11-098	DRAWN BY: JNR
	CHECKED BY:

S&ME
WWW.SMEINC.COM

Boring Location Plan (Sta. 15 To 23)

Reservoir Street Widening
Harrisonburg, Virginia

DRAWING 1C



Source: Created From Drawings Provided By McCormick Taylor

Legend

B-XX Soil Test Borings

GRAPHIC SCALE
0 30 60

SCALE: 1"=60'
DATE: 3/29/12
PROJECT NO. 1081-11-098
DRAWN BY: JNR
CHECKED BY:

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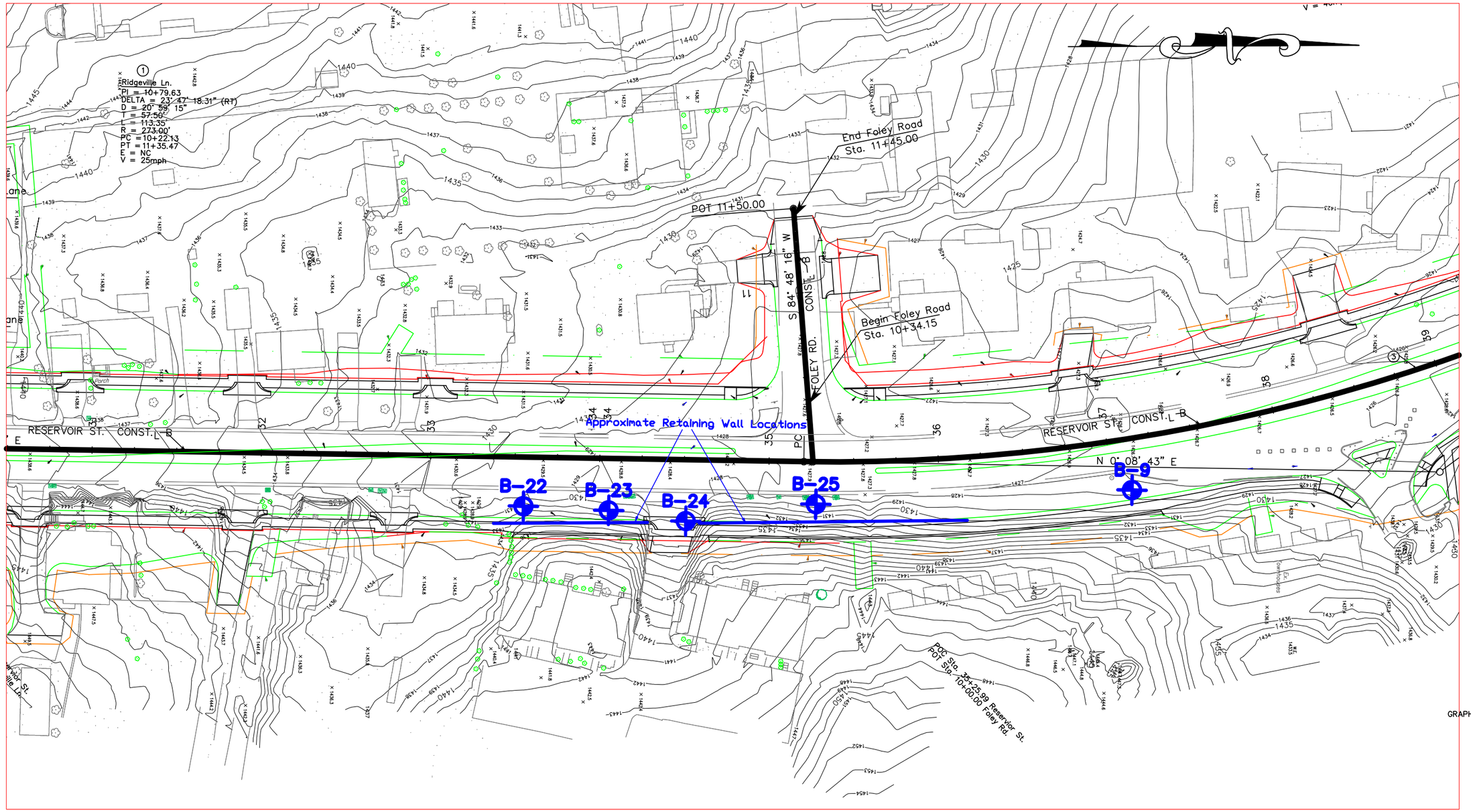
Boring Location Plan (Sta. 23 To 31)

Reservoir Street Widening
Harrisonburg, Virginia

DRAWING
1D



Source: Created From Drawings Provided By McCormick Taylor

Legend

B-XX Soil Test Borings

GRAPHIC SCALE
0 30 60

DATE: 3/29/12	
DRAWN BY: JNR	
CHECKED BY:	
SCALE: 1"=60'	
PROJECT NO. 1081-11-098	

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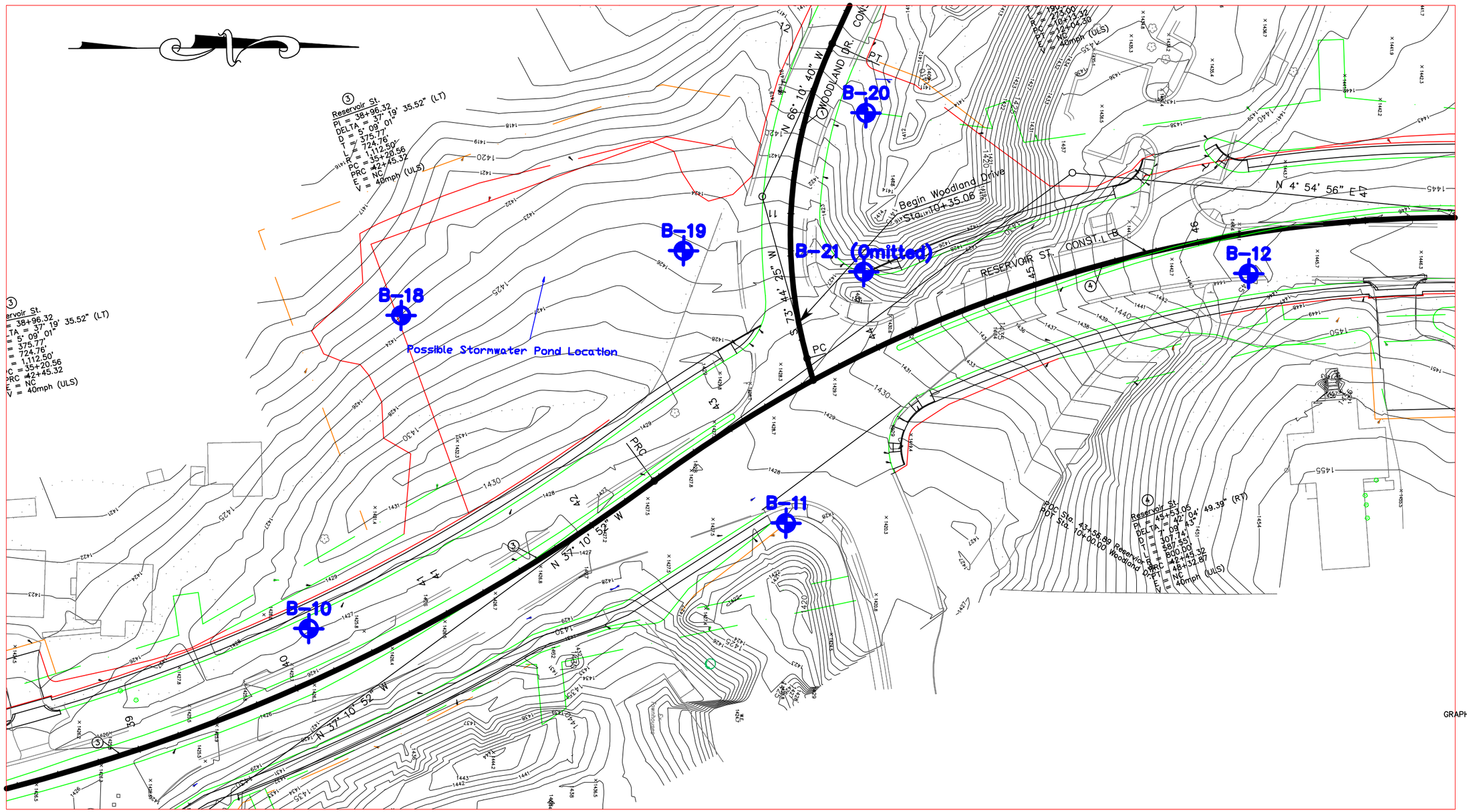
Boring Location Plan (Sta. 31 To 39)

Reservoir Street Widening
Harrisonburg, Virginia

DRAWING
1E



Source: Created From Drawings Provided By McCormick Taylor

Legend

B-XX Soil Test Borings

GRAPHIC SCALE
0 30 60

SCALE: 1"=60'	DATE: 3/29/12
PROJECT NO. 1081-11-098	DRAWN BY: JNR
	CHECKED BY:

S&ME
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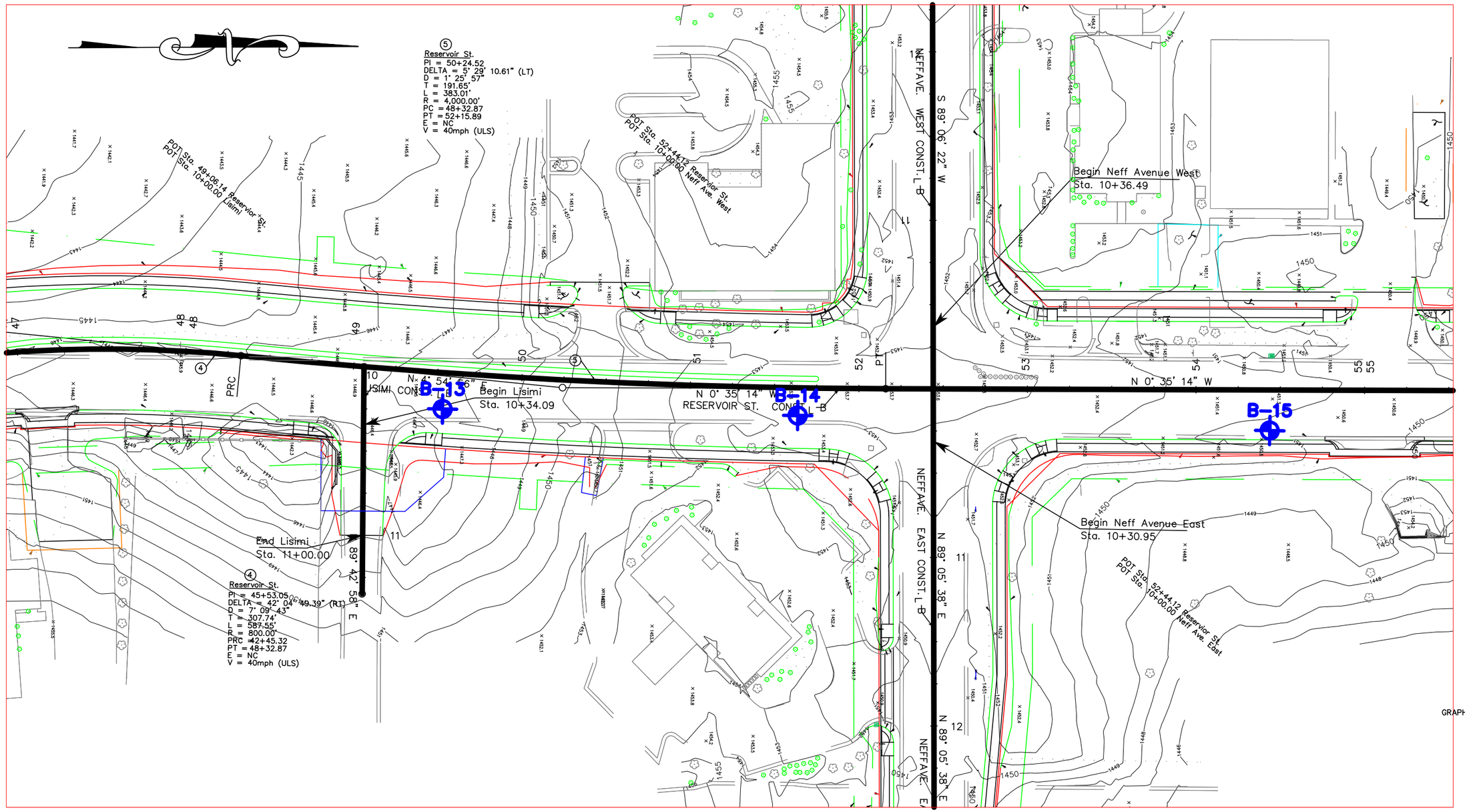
Boring Location Plan (Sta. 39 To 47)

Reservoir Street Widening
Harrisonburg, Virginia

DRAWING
1F



Source: Created From Drawings Provided By McCormick Taylor

Legend

B-XX Soil Test Borings

GRAPHIC SCALE
0 30 60

SCALE: 1"=60'	DATE: 3/29/12
PROJECT NO. 1081-11-098	DRAWN BY: JNR
	CHECKED BY:

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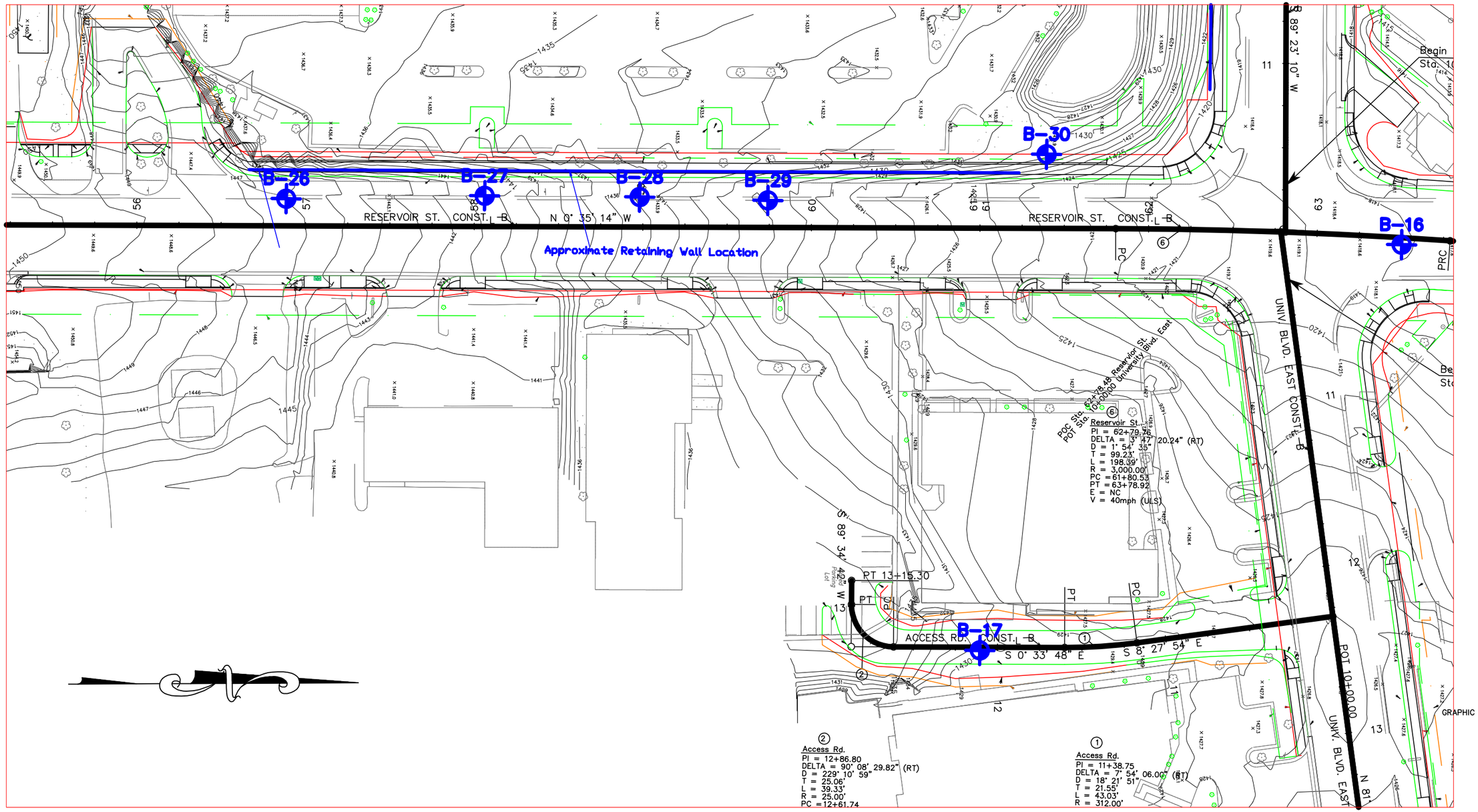
Boring Location Plan (Sta. 47 To 55)

Reservoir Street Widening
Harrisonburg, Virginia

DRAWING
1G



Source: Created From Drawings Provided By McCormick Taylor

Legend

B-XX Soil Test Borings

GRAPHIC SCALE
0 30 60

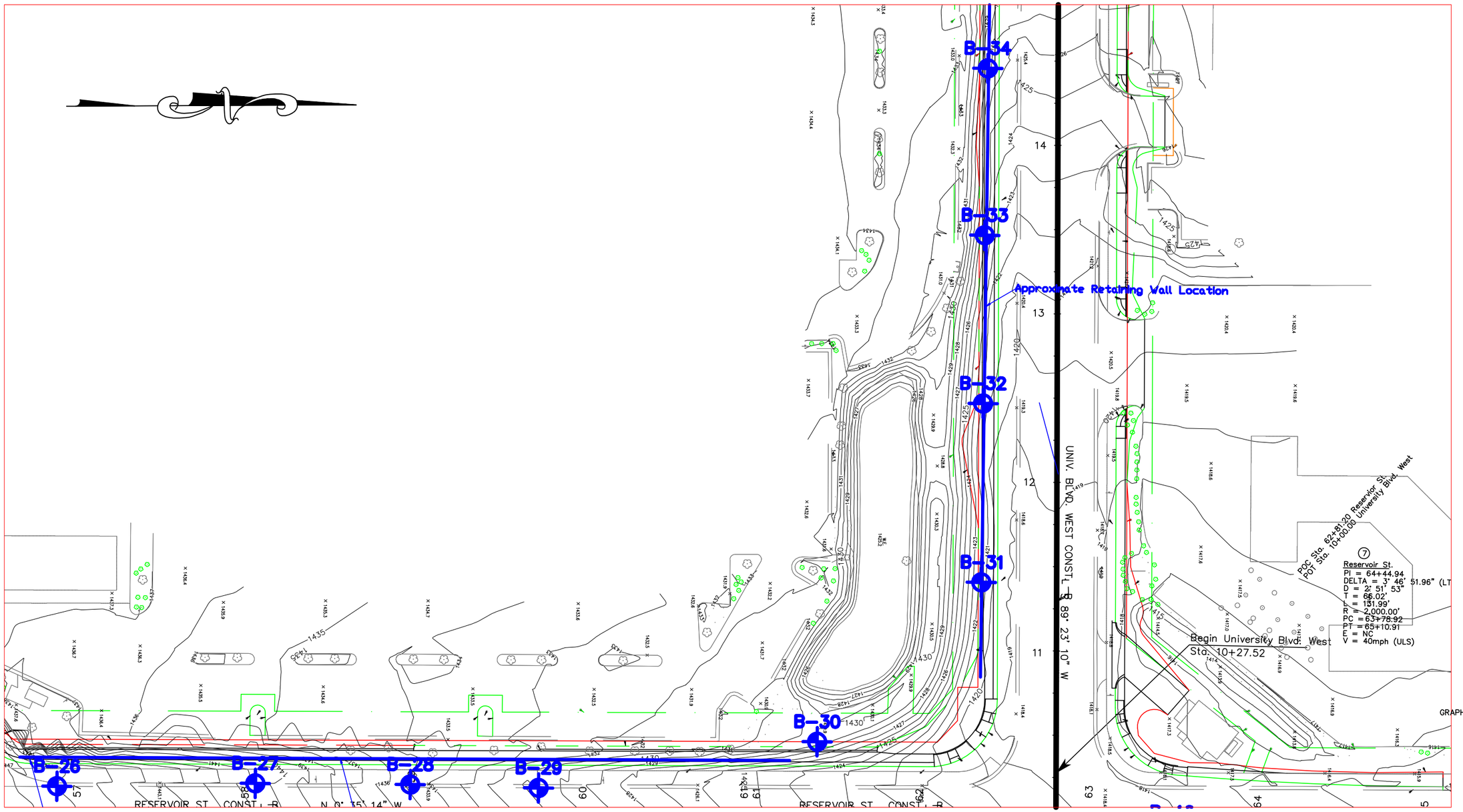
SCALE: 1"=60'	DATE: 3/29/12
PROJECT NO. 1081-11-098	DRAWN BY: JNR
	CHECKED BY:

S&ME
WWW.SMEINC.COM

Boring Location Plan (Sta. 55 To 64)

Reservoir Street Widening
Harrisonburg, Virginia

DRAWING
1H



Source: Created From Drawings Provided By McCormick Taylor

Legend

B-XX Soil Test Borings

GRAPHIC SCALE
0 30 60

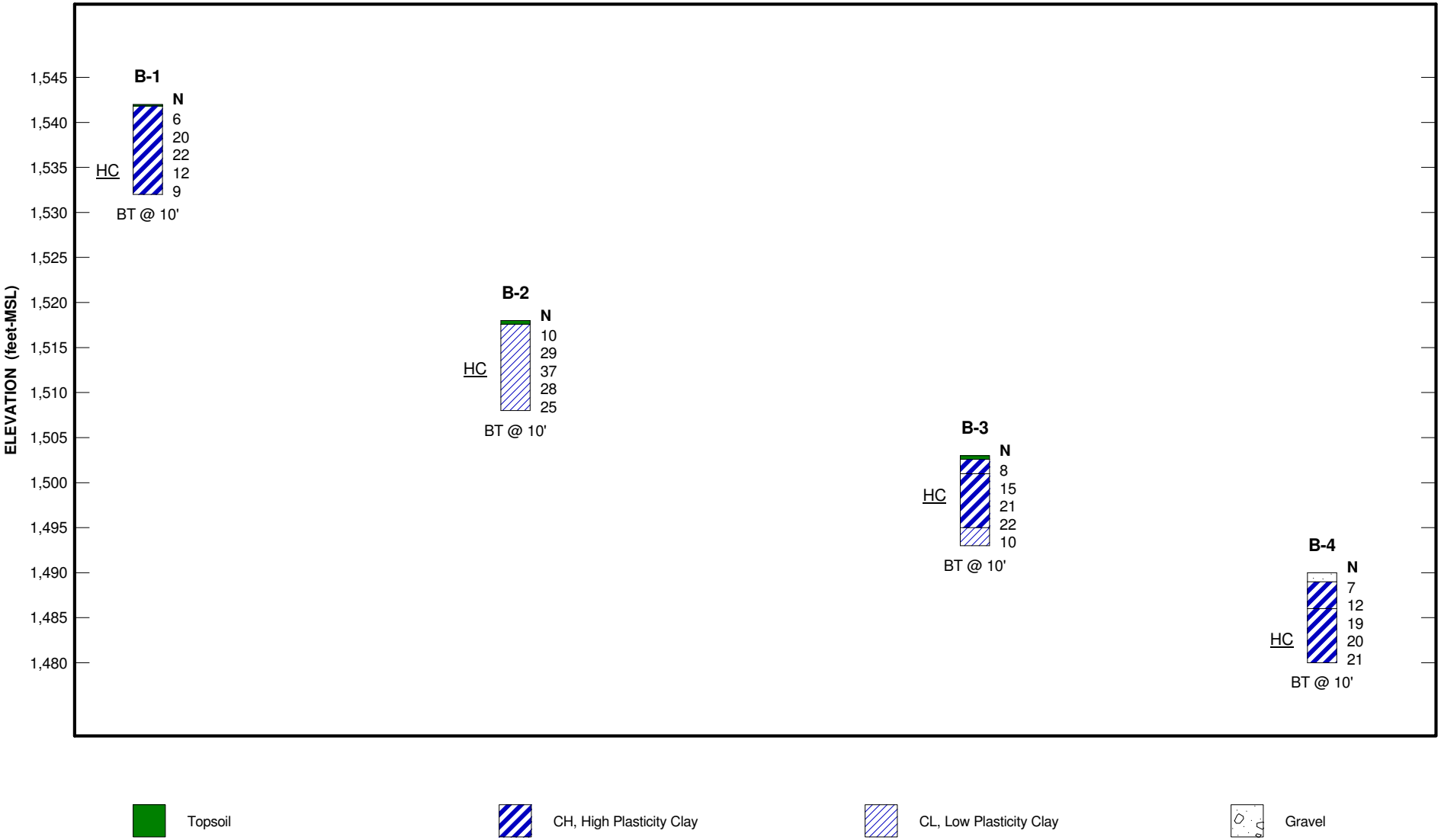
SCALE: 1"=60'
PROJECT NO. 1081-11-098
DATE: 3/29/12
DRAWN BY: JNR
CHECKED BY:

S&ME
WWW.SMEINC.COM

Boring Location Plan (University Blvd)

Reservoir Street Widening
Harrisonburg, Virginia

DRAWING
1J



Topsoil

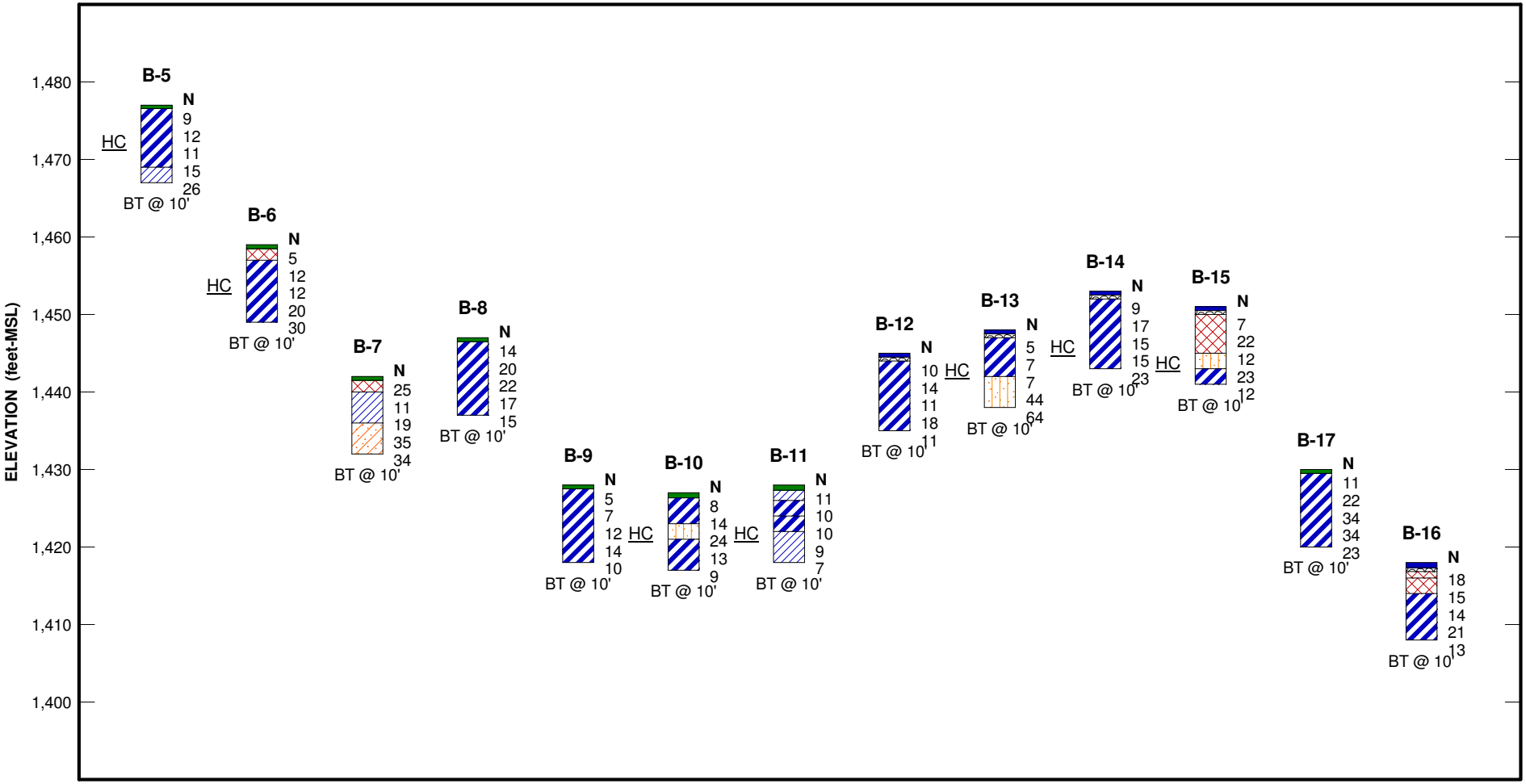
CH, High Plasticity Clay

CL, Low Plasticity Clay

Gravel

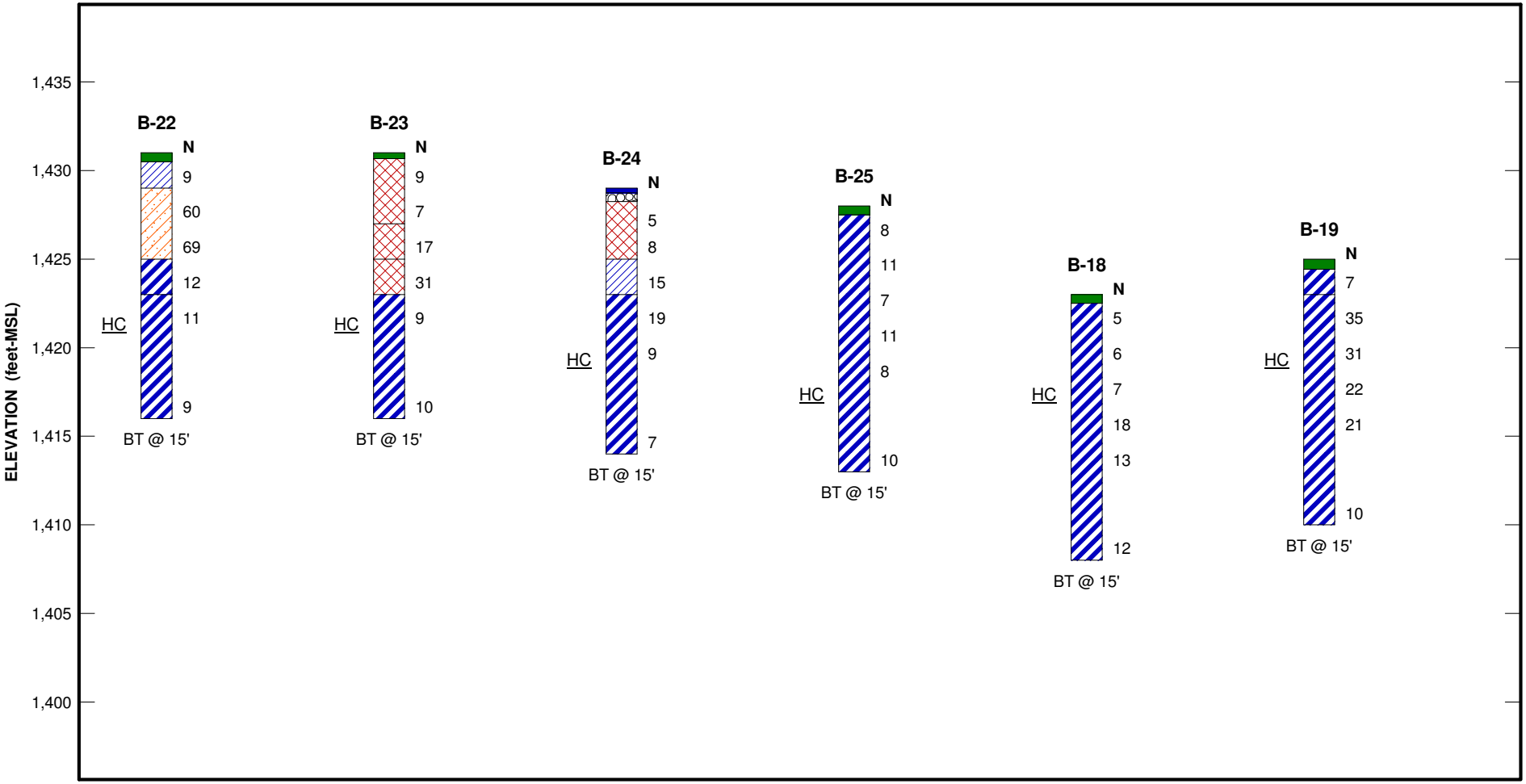
N = Standard Penetration Test resistance value (blows per foot). The depicted stratigraphy is shown for illustrative purposes only. The actual subsurface conditions will vary between boring locations.

JOB NO: 1081-11-098	S&ME	8211 Hermitage Road Henrico, VA 23228	Diagram: Generalized Subsurface Conditions (B-1 to B-4) Project: Reservoir Street Improvements (Route 710) Location: Harrisonburg, Virginia	Drawing 2A
DATE: 4/2/12				



N = Standard Penetration Test resistance value (blows per foot). The depicted stratigraphy is shown for illustrative purposes only. The actual subsurface conditions will vary between boring locations.

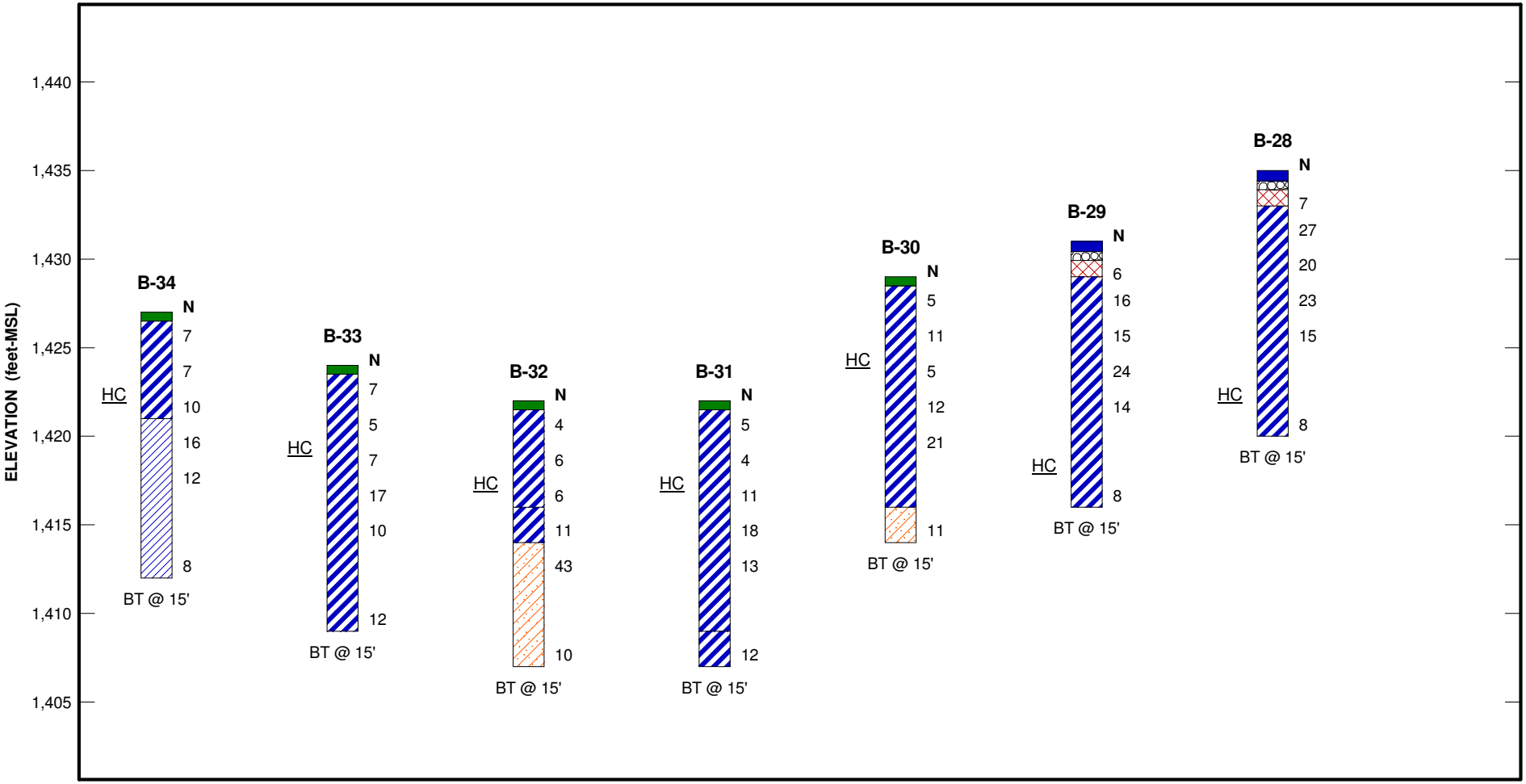
JOB NO: 1081-11-098	S&ME	8211 Hermitage Road Henrico, Virginia 23228	Diagram: Generalized Subsurface Conditions (B-5 To B-17) Project: Reservoir Street Improvements (Route 710) Location: Harrisonburg, Virginia	Drawing 2B
DATE: 4/2/12				



Topsoil
Fill
CH, High Plasticity Clay
Asphalt
CL, Low Plasticity Clay
Aggregate Base Course
SC, Clayey Sand

N = Standard Penetration Test resistance value (blows per foot). The depicted stratigraphy is shown for illustrative purposes only. The actual subsurface conditions will vary between boring locations.

JOB NO: 1081-11-098	S&ME	8211 Hermitage Road Henrico, Virginia 23228	Diagram: Generalized Subsurface Conditions (B-18 To B-25) Project: Reservoir Street Improvements (Route 710) Location: Harrisonburg, Virginia	Drawing 2C
DATE: 4/2/12				



Asphalt
Topsoil
Aggregate Base Course
SC, Clayey Sand
Fill
CL, Low Plasticity Clay
CH, High Plasticity Clay

N = Standard Penetration Test resistance value (blows per foot). The depicted stratigraphy is shown for illustrative purposes only. The actual subsurface conditions will vary between boring locations.

JOB NO: 1081-11-098	S&ME	8211 Hermitage Road Henrico, Virginia 23228	Diagram: Generalized Subsurface Conditions (B-26 To B-34) Project: Reservoir Street Improvements (Route 710) Location: Harrisonburg, Virginia	Drawing 2D
DATE: 4/2/12				

APPENDIX II – SUBSURFACE EXPLORATION

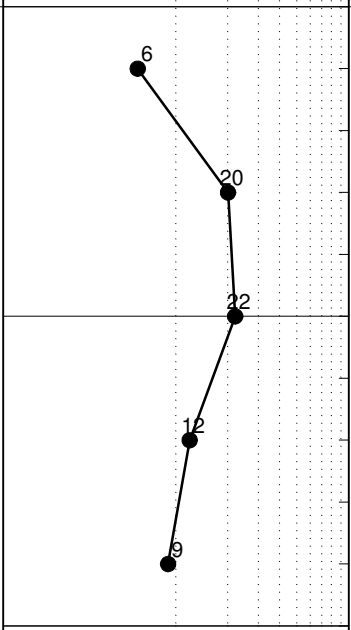
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-1**

DATE DRILLED: **1/23/12**	ELEVATION: **1542.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6834399** EASTING: **11381052**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		TOPSOIL (2 inches)									
		FAT CLAY (CH) mostly high plasticity fines, firm to stiff, moist, orange-brown, with few fine to coarse angular gravels			1			3	3	3	6
					2			10	10	10	20
5				1537.0	3			10	10	12	22
					4			5	6	6	12
			HC		5			4	4	5	9
10		Boring terminated at 10 feet		1532.0							

REMARKS

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-2**

DATE DRILLED: **1/23/12**	ELEVATION: **1518.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6834585** / EASTING: **11381273**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	REMARKS STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 60 80	N VALUE
		TOPSOIL (5 inches)										
		SANDY LEAN CLAY (CL) mostly moderate plasticity fines, some fine to medium sand, stiff to hard, moist, orange-tan to red-brown, with some fine to coarse angular gravels and few pockets of fat clay			1			5	6	4	10	10
					2			12	13	16	29	29
5				1513.0	3			13	20	17	37	37
			HC		4			22	15	13	28	28
					5			16	12	13	25	25
10		Boring terminated at 10 feet		1508.0								

S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

NOTES:

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2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

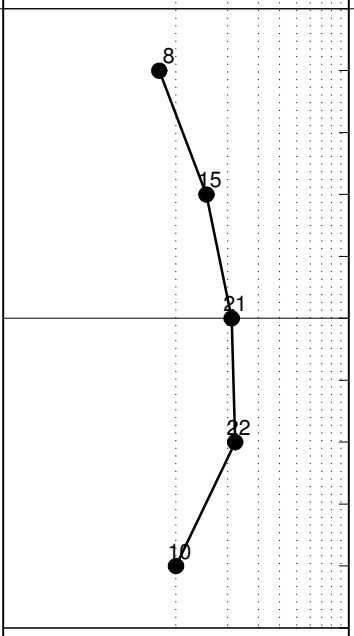
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-3**

DATE DRILLED: **1/23/12**	ELEVATION: **1503.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6834891** / EASTING: **11381424**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		TOPSOIL (5 inches)									
		FAT CLAY with SAND (CH) mostly high plasticity fines, little fine sand, firm, moist, tan-brown			1			2	4	4	8
		SANDY FAT CLAY (CH) mostly high plasticity fines, some fine to coarse sand, stiff to very stiff, moist, red-brown, orange-brown, with some fine to coarse angular gravels			2			6	6	9	15
5			HC	1498.0	3			5	8	13	21
					4			10	9	13	22
		LEAN CLAY (CL) mostly moderate plasticity fines, stiff, moist, red-brown			5			3	4	6	10
10		Boring terminated at 10 feet		1493.0							

REMARKS

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-4**

DATE DRILLED: **1/23/12**	ELEVATION: **1490.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6835167** EASTING: **11381462**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	REMARKS STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 60 80	N VALUE
		GRAVEL (12 inches)										
		FAT CLAY (CH) with SAND mostly high plasticity fines, little fine to medium sand, stiff, moist, red-brown, with some fine to coarse angular gravels			1			6	5	2	7	7
					2			4	5	7	12	12
5		**FAT CLAY (CH)** mostly high plasticity fines, very stiff, moist, red-brown, orange-brown, tan, with few fine to coarse angular gravels from 4 to 6 feet		1485.0	3			7	9	10	19	19
			HC		4			7	7	13	20	20
					5			13	10	11	21	21
10		Boring terminated at 10 feet		1480.0								

S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

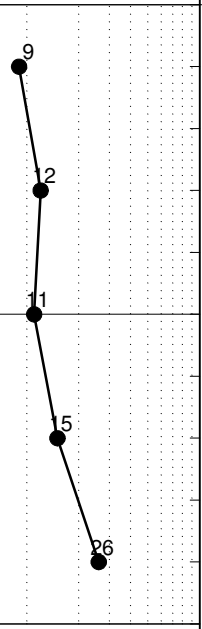
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-5**

DATE DRILLED: **1/23/12**	ELEVATION: **1477.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6835490** / EASTING: **11381495**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		TOPSOIL (5 inches)									
		FAT CLAY (CH) mostly high plasticity fines, stiff, moist, orange-brown			1			3	4	5	9
					2			6	6	6	12
		- - - Little fine to coarse sand at 4 to 6 feet									
5			HC	1472.0	3			4	5	6	11
					4			9	7	8	15
		SANDY LEAN CLAY (CL) mostly moderate plasticity fines, some fine to coarse sand, very stiff, moist, orange-brown, with some fine to coarse angular gravels			5			13	13	13	26
10		Boring terminated at 10 feet		1467.0							

REMARKS

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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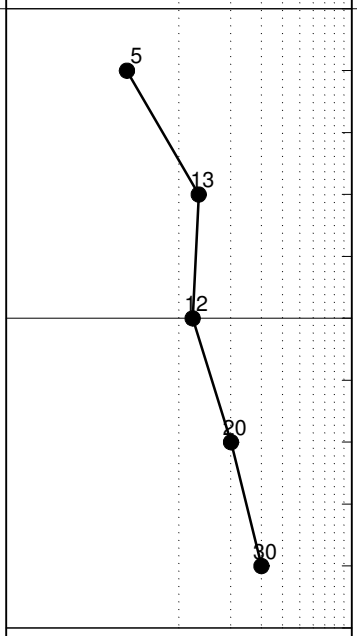
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-6**

DATE DRILLED: **1/20/12**	ELEVATION: **1459.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6835792** / EASTING: **11381507**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		TOPSOIL (6 inches)									
		SANDY SILT (ML) FILL, mostly low to moderate plasticity fines, some fine to coarse sand, firm, moist, brown, tan, with some fine to coarse angular gravels			1			5	2	3	5
		FAT CLAY (CH) mostly high plasticity fines, stiff to very stiff, moist, orange-brown, tan, with few fine to coarse angular gravels			2			5	6	7	13
5			HC	1454.0	3			4	6	6	12
		- - - Little fine to medium sand from 6 to 10 feet			4			9	9	11	20
					5			13	13	17	30
10		Boring terminated at 10 feet		1449.0							

REMARKS

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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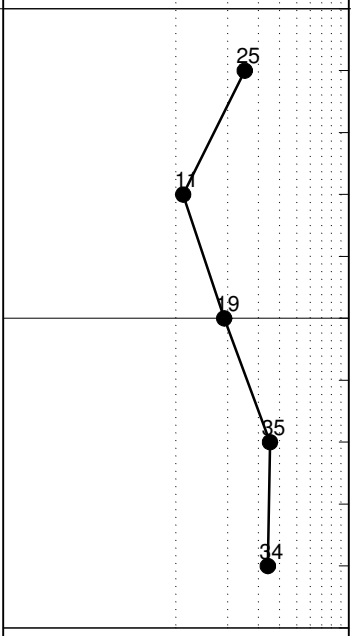
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-7**

DATE DRILLED: **1/20/12**	ELEVATION: **1442.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6836101** EASTING: **11381505**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		TOPSOIL (6 inches)									
		SILTY SAND (SM) FILL, mostly fine to medium sand, some low plasticity fines, medium dense, moist, dark brown, with fine to coarse angular gravels and few roots/rootlets			1			6	12	13	25
		SANDY LEAN CLAY (CL) mostly moderate plasticity fines, some fine to coarse sand, stiff to very stiff, moist, brown with orange-brown, with fine to coarse angular gravels			2			3	4	7	11
5				1437.0	3			6	11	8	19
		CLAYEY SAND (SC) mostly fine to coarse sand, some moderate plasticity fines, dense, moist, orange-brown, orange-tan, light gray, with fine to coarse angular gravels			4			8	16	19	35
					5			16	16	18	34
10		Boring terminated at 10 feet		1432.0							

REMARKS

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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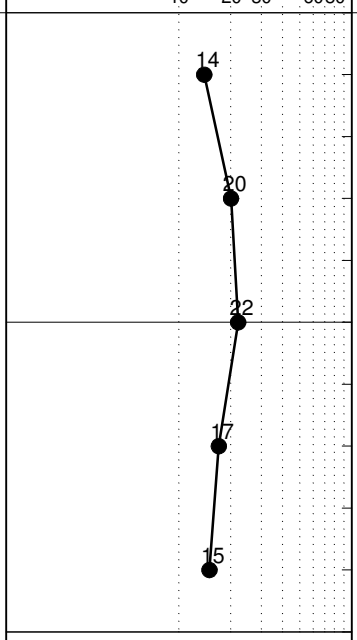
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-8**

DATE DRILLED: **1/20/12**	ELEVATION: **1447.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6836399** EASTING: **11381501**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		TOPSOIL (6 inches)									
		FAT CLAY (CH) mostly high plasticity fines, stiff to very stiff, dry to moist, orange-brown, red-brown			1			2	4	10	14
		- - - Some fine to coarse angular gravels at 2 to 4 feet			2			8	10	10	20
5				1442.0	3			18	12	10	22
					4			8	8	9	17
		- - - Few fine to medium angular gravels at 8 to 10 feet			5			7	8	7	15
10				1437.0							
		Boring terminated at 10 feet									

REMARKS

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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PROJECT: **Reservoir Street Improvements (Route 710)**
Harrisonburg, Virginia
S&ME Project No. 1081-11-098

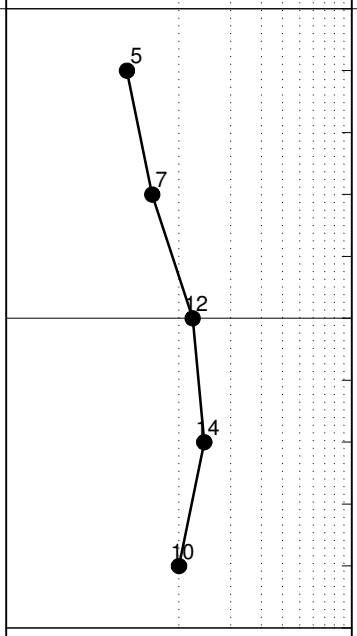
BORING LOG B-9

DATE DRILLED: **1/19/12**	ELEVATION: **1428.0 ft**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**
SAMPLING METHOD: **Split spoon**	NORTHING: **6837004** / EASTING: **11381478**
DRILLING METHOD: **2¼" H.S.A.**	

NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**

DEPTH (feet)	MATERIAL DESCRIPTION	ELEVATION (feet)	SAMPLE NO.	1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
	TOPSOIL (6 inches)						
	FAT CLAY (CH) mostly high plasticity fines, firm to stiff, moist, orange-brown with orange-tan		1	2	2	3	5
			2	3	3	4	7
	- - - Few fine to medium angular gravels from 4 to 6 feet						
5		1423.0	3	5	6	6	12
			4	6	6	8	14
			5	6	5	5	10
10	Boring terminated at 10 feet	1418.0					

REMARKS — STANDARD PENETRATION TEST DATA (blows/ft)



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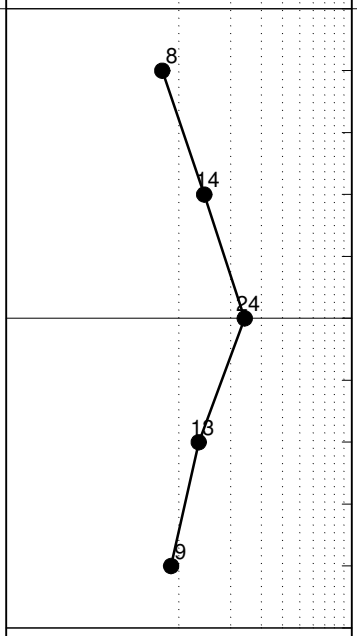
S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-10**

DATE DRILLED: **1/18/12**	ELEVATION: **1427.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6837255** EASTING: **11381331**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	REMARKS	N VALUE
		TOPSOIL (8 inches)										
		FAT CLAY (CH) mostly high plasticity fines, stiff to very stiff, moist, red-brown with orange-brown, with few coarse angular gravels - - - Rootlets observed in first sample			1			2	4	4		8
					2			6	5	9		14
5		**SILTY SAND (SM)** mostly fine to coarse sand, some low plasticity fines, medium dense, moist, tan, with few pockets of lean clay		1422.0	3			9	10	14		24
		FAT CLAY (CH) mostly high plasticity fines, stiff, moist, red-brown with orange-brown	HC		4			6	6	7		13
					5			3	4	5		9
10		Boring terminated at 10 feet		1417.0								

STANDARD PENETRATION TEST DATA (blows/ft)



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S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-11**

DATE DRILLED: **1/18/12**	ELEVATION: **1428.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6837537** / EASTING: **11381243**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.) / SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	REMARKS STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 60 80	N VALUE
		TOPSOIL (8 inches)									
		SANDY LEAN CLAY (CL) mostly moderate plasticity fines, some fine to coarse sand, stiff, dry, brown, with some fine to coarse angular gravels			1		4	5	6	11	11
		SANDY FAT CLAY (CH) mostly high plasticity fines, some fine to medium sand, stiff, dry to moist, red-brown with brown			2		4	4	6	10	10
5		**FAT CLAY (CH)** mostly high plasticity fines, stiff, moist, red-brown, with few fine to coarse angular gravels		1423.0	3		6	5	5	10	10
		SANDY LEAN CLAY (CL) mostly moderate plasticity fines, some fine to medium sand, stiff to firm, very moist, brown	HC		4		4	5	4	9	9
					5		5	3	4	7	7
10		Boring terminated at 10 feet		1418.0							

S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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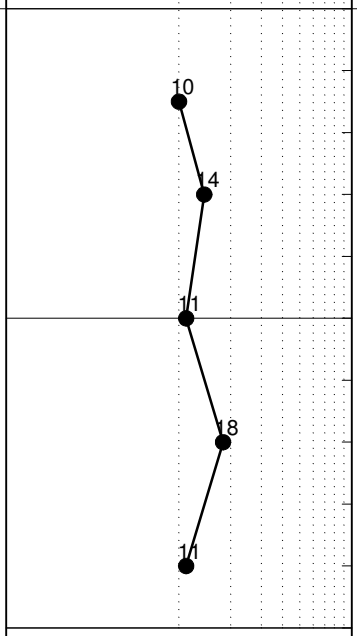
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-12**

DATE DRILLED: **1/19/12**	ELEVATION: **1445.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6837808** EASTING: **11381113**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	REMARKS	N VALUE
		ASPHALT (6 inches)										
		CRUSHED STONE (6 inches)										
		FAT CLAY (CH) mostly high plasticity fines, trace fine to medium sand, stiff to very stiff, moist, red-brown, with few coarse gravels			1			10	5	5		10
					2			5	6	8		14
5				1440.0	3			5	4	7		11
					4			9	8	10		18
					5			4	5	6		11
10		Boring terminated at 10 feet		1435.0								

STANDARD PENETRATION TEST DATA (blows/ft)



NOTES:

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3. ***STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.***
4. ***WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.***

S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-13**

DATE DRILLED: **1/19/12**	ELEVATION: **1448.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6838111** / EASTING: **11381096**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.) / SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	REMARKS STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 60 80	N VALUE
		ASPHALT (6 inches)									
		CRUSHED STONE (6 inches)									
		FAT CLAY (CH) mostly high plasticity fines, firm, moist, red-brown and tan, with few fine gravels			1		3	3	2	5	5
					2		4	3	4	7	7
5				1443.0	3		4	3	4	7	7
		SILTY SAND (SM) mostly fine to coarse sand, some low plasticity fines, dense to very dense, dry to moist, with few clay pockets and some fine to coarse angular gravels	HC		4		5	7	37	44	44
					5		4	26	38	64	64
10		Boring terminated at 10 feet		1438.0							

S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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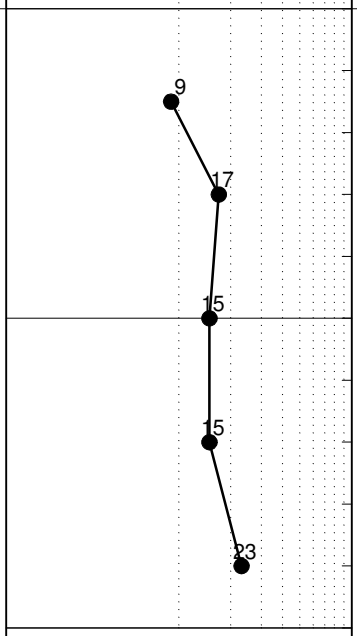
PROJECT: **Reservoir Street Improvements (Route 710)**
Harrisonburg, Virginia
S&ME Project No. 1081-11-098

BORING LOG B-14

DATE DRILLED: **1/19/12**	ELEVATION: **1453.0 ft**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**
SAMPLING METHOD: **Split spoon**	NORTHING: **6838341** / EASTING: **11381113**
DRILLING METHOD: **2¼" H.S.A.**	

NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**

DEPTH (feet)	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
	ASPHALT (6 inches)							
	CRUSHED STONE (6 inches)							
	FAT CLAY (CH) mostly high plasticity fines, stiff to very stiff, moist, red-brown			1	5	5	4	9
				2	6	7	10	17
5			1448.0	3	7	8	7	15
				4	7	8	7	15
	- - - Some fine to coarse angular gravels from 8 to 10 feet	HC		5	7	10	13	23
10			1443.0					
	Boring terminated at 10 feet							



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-15**

DATE DRILLED: **1/19/12**	ELEVATION: **1451.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6838619** / EASTING: **11381087**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.) / SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	REMARKS STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 60 80	N VALUE
		ASPHALT (6 inches)									
		CRUSHED STONE (6 inches)									
		SILTY SAND (SM) FILL, mostly fine to medium sand, some low plasticity fines, loose to medium dense, moist, brown to dark brown, with pockets of fat clay			1		8	4	3	7	7
					2		11	13	9	22	22
		- - - Some fine to coarse angular gravels from 4 to 6 feet									
5				1446.0	3		7	6	6	12	12
		SILTY SAND (SM) mostly fine to medium sand, some low plasticity fines, medium dense, moist, tan-brown, with pockets of fat clay			4		5	13	10	23	23
			HC								
		FAT CLAY (CH) mostly high plasticity fines, stiff, moist, red-brown			5		4	6	6	12	12
10				1441.0							
		Boring terminated at 10 feet									

S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-16**

CLIENT:	ELEVATION: **1418.0 ft**	NOTES: Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."
DATE DRILLED: **1/19/12 - 1/19/12**	BORING DEPTH: **10.0 ft**	
DRILL RIG: **ATV**	WATER LEVEL: **Not encountered**	
DRILLER: **Fishburne Drilling Inc.**	CAVE-IN DEPTH:	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	ELEV. (')	GRAPHIC LOG	MATERIAL DESCRIPTION	TESTS	BLOWS	SAMPLE DATA	STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 60 80
			ASPHALT (8 inches)				
			CRUSHED STONE (6 inches)				
			POORLY GRADED SAND (SP-SM) FILL, mostly fine to coarse sand, little low plasticity fines, medium dense, dry, dark gray, with fine to coarse angular gravels		26 10 8	1	18
	1415		**FAT CLAY (CH)** FILL, mostly high plasticity fines, stiff, moist, dark orange-brown, with fine to coarse angular gravels		7 8 7 9	2	15
5			**FAT CLAY (CH)** mostly high plasticity fines, stiff to very stiff, moist, orange brown with tan		6 6 8 8	3	14
					7 9 12 17	4	21
	1410				5 6 7 12	5	13
10			Boring terminated at 10 feet				

S&ME BORING LOG - NEW 1081-11-098 LOGS.GPJ S&ME.GDT 4/9/12

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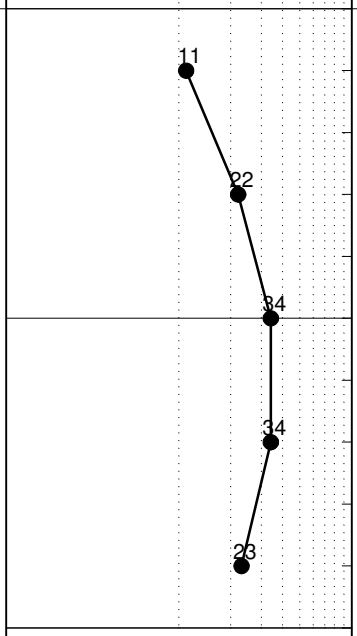
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-17**

DATE DRILLED: **1/25/12**	ELEVATION: **1430.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **10.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6839268** EASTING: **11381338**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	REMARKS	N VALUE
		TOPSOIL (6 inches)										
		FAT CLAY (CH) mostly high plasticity fines, trace fine to medium sand, stiff to hard, dry to moist, red-brown with tan			1			1	6	5		11
					2			7	10	12		22
5				1425.0	3			11	13	21		34
					4			13	16	18		34
					5			7	10	13		23
10		Boring terminated at 10 feet		1420.0								

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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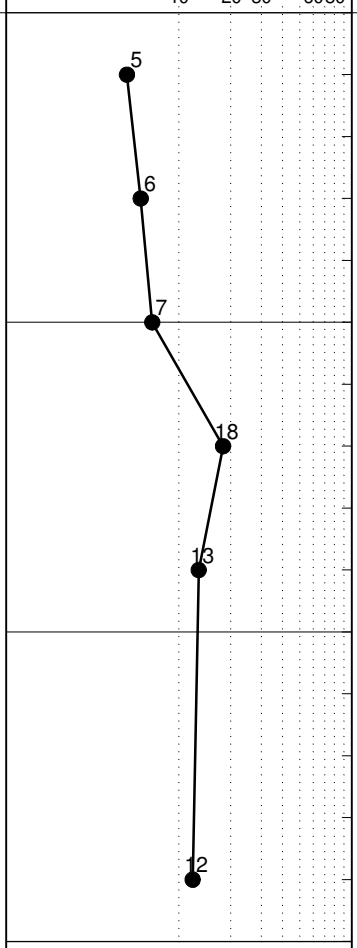
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-18**

DATE DRILLED: **1/18/12**	ELEVATION: **1423.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **15.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6837326** EASTING: **11381144**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		TOPSOIL (6 inches)									
		FAT CLAY (CH) mostly high plasticity fines, firm to very stiff, moist, orange-brown with light gray - - - Few fine to medium angular gravels from 2 to 4 feet			1			2	2	3	5
					2			3	3	3	6
5				1418.0	3			3	3	4	7
		- - - Few fine to medium angular gravels from 6 to 8 feet	HC		4			13	10	8	18
					5			5	5	8	13
10				1413.0							
					6			5	5	7	12
15		Boring terminated at 15 feet		1408.0							

REMARKS

STANDARD PENETRATION TEST DATA (blows/ft)



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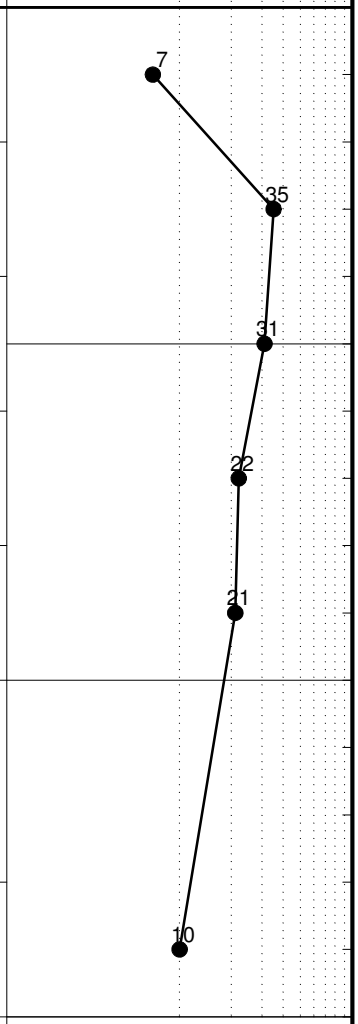
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-19**

CLIENT:	ELEVATION: **1425.0 ft**	NOTES: Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."
DATE DRILLED: **1/18/12 - 1/18/12**	BORING DEPTH: **15.0 ft**	
DRILL RIG: **ATV**	WATER LEVEL: **Not encountered**	
DRILLER: **Fishburne Drilling Inc.**	CAVE-IN DEPTH: **6'**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	ELEV. (')	GRAPHIC LOG	MATERIAL DESCRIPTION	TESTS	BLOWS	SAMPLE DATA
			TOPSOIL (7 inches)			
			FAT CLAY (CH) mostly high plasticity fines, firm, very moist, tan-brown, with few fine to coarse angular gravels		1 2 5 12	1
			FAT CLAY (CH) mostly high plasticity fines, trace fine to medium sand, hard to stiff, dry to moist, red-brown, orange-brown, with some fine to coarse angular gravels		12 13 22 22	2
5	1420				10 15 16 15	3
HC					8 9 13 15	4
					9 10 11 12	5
10	1415					
					6 5 5 7	6
15	1410		Boring terminated at 15 feet			

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG - NEW 1081-11-098 LOGS.GPJ S&ME.GDT 4/9/12

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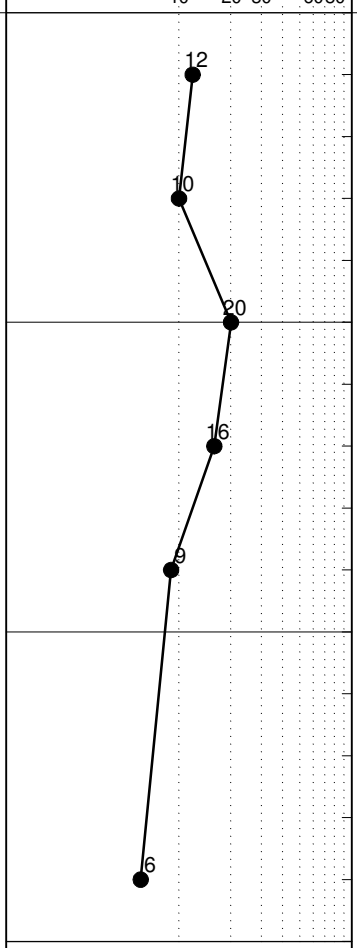
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-20**

DATE DRILLED: **1/18/12**	ELEVATION: **1417.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **15.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6837580** EASTING: **11381022**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		TOPSOIL (6 inches)									
		CLAYEY SAND (SC) mostly fine to medium sand, some moderate plasticity fines, medium dense, moist, brown, with few fine to medium angular gravels			1			4	5	7	12
		SANDY LEAN CLAY (CL) mostly moderate plasticity fines, some fine to coarse sand, stiff to very stiff, moist, orange-brown, with some fine to coarse angular gravels			2			6	4	6	10
5			HC	1412.0	3			9	7	13	20
		FAT CLAY (CH) mostly high plasticity fines, stiff to firm, moist, red-brown with orange-brown			4			10	8	8	16
					5			4	4	5	9
10				1407.0							
					6			2	3	3	6
15		Boring terminated at 15 feet		1402.0							

REMARKS

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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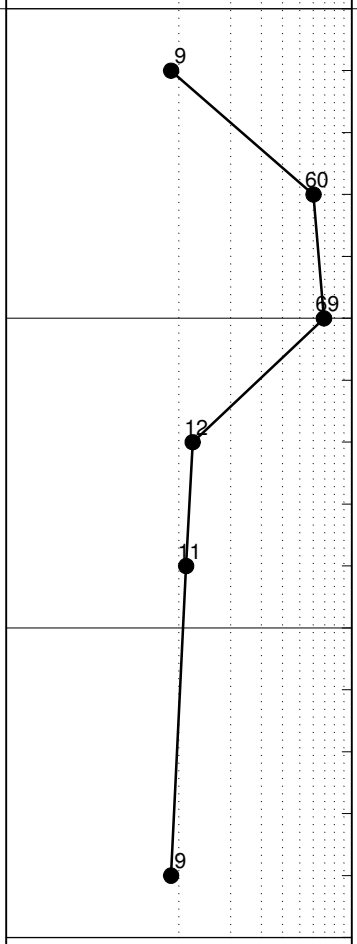
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-22**

DATE DRILLED: **1/20/12**	ELEVATION: **1431.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **15.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6836623** / EASTING: **11381525**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		TOPSOIL (6 inches)									
		SANDY LEAN CLAY (CL) mostly moderate plasticity fines, some fine to coarse sand, stiff, moist, brown, with fine to coarse angular gravels			1			2	4	5	9
		CLAYEY SAND (SC) mostly fine to coarse sand, some moderate to high plasticity fines, very dense, brown with red, dry, with fine to coarse gravels			2			13	26	34	60
5				1426.0	3			29	34	35	69
		FAT CLAY (CH) mostly high plasticity fines, stiff, moist, orange-brown			4			8	6	6	12
		SANDY FAT CLAY (CH) mostly high plasticity fines, some fine to coarse sand, stiff, moist, orange-brown, with little fine to medium gravels			5			7	6	5	11
10			HC	1421.0							
					6			6	6	3	9
15		Boring terminated at 15 feet		1416.0							

REMARKS

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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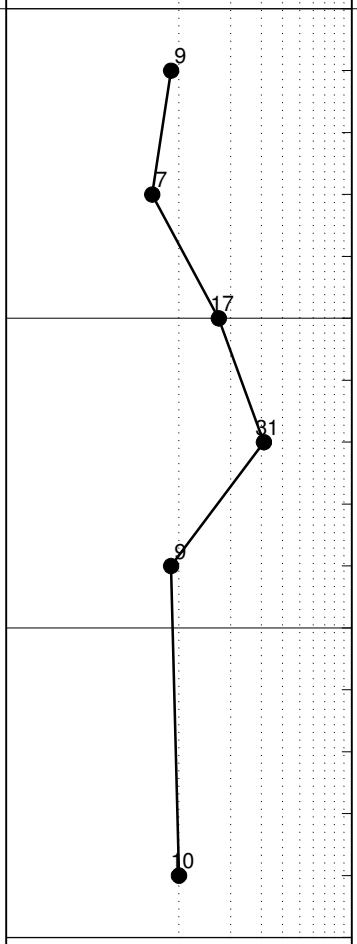
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-23**

DATE DRILLED: **1/20/12**	ELEVATION: **1431.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **15.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6836681** EASTING: **11381524**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		TOPSOIL (4 inches)									
		FAT CLAY (CH) FILL, mostly high plasticity fines, stiff to firm, moist, brown with orange-brown and red-brown, with little coarse sand and fine to coarse angular gravels, trace rootlets			1			4	4	5	9
					2			4	3	4	7
5		**SANDY LEAN CLAY (CL)** FILL, mostly moderate plasticity fines, some fine to coarse sand, very stiff, dark brown with orange brown, with fine to coarse angular gravels		1426.0	3			3	3	14	17
		SILTY SAND (SM) FILL, mostly fine to coarse sand, some low plasticity fines, dense, moist, dark gray, brown, with fine to coarse angular gravels			4			10	18	13	31
		FAT CLAY (CH) mostly high plasticity fines, little fine sand, stiff, moist, orange-brown with dark brown, with few fine to coarse angular gravels			5			4	4	5	9
10			HC	1421.0							
					6			4	4	6	10
15		Boring terminated at 15 feet		1416.0							

REMARKS

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

NOTES:

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2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-24**

DATE DRILLED: **1/20/12**	ELEVATION: **1429.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **15.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6836725** / EASTING: **11381527**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.) / SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	REMARKS STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 60 80	N VALUE
		ASPHALT (3 inches)									
		CRUSHED STONE (6 inches)									
		FAT CLAY (CH) FILL, mostly high plasticity fines, firm, moist, orange-tan, white, brown, with fine to coarse angular gravels - - - Little coarse sand from 2 to 4 feet			1		2	3	2	5	5
					2		2	4	4	8	8
5		**LEAN CLAY (CL)** mostly moderate plasticity fines, stiff, moist, red-brown - - - Little coarse sand at top of sample		1424.0	3		3	5	10	15	15
		FAT CLAY (CH) mostly high plasticity fines, very stiff to firm, moist, orange-tan, orange, light gray, brown, with few fine to medium angular gravels and some manganese staining observed in samples			4		11	11	8	19	19
					5		3	4	5	9	9
10			HC	1419.0							
					6		3	3	4	7	7
15		Boring terminated at 15 feet		1414.0							

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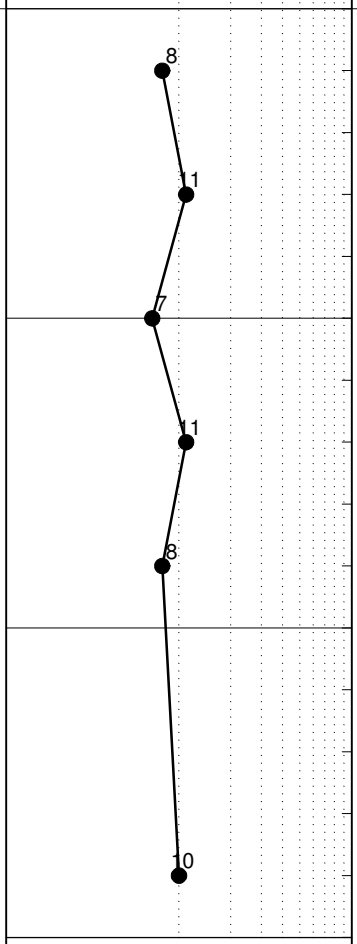
S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-25**

DATE DRILLED: **1/19/12**	ELEVATION: **1428.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **15.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6836809** EASTING: **11381527**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	REMARKS	N VALUE
		TOPSOIL (6 inches)										
		FAT CLAY (CH) mostly high plasticity fines, firm to stiff, moist, orange-brown with orange-tan, with few fine to coarse angular gravels			1			3	4	4		8
					2			6	6	5		11
5				1423.0	3			6	3	4		7
					4			10	7	4		11
					5			4	4	4		8
10			HC	1418.0								
					6			5	5	5		10
15		Boring terminated at 15 feet		1413.0								

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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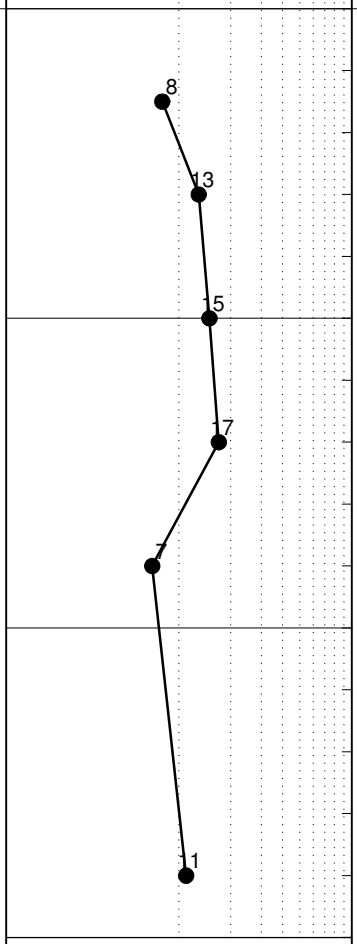
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-26**

DATE DRILLED: **1/19/12**	ELEVATION: **1446.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **15.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6838845** EASTING: **11381053**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.) / SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	REMARKS	N VALUE
		ASPHALT (6 inches)									
		CRUSHED STONE (6 inches)									
		FAT CLAY (CH) moslty high plasticity fines, firm to very stiff, moist, red-brown - - - Little fine to medium sand at 1 to 2 feet - - - Few fine to coarse angular gravels at 2 to 4 feet			1		6	5	3	8	8
					2		4	6	7	13	13
5				1441.0	3		6	7	8	15	15
					4		8	8	9	17	17
					5		4	3	4	7	7
10				1436.0							
			HC		6		3	4	7	11	11
15		Boring terminated at 15 feet		1431.0							

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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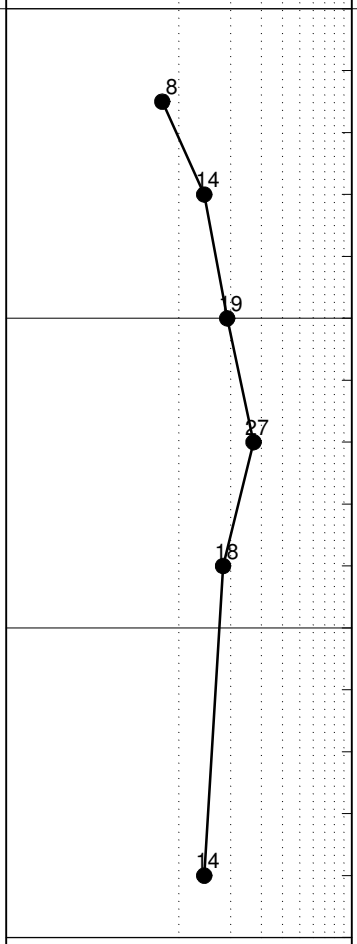
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-27**

DATE DRILLED: **1/19/12**	ELEVATION: **1441.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **15.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6838977** / EASTING: **11381053**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.) / SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		ASPHALT (6 inches)								
		CRUSHED STONE (6 inches)								
		FAT CLAY (CH) mostly high plasticity fines, firm to very stiff, moist, red-brown			1		9	3	5	8
					2		6	7	7	14
5				1436.0	3		9	9	10	19
		- - - Fine to coarse angular gravels from 6 to 10 feet			4		9	12	15	27
					5		5	10	8	18
10			HC	1431.0						
		LEAN CLAY (CL) mostly moderate plasticity fines, stiff, moist, orange-brown			6		3	5	9	14
15		Boring terminated at 15 feet		1426.0						



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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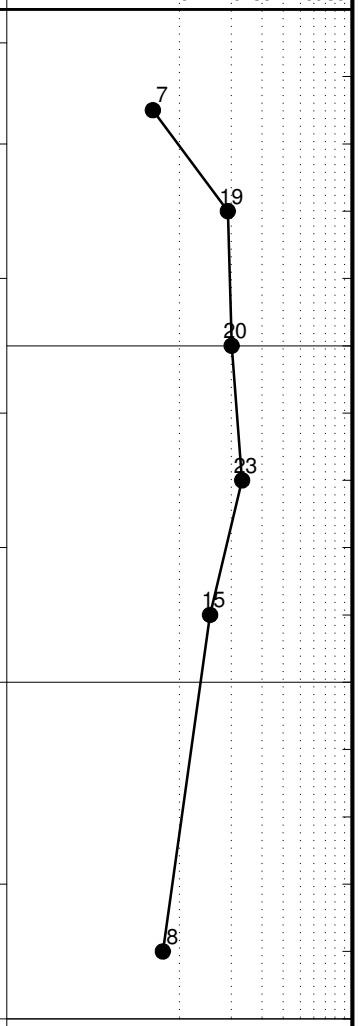
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-28**

CLIENT:	ELEVATION: **1435.0 ft**	NOTES: Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."
DATE DRILLED: **1/19/12 - 1/19/12**	BORING DEPTH: **15.0 ft**	
DRILL RIG: **ATV**	WATER LEVEL: **Not encountered**	
DRILLER: **Fishburne Drilling Inc.**	CAVE-IN DEPTH: **13'**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	ELEV. (')	GRAPHIC LOG	MATERIAL DESCRIPTION	TESTS	BLOWS	SAMPLE DATA
			ASPHALT (7 inches)			
			Crushed Stone (6 inches)			
			SILTY SAND (SM) FILL, moistly fine to coarse sand, some low plasticity fines, loose, dry, dark gray, with fine to coarse angular gravels		5 5 2	1
			FAT CLAY (CH) mostly high plasticity fines, very stiff to firm, moist, red-brown		8 9 10 17	2
5	1430				7 10 10 12	3
			- - - Trace fine angular gravels from 6 to 8 feet		8 11 12 15	4
					7 7 8 10	5
10	1425					
HC					3 4 4 5	6
15	1420		Boring terminated at 15 feet			

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG - NEW 1081-11-098 LOGS.GPJ S&ME.GDT 4/9/12

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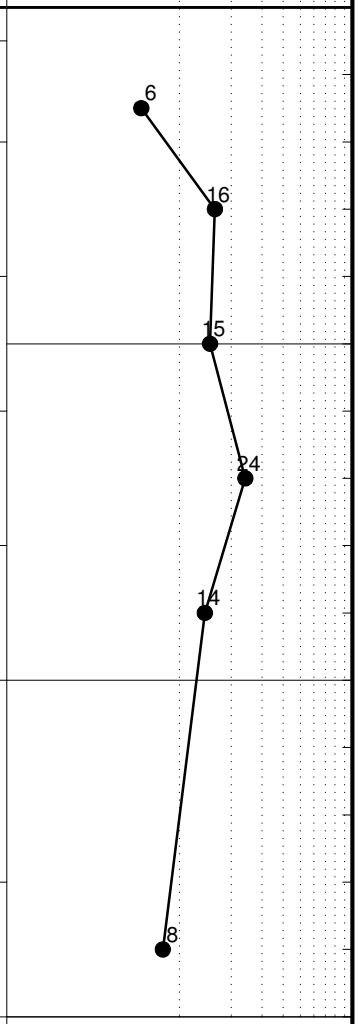
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-29**

CLIENT:	ELEVATION: **1431.0 ft**	NOTES: Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."
DATE DRILLED: **1/19/12 - 1/19/12**	BORING DEPTH: **15.0 ft**	
DRILL RIG: **ATV**	WATER LEVEL: **Not encountered**	
DRILLER: **Fishburne Drilling Inc.**	CAVE-IN DEPTH: **13'**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	ELEV. (')	GRAPHIC LOG	MATERIAL DESCRIPTION	TESTS	BLOWS	SAMPLE DATA
			ASPHALT (7 inches)			
	1430		**Crushed Stone (6 inches)**			
			FAT CLAY (CH) FILL, mostly high plasticity fines, firm, moist, red-brown with brown, with some fine to coarse angular gravels		10 2 4	1
			FAT CLAY (CH) mostly high plasticity fines, firm to very stiff, moist, red-brown		8 7 9 11	2
5					5 6 9 10	3
	1425		- - - Trace fine to coarse angular gravels from 6 to 8 feet		9 10 14 14	4
					6 6 8 9	5
10	1420					
HC					3 4 4 4	6
15			Boring terminated at 15 feet			



S&ME BORING LOG - NEW 1081-11-098 LOGS.GPJ S&ME.GDT 4/9/12

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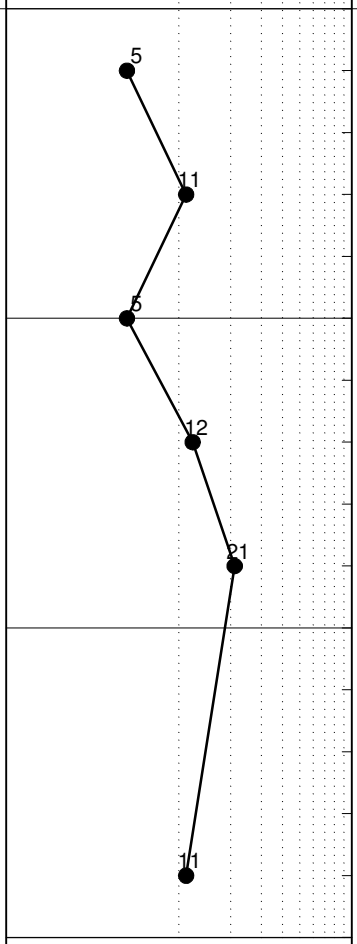
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-30**

DATE DRILLED: **1/18/12**	ELEVATION: **1429.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **15.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6839303** / EASTING: **11381049**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		TOPSOIL (6 inches)									
		FAT CLAY (CH) mostly high plasticity fines, firm to very stiff, moist, red-brown, with few fine angular gravels			1			1	2	3	5
					2			4	5	6	11
5			HC	1424.0	3			4	3	2	5
					4			5	5	7	12
					5			4	7	14	21
10				1419.0							
		CLAYEY SAND (SC) mostly fine to coarse sand, some high plasticity fines, medium dense, moist, brown with red-brown, with fine to coarse angular gravels			6			4	5	6	11
15		Boring terminated at 15 feet		1414.0							

REMARKS

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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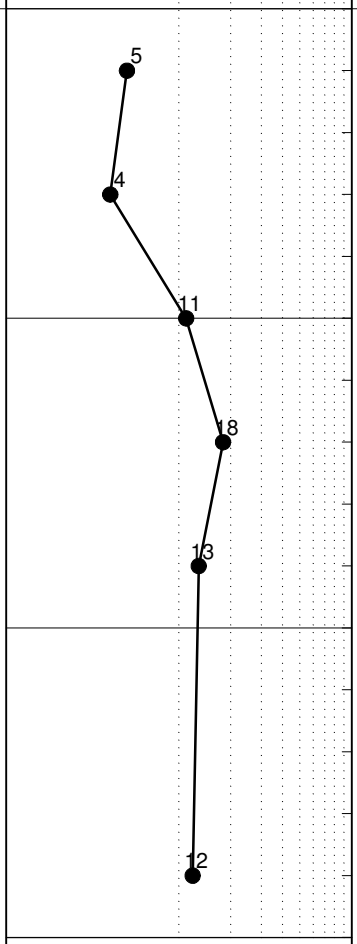
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-31**

DATE DRILLED: **1/18/12**	ELEVATION: **1422.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **15.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6839411** EASTING: **11380947**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		TOPSOIL (6 inches)									
		FAT CLAY (CH) mostly high plasticity fines, soft to very stiff, moist, red-brown, tan, orange-brown - - - Trace rootlets from 0 to 2 feet - - - Few coarse gravels from 0 to 4 feet			1			2	2	3	5
					2			2	2	2	4
5			HC	1417.0	3			4	4	7	11
					4			6	9	9	18
					5			5	6	7	13
10				1412.0							
		SANDY FAT CLAY (CH) mostly high plasticity fines, some fine to coarse sand, stiff, moist, brown with orange-brown, with some fine to coarse angular gravels			6			3	5	7	12
15		Boring terminated at 15 feet		1407.0							

REMARKS

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

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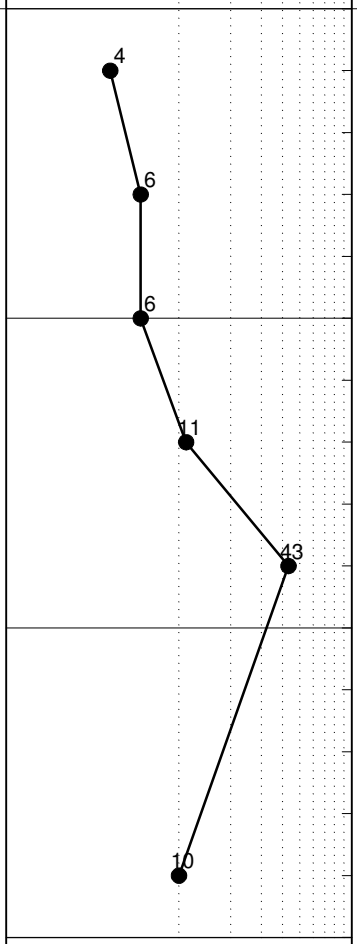
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-32**

DATE DRILLED: **1/18/12**	ELEVATION: **1422.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **15.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6839412** / EASTING: **11380840**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.) / SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		TOPSOIL (6 inches)								
		FAT CLAY (CH) mostly high plasticity fines, soft to firm, moist, red-brown			1		1	2	2	4
		- - - Little coarse sand from 2 to 6 feet			2		2	2	4	6
5			HC	1417.0	3		3	3	3	6
		SANDY FAT CLAY (CH) mostly high plasticity fines, some fine to coarse sand, stiff, moist, brown with red			4		6	5	6	11
		CLAYEY SAND (SC) mostly fine to coarse sand, some high plasticity fines, dense to loose, moist, brown, with some fine to coarse angular gravels			5		4	5	38	43
10				1412.0						
					6		2	4	6	10
15		Boring terminated at 15 feet		1407.0						

REMARKS

STANDARD PENETRATION TEST DATA (blows/ft)



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S&ME

S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

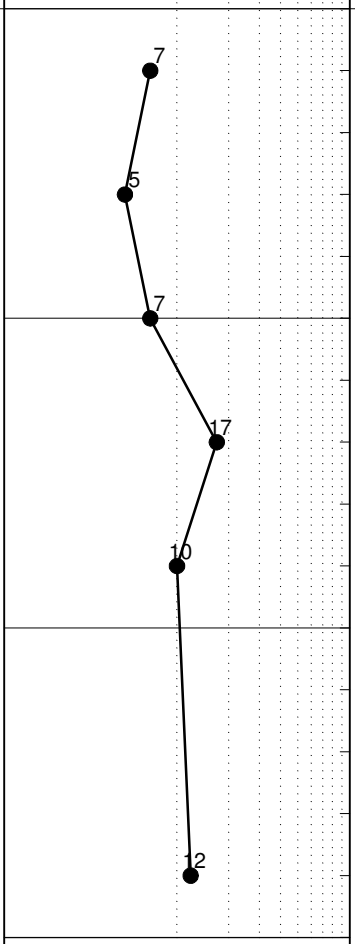
PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-33**

DATE DRILLED: **1/18/12**	ELEVATION: **1424.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **15.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6839410** EASTING: **11380741**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	N VALUE
		TOPSOIL (6 inches)									
		FAT CLAY (CH) mostly high plasticity fines, firm to very stiff, moist, red-brown to orange-tan			1			1	4	3	7
					2			2	2	3	5
5		- - - Some fine to coarse angular gravels from 0.5 to 6 feet	HC	1419.0	3			2	3	4	7
					4			7	7	10	17
					5			6	4	6	10
10				1414.0							
					6			6	6	6	12
15		Boring terminated at 15 feet		1409.0							

REMARKS

STANDARD PENETRATION TEST DATA (blows/ft)



S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

NOTES:

1. *THIS LOG IS ONLY A PORTION OF A REPORT PREPARED FOR THE NAMED PROJECT AND MUST ONLY BE USED TOGETHER WITH THAT REPORT.*
2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

PROJECT: **Reservoir Street Improvements (Route 710)** **Harrisonburg, Virginia** **S&ME Project No. 1081-11-098**	**BORING LOG B-34**

DATE DRILLED: **1/18/12**	ELEVATION: **1427.0 ft**	NOTES: **Soil sampling and penetration testing were performed in general accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split Barrel Sampling of Soils."**
DRILL RIG: **ATV**	BORING DEPTH: **15.0 ft**	
DRILLER: **Fishburne Drilling Inc.**	WATER LEVEL: **Not encountered**	
HAMMER TYPE: **Auto**	LOGGED BY: **M. Longshore**	
SAMPLING METHOD: **Split spoon**		NORTHING: **6839411** EASTING: **11380642**
DRILLING METHOD: **2¼" H.S.A.**		

DEPTH (feet)	GRAPHIC LOG	MATERIAL DESCRIPTION	WATER LEVEL	ELEVATION (feet)	SAMPLE NO.	SPT REC. (in.)	SAMPLE TYPE	BLOW COUNT / CORE DATA 1st 6in / RUN #	2nd 6in / REC	3rd 6in / RQD	REMARKS STANDARD PENETRATION TEST DATA (blows/ft) 10 20 30 60 80	N VALUE
		TOPSOIL (6 inches)										
		FAT CLAY (CH) mostly high plasticity fines, little fine to medium sand, firm to stiff, moist, red-brown to orange-brown			1			1	4	3	7	7
					2			4	4	3	7	7
5			HC	1422.0	3			4	5	5	10	10
		SANDY LEAN CLAY (CL) mostly moderate plasticity fines, some fine to coarse sand, stiff to firm, moist, orange-brown, with some fine to coarse angular gravels			4			5	8	8	16	16
					5			3	5	7	12	12
10				1417.0								
					6			2	3	5	8	8
15		Boring terminated at 15 feet		1412.0								

S&ME BORING LOG 1081-11-098 LOGS.GPJ S&ME.GDT 4/5/12

NOTES:

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2. *BORING, SAMPLING AND PENETRATION TEST DATA IN GENERAL ACCORDANCE WITH ASTM D-1586.*
3. *STRATIFICATION AND GROUNDWATER DEPTHS ARE NOT EXACT.*
4. *WATER LEVEL IS AT TIME OF EXPLORATION AND WILL VARY.*

LEGEND TO SOIL CLASSIFICATION AND SYMBOLS

SOIL TYPES

(Shown in Graphic Log)

- Fill
- Asphalt
- Concrete
- Topsoil
- Gravel
- Sand
- Silt
- Clay
- Organic
- Silty Sand
- Clayey Sand
- Sandy Silt
- Clayey Silt
- Sandy Clay
- Silty Clay
- Partially Weathered Rock
- Cored Rock

WATER LEVELS

(Shown in Water Level Column)

▽ = Water Level At Termination of Boring
▼ = Water Level Taken After 24 Hours
◄ = Loss of Drilling Water
HC = Hole Cave

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	31 to 50
Very Hard	Over 50

RELATIVE DENSITY OF COHESIONLESS SOILS

RELATIVE DENSITY	STD. PENETRATION RESISTANCE BLOWS/FOOT
Very Loose	0 to 4
Loose	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	Over 50

SAMPLER TYPES

(Shown in Samples Column)

- Shelby Tube
- Split Spoon
- Rock Core
- No Recovery

TERMS

Standard Penetration Resistance - The Number of Blows of 140 lb. Hammer Falling 30 in. Required to Drive 1.4 in. I.D. Split Spoon Sampler 1 Foot. As Specified in ASTM D-1586.

REC - Total Length of Rock Recovered in the Core Barrel Divided by the Total Length of the Core Run Times 100%.

RQD - Total Length of Sound Rock Segments Recovered that are Longer Than or Equal to 4" (mechanical breaks excluded) Divided by the Total Length of the Core Run Times 100%.

S&ME
ENGINEERING • TESTING
ENVIRONMENTAL SERVICES

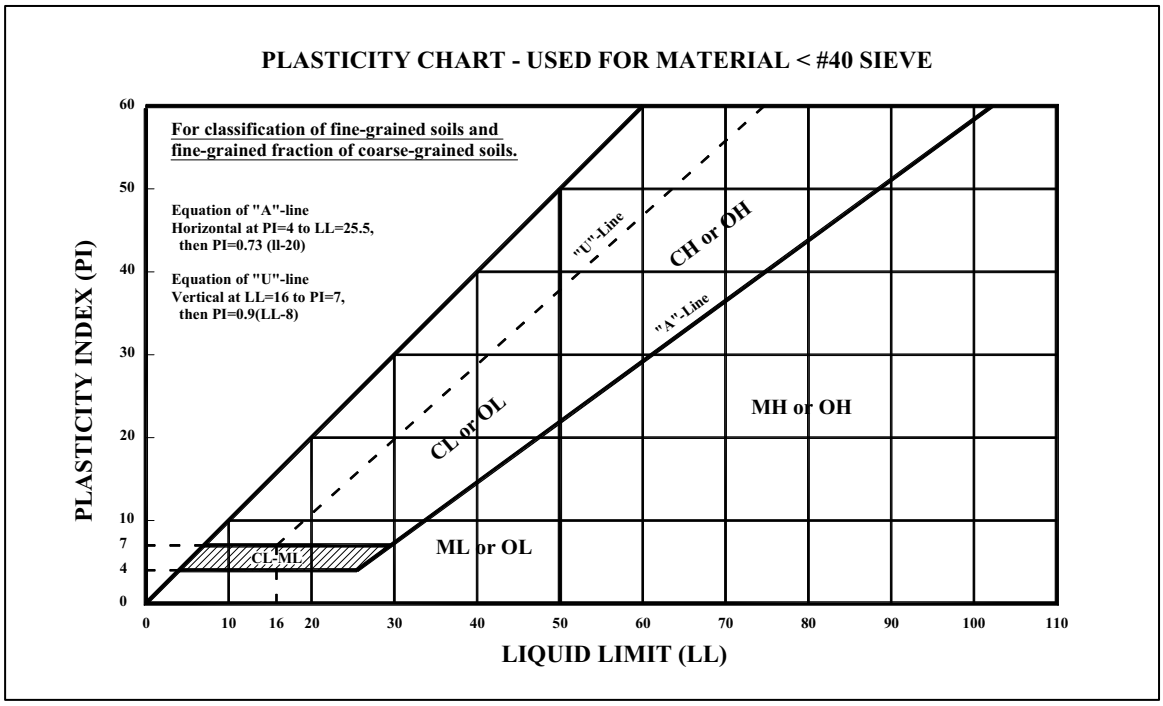
Key to Boring Log Terminology
Updated June 20, 2011

Boring Log Soil Description Format

Consistency (Density), color, major modifier PRIMARY CONSTITUENT, minor modifiers or further descriptors, moisture content.

Relative Density – Used for soils with < 50% finer than the #200 sieve.		Consistency – Used for soils with > 50% finer than the #200 sieve		Color – May use light and dark as modifiers	
Relative Density	N-Value	Consistency	N-Value	red	yellow-brown
Very loose	0 to 4	Very soft	0 to 1	gray	red-brown
Loose	5 to 10	Soft	2 to 4	black	gray-brown
Medium dense	11 to 30	Medium Stiff	5 to 8	brown	green-gray
Dense	31 to 50	Stiff	9 to 15	blue	blue-gray
Very dense	50 +	Very stiff	16 to 30	Mottled – irregularly marked with spots or patches of different colors	
		Hard	30+		

Grain Size Terminology (U.S. Standard Sieves)		Natural Moisture Content	
Term	Particle Size	dry	No apparent moisture
Boulder	12-inches +	moist	Damp but no visible water
Cobble	3-inches to 12 inches	wet	Visible free water
Coarse Gravel	¾ inch to 3 inches		
Fine Gravel	#4 to ¾ inch	Descriptive Terms	
Coarse Sand	#10 to #4	"trace"	Less than 5%
Medium Sand	#40 to #10	"little"	5 to 15%
Fine Sand	#200 to #40	"some"	15 to 30%
Silt and Clay	< #200	"and"	30 to 50%



S:\GT\Template\Standard GT Report Documents\Appendices\Appendix B - Subsurface Exploration Data\Key to Boring Log Terminology.doc

HOLLOW STEM AUGER (HSA) DRILLING AND SAMPLING METHOD

Hollow stem augers with a solid center plug are rotated into the soil. At a specified interval the drill bit is removed from the drill rods and a standard split barrel sampling spoon is attached and lowered to bear on the soil below. The driller uses an automatic trip hammer which raises a 140-pound (65 kg) weight and allows it to freely drop 30-inches (76 cm) to drive the sampling spoon. The number of blows (blow count) required to drive the sampling spoon is recorded for three successive 6-inch increments. This is the Standard Penetration Test (SPT).

The SPT N-value is the sum of the blow counts for the last two 6-inch increments. If the blow count for any 6-inch increment exceeds 50, or if the total blow count exceeds 100 at any time, or if 10 blows have not penetrated the soil strata any further, the test may be terminated as "sampler refusal." The N-value is used as an indication of the consistency of fine-grained soils (e.g., soft, stiff, hard) or as an indication of relative density of coarse-grained soils (e.g., loose, dense, very dense).

SOIL CONTACTS

Contacts between soil types are shown on the boring logs. Sometimes these contacts are observed in soil samples and therefore their location is reasonably well known. At other times the contacts may be gradational or may occur between soil samples. The location of these soil contacts is then approximated or inferred. Therefore, it is appropriate to assume that the contacts shown on the boring logs are approximate. Contacts shown with solid lines on the boring logs are major contacts between soil strata while the contacts shown with dashed lines indicate variation within a single stratum.

SAMPLE DISPOSITION

All soil samples collected during the field exploration program and not used in laboratory testing will be stored for sixty (60) days after report date and then discarded unless other arrangements are completed.

X:\GT\Template\Report & Correspondance Templates\Hollow Stem Auger with Auto Hammer.doc

APPENDIX III – LABORATORY TESTING

Form No. 1081-TR-LST
Revision No. : 0
Revision Date: 1/17/12

SUMMARY OF LABORATORY RESULTS

S&ME, Inc. - Richmond 8211 Hermitage Road Richmond, VA 23228

Project No.: **1081-11-098** Project Name: Reservoir Street Improvements Report Date: 3/6/2012

Client Name: McCormick Taylor Address: Glen Allen, Virginia

									PROCTOR		LABORATORY CBR TEST				
BORING	SAMPLE DEPTH	SAMPLE TYPE	LAB ID	MC (%)	LIMITS LL	PL	PI	% < # 200	MDD (pcf)	OMC (%)	DD (pcf)	MC (%)	SOAK VALUE	% SWELL	USCS CLASS
B-1	1 to 5 ft	Bulk	18547	-----	81	24	57	81.5	96.8	24.6	95.8	24.2	5.1	0.5	CH
B-3	1 to 5 ft	Bulk	18548	-----	---	---	---	74.0	107.0	18.6	105.2	16.8	4.1	1.9	-----
B-8	1 to 5 ft	Bulk	18549	28.9	---	---	---	68.9	113.0	15.5	112.9	16.6	12.6	0.0	-----
B-10	1 to 5 ft	Bulk	18550	27.6	80	26	54	72.4	103.3	20.3	102.0	20.1	10.0	0.3	CH
B-15	1 to 5 ft	Bulk	18551	15.2	---	---	---	68.9	120.1	12.2	118.0	11.5	10.5	0.6	-----
B-19	1 to 5 ft	Bulk	18552	25.0	---	---	---	77.9	105.6	19.2	103.8	20.0	13.2	0.1	-----
B-24	1 to 5 ft	Bulk	18553	18.6	---	---	---	50.4	122.1	12.3	119.3	10.2	5.8	0.8	-----
B-31	1 to 5 ft	Bulk	18554	23.5	61	20	41	81.5	106.5	17.6	107.6	17.7	9.7	0.1	CH

References / Comments / Deviations:

Technical Responsibility *Signature* *Position* *Date*

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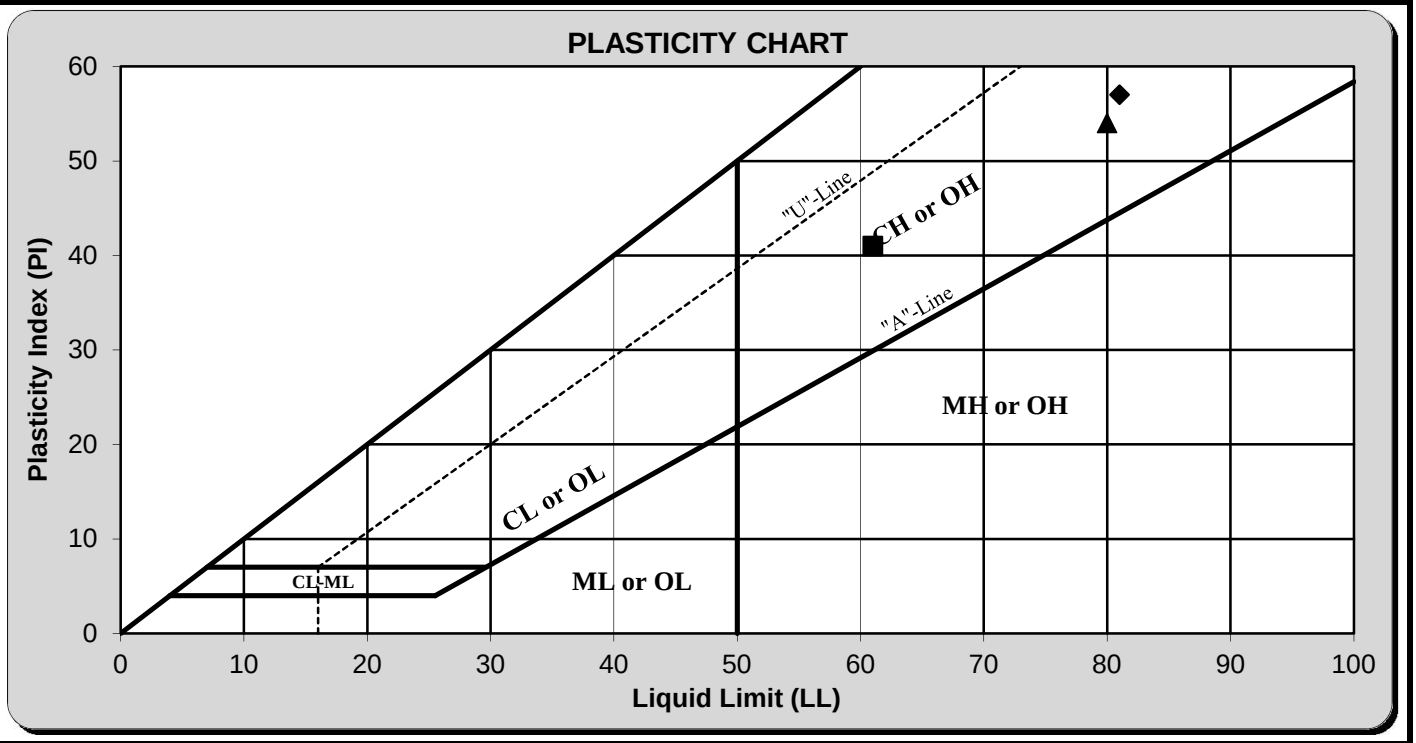
Form No. 1081-TR-Limits
Revision No. : 0
Revision Date: 1/17/12

SUMMARY OF ATTERBERG LIMITS

ASTM D 4318

S&ME, Inc. - Richmond 8211 Hermitage Road Richmond, VA 23228

Project No.:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s):	2/13/2012
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		



	Boring	Depth	Lab #	LL	PL	PI	Fines	MC	USCS Classification
◆	B-1	1 ft	18547	81	24	57	81.5%	-----	FAT CLAY WITH SAND (CH)
▲	B-10	1 ft	18550	80	26	54	72.4%	27.6%	FAT CLAY WITH SAND (CH)
■	B-31	1 ft	18554	61	20	41	81.5%	23.5%	FAT CLAY WITH SAND (CH)

References / Comments / Deviations:

Technician Name *Date* *Technical Responsibility* *Date*

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Form No. TR-D698-2
Revision No. : 0
Revision Date: 11/21/07

Moisture - Density Report

VIRGINIA TEST METHOD 1

Quality Assurance

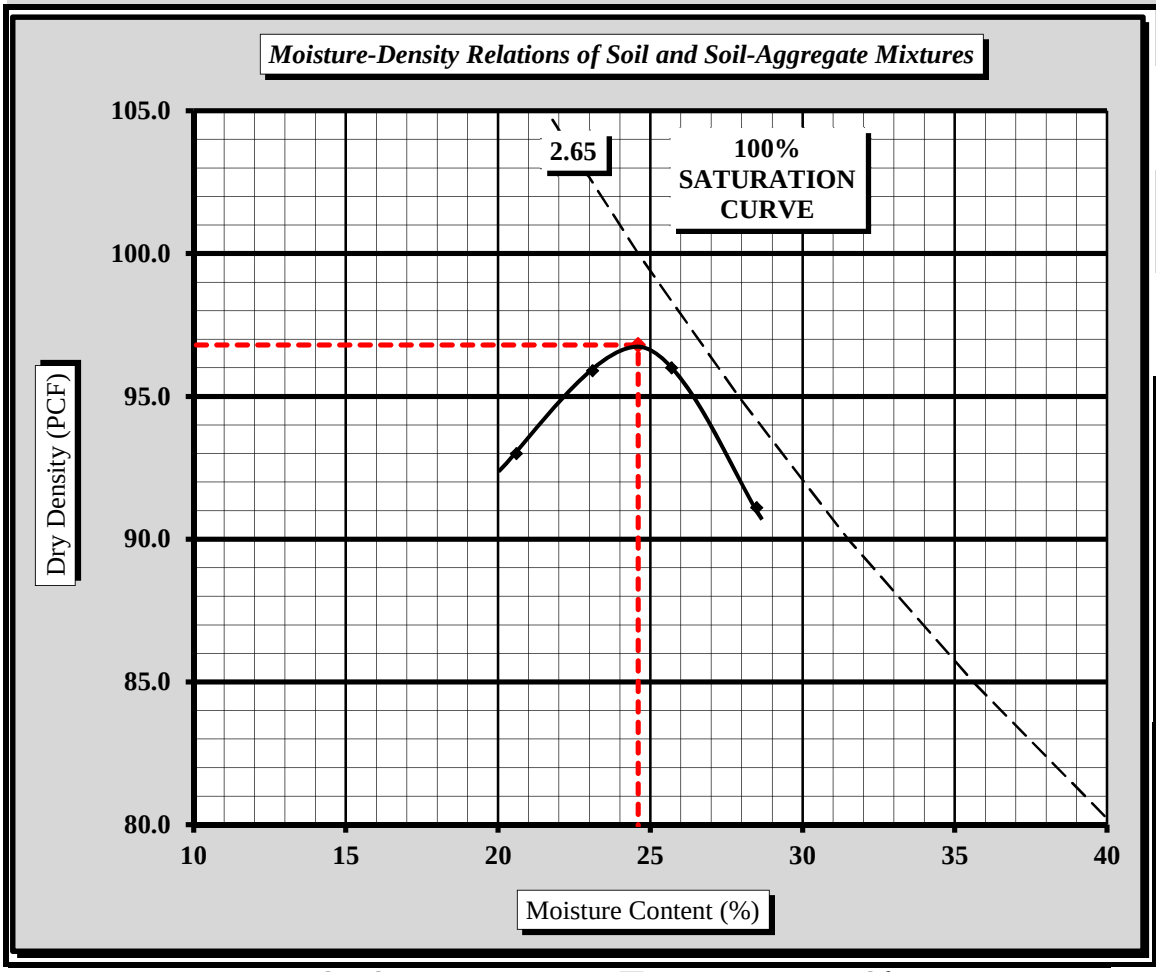
S&ME, Inc. - Richmond 8211 Hermitage Road Richmond, Virginia 23228

S&ME Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s):	2/8/2012
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring:	B-1	Sample #:	18547	Sample Date:	1/23/2012
Station:		Offset:		Depth:	1 to 5 feet

Sample Description: Orange-brown, FAT CLAY with sand (CH)

Maximum Dry Density 96.8 PCF. **Optimum Moisture Content 24.6%**



Soil Properties	
As Received Moisture Content	-----
Specific Gravity of Soil	-----
Liquid Limit	**81**
Plastic Limit	**24**
Plastic Index	**57**

% Passing	
No. 4	90.9%
No. 200	81.5%

Oversize Fraction
Bulk Gravity
% Moisture
% Oversize
MDD
Opt. MC

Moisture-Density Curve Displayed: Fine Fraction ☒ Corrected for Oversize Fraction ☐

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Rammer ☐ Manual Rammer ☒ Moist Preparation ☐ Dry Preparation ☒

References / Comments / Deviations:

Specific gravity for ZAV Line is estimated

Technical Responsibility *Signature* *Position* *Date*

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Form No. TR-D698-2
Revision No. : 0
Revision Date: 11/21/07

Moisture - Density Report

VIRGINIA TEST METHOD 1

Quality Assurance

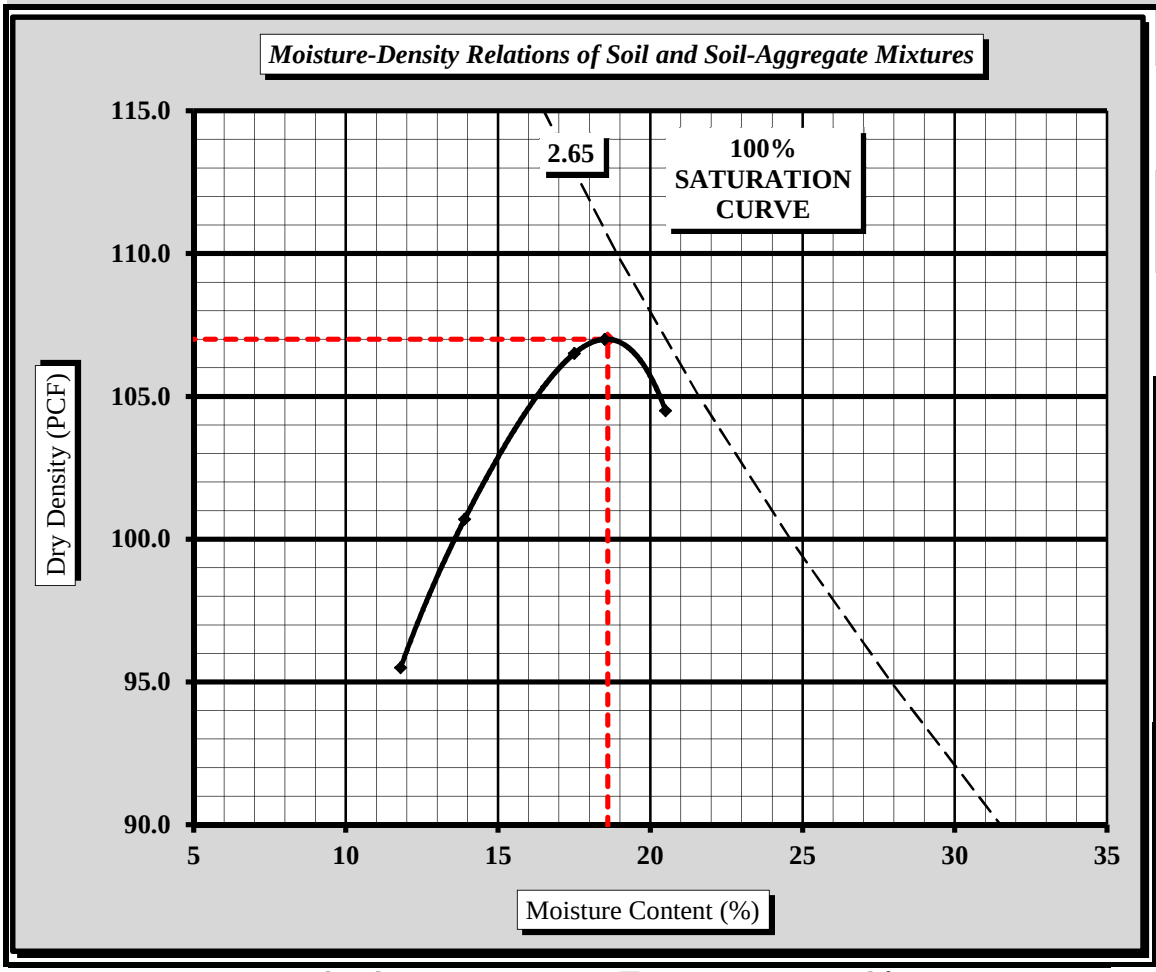
S&ME, Inc. - Richmond 8211 Hermitage Road Richmond, Virginia 23228

S&ME Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s):	2/8/2012
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring:	B-3	Sample #:	18578	Sample Date:	1/23/2012
Station:		Offset:		Depth:	1 to 5 feet

Sample Description: Orange-brown, FAT CLAY with sand (CH)

Maximum Dry Density 107.0 PCF. **Optimum Moisture Content 18.6%**



Soil Properties	
As Received Moisture Content	-----
Specific Gravity of Soil	-----
Liquid Limit	-----
Plastic Limit	-----
Plastic Index	-----

% Passing	
No. 4	88.5%
No. 200	74.0%

Oversize Fraction	
Bulk Gravity	2.540
% Moisture	1.0%
% Oversize	11.5%
MDD	**107.0**
Opt. MC	**18.6%**

Moisture-Density Curve Displayed: Fine Fraction ☐ Corrected for Oversize Fraction ☒

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Rammer ☐ Manual Rammer ☒ Moist Preparation ☐ Dry Preparation ☒

References / Comments / Deviations:

Specific gravities for ZAV Line and Correction for Oversize Fraction are estimated.

Moisture content of the Oversize Fraction used in Correction for Oversize Fraction is estimated.

Technical Responsibility	*Signature*	*Position*	*Date*

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Form No. TR-D698-2
Revision No. : 0
Revision Date: 11/21/07

Moisture - Density Report

VIRGINIA TEST METHOD 1 ***Quality Assurance***

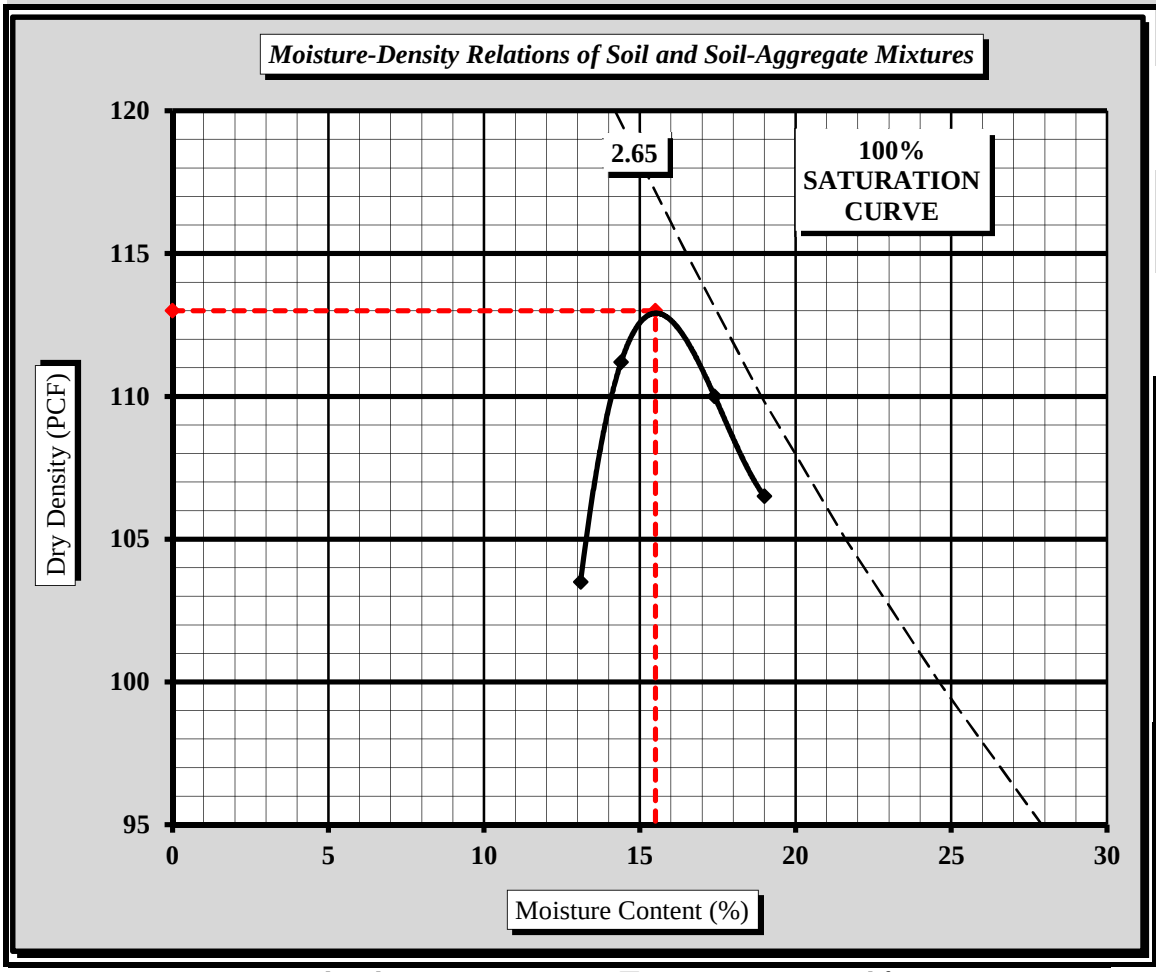
S&ME, Inc. - Richmond 8211 Hermitage Road Richmond, Virginia 23228

S&ME Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s):	2/8/2012
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring:	B-8	Sample #:	18549	Sample Date:	1/20/2012
Station:		Offset:		Depth:	1 to 5 feet

Sample Description: Brown, sandy FAT CLAY (CH)

Maximum Dry Density 113.0 PCF. **Optimum Moisture Content 15.5%**



Soil Properties	
As Received Moisture Content	**28.9%**
Specific Gravity of Soil	-----
Liquid Limit	-----
Plastic Limit	-----
Plastic Index	-----

% Passing	
No. 4	85.1%
No. 200	68.9%

Oversize Fraction	
Bulk Gravity	2.540
% Moisture	1.0%
% Oversize	14.9%
MDD	**113.0**
Opt. MC	**15.5%**

Moisture-Density Curve Displayed: Fine Fraction ☐ Corrected for Oversize Fraction ☒

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Rammer ☐ Manual Rammer ☒ Moist Preparation ☐ Dry Preparation ☒

References / Comments / Deviations:

Specific gravities for ZAV Line and Correction for Oversize Fraction are estimated.

Moisture content of the Oversize Fraction used in Correction for Oversize Fraction is estimated.

Technical Responsibility *Signature* *Position* *Date*

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Form No. TR-D698-2
Revision No. : 0
Revision Date: 11/21/07

Moisture - Density Report

VIRGINIA TEST METHOD 1

Quality Assurance

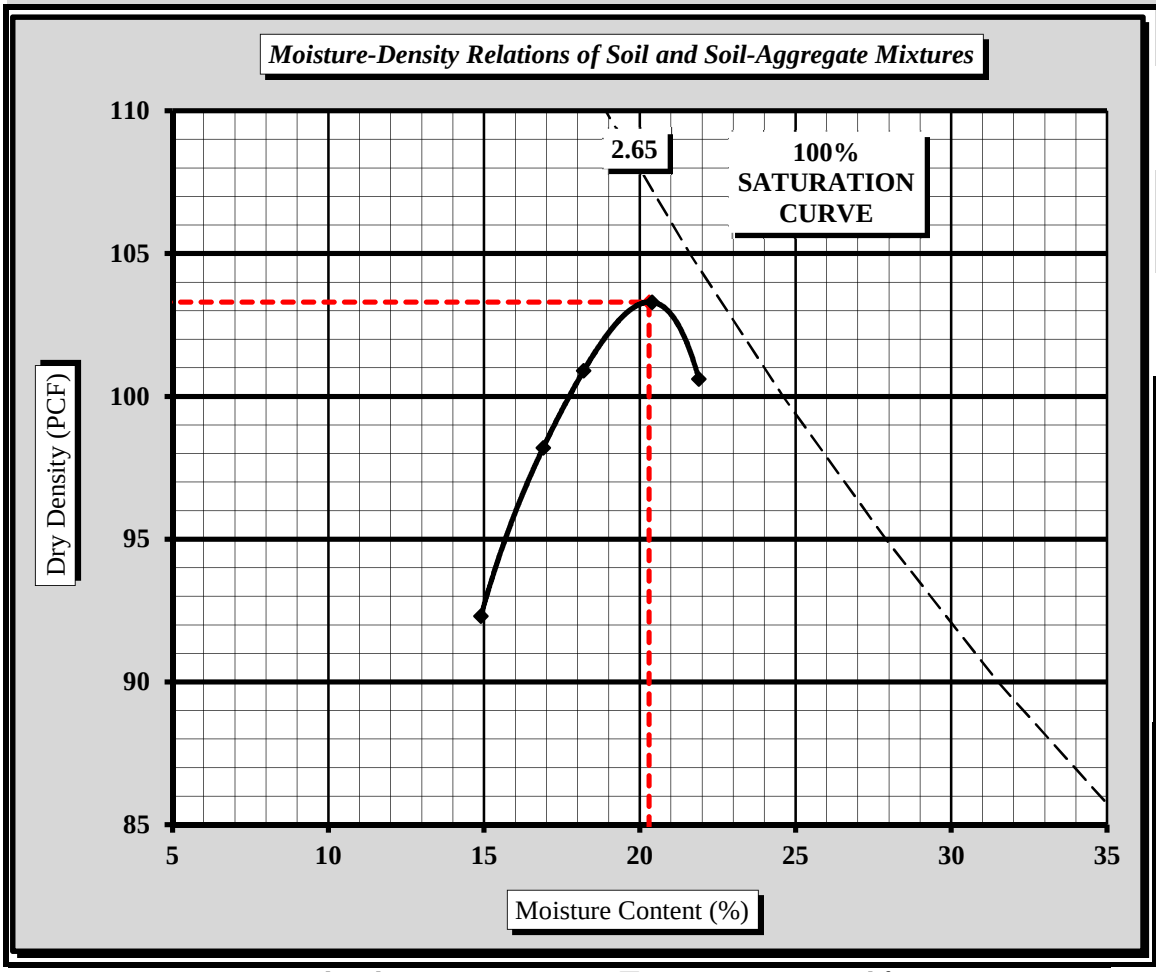
S&ME, Inc. - Richmond 8211 Hermitage Road Richmond, Virginia 23228

S&ME Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s):	2/8/2012
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring:	B-10	Sample #:	18550	Sample Date:	1/18/2012
Station:		Offset:		Depth:	1 to 5 feet

Sample Description: Red-brown, FAT CLAY with sand (CH)

Maximum Dry Density 103.3 PCF. **Optimum Moisture Content 20.3%**



Soil Properties	
As Received Moisture Content	**27.6%**
Specific Gravity of Soil	-----
Liquid Limit	**80**
Plastic Limit	**26**
Plastic Index	**54**

% Passing	
No. 4	86.9%
No. 200	72.4%

Oversize Fraction	
Bulk Gravity	2.540
% Moisture	1.0%
% Oversize	13.1%
MDD	**103.3**
Opt. MC	**20.3%**

Moisture-Density Curve Displayed: Fine Fraction ☐ Corrected for Oversize Fraction ☒

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Rammer ☐ Manual Rammer ☒ Moist Preparation ☐ Dry Preparation ☒

References / Comments / Deviations:

Specific gravities for ZAV Line and Correction for Oversize Fraction are estimated.

Moisture content of the Oversize Fraction used in Correction for Oversize Fraction is estimated.

Technical Responsibility	*Signature*	*Position*	*Date*

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Form No. TR-D698-2
Revision No. : 0
Revision Date: 11/21/07

Moisture - Density Report

VIRGINIA TEST METHOD 1 ***Quality Assurance***

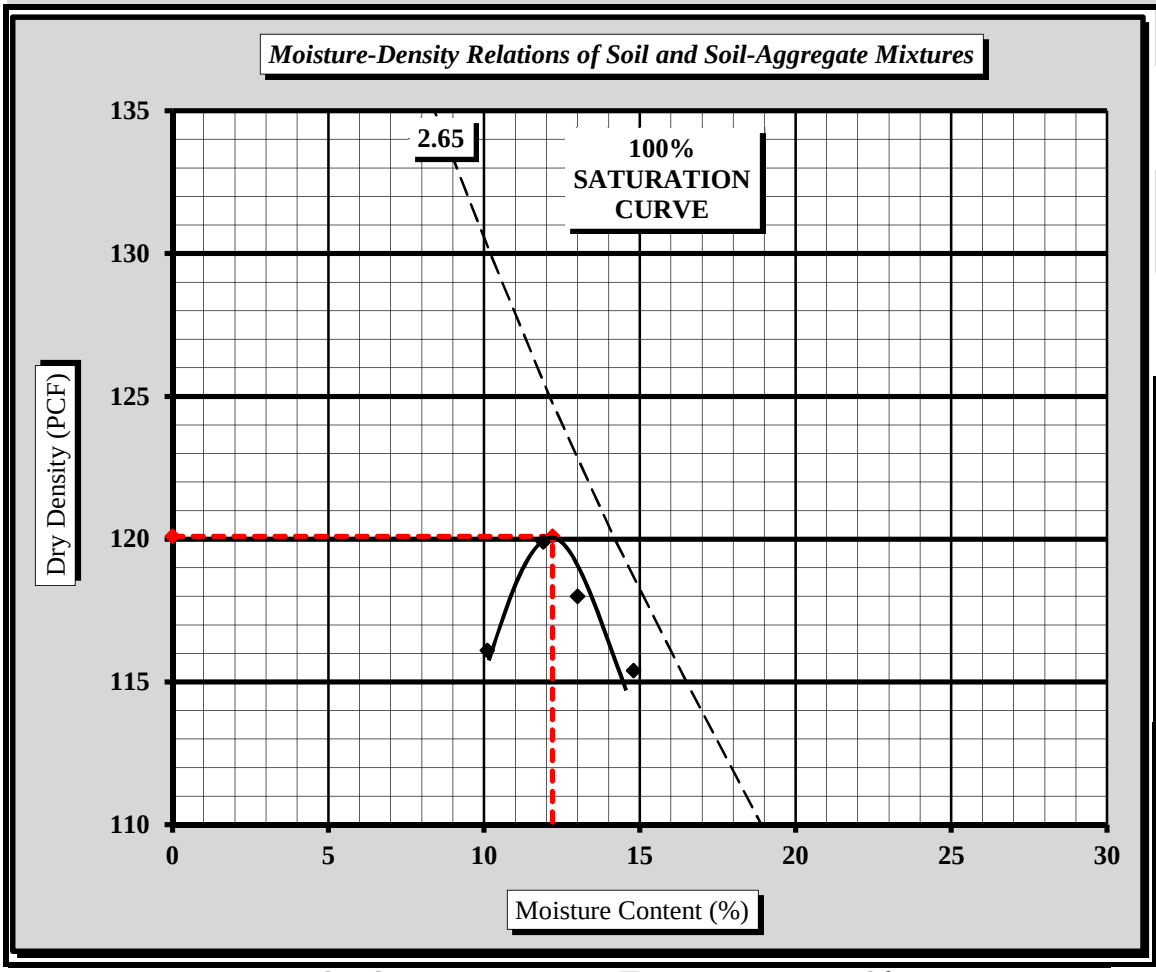
S&ME, Inc. - Richmond 8211 Hermitage Road Richmond, Virginia 23228

S&ME Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s):	2/8/2012
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring:	B-15	Sample #:	18551	Sample Date:	1/19/2012
Station:		Offset:		Depth:	1 to 5 feet

Sample Description: Gray, sandy FAT CLAY with gravel (CH)

Maximum Dry Density 120.1 PCF. **Optimum Moisture Content 12.2%**



Soil Properties	
As Received Moisture Content	**15.2%**
Specific Gravity of Soil	-----
Liquid Limit	-----
Plastic Limit	-----
Plastic Index	-----

% Passing	
No. 4	90.0%
No. 200	68.9%

Oversize Fraction	
Bulk Gravity	2.540
% Moisture	1.0%
% Oversize	10.0%
MDD	**120.1**
Opt. MC	**12.2%**

Moisture-Density Curve Displayed: Fine Fraction ☐ Corrected for Oversize Fraction ☒

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Rammer ☐ Manual Rammer ☒ Moist Preparation ☐ Dry Preparation ☒

References / Comments / Deviations:

Specific gravities for ZAV Line and Correction for Oversize Fraction are estimated.

Moisture content of the Oversize Fraction used in Correction for Oversize Fraction is estimated.

Technical Responsibility *Signature* *Position* *Date*

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Form No. TR-D698-2
Revision No. : 0
Revision Date: 11/21/07

Moisture - Density Report

VIRGINIA TEST METHOD 1 ***Quality Assurance***

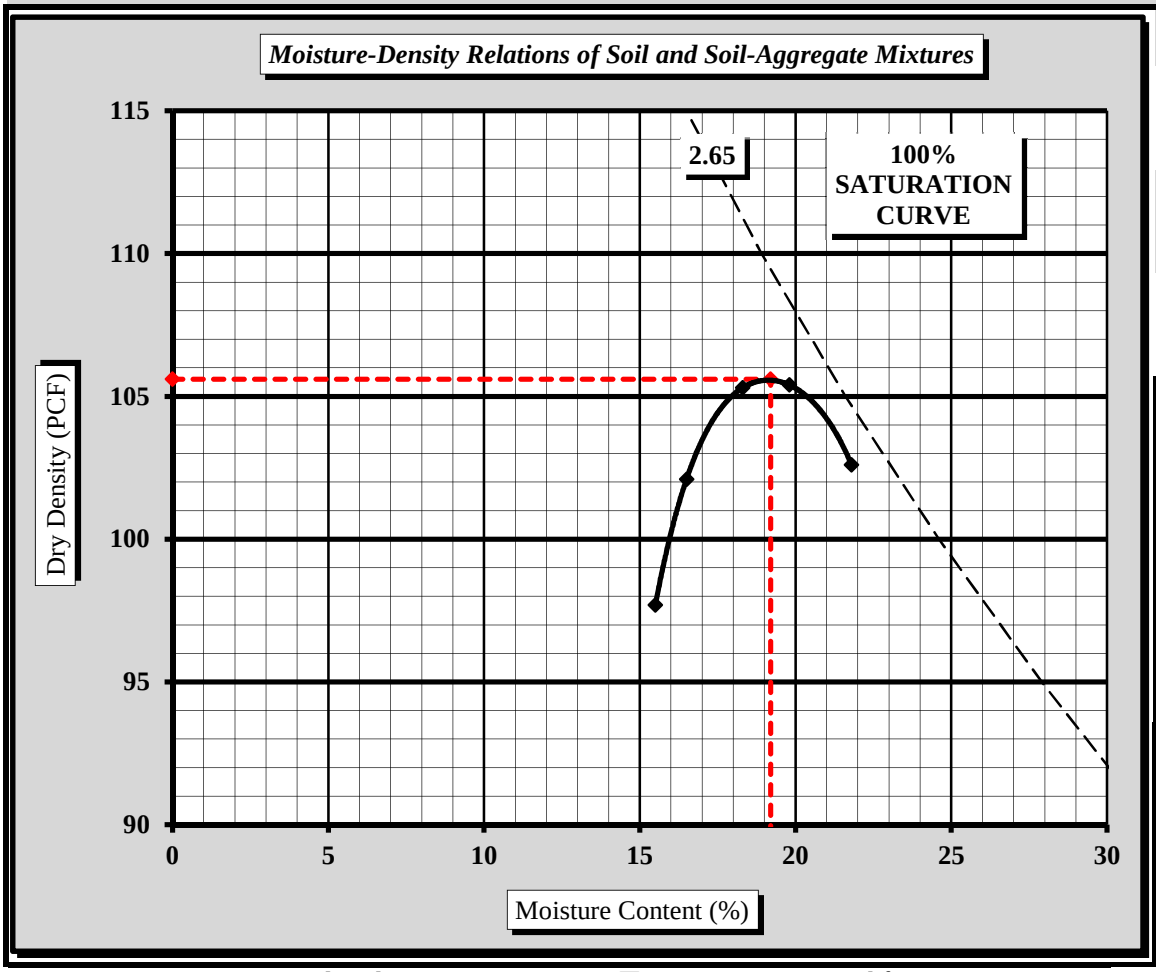
S&ME, Inc. - Richmond 8211 Hermitage Road Richmond, Virginia 23228

S&ME Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s):	2/8/2012
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring:	B-19	Sample #:	18552	Sample Date:	1/18/2012
Station:		Offset:		Depth:	1 to 5 feet

Sample Description: Orange-brown, FAT CLAY with sand (CH)

Maximum Dry Density 105.6 PCF. **Optimum Moisture Content 19.2%**



Soil Properties

As Received Moisture Content	**25.0%**
Specific Gravity of Soil	-----
Liquid Limit	-----
Plastic Limit	-----
Plastic Index	-----

% Passing

No. 4	88.1%
No. 200	77.9%

Oversize Fraction

Bulk Gravity	2.540
% Moisture	1.0%
% Oversize	11.9%
MDD	**105.6**
Opt. MC	**19.2%**

Moisture-Density Curve Displayed: Fine Fraction ☐ Corrected for Oversize Fraction ☒

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Rammer ☐ Manual Rammer ☒ Moist Preparation ☐ Dry Preparation ☒

References / Comments / Deviations:

Specific gravities for ZAV Line and Correction for Oversize Fraction are estimated.

Moisture content of the Oversize Fraction used in Correction for Oversize Fraction is estimated.

Technical Responsibility *Signature* *Position* *Date*

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Form No. TR-D698-2
Revision No. : 0
Revision Date: 11/21/07

Moisture - Density Report

VIRGINIA TEST METHOD 1

Quality Assurance

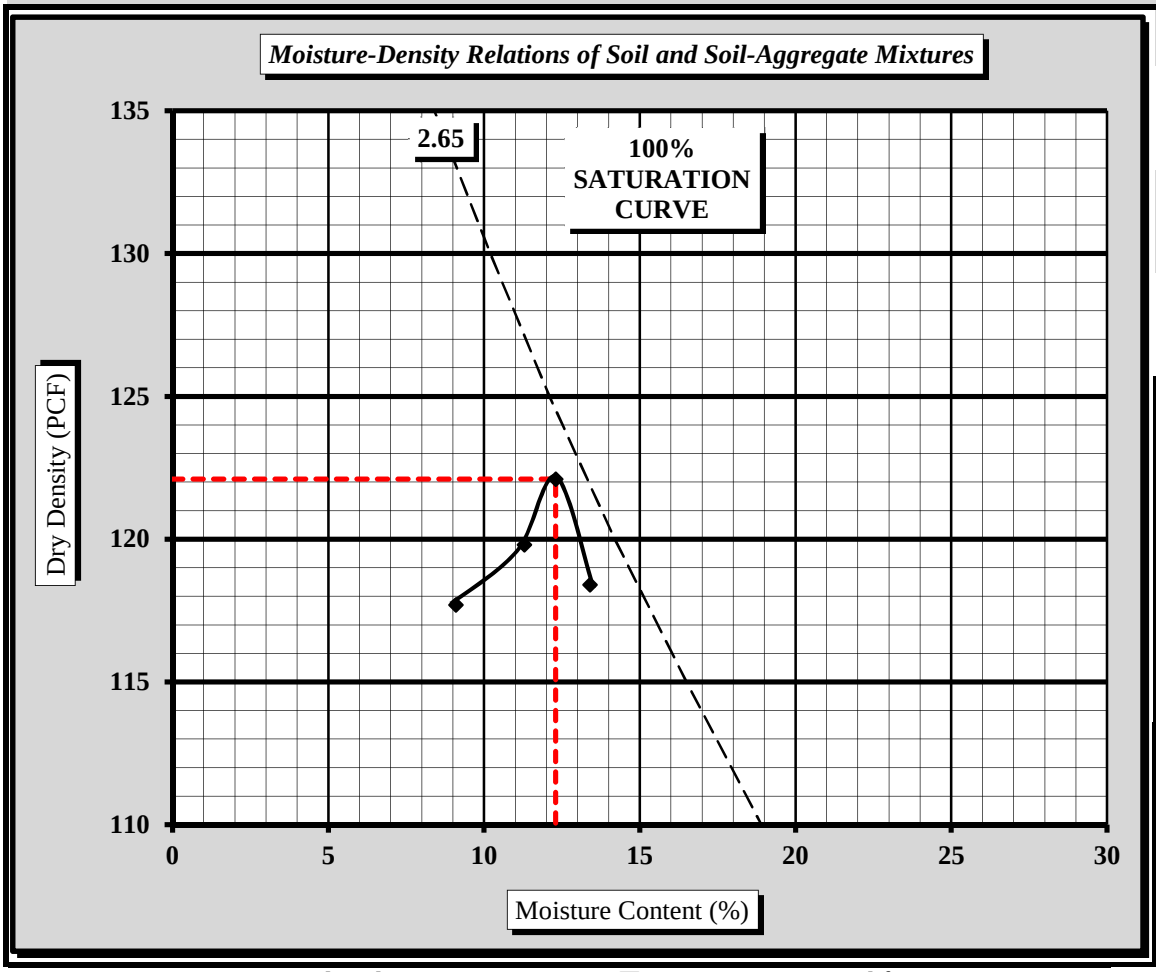
S&ME, Inc. - Richmond 8211 Hermitage Road Richmond, Virginia 23228

S&ME Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s):	2/8/2012
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring:	B-24	Sample #:	18553	Sample Date:	1/20/2012
Station:		Offset:		Depth:	1 to 5 feet

Sample Description: Gray-brown, sandy FAT CLAY with gravel (CH)

Maximum Dry Density 122.1 PCF. **Optimum Moisture Content 12.3%**



Soil Properties	
As Received Moisture Content	**18.6%**
Specific Gravity of Soil	-----
Liquid Limit	-----
Plastic Limit	-----
Plastic Index	-----

% Passing	
No. 4	78.9%
No. 200	50.4%

Oversize Fraction	
Bulk Gravity	2.540
% Moisture	1.0%
% Oversize	21.1%
MDD	**122.1**
Opt. MC	**12.3%**

Moisture-Density Curve Displayed: Fine Fraction ☐ Corrected for Oversize Fraction ☒

Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐

Mechanical Rammer ☐ Manual Rammer ☒ Moist Preparation ☐ Dry Preparation ☒

References / Comments / Deviations:

Specific gravities for ZAV Line and Correction for Oversize Fraction are estimated.

Moisture content of the Oversize Fraction used in Correction for Oversize Fraction is estimated.

Technical Responsibility	*Signature*	*Position*	*Date*

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Form No. TR-D698-2
Revision No. : 0
Revision Date: 11/21/07

Moisture - Density Report

VIRGINIA TEST METHOD 1 ***Quality Assurance***

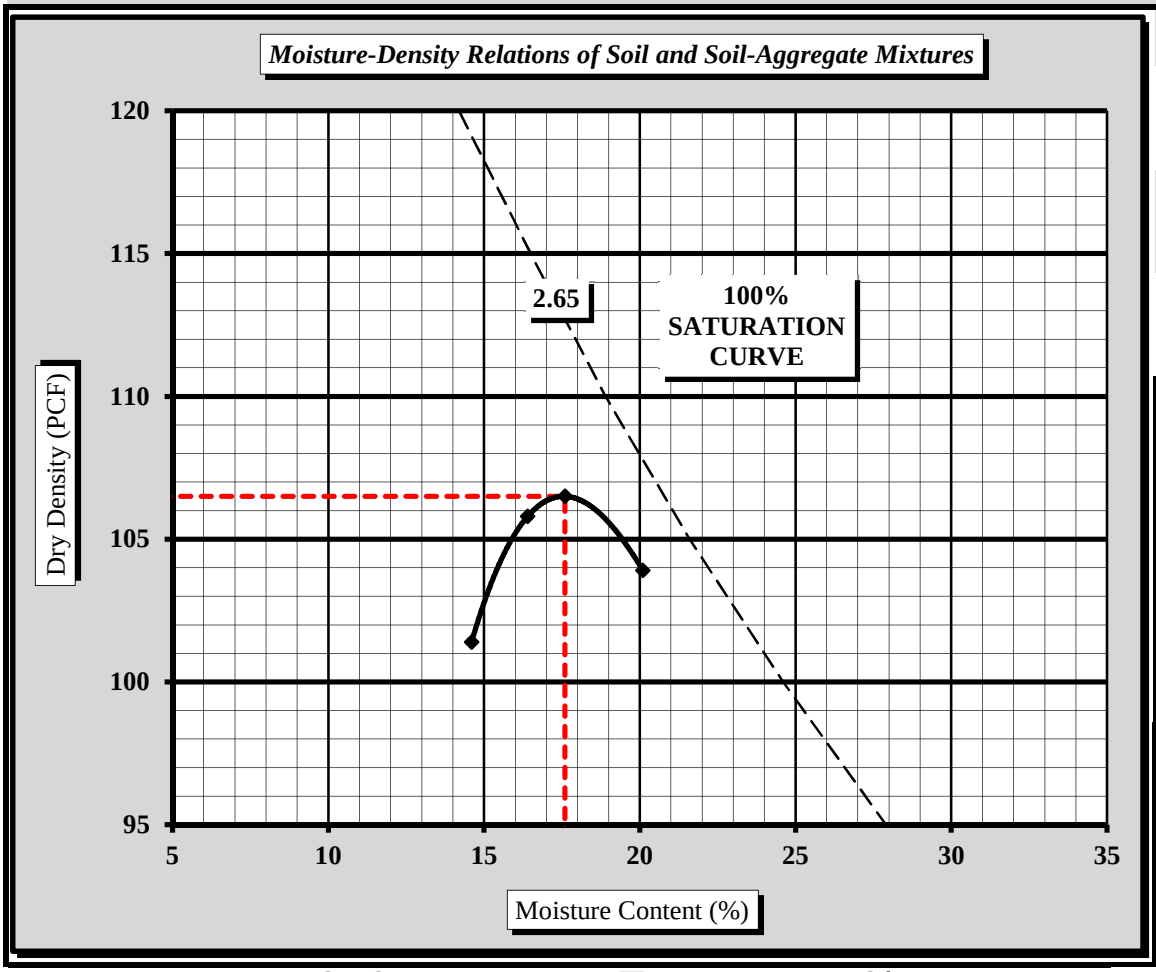
S&ME, Inc. - Richmond 8211 Hermitage Road Richmond, Virginia 23228

S&ME Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s):	2/8/2012
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring:	B-31	Sample #:	18554	Sample Date:	1/18/2012
Station:		Offset:		Depth:	1 to 5 feet

Sample Description: Brown, FAT CLAY with sand (CH)

Maximum Dry Density 106.5 PCF. **Optimum Moisture Content 17.6%**



Soil Properties

As Received Moisture Content	**23.5%**
Specific Gravity of Soil	-----
Liquid Limit	**61**
Plastic Limit	**20**
Plastic Index	**41**

% Passing

No. 4	90.7%
No. 200	81.5%

Oversize Fraction

Bulk Gravity
% Moisture
% Oversize
MDD
Opt. MC

Moisture-Density Curve Displayed: Fine Fraction ☒ Corrected for Oversize Fraction ☐
Sieve Size used to separate the Oversize Fraction: #4 Sieve ☒ 3/8 inch Sieve ☐ 3/4 inch Sieve ☐
Mechanical Rammer ☐ Manual Rammer ☒ Moist Preparation ☐ Dry Preparation ☒

References / Comments / Deviations:
Specific gravity for ZAV Line is estimated.

Technical Responsibility *Signature* *Position* *Date*

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Form No. TR-D1883-T193-3
Revision No. 1
Revision Date: 9/29/08

CBR (California Bearing Ratio) of Laboratory Compacted Soil

VIRGINIA TEST METHOD - 8

Quality Assurance

S&ME, Inc. - Richmond Branch 8211 Hermitage Road Richmond, Virginia 23228

Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s)	2/28/12 to 3/5/12
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring: B-1 Sample #: 18547 Sample Date: 1/23/2012

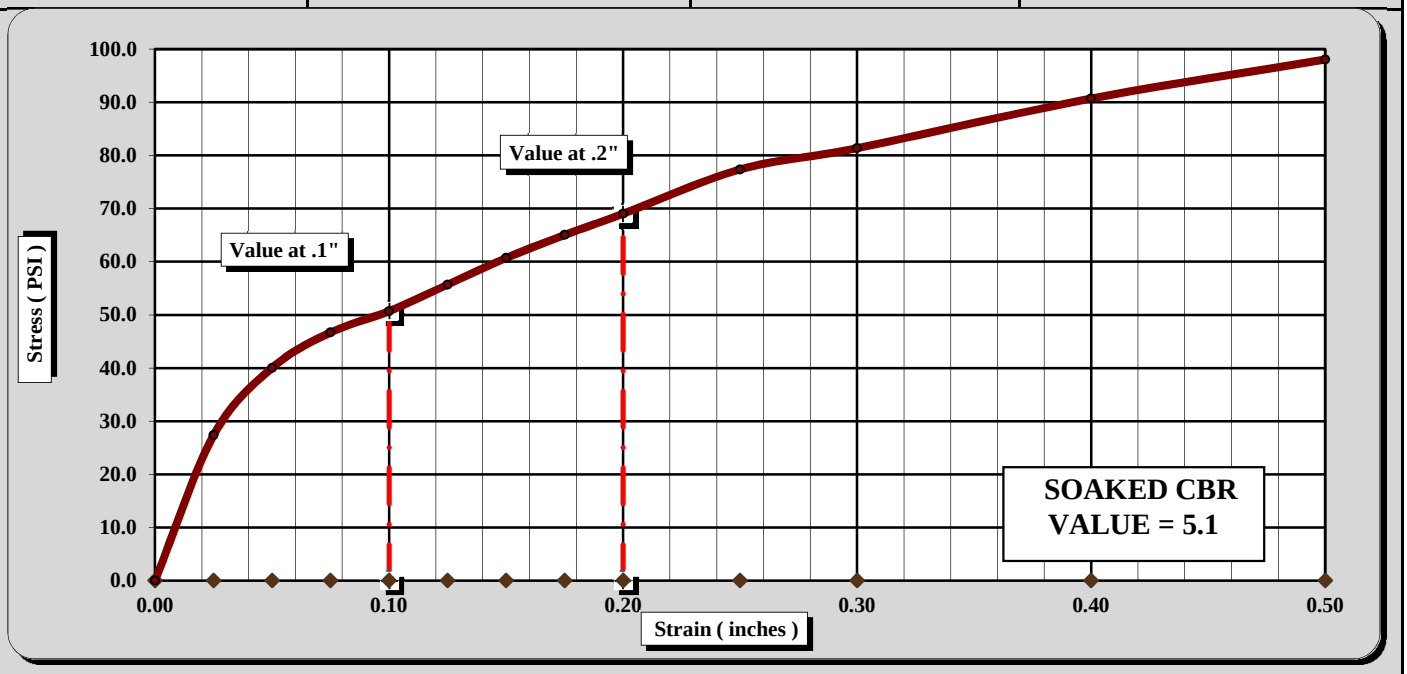
Station: Offset: Depth: 1 to 5 feet

Sample Description: Orange-brown, FAT CLAY with sand (CH)

VIRGINIA TEST METHOD - 1 Maximum Dry Density: **96.8 PCF** Optimum Moisture Content: **24.6%**

Compaction Test performed on the Fine Fraction only % Retained on the 3/4" sieve: **0.0%**

CBR Values			
CBR at 0.1 in.	**5.1**	**CBR at 0.2 in.**	**4.6**



CBR Sample Preparation:

The replacement method was used and compacted in a 6" CBR mold in accordance with VIRGINIA TEST METHOD - 8

Before Soaking		*After Soaking*	
Compactive Effort (Blows per Layer)	40	Final Dry Density (PCF)	94.5
Initial Dry Density (PCF)	95.8	Average Final Moisture Content	25.5%
Moisture Content of the Compacted Specimen	24.2%	Moisture Content (top 1" after soaking)	27.1%
Percent Compaction	98.9%	Percent Swell	0.5%

Soak Time: 144 hrs. Surcharge Weight 20.0 Surcharge Wt. per sq. Ft. 101.8

Liquid Limit 81 Plastic Index 57

Notes/Deviations/References:

Technical Responsibility *Signature* *Position* *Date*

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Form No. TR-D1883-T193-3
Revision No. 1
Revision Date: 9/29/08

CBR (California Bearing Ratio) of Laboratory Compacted Soil

VIRGINIA TEST METHOD - 8

Quality Assurance

S&ME, Inc. - Richmond Branch 8211 Hermitage Road Richmond, Virginia 23228

Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s)	2/28/12 to 3/5/12
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring: B-3 Sample #: 18548 Sample Date: 1/23/2012

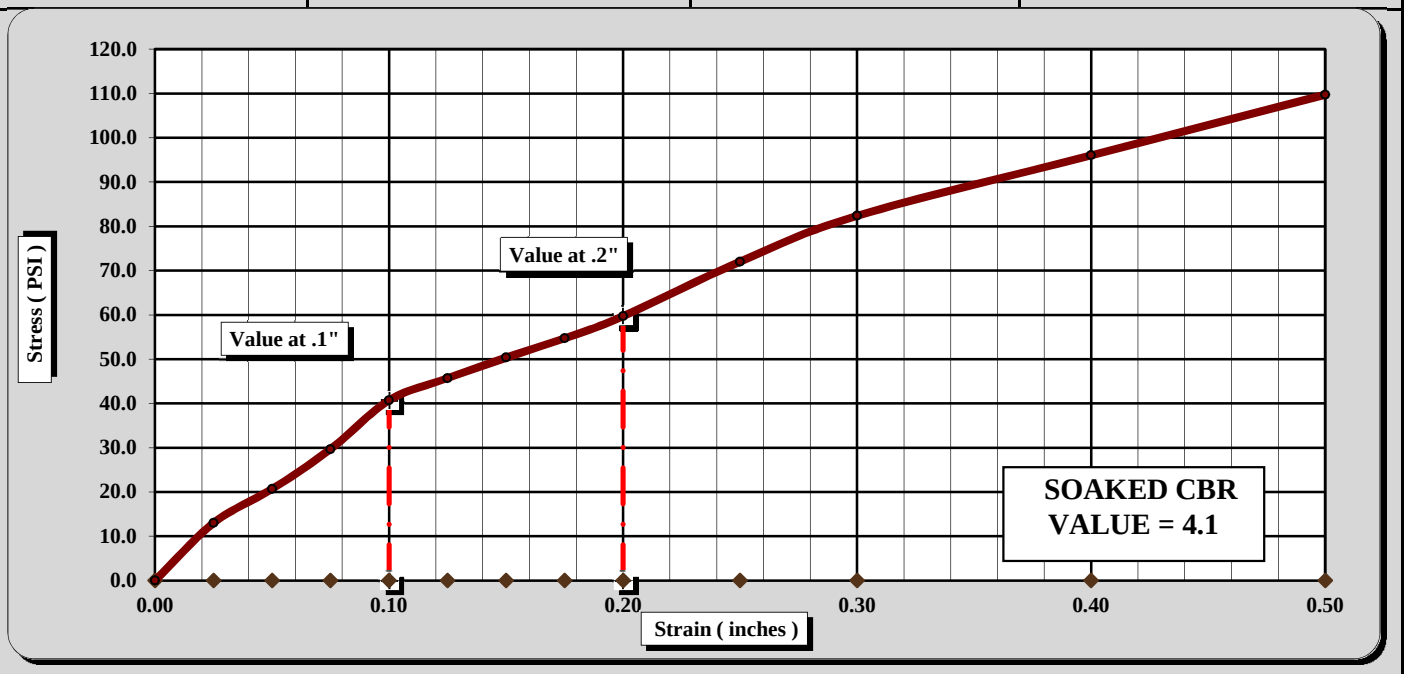
Station: Offset: Depth: 1 to 5 feet

Sample Description: Orange-brown, FAT CLAY with sand (CH)

VIRGINIA TEST METHOD - 1 Maximum Dry Density: **107.0 PCF** Optimum Moisture Content: **18.6%**

Compaction Test performed on the Fine Fraction only % Retained on the 3/4" sieve: **0.0%**

CBR Values			
CBR at 0.1 in. 4.1	**CBR at 0.2 in. 4.0**		



CBR Sample Preparation:

The replacement method was used and compacted in a 6" CBR mold in accordance with VIRGINIA TEST METHOD - 8

Before Soaking		*After Soaking*	
Compactive Effort (Blows per Layer)	75	Final Dry Density (PCF)	98.8
Initial Dry Density (PCF)	105.2	Average Final Moisture Content	22.0%
Moisture Content of the Compacted Specimen	16.8%	Moisture Content (top 1" after soaking)	22.8%
Percent Compaction	98.3%	Percent Swell	1.9%

Soak Time: 144 hrs. Surcharge Weight 20.0 Surcharge Wt. per sq. Ft. 101.9

Liquid Limit ----- Plastic Index -----

Notes/Deviations/References:

Technical Responsibility *Signature* *Position* *Date*

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Form No. TR-D1883-T193-3
Revision No. 1
Revision Date: 9/29/08

CBR (California Bearing Ratio) of Laboratory Compacted Soil

VIRGINIA TEST METHOD - 8

Quality Assurance

S&ME, Inc. - Richmond Branch 8211 Hermitage Road Richmond, Virginia 23228

Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s)	2/28/12 to 3/5/12
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring: B-8 Sample #: 18549 Sample Date: 1/20/2012

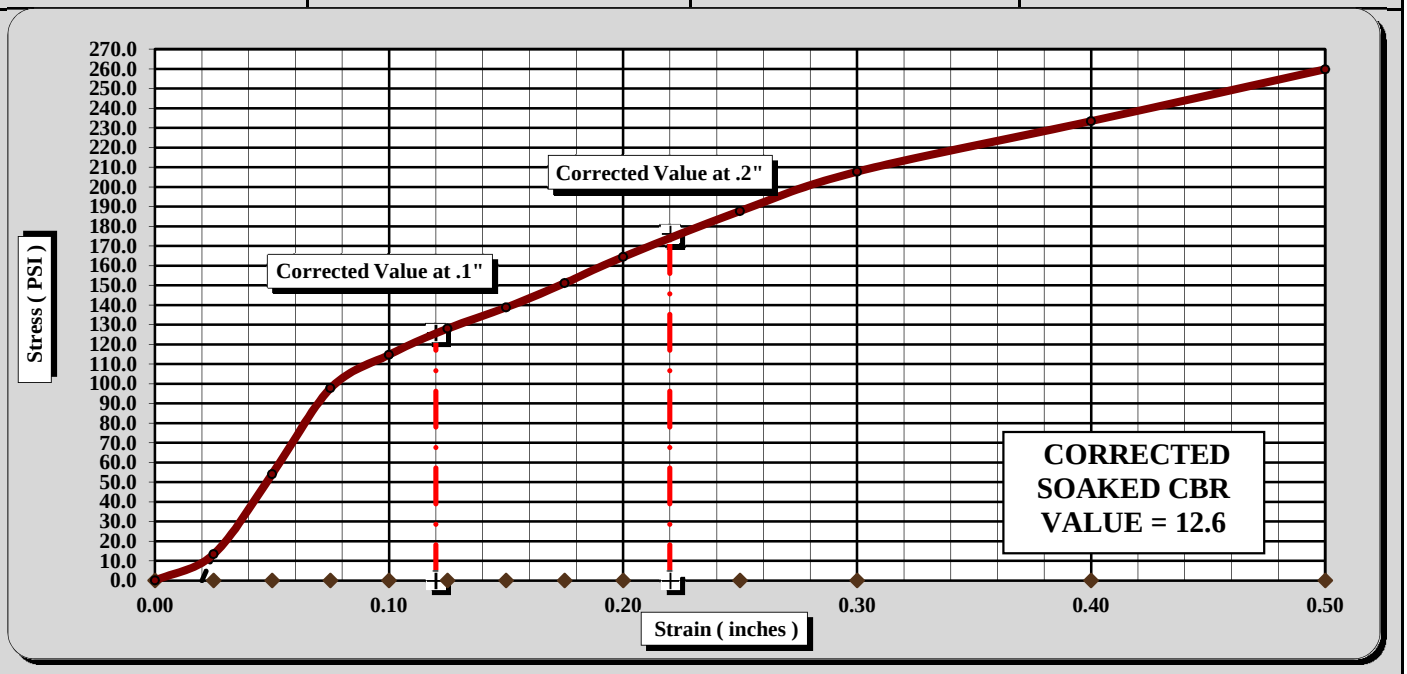
Station: Offset: Depth: 1 to 5 feet

Sample Description: Brown, sandy FAT CLAY (CH)

VIRGINIA TEST METHOD - 1 Maximum Dry Density: **113.0 PCF** Optimum Moisture Content: **15.5%**

Compaction Test performed on the Fine Fraction only % Retained on the 3/4" sieve: **0.0%**

Uncorrected CBR Values		Corrected CBR Values	
CBR at 0.1 in. 11.5	**CBR at 0.2 in. 11.0**	**CBR at 0.1 in. 12.6**	**CBR at 0.2 in. 11.7**



CBR Sample Preparation:

The replacement method was used and compacted in a 6" CBR mold in accordance with VIRGINIA TEST METHOD - 8

Before Soaking		*After Soaking*	
Compactive Effort (Blows per Layer)	75	Final Dry Density (PCF)	112.4
Initial Dry Density (PCF)	112.9	Average Final Moisture Content	17.2%
Moisture Content of the Compacted Specimen	16.6%	Moisture Content (top 1" after soaking)	17.5%
Percent Compaction	99.9%	Percent Swell	0.0%

Soak Time: 144 hrs. Surcharge Weight 20.0 Surcharge Wt. per sq. Ft. 102.0

Liquid Limit ----- Plastic Index -----

Notes/Deviations/References:

Technical Responsibility *Signature* *Position* *Date*

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Form No. TR-D1883-T193-3
Revision No. 1
Revision Date: 9/29/08

CBR (California Bearing Ratio) of Laboratory Compacted Soil

VIRGINIA TEST METHOD - 8

Quality Assurance

S&ME, Inc. - Richmond Branch 8211 Hermitage Road Richmond, Virginia 23228

Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s)	2/28/12 to 3/5/12
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring: B-10 Sample #: 18550 Sample Date: 1/18/2012

Station: Offset: Depth: 1 to 5 feet

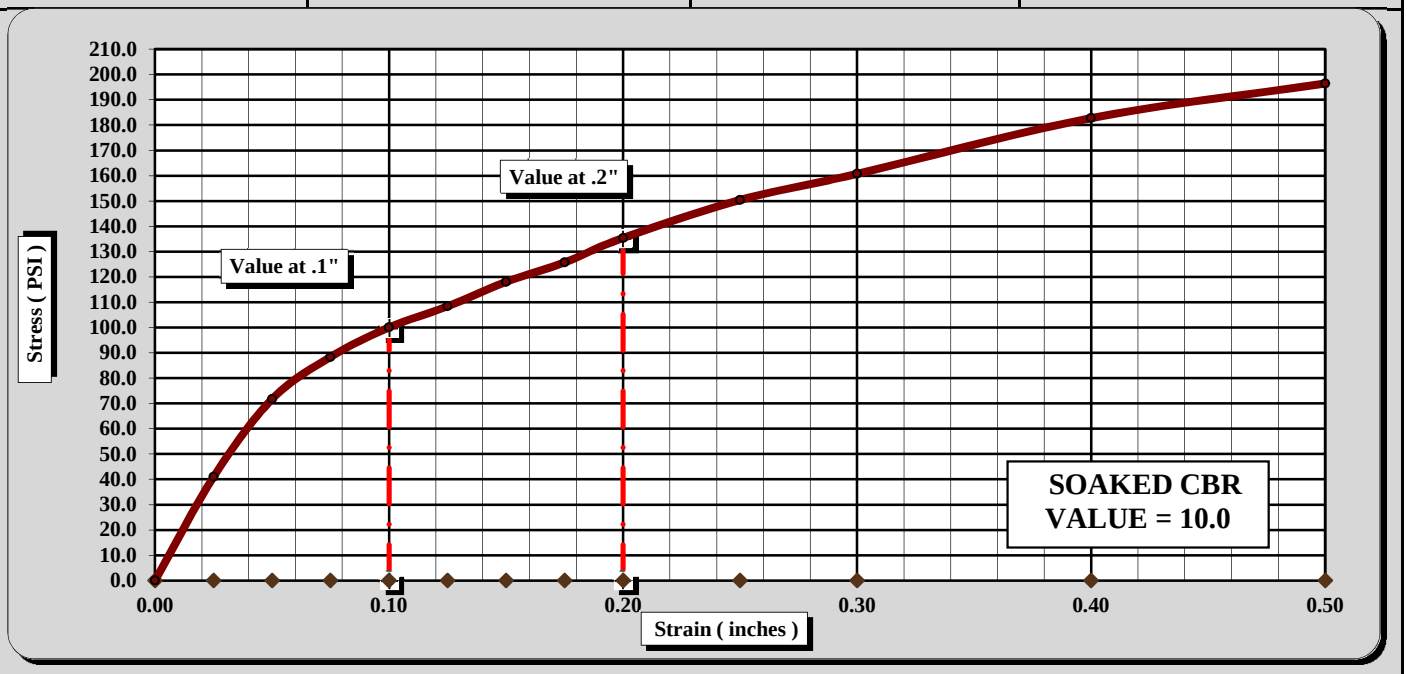
Sample Description: Red-brown, FAT CLAY with sand (CH)

VIRGINIA TEST METHOD - 1 Maximum Dry Density: **103.3 PCF** Optimum Moisture Content: **20.3%**

Compaction Test performed on the Fine Fraction only % Retained on the 3/4" sieve: **0.0%**

CBR Values

CBR at 0.1 in. 10.0 **CBR at 0.2 in. 9.0**



CBR Sample Preparation:

The replacement method was used and compacted in a 6" CBR mold in accordance with VIRGINIA TEST METHOD - 8

Before Soaking		*After Soaking*	
Compactive Effort (Blows per Layer)	65	Final Dry Density (PCF)	100.8
Initial Dry Density (PCF)	102.0	Average Final Moisture Content	21.5%
Moisture Content of the Compacted Specimen	20.1%	Moisture Content (top 1" after soaking)	23.3%
Percent Compaction	98.8%	Percent Swell	0.3%

Soak Time: 144 hrs. Surcharge Weight 20.0 Surcharge Wt. per sq. Ft. 101.8

Liquid Limit 80 Plastic Index 54

Notes/Deviations/References:

Technical Responsibility *Signature* *Position* *Date*

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Form No. TR-D1883-T193-3
Revision No. 1
Revision Date: 9/29/08

CBR (California Bearing Ratio) of Laboratory Compacted Soil

VIRGINIA TEST METHOD - 8

Quality Assurance

S&ME, Inc. - Richmond Branch 8211 Hermitage Road Richmond, Virginia 23228

Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s)	2/28/12 to 3/5/12
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring: B-15 Sample #: 18551 Sample Date: 1/19/2012

Station: Offset: Depth: 1 to 5 feet

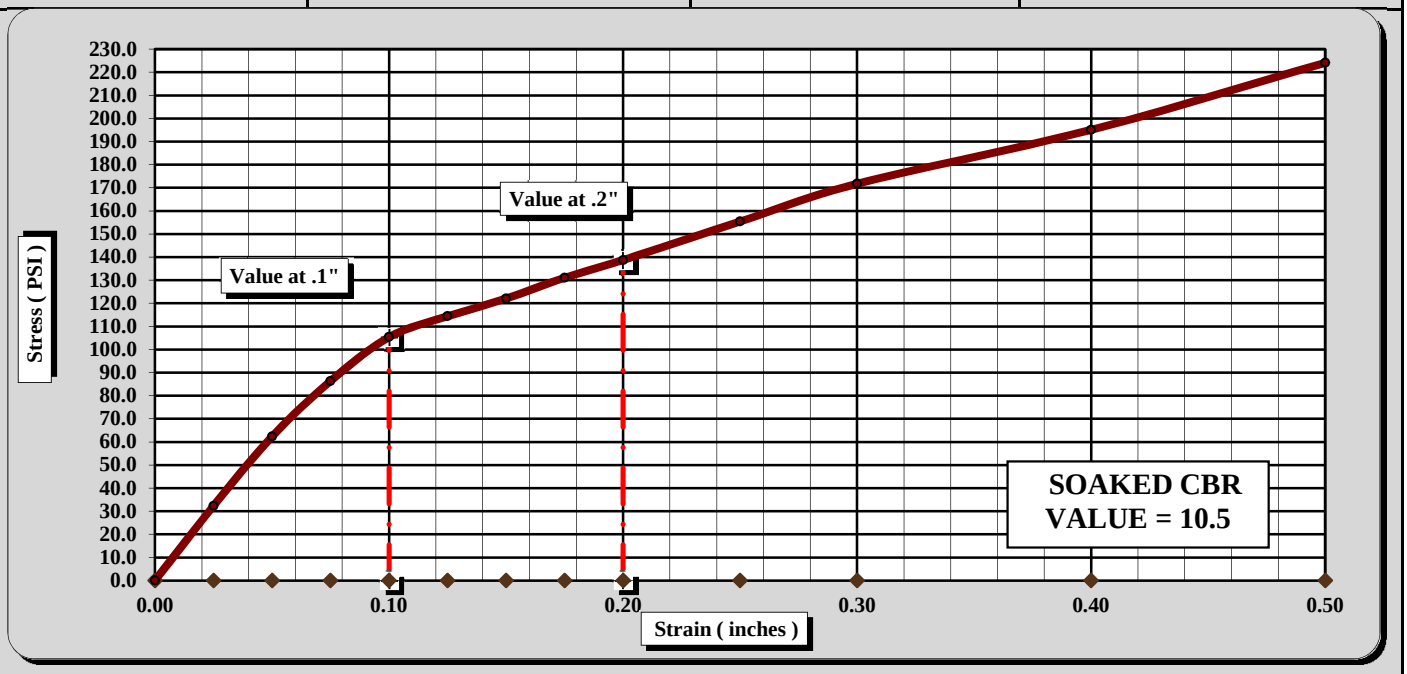
Sample Description: Gray, sandy FAT CLAY (CH)

VIRGINIA TEST METHOD - 1 Maximum Dry Density: **120.1 PCF** Optimum Moisture Content: **12.2%**

Compaction Test performed on the Fine Fraction only % Retained on the 3/4" sieve: **0.0%**

CBR Values

CBR at 0.1 in.	**10.5**	**CBR at 0.2 in.**	**9.2**



CBR Sample Preparation:

The replacement method was used and compacted in a 6" CBR mold in accordance with VIRGINIA TEST METHOD - 8

Before Soaking		*After Soaking*	
Compactive Effort (Blows per Layer)	75	Final Dry Density (PCF)	115.0
Initial Dry Density (PCF)	118.0	Average Final Moisture Content	13.5%
Moisture Content of the Compacted Specimen	11.5%	Moisture Content (top 1" after soaking)	13.8%
Percent Compaction	98.3%	Percent Swell	0.6%

Soak Time: 144 hrs. Surcharge Weight 20.0 Surcharge Wt. per sq. Ft. 101.8

Liquid Limit ----- Plastic Index -----

Notes/Deviations/References:

Technical Responsibility *Signature* *Position* *Date*

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Form No. TR-D1883-T193-3
Revision No. 1
Revision Date: 9/29/08

CBR (California Bearing Ratio) of Laboratory Compacted Soil

VIRGINIA TEST METHOD - 8

Quality Assurance

S&ME, Inc. - Richmond Branch 8211 Hermitage Road Richmond, Virginia 23228

Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s)	2/28/12 to 3/5/12
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring: B-19 Sample #: 18552 Sample Date: 1/18/2012

Station: Offset: Depth: 1 to 5 feet

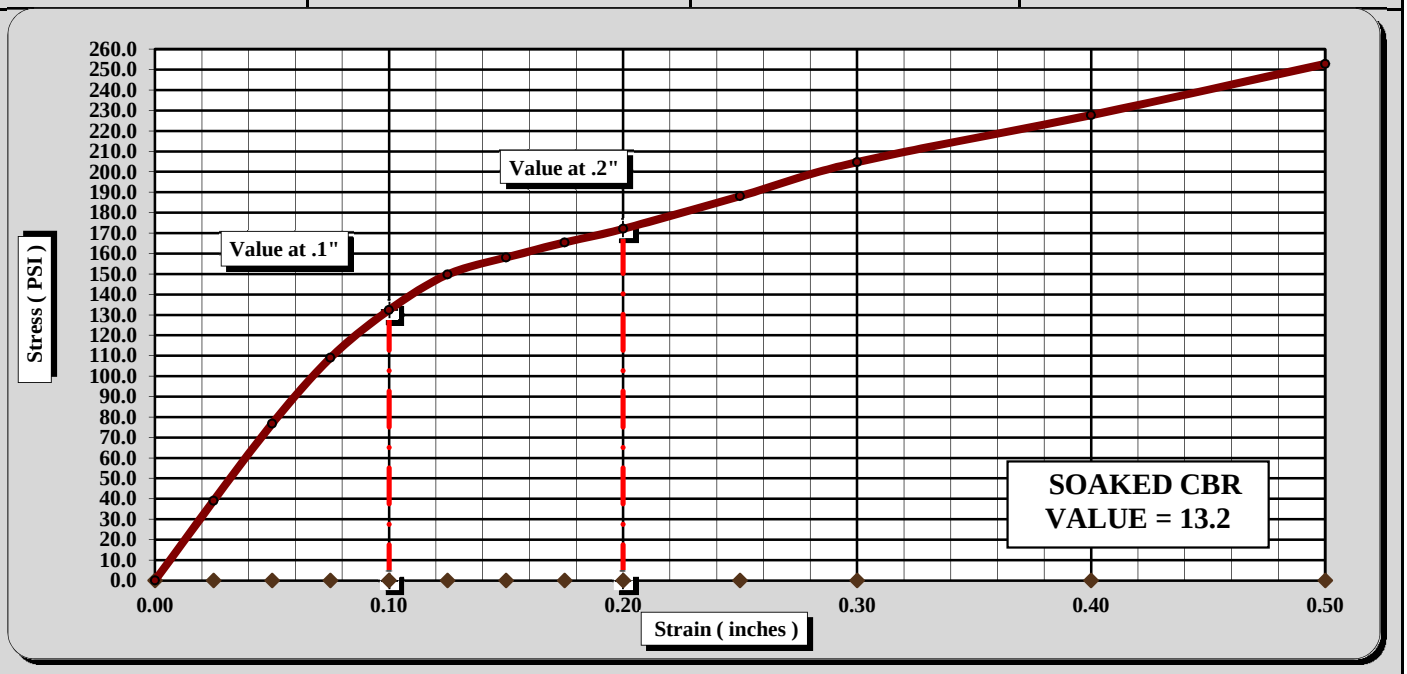
Sample Description: Orange-brown, FAT CLAY with sand (CH)

VIRGINIA TEST METHOD - 1 Maximum Dry Density: **105.6 PCF** Optimum Moisture Content: **19.2%**

Compaction Test performed on the Fine Fraction only % Retained on the 3/4" sieve: **0.0%**

CBR Values

CBR at 0.1 in. 13.2 **CBR at 0.2 in. 11.5**



CBR Sample Preparation:

The replacement method was used and compacted in a 6" CBR mold in accordance with VIRGINIA TEST METHOD - 8

Before Soaking		*After Soaking*	
Compactive Effort (Blows per Layer)	60	Final Dry Density (PCF)	103.1
Initial Dry Density (PCF)	103.8	Average Final Moisture Content	20.9%
Moisture Content of the Compacted Specimen	20.0%	Moisture Content (top 1" after soaking)	22.4%
Percent Compaction	98.3%	Percent Swell	0.1%

Soak Time: 144 hrs. Surcharge Weight 20.0 Surcharge Wt. per sq. Ft. 101.8

Liquid Limit ----- Plastic Index -----

Notes/Deviations/References:

Technical Responsibility *Signature* *Position* *Date*

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Form No. TR-D1883-T193-3
Revision No. 1
Revision Date: 9/29/08

CBR (California Bearing Ratio) of Laboratory Compacted Soil

VIRGINIA TEST METHOD - 8

Quality Assurance

S&ME, Inc. - Richmond Branch 8211 Hermitage Road Richmond, Virginia 23228

Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s)	2/28/12 to 3/5/12
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring: B-24 Sample #: 18553 Sample Date: 1/20/2012

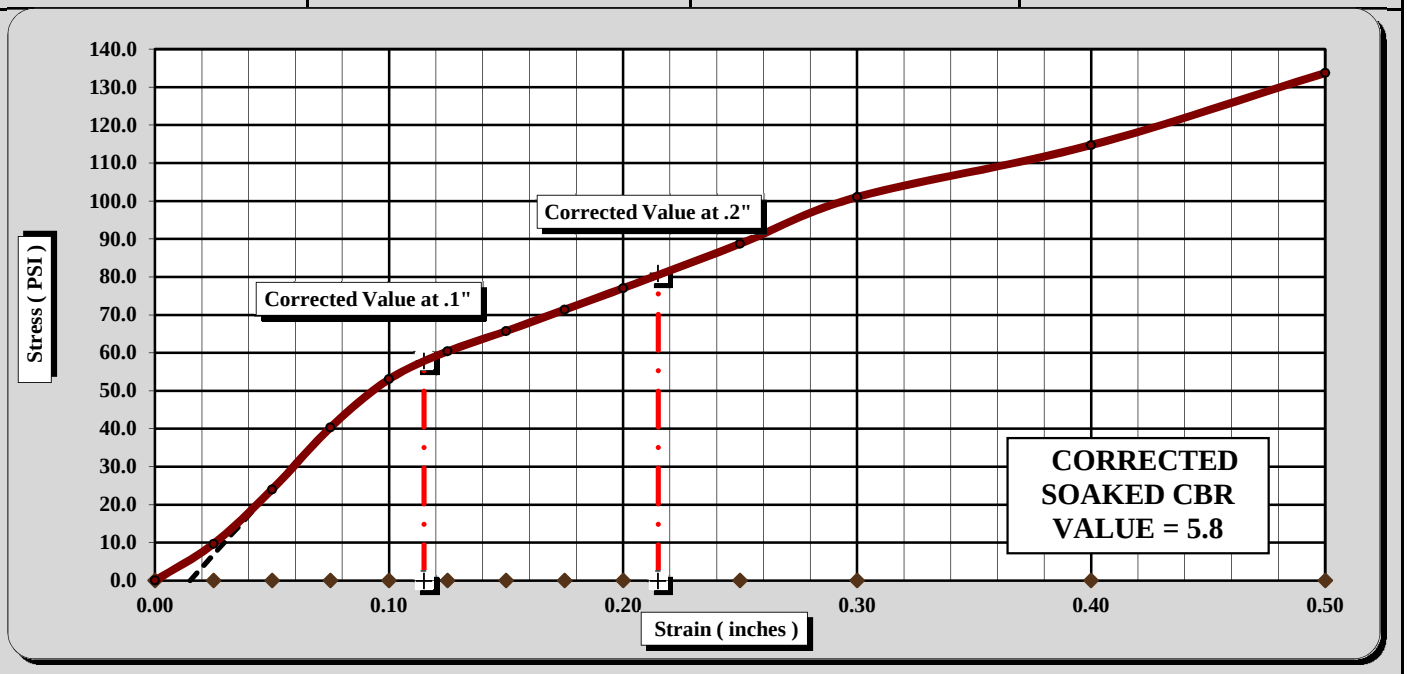
Station: Offset: Depth: 1 to 5 feet

Sample Description: Gray-brown, sandy FAT CLAY with gravel (CH)

VIRGINIA TEST METHOD - 1 Maximum Dry Density: **122.1 PCF** Optimum Moisture Content: **12.3%**

Compaction Test performed on the Fine Fraction only % Retained on the 3/4" sieve: **0.0%**

Uncorrected CBR Values		Corrected CBR Values	
CBR at 0.1 in. 5.3	**CBR at 0.2 in. 5.1**	**CBR at 0.1 in. 5.8**	**CBR at 0.2 in. 5.4**



CBR Sample Preparation:

The replacement method was used and compacted in a 6" CBR mold in accordance with VIRGINIA TEST METHOD - 8

Before Soaking		*After Soaking*	
Compactive Effort (Blows per Layer)	75	Final Dry Density (PCF)	115.4
Initial Dry Density (PCF)	119.3	Average Final Moisture Content	13.1%
Moisture Content of the Compacted Specimen	10.2%	Moisture Content (top 1" after soaking)	14.1%
Percent Compaction	97.7%	Percent Swell	0.8%

Soak Time: 144 hrs. Surcharge Weight 20.0 Surcharge Wt. per sq. Ft. 101.9

Liquid Limit ----- Plastic Index -----

Notes/Deviations/References:

Technical Responsibility *Signature* *Position* *Date*

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Form No. TR-D1883-T193-3
Revision No. 1
Revision Date: 9/29/08

CBR (California Bearing Ratio) of Laboratory Compacted Soil

VIRGINIA TEST METHOD - 8

Quality Assurance

S&ME, Inc. - Richmond Branch 8211 Hermitage Road Richmond, Virginia 23228

Project #:	**1081-11-098**	Report Date:	3/6/2012
Project Name:	Reservoir Street Improvements	Test Date(s)	2/28/12 to 3/5/12
Client Name:	McCormick Taylor		
Client Address:	Glen Allen, Virginia		

Boring: B-31 Sample #: 18554 Sample Date: 1/18/2012

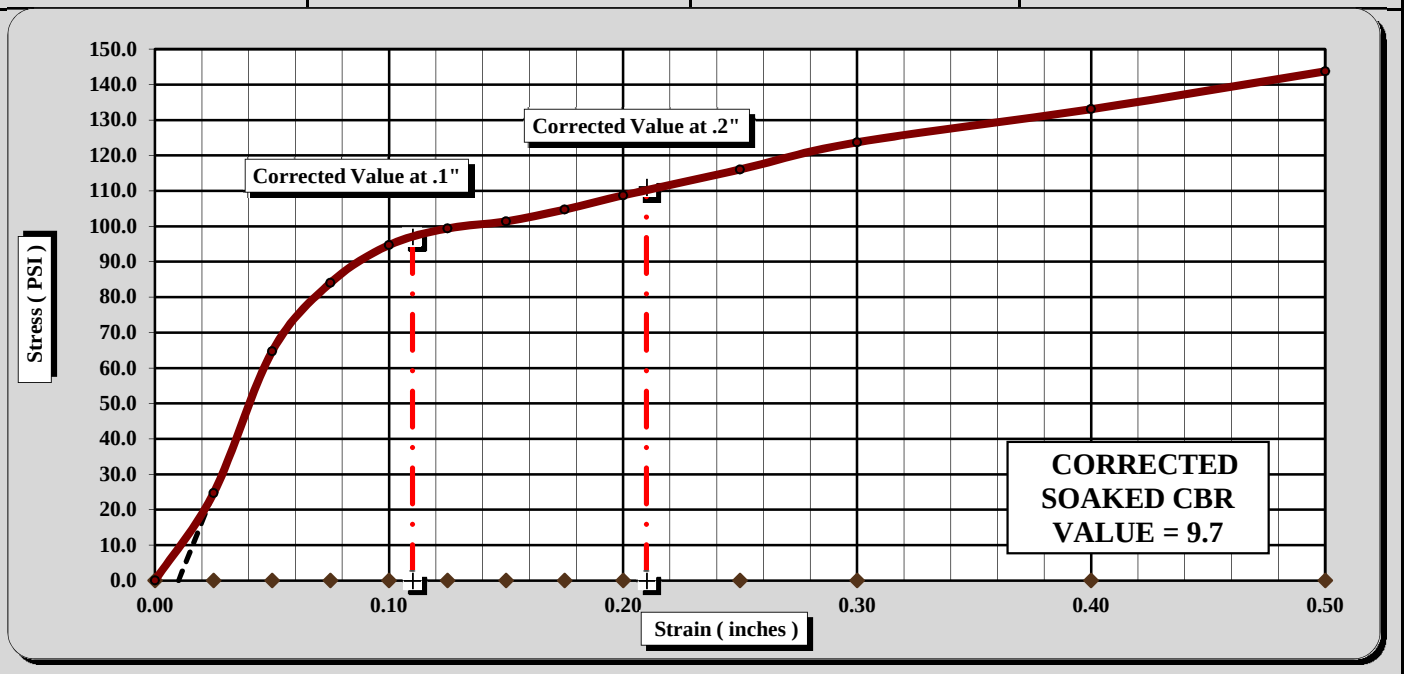
Station: Offset: Depth: 1 to 5 feet

Sample Description: Brown, FAT CLAY with sand (CH)

VIRGINIA TEST METHOD - 1 Maximum Dry Density: **106.5 PCF** Optimum Moisture Content: **17.6%**

Compaction Test performed on the Fine Fraction only % Retained on the 3/4" sieve: **0.0%**

Uncorrected CBR Values		Corrected CBR Values	
CBR at 0.1 in. 9.5	**CBR at 0.2 in. 7.2**	**CBR at 0.1 in. 9.7**	**CBR at 0.2 in. 7.4**



CBR Sample Preparation:

The replacement method was used and compacted in a 6" CBR mold in accordance with VIRGINIA TEST METHOD - 8

Before Soaking		*After Soaking*	
Compactive Effort (Blows per Layer)	35	Final Dry Density (PCF)	107.0
Initial Dry Density (PCF)	107.6	Average Final Moisture Content	18.6%
Moisture Content of the Compacted Specimen	17.7%	Moisture Content (top 1" after soaking)	19.1%
Percent Compaction	101.1%	Percent Swell	0.1%

Soak Time: 144 hrs. Surcharge Weight 20.0 Surcharge Wt. per sq. Ft. 101.9

Liquid Limit 61 Plastic Index 41

Notes/Deviations/References:

Technical Responsibility *Signature* *Position* *Date*

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