January 7, 2015

Mr. Mike Cox, AIA
Architectural Design Studio
90 Church Street
Asheville, North Carolina 28801

Reference: Report of Subsurface Exploration and Geotechnical Engineering Evaluation
Proposed Montreat Town Hall
Florida Terrace
Town of Montreat, North Carolina
ECS Project No. 31-2648-A

Mr. Cox:

ECS Carolinas, LLP (ECS) has completed the subsurface exploration and geotechnical engineering evaluation for the above referenced project, as authorized by your acceptance of our revised Proposal Number 31-3572-PR dated October 17, 2014. This report contains the results of our subsurface exploration, as well as our recommendations concerning the geotechnical aspects for the design and construction of the proposed development.

We appreciate the opportunity to provide geotechnical services to you at this time, and we look forward to continuing to assist you during the construction phase of this project. If you have any questions concerning the information and recommendations presented in this report, or if we can be of further assistance, please contact us.

Sincerely,

ECS CAROLINAS, LLP represented by:

David Marsh, P.E.
Senior Geotechnical Engineer
NC License No. 41645
DMarsh@ecslimited.com

Matthew S. Fogleman, P.E.
Principal Engineer
MFogleman@ecslimited.com

NORTH CAROLINA PROFESSIONAL SEAL 041645 ENGINEER DAVID G. MARSH
01/07/15

REPORT OF SUBSURFACE EXPLORATION
AND
GEOTECHNICAL ENGINEERING EVALUATION

PROPOSED MONTREAT TOWN HALL

TOWN OF MONTREAT, NORTH CAROLINA
ECS PROJECT 31-2648-A

Prepared For

ARCHITECTURAL DESIGN STUDIO

Prepared By

JANUARY 7, 2015

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

This report contains the results of our subsurface exploration and geotechnical engineering evaluation for the proposed new Town Hall for the Town of Montreat to be located on Florida Terrace in Montreat, North Carolina. The subject site consists of a 0.78 acre parcel. The site is bounded to the west by Florida Terrace, to the east by Arkansas Trail, and to the north and south by residential properties. Presently, the site is vacant and is sloped steeply upward from the west to the east. Site relief is on the order of 50 feet. Prior to site drilling, the site was thickly wooded with old-growth trees and rhododendrons.

Based on the preliminary grading information provided, we anticipate that the new building will require significant cuts on the order of 14 to 17 feet and minor fills of up to approximately 3 feet in the southwestern building corner in order to establish final subgrade elevations. We understand that structural site walls are also planned for the site finishes around the building perimeter (primarily the southern half of the building).

The footprint of the proposed parking area falls primarily within the prior excavated area in the northwest corner of the site and will require minimal cuts and fills. However, the eastern portion of the proposed parking area will require cuts of up to approximately 7 feet to reach proposed site grades. We understand a site retaining wall is proposed for the eastern portion of the parking area.

The primary geotechnical consideration for the subject site is the steepness of the site in its preconstruction condition. Proposed site grading will require the construction of both structural and site retaining walls. Grading in areas not requiring retaining walls will require fill or cut slopes. Final engineered cut and fill slopes should typically be inclined no steeper than 1.5H:1V (Horizontal: Vertical) and 2H:1V, respectively, to maintain a suitable long-term factor of safety for slope heights of 20 feet or less.

Provided the subgrade preparation and earthwork operations are completed in strict accordance with the recommendations of this report, the planned construction can be supported on conventional shallow foundations bearing on natural residual soils or newly placed engineered fill. We recommend a net allowable soil bearing pressure of up to 3,000 psf be used for the design of the building footings. Foundations for the cast-in-place structural retaining wall may be proportioned for an increased net allowable design bearing pressure from the building footings to a value of 3,500 psf. Concrete slabs-on-grade can be designed using a modulus of subgrade reaction (k) of 125 pounds per cubic inch (pci). An NCSBC Seismic Site Class “D” is recommended for this site based upon the soil test boring results.

2.0 PROJECT INFORMATION

Our understanding of the project is based on our recent emails and conversations with Mr. Mike Cox and Ms. Amy Dowty with Architectural Design Studio (ADS). We were also provided a Preliminary Site Plan (Sheet SP1.2, dated December 4, 2014) developed by ADS. This site plan showed preliminary proposed grading with a proposed Finished Floor Elevation of the building of 2803.1. We understand that the project consists of the construction of the new Town Hall facility with associated parking and utilities for the Town of Montreat, North Carolina.

The subject site is bounded to the west by Florida Terrace, to the east by Arkansas Trail, and to the north and south by residential properties. We understand that the proposed construction will consist of a two-story building with an approximate 3700 square foot footprint, associated at-grade parking and drive areas, and associated utilities. The construction will consist of wood framing with structural retaining walls up to 14 feet tall for the eastern building wall. We were provided preliminary structural loading information from Mr. Cox and understand that maximum column loads will be on the order of 30 kips and maximum wall loads will be on the order of 1 kip per linear foot.

The building footprint is located on an existing undeveloped, steep, thickly wooded site. Based on the preliminary grading information provided, we anticipate that the new building will require significant cuts on the order of 14 to 17 feet and minor fills of up to approximately 3 feet in the southwestern building corner in order to establish final subgrade elevations. We understand that structural site walls are also planned for the site finishes around the building perimeter (primarily the southern half of the building).

The footprint of the proposed parking area falls primarily within the prior excavated area in the northwest corner of the site and will require minimal cuts and fills. However, the eastern portion of the proposed parking area will require cuts of up to approximately 7 feet to reach proposed site grades. We understand a site retaining wall is proposed for the eastern portion of the parking area.

3.0 EXPLORATION PROCEDURES

3.1 Soil Test Borings

The scope for this exploration included a total of ten (10) soil test borings designated B-1 through B-10. Borings B-1 and B-2 were located approximately within the area of a proposed site retaining wall in a cut condition east of the proposed parking area and were extended to a termination depth of 20 feet below the existing ground surface (BGS). Borings B-3, B-4, B-6, B-7, and B-9 were located approximately within the proposed building footprint. These borings were extended to depths ranging from 10 to 20 feet BGS depending upon the elevation at the boring location. Borings B-5, B-8, and B-10 were approximately located within a proposed parking area and were extended to depths ranging from 9 to 15 feet BGS. Boring B-8 was the only location that was terminated at less than planned depth due to split-spoon refusal on rock. The boring locations were designated by the ECS project engineer based on the provided site plan, and established in the field by ECS personnel utilizing site features and grades. The locations shown on the Boring Location Diagram included in the Appendix of this report are for illustrative purposes and should be considered approximate.

The soil test borings were performed using a trailer-mounted drill rig utilizing continuous-flight, hollow stem augers (HSA) to advance the boreholes. Drilling fluid was not used in this process. Representative soil samples were obtained by means of the split-barrel sampling procedure in general conformance with ASTM D1586. In this procedure, a 2-inch O.D., split-barrel sampler is driven into the soil a distance of 18 inches by a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler through a 12-inch interval is termed the Standard Penetration Test (SPT) value and is indicated for each sample on the boring logs. This value can be used as a qualitative indication of the in-place relative density of cohesionless soils. In a less reliable way, it also indicates the consistency of cohesive soils. This indication is qualitative, since many factors can significantly affect the Standard Penetration resistance value and prevent a direct correlation between drill crews, drill rigs, drilling procedures, and hammer-rod-sampler assemblies. Split-spoon samples were obtained at approximately 2 ½-foot intervals within the upper 10 feet of the borings and at 5-foot intervals thereafter.

The drilling crew maintained a field log of the soils encountered in the borings. After recovery, each sample was removed from the sampler and visually classified. Representative portions of each recovered sample were then sealed in air-tight containers and brought to our laboratory in Asheville, North Carolina, for visual examination by a geotechnical engineer in accordance with the Unified Soil Classification System.

The basic elements of the USCS are described on a legend sheet included in the Appendix of this report. Additional information from each soil boring is provided on the individual soil test boring logs included in the Appendix of this report.

3.2 Refraction Survey

In addition to the soil test borings referenced in the subject study, four (4) seismic refraction survey lines were performed at the site as a preliminary study. The primary focus of the study was to estimate depth to rock at the subject site. The details and findings of the preliminary study were presented under separate cover in the ECS report, dated August 4, 2014.

3.3 Laboratory Testing

Representative split-barrel samples obtained during our field exploration were selected and tested in our laboratory to check field classifications and to help determine pertinent index and engineering properties of the site soils. The geotechnical laboratory testing included:

- Visual classification of soil samples in conformance with ASTM D 2487,

- Index property testing of select soil samples including natural moisture content determinations (ASTM D 2216), Atterberg Limits testing (ASTM D 4318), and percent passing the No. 200 sieve (ASTM D 1140)

The laboratory test results are included on the Laboratory Testing Summary in the Appendix of this report. Natural moisture content test results are also presented on the individual Boring Logs.

4.0 SITE AND SUBSURFACE CONDITIONS

4.1 Site Observations

The subject site is located within the Town of Montreat, and consists of a 0.78 acre parcel designated by PIN 0720-16-4118 according to the Buncombe County GIS. The site is bounded to the west by Florida Terrace, to the east by Arkansas Trail, and to the north and south by residential properties.

Presently, the site is vacant and is sloped steeply upward from the west to the east. Site relief is on the order of 50 feet. Prior to site drilling, the site was thickly wooded with old-growth trees and rhododendrons.

The site has no apparent prior development except for an area in the northwest corner. A prior excavation extends approximately 70 feet into the site from the eastern side of Florida Terrace. The excavation is approximately 30 to 40 feet wide and is relatively flat. We understand from Mr. Ron Nalley with the Town of Montreat that this excavation was begun and subsequently abandoned in the 1970s.

4.2 Area Geology

The project site is located in the Blue Ridge Belt of the Blue Ridge Physiographic Province of North Carolina. The Blue Ridge consists of a variety of high-grade metamorphic and metasedimentary rocks with numerous igneous rock intrusions. According to the 1985 Geologic Map of North Carolina, the bedrock at the site consists of metagraywacke of the Ashe Metamorphic Suite and Tallulah Falls Formation from the late Proterozoic eon interlayered and gradational with mica schist, muscovite-biotite gneiss, and rare graphitic schist. The residual soils in this area are the product of in-place chemical weathering of rock. The typical residual soil profile not affected by erosion or man-made development consists of silty and clayey soils near the surface where soil weathering is more advanced, underlain by sandy silts and silty sands that generally become harder with depth to the top of parent bedrock.

The boundary between soil and rock in this geology is not sharply defined. A transitional zone termed “partially weathered rock” (PWR) is normally found overlying the parent bedrock. Partially weathered rock is defined for engineering purposes as residual material with standard penetration test resistance exceeding 100 blows per foot but can be penetrated by standard drilling equipment. The transition between hard/dense residual soils and partially weathered rock can occur at irregular depths due to variations in the degree of weathering. The variable weathering can also cause rock fragments and boulders to remain within the residual soil matrix.

4.3 Subsurface Conditions

Residual soil was encountered from the surface of each boring location to termination depth. With the exception of borings B-8 and B-10, the residual soils in the upper 5 to 8 feet of each boring location typically consisted of lean clay or clayey sand (CL or SC) with varying amounts of mica and significant roots. In this upper layer, the N-values ranged between 3 and 30 bpf with typical N-values between 3 and 16 bpf.

A silty sand (SM) layer was typically encountered below the lean clay or clayey sand layer at borings B-1 through B-7 and B-9 and the full depth of boring for B-8 and B-10. This layer contained varying amounts of mica and rock fragments. The N-values ranged between 9 and 57 bpf with typical N-values between 10 and 25 bpf.

Groundwater was not encountered at the time of drilling in the borings. Please note that variations in the location of the static water table may occur as a result of changes in precipitation, evaporation, surface water runoff, absorption, and other factors not immediately apparent at the time of this exploration. Consequently, fluctuations in the elevation of the groundwater table should be expected. In general, the highest groundwater levels typically occur in late winter and spring, while the lowest levels typically occur in late summer and fall.

The above paragraphs provide a general summary of the subsurface conditions encountered at the site at the time of our exploration. The Boring Logs included in the Appendix contain detailed information regarding the subsurface conditions encountered at each boring location. These Logs represent our visual classification of the samples retrieved during the field exploration. The stratification lines on the Logs designate approximate boundaries between various subsurface strata. The actual in-situ transitions are expected to be more gradual. Conditions intermediate of the actual boring locations may also differ.

4.4 Laboratory Test Results

Laboratory index test results indicate the in-situ moisture contents of the tested samples range from approximately 10 to 43 percent. Grain size analyses performed on several split-spoon samples indicated approximately 23 to 49 percent of the specimens passing the No. 200 sieve. This is indicative of primarily coarse-grained soils.

Atterberg Limits tests performed on these select samples indicated a non-plastic specimen where tested at Boring B-4. The sample tested at Boring B-9 indicated moderately plastic clay with a Liquid Limit of 48% and a Plasticity Index of 21%. It should be noted that this sample consisted of approximately 43% fine-grained material and 57% coarse-grained material.

The laboratory test results are included on the Laboratory Testing Summary and individual test data sheets in the Appendix of this report. Natural moisture content and index test results are also provided on the individual Boring Logs.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the subsurface conditions encountered within the test borings and our experience with similar site conditions and construction, the soils at the site appear generally suitable for support of the proposed building and pavements using conventional construction techniques. The on-site soils should be able to be excavated using conventional earthmoving equipment and are generally suitable for re-use as fill. The proposed building can be supported on conventional shallow foundations bearing in residual soils or newly placed engineered fill, and the footings can be sized for a net allowable bearing pressure of 3,000 psf. Pavements can also be designed and constructed using conventional flexible (asphalt) or rigid (concrete) pavement sections.

The primary geotechnical consideration for the subject site is the steepness of the site in its preconstruction condition. Proposed site grading will require the construction of both structural and site retaining walls. Grading in areas not requiring retaining walls will require fill or cut slopes. Final engineered cut and fill slopes should typically be inclined no steeper than 1.5H:1V (Horizontal: Vertical) and 2H:1V, respectively, to maintain a suitable long-term factor of safety for slope heights of 20 feet or less.

Based on the existing grades, the results of the soil test borings, and the proposed finished floor elevation of the building, we do not anticipate widespread rock excavation will be required.

Provided the subgrade preparation and earthwork operations are completed in strict accordance with the recommendations of this report, the planned construction can be supported on conventional shallow foundations bearing on natural residual soils or newly placed engineered fill. We recommend a net allowable soil bearing pressure of up to 3,000 psf be used for the design of the building footings. Foundations for the cast-in-place structural retaining wall may be proportioned for an increased net allowable design bearing pressure from the building footings to a value of 3,500 psf. Concrete slabs-on-grade can be designed using a modulus of subgrade reaction (k) of 125 pounds per cubic inch (pci). An NCSBC Seismic Site Class “D” is recommended for this site based upon the soil test boring results.

5.1 Site and Subgrade Preparation

The first step in preparing the site for the proposed construction should be to remove existing vegetation or topsoil and other soft, unsuitable, or deleterious material from the existing ground surface within the construction limits. These operations should extend at least 10 feet beyond the planned limits of the proposed building and 5 feet beyond the planned pavement areas, where practical. Furthermore, these operations should be extended an additional one foot for each foot of fill required at the building's exterior perimeter.

Please note that roots were encountered in most boring locations to depths of up to 3 to 5 feet. Due to the large, old-growth trees and thick brush on the site, localized deep roots should be anticipated. A provision should be made in the contract documents for removal of topsoil and the root mat an average of 12 to 18 inches across the site and in localized areas around stumps to a depth of up to 3 to 5 feet, as directed by the Geotechnical Engineer at the time of clearing.

After removal of existing deleterious surface and subsurface materials, and prior to fill placement, the exposed subgrade soils should be evaluated by the ECS geotechnical engineer or his authorized representative to identify localized loose, yielding, or otherwise unsuitable materials. After observing the exposed soils, loose and yielding areas can be identified by proofrolling with an approved piece of rubber-tired equipment, such as a loaded dump truck, having an axle weight of at least 10 tons. Unsuitable subgrade materials may require in-place densification, excavation and replacement with engineered fill, or other suitable remedial repairs. The most appropriate remedial activity to repair unstable or unsuitable subgrades should be determined in the field by ECS at the time of proofrolling.

The preparation of fill subgrades, as well as the proposed building or pavement subgrades, should be observed on a full-time basis by a representative of ECS. These observations should be performed by an experienced geotechnical engineer, or his representative, to help document that unsuitable materials have been removed and that the prepared subgrade is suitable for support of the proposed construction.

5.2 <u>Excavation and Groundwater Considerations</u>

The residual soils encountered within the soil test borings should generally be excavatable with conventional earth moving equipment such as loaders, bulldozers, backhoes, etc. Based upon our assumptions of the planned site grading, we do not anticipate difficult excavation characteristics for the majority of mass excavation or utility trenches. Partially weathered rock (PWR) or mass intact rock was not encountered within our borings up to a depth of 20 feet below existing site grades.

Groundwater was not encountered within the borings at the time of our exploration. Although groundwater will be expected to rise during winter months, we would not anticipate typical seasonal fluctuations of the groundwater table to rise to an elevation above that which is expected for conventional construction at this site.

<u>5.3 Engineered Fill</u>

Following the removal of all soft or otherwise unsuitable surface and subsurface features, and after achieving a competent subgrade, the contractor can place and compact approved, controlled engineered fill to achieve the desired site grades. Fill for support of the proposed construction and for backfill of utility lines within building and pavement limits should consist of an approved material, free of organic matter and debris. The maximum nominal particle size within the engineered fill should not exceed 3 inches. Excavated rock and PWR (if encountered) from on-site will likely contain material in excess of 3 inches in nominal particle size. The material should be processed to break down or remove over-sized fragments prior to reuse as engineered fill. The engineered fill materials should have a plasticity index less than 25 and a liquid limit less than 45. We also recommend that all fills within structural areas have a standard Proctor (ASTM D 698) maximum dry density of at least 95 pounds per cubic foot (pcf).

Prior to the commencement of fill operations and/or utilization of off-site borrow materials, the contractor should provide representative samples of the soil materials to the geotechnical engineer. The geotechnical engineer will determine the material’s suitability for use as an engineered fill and develop moisture-density relationships in accordance with the recommendations provided herein. Samples should be provided to the geotechnical engineer at least 3 days prior to their use in the field to allow for the appropriate laboratory testing to be performed.

Mass areas of engineered fill placed within the building and pavement areas should be placed in lifts not exceeding 8 inches in loose thickness, moisture conditioned to within their working range of optimum moisture content, and compacted to a minimum of 95 percent of their standard Proctor maximum dry density (ASTM D 698). Similarly, isolated areas of engineered fill, such as trench backfill, should be placed in lifts not exceeding 6 inches and moisture conditioned as mentioned above. The working range of optimum is typically within approximately 3 percent of the optimum moisture content. The upper 18 inches of soil supporting slabs-on-grade, pavements and sidewalks should be compacted to 98 percent of the standard Proctor maximum dry density.

The actual extent of the built-over portions of the site should be well defined during fill placement. Proper grade controls should also be maintained by the contractor throughout the filling operations. Filling operations should be observed on a full-time basis by an experienced soils engineering technician to determine that the required degrees of compaction are being achieved. We recommend at least one field density test be performed for every 2,500 square feet of fill placed per lift for buildings, and one field density test be performed for every 5,000 square feet of fill placed per lift for pavements and other site construction. We recommend at least one test per lift of fill for every 100 linear feet of utility trench backfill. The elevation and location of the tests should be accurately identified at the time of fill placement. Areas which fail to achieve the required degree of compaction should be re-compacted and re-tested until the required compaction is achieved. Failing test areas may require moisture adjustments or other suitable remedial activities in order to achieve the required compaction.

Fill materials should not be placed on frozen soils or frost-heaved soils and/or soils which have been recently subjected to precipitation. Borrow fill materials should not contain wet or frozen materials at the time of placement. Wet or frost-heaved soils should be removed prior to placement of engineered fill, granular sub-base materials, foundation or slab concrete, and paving materials.

If problems are encountered during the site grading operations, or if the actual site conditions differ from those encountered during our subsurface exploration, the geotechnical engineer should be notified immediately.

5.4 Earth Slopes

Final engineered cut and fill slopes should typically be inclined no steeper than 1.5H:1V (Horizontal: Vertical) and 2H:1V, respectively, to maintain a suitable long-term factor of safety for slope heights of 20 feet or less. Fill slopes shall not be constructed using organic strippings, topsoil or other deleterious materials, and should be over-built and cut back to the required inclination in order to properly compact the slope face and to help enhance their long-term stability. Slopes should be properly vegetated to prevent erosion and shallow surficial sloughing which could lead to other instabilities. We recommend a permanent erosion control mat, such as the North American Green SC250 or approved substitute, be installed on all slopes with an inclination of 2H:1V or steeper.

Based on the boring results, the residual soils encountered on-site appear to be OSHA Type C soils. As such, OSHA regulations require that temporary slopes less than 20 feet in height that are excavated into these soils be sloped back at an inclination no steeper than 1.5H:1V. Regardless, site and excavation safety shall be the sole responsibility of the contractor and his subcontractors.

5.5 Foundation Design

Provided the subgrade preparation and earthwork operations are completed in accordance with the "Site and Subgrade Preparation" and "Engineered Fill" sections of this report, the proposed construction can be supported on conventional shallow foundations bearing on approved natural soils or newly placed engineered fill. Shallow foundations may be proportioned for a net allowable design bearing pressure of **3,000 psf**. To help reduce the possibility of foundation bearing failure and excessive settlement due to local shear or "punching" failures, we recommend that continuous footings have a minimum width of 18 inches and that isolated column footings have a minimum lateral dimension of 24 inches, even if the allowable bearing pressure is not fully developed. We recommend the bearing elevation for all foundations be a minimum depth of 18 inches below the finished exterior grade for frost protection. *Please note that design bearing pressure recommendations for the structural retaining wall are provided separately in Section 5.9.*

Provided the recommendations outlined in this report are strictly adhered to, we expect total settlements for the proposed construction to be less than 1 inch. The maximum settlement will likely occur along the southwestern wall footing over the area of fill. We expect that the eastern portion of the building will bear in deeper residual cut soils and total settlement will be on the order of ¼ to ½ inch in this area. Therefore, the maximum differential settlement along wall footings or between column footings may be approximately ½ inch or less. This evaluation is based on our engineering experience and the anticipated structural loadings for this type of structure; it is intended to aid the structural engineer with his design.

Exposure to the environment may weaken the soils at the foundation bearing level if the foundation excavations remain exposed during periods of inclement weather. This is a particularly important consideration for foundations bearing in the micaceous silty sands, be it residual or newly placed fill, as this material will be highly moisture sensitive. Therefore, foundation concrete should be placed the same day that proper excavation is achieved and the design bearing pressure verified. If the bearing soils are softened by surface water absorption or exposure to the environment, the softened soils should be removed from the foundation excavation bottom prior to placement of concrete. If the foundation excavation must remain open overnight, or if inclement weather is expected while the bearing soils are exposed, we recommend that a 2 to 3-inch thick "mud mat" of "lean" concrete be placed over the exposed bearing soils before the placement of reinforcing steel.

The net allowable soil bearing pressure refers to that pressure which may be transmitted to the foundation bearing soils in excess of the final minimum surrounding overburden pressure. The final footing elevation should be evaluated by ECS personnel to document that the bearing soils are capable of supporting the recommended net allowable bearing pressure and suitable for foundation construction. These evaluations should include visual observations, hand rod probing, and dynamic cone penetrometer (ASTM STP-399) testing in each column footing excavation and at intervals not greater than 25 feet in continuous footing excavations. The dynamic cone penetrometer testing should be conducted in hand auger boreholes at 1 foot intervals to a depth equal to at least 1 B (where B equals the footing width) in isolated column footing excavations and to at least 2 B in load-bearing wall footing excavations; or to a depth at least 4 feet below the bearing elevation of the footings, whichever is greater.

5.6 Concrete Slab-On-Grade

For the design and construction of the slab-on-grade for the proposed building, a modulus of subgrade reaction value (k) of 125 pci is appropriate for design provided the subgrades are properly prepared as recommended in this report. We also recommend the slab-on-grade be underlain by a minimum of 4 inches of granular material having a maximum aggregate size of 1½ inches and no more than 2 percent fines.

Prior to placing the granular material, the floor subgrade soil should be properly compacted, unyielding during a final proofroll, and free of standing water, mud, and frozen soil. A properly designed and constructed capillary break layer can often eliminate the need for a moisture retarder and can assist in more uniform curing of concrete. If a vapor retarder is considered to provide additional moisture protection, special attention should be given to the surface curing of the slabs to minimize uneven drying of the slabs and associated cracking and/or slab curling. The use of a blotter or cushion layer above the vapor retarder can also be considered for project specific reasons. Please refer to ACI 302.1R04 *Guide for Concrete Floor and Slab Construction* and ASTM E1643 *Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs* for additional guidance on this issue.

In order to help minimize the crack width of shrinkage cracks that may develop near the surface of the slab, we recommend mesh reinforcement, as a minimum, be included in the design of the floor slab. For maximum effectiveness, temperature and shrinkage reinforcements in slabs on ground should be positioned in the upper third of the slab thickness. The Wire Reinforcement Institute recommends the mesh reinforcement be placed 2 inches below the slab surface or upper one-third of slab thickness, whichever is closer to the surface. Adequate construction joints, contraction joints and isolation joints should also be provided in the slab to reduce the impacts of cracking and shrinkage. Please refer to ACI 302.1R04 *Guide for Concrete Floor and Slab Construction* for additional information regarding concrete slab joint design.

5.7 Pavement Considerations

New pavements may be supported on approved natural residual soils or new engineered fill provided that the recommendations herein are strictly followed. The pavement subgrades should be prepared in strict accordance with the recommendations in the "Site and Subgrade Preparation" and "Engineered Fill" sections of this report.

We have developed the minimum pavement sections recommended below using AASHTO guidelines based on an assumed CBR value of 5.0 and an anticipated design life of 20 years. Anticipated traffic conditions used in our analysis include 20-year equivalent single axle loading (ESAL) of 15,000 for light duty pavement and do not account for any heavy truck traffic. Should the actual traffic conditions be different than those stated, especially if heavy truck traffic is anticipated, ECS should be allowed to carefully review these recommendations and make appropriate revisions based upon the new traffic design criteria and/or determination of the engineering properties of the actual pavement subgrade soils. It is important to understand the recommended sections do not take into account construction traffic.

Table 1 – Pavement Section Summary

Material Designation	Light Duty Asphalt Pavement	Light Duty Portland Cement Concrete (PCC) Pavement	Heavy Duty PCC Pavement for Trash Dumpster (If Applicable)
Asphalt (S 9.5A/B and/or I 19.0B)	2.5 inches	-	-
Portland Cement Concrete	-	5.0 inches	6.0 inches
Aggregate Base Course	6 inches	4 inches (optional)	4 inches (optional)

NOTE: ECS should be allowed to carefully review these recommendations and make appropriate revisions based upon the formulation of the final traffic design criteria for the project.

Base course materials beneath pavements should be compacted to at least 98 percent of their modified Proctor maximum dry density (ASTM D 1557). The asphalt concrete and all crushed stone materials should conform to the North Carolina Department of Transportation (NCDOT) Standard Specifications. PCC sections should consist of concrete having a minimum compressive strength of 4,000 psi. Appropriate jointing should be incorporated into the design of PCC pavements.

Front-loading trash dumpsters frequently impose concentrated front-wheel loads on pavements during loading. This type of loading typically results in rutting and shoving of bituminous pavements and ultimately pavement failures and costly repairs. Therefore, we recommend that the pavements in trash pickup areas (if applicable at the subject site) utilize the Portland Cement Concrete (PCC) pavement section with a minimum of 6 inches of concrete. Appropriate steel reinforcing and jointing should also be incorporated into the design of all PCC pavement.

An important consideration with the design, construction and performance of pavements is surface and subsurface drainage. Where standing water develops, either on the pavement surface or within the base course layer, softening of the subgrades and other problems related to the deterioration of the pavement can be expected. Furthermore, good drainage should help reduce the possibility of the subgrade materials becoming saturated during the normal service period of the pavement.

5.8 Seismic Site Class

The 2012 North Carolina State Building Code (NCSBC) requires that a seismic Site Class be assigned for new structures. The seismic Site Class for the site was determined by calculating a weighted average of the N-Values recorded in the test borings. Based on the soil test boring data, a seismic Site Class of "D" is recommended for this site.

5.9 Retaining Walls

Based on the proposed construction and site grades, we anticipate the construction of a retaining wall constructed in a cut condition for the building and parking areas in the eastern portion of the subject site. We also note that a fill wall transitioning to a cut wall from west to east along the southern edge of the site development will be required. We anticipate that the retaining walls around the building will be structural and the retaining wall for the parking area will be a terraced site wall.

We understand that the structural retaining wall for the proposed building will be constructed of cast-in-place concrete. Because of the depth of cut of up to 14 feet, foundations for the cast-in-place structural retaining wall may be proportioned for an increased net allowable design bearing pressure from the building shallow footings to a value of **3,500 psf**. Please note that the building retaining walls and cast-in-place site walls should be designed by a licensed Structural Engineer. If the site wall is a geotechnical wall system (such as segmental block, soil nails, or other mechanically stabilized earth system), ECS can provide design services for the site retaining wall at the parking area, if requested.

5.10 Lateral Earth Pressures for Retaining Walls

For the design of below-grade and cast-in-place (CIP) retaining walls to restrain compacted backfill, existing fill or in-situ natural soils, the equivalent fluid pressure parameters presented below can be used to determine lateral earth pressure loads. Please note that the values presented below are for the residual silty sand (SM) and sandy clay/clayey sand (SC/CL) encountered on-site, or similar material with a minimum $\Phi' = 28°$ and a moist unit weight (γ_w) = 120 pcf. We have also provided values for granular backfill (such as clean sand or washed stone), should the designer or contractor elect to use such material.

Earth Pressure Condition	*Material Type*	*Coefficient*	***Equivalent Fluid Pressure (pcf)***
At-Rest	Silty Sand (SM)	$K_0 = 0.53$	**64**
	Granular	$K_0 = 0.35$	**40**
Active	Silty Sand (SM)	$K_a = 0.36$	**43**
	Granular	$K_a = 0.21$	**25**
Passive	Silty Sand (SM)	$K_p = 2.77$	**332**
	Granular	--	--

*Assumes functional drainage system behind wall

**For the granular values to be valid, the clean sand or washed stone must extend out from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active/at-rest and passive cases, respectively

The lateral earth pressure values presented in the preceding table assume level backfill behind the wall, and do not account for hydrostatic pressures against the walls or surcharge loads. Moderate to highly plastic clays and silts (CH and MH) should not be utilized behind below-grade or retaining walls.

For wall conditions where outward wall movement on the order of ½ to 1 percent of the wall height can be tolerated, the "Active" earth pressure should be used. For wall conditions where wall movement cannot be tolerated or where the wall is restrained at the top, such as basement walls, the "At Rest" earth pressure should be used.

Resistance to sliding can be provided by friction between the bottom of the wall foundation and the underlying soils, as well as passive resistance of soil in front of the footing. Passive resistance values based on granular fills should not be used to resist sliding. An ultimate coefficient of friction of 0.40 for concrete bearing on approved natural soils or properly prepared engineered fill is recommended.

Drainage behind freestanding retaining walls is considered essential towards relieving hydrostatic pressures. Drainage can be established by providing a perimeter drainage system located just above the below grade/retaining wall footings which discharges by gravity flow to a suitable outlet. This system should consist of "perforated pipe" or "porous wall", closed-joint drain lines. These drain lines should be surrounded by a minimum 6 inches of free-draining, granular filter material having a gradation compatible with the size of the openings utilized in the drain lines and the surrounding soils to be retained, or by gravel wrapped in filter fabric. The space between the interior face of the wall and the earth fill should be backfilled with at least 12 inches of granular fill of porous quality or better extending from the perimeter drainage system to just below the top of the wall. The ground surface adjacent to the below-grade walls should be kept properly graded to prevent ponding of water adjacent to the walls.

As an alternative to the recommended granular porous backfill against the back of the wall, a suitable pre-fabricated composite drainage board could be utilized. These materials should be covered with a filter fabric having an equivalent opening size (EOS) consistent with the size of the soil to be retained. The drainage board should be placed in accordance with the manufacturer's recommendations and connected to a drainage system that discharges beyond the wall.

5.11 Site Drainage

Positive drainage should be provided around the perimeter of the building structures to reduce the potential for moisture infiltration into the foundation and/or subgrade soils. We recommend that landscaped areas adjacent to these structures be sloped away from the construction and maintain a fall of at least 6 inches for the first 10 feet outward from the structures. Similarly, roof drains should drain a sufficient distance from the building perimeter or discharge directly into below-grade storm water piping. The parking lots, sidewalks, and other paved areas should also be sloped to divert surface water away from the proposed buildings.

5.12 Construction Considerations

It is imperative to maintain good site drainage during earthwork operations to help maintain the integrity of the surface soils. The surface of the site should be kept properly graded to enhance drainage of surface water away from the proposed construction areas during the earthwork phase of this project. This is particularly important for this site because of the presence of micaceous silty sand across the site. If site preparation and earthwork are performed during the typically wetter, cooler months of the year (November through April), a 4-inch-thick layer of sacrificial, well-graded crushed stone may be placed on the soil subgrade to protect it from precipitation. We recommend that surface drainage be diverted away from the proposed buildings and pavements areas without significantly interrupting its flow. Other practices would involve sealing the exposed soils daily with a smooth-drum roller at the end of the day’s work to reduce the potential for infiltration of surface water into the exposed soils.

The key to minimizing disturbance problems with the soils is to have proper control of the earthwork operations. Specifically, it should be the earthwork contractor's responsibility to maintain the site soils within a workable moisture content range to obtain the required in-place density and maintain a stable subgrade. Scarifying and drying operations should be included in the contractor's price and not be considered an extra to the contract. In addition, construction equipment cannot be permitted to randomly run across the site, especially once the desired final grades have been established. Construction equipment should be limited to designated lanes and areas, especially during wet periods to minimize disturbance of the site subgrades.

6.0 CLOSING

This report has been prepared in accordance with generally accepted geotechnical engineering practice. No other warranty is expressed or implied. No third party may rely upon this report without prior written approval from ECS. The recommendations presented in this report are based on our understanding of the site and project information provided by the client, and the data obtained during our exploration. The general subsurface conditions utilized in our evaluations are based on interpolation of subsurface conditions between the borings. In evaluating the subsurface data, we have considered previous correlations between penetration resistance values and engineering properties for soil conditions similar to those at your site. The discovery of any site or subsurface conditions during construction which deviate from those described herein should be reported to us for our evaluation. Furthermore, ECS shall be provided with final project drawings and specifications to verify that our recommendations have been correctly interpreted. Any required revisions to the recommendations contained herein shall be made in writing by ECS prior to construction. The assessment of site environmental conditions for the presence of pollutants in the soil, rock, and groundwater of the site was beyond the scope of this geotechnical exploration.

The recommendations outlined herein should not be construed to address moisture or water intrusion effects after construction is completed. Proper design of landscaping, surface and subsurface water control measures are required to properly address these issues. In addition, proper operation and maintenance of building systems is required to minimize the effects of moisture or water intrusion. The design, construction, operation, and maintenance of waterproofing and dampproofing systems are beyond the scope of services for this project.

APPENDIX

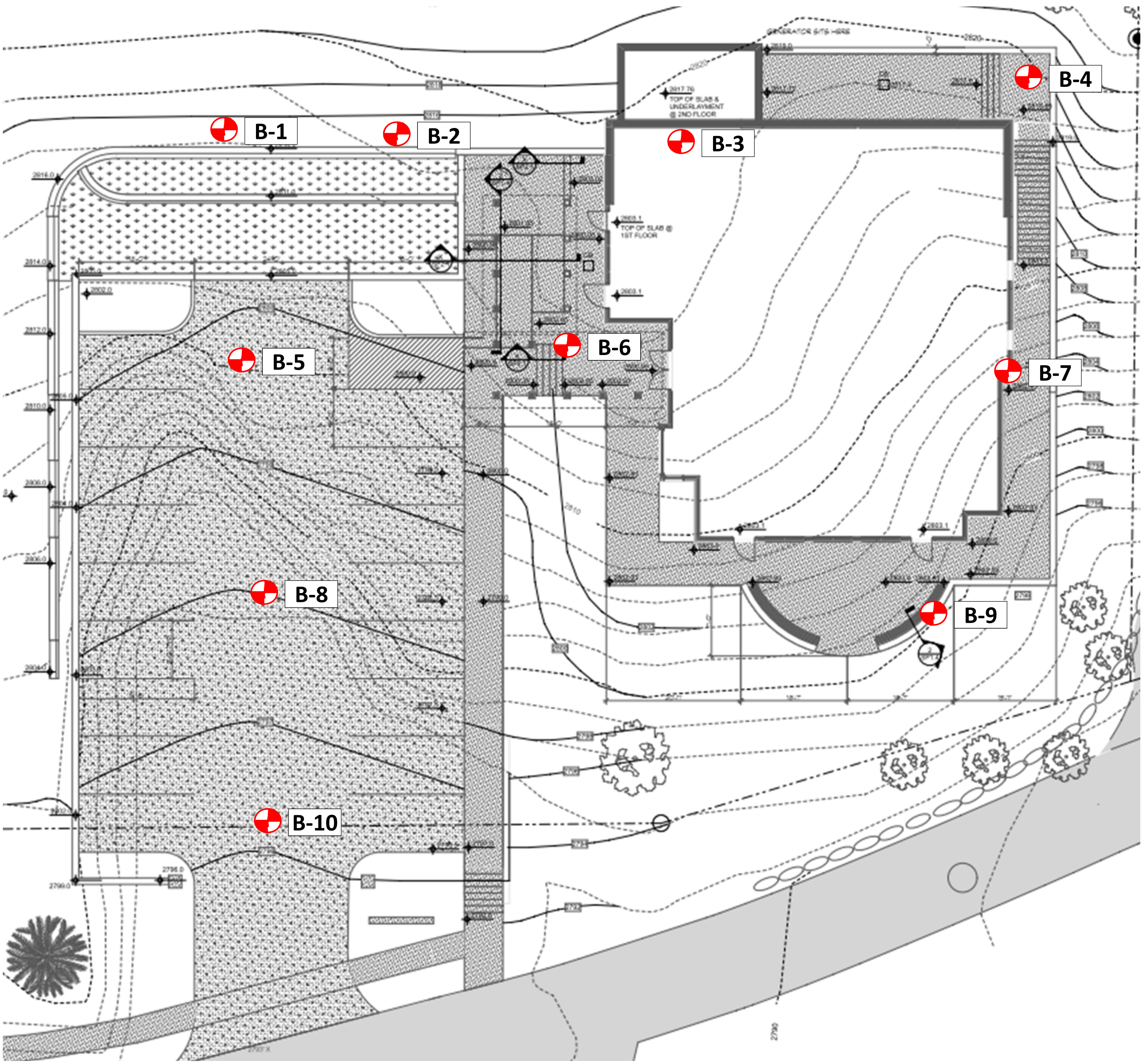
Boring Location Diagram

Soil Test Boring Logs (B-1 through B-10)

Laboratory Summary

Unified Soil Classification System

Reference Notes for Boring Logs



Not to Scale

Note: Drawing provided by ADS, dated 12/04/2014

LEGEND

B-1 **Approximate Boring Location**

Boring Location Diagram

Proposed Montreat Town Hall
Florida Terrace
Town of Montreat, North Carolina
ECS Project No. 31-2648-A

CLIENT	JOB #	BORING #	SHEET
Architectural Design Studio	2648-A	B-1	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montreat Town Hall Geotechnical	

SITE LOCATION
Florida Terrace, Montreat, Buncombe County

NORTHING	EASTING	STATION

—○— CALIBRATED PENETROMETER TONS/FT²

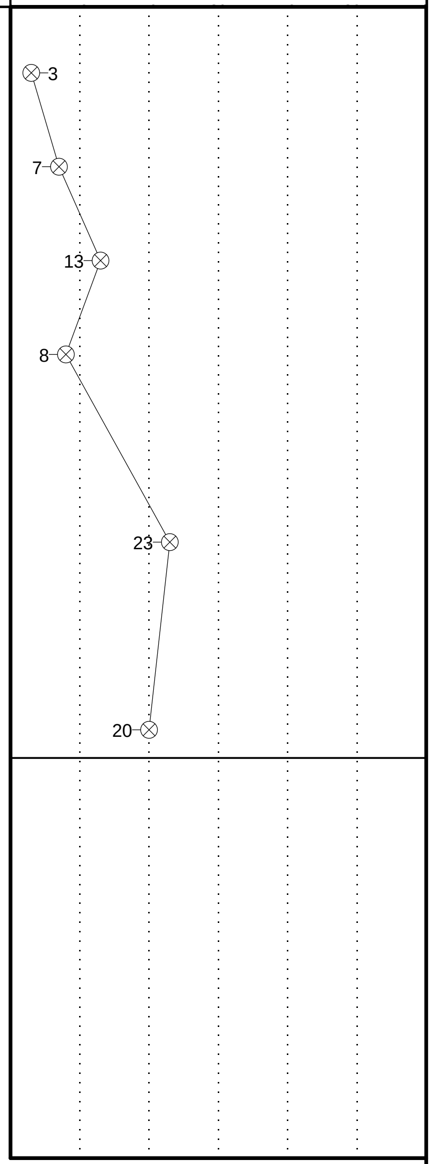
ROCK QUALITY DESIGNATION & RECOVERY
RQD% – – – REC% ———

PLASTIC LIMIT% ✕ —— WATER CONTENT% ● —— LIQUID LIMIT% △

⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS
BOTTOM OF CASING — LOSS OF CIRCULATION
SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					(CL) SANDY LEAN CLAY, Contains Significant Roots and Contains Mica, Brown, Moist, Soft			
	S-1	SS	18	14				3 1 2
					(CL) SANDY LEAN CLAY, Contains Slight Roots and Mica, Brown, Moist, Medium Stiff			
	S-2	SS	18	15				4 3 4
5					(SM) SILTY SAND, Contains Significant Mica, Tan- Brown, Moist, Medium Dense			
	S-3	SS	18	14				6 8 5
					(CL) SANDY LEAN CLAY, Contains Mica and Rock Fragments, Tan- Brown, Moist, Medium Stiff			
	S-4	SS	18	12				6 4 4
10								
					(SM) SILTY SAND, Contains Mica and Rock Fragments, Tan- Brown, Moist, Medium Dense			
	S-5	SS	18	12				11 12 11
15								
	S-6	SS	18	18				8 9 11
20					END OF BORING @ 20.00'			
25								
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL — WS ☐ WD ☐	BORING STARTED 11/24/14	
WL(BCR) — WL(ACR)	BORING COMPLETED 11/24/14	CAVE IN DEPTH @ 15.00'
WL	RIG 45C Tk. — FOREMAN B. Jordan	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Architectural Design Studio	2648-A	B-2	1 OF 1

PROJECT NAME: Montreat Town Hall Geotechnical

ARCHITECT-ENGINEER:

SITE LOCATION: Florida Terrace, Montreat, Buncombe County

NORTHING: | EASTING: | STATION:

CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY: RQD% — — — REC% ———

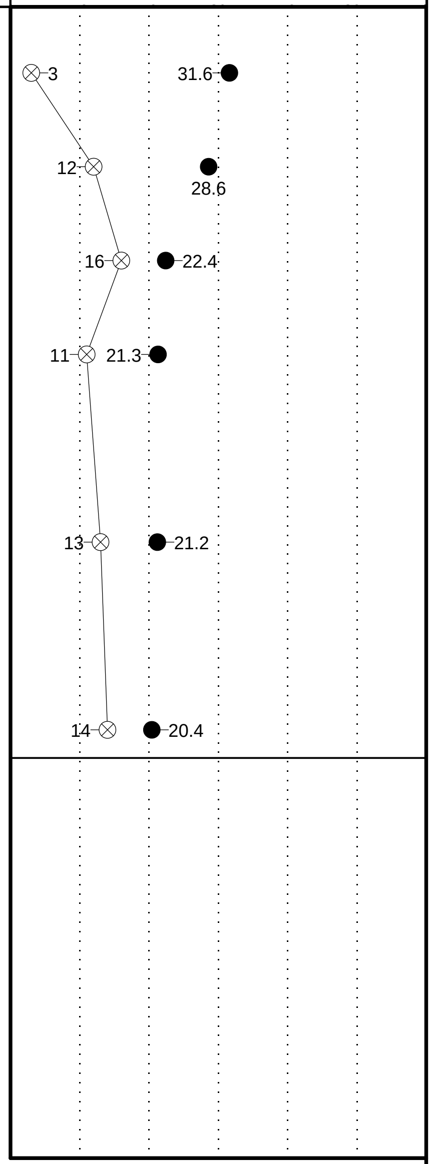
PLASTIC LIMIT% — WATER CONTENT% — LIQUID LIMIT%

STANDARD PENETRATION BLOWS/FT

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL (ENGLISH UNITS)	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	SPT (BLOWS/FT)	WATER CONTENT %
0	S-1	SS	18	11	(CL) LEAN CLAY, Trace Sand, Contains Significant Roots and Contains Slight Mica, Brownish Red, Moist, Soft			2 1 2	3	31.6
	S-2	SS	18	18	(SP-SC) SAND WITH CLAY, Contains Significant Mica and Contains Slight Roots, Brownish Red, Moist, Medium Dense			4 6 6	12	28.6
5	S-3	SS	18	8				6 9 7	16	22.4
	S-4	SS	18	14	(SP-SM) SAND WITH SILT, Contains Significant Mica, Red- Tan, Moist, Medium Dense			7 5 6	11	21.3
10										
	S-5	SS	18	12				11 5 8	13	21.2
15										
	S-6	SS	18	15	(SP-SM) SAND WITH SILT, Contains Significant Mica and Rock Fragments, Red-Tan, Moist, Medium Dense			16 6 8	14	20.4
20					END OF BORING @ 20.00'					
25										
30										



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS ☐ WD ☐	BORING STARTED 11/24/14	
WL(BCR) WL(ACR)	BORING COMPLETED 11/24/14	CAVE IN DEPTH @ 15.50'
WL	RIG 45C Tk. FOREMAN B. Jordan	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Architectural Design Studio	2648-A	B-3	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montreat Town Hall Geotechnical	

SITE LOCATION

Florida Terrace, Montreat, Buncombe County

NORTHING	EASTING	STATION

-○- CALIBRATED PENETROMETER TONS/FT²

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – – – REC% ———

PLASTIC LIMIT% × WATER CONTENT% ● LIQUID LIMIT% △

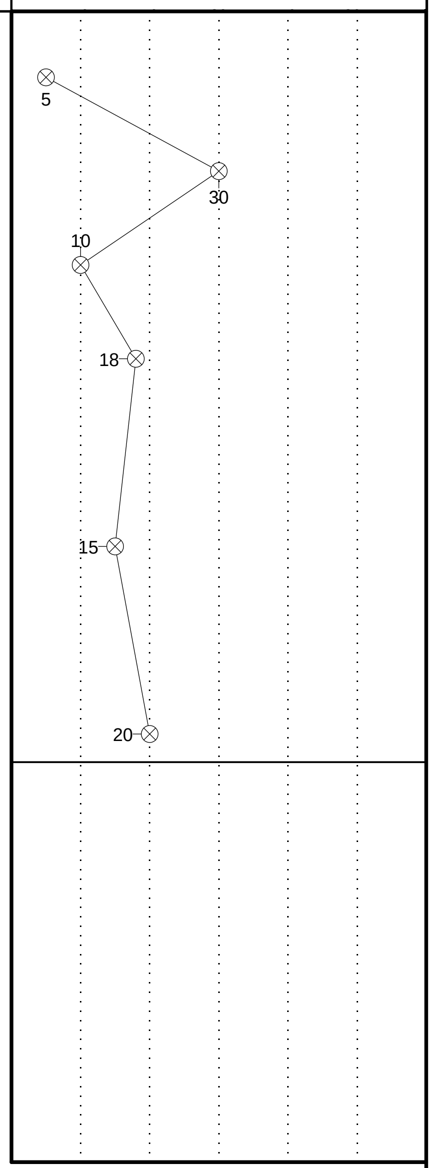
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION (100%)

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					(CL) SANDY LEAN CLAY, Contains Significant Mica and Contains Roots, Red Tan and Black, Moist, Medium Stiff			
	S-1	SS	18	10				2 2 3
	S-2	SS	18	10				9 12 18
5					(SM) SILTY SAND, Contains Significant Mica and Rock Fragments, Pink- Tan, Moist, Medium Dense			
	S-3	SS	18	13				4 4 6
					(SM) SILTY SAND, Contains Significant Mica, Brownish Tan, Moist, Medium Dense			
	S-4	SS	18	12				8 8 10
10								
					(CL) LEAN CLAY WITH SAND, Contains Mica, Red, Moist, Stiff			
	S-5	SS	18	14				6 6 9
15					(SM) SILTY SAND, Contains Significant Mica, Red- Tan, Moist, Medium Dense			
	S-6	SS	18	9				7 8 12
20					END OF BORING @ 20.00'			
25								
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL — WS ☐ WD ☐	BORING STARTED 11/24/14	
WL(BCR) — WL(ACR)	BORING COMPLETED 11/24/14	CAVE IN DEPTH @ 15.00'
WL	RIG 45C Tk. — FOREMAN B. Jordan	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Architectural Design Studio	2648-A	B-4	1 OF 1

PROJECT NAME: Montreat Town Hall Geotechnical

ARCHITECT-ENGINEER:

SITE LOCATION: Florida Terrace, Montreat, Buncombe County

NORTHING: EASTING: STATION:

-○- CALIBRATED PENETROMETER TONS/FT²

ROCK QUALITY DESIGNATION & RECOVERY
RQD% – – – REC% ———

PLASTIC LIMIT% ✕ — WATER CONTENT% ● — LIQUID LIMIT% △

⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION 100%

SURFACE ELEVATION

SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	SPT (BLOWS/FT)	WATER CONTENT %	PLASTIC / LIQUID LIMIT
				(CL) LEAN CLAY WITH SAND, Contains Mica and Roots, Brown, Moist, Soft to Medium Stiff						
S-1	SS	18	15				1 1 2	3	36.2	
S-2	SS	18	2				6 6 7	13	42.5	
				(SM/ML) SILTY SAND, Contains Mica and Roots, Tan- Brown, Moist, Medium Dense						
S-3	SS	18	14				6 7 7	14	23.1	NP / NP
S-4	SS	18	15				14 13 27	40	21.0	
				(SM) SILTY SAND, Contains Significant Mica and Rock Fragments, Brown, Moist, Medium Dense to Dense						
S-5	SS	18	8				9 11 11	22	17.3	
S-6	SS	18	10				12 11 10	21	18.3	
				END OF BORING @ 20.00'						

DEPTH (FT): 0, 5, 10, 15, 20, 25, 30

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS☐ WD☐	BORING STARTED 11/24/14	
WL(BCR) WL(ACR)	BORING COMPLETED 11/24/14	CAVE IN DEPTH @ 14.00'
WL	RIG 45C Tk. FOREMAN B. Jordan	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Architectural Design Studio	2648-A	B-5	1 OF 1

PROJECT NAME: Montreat Town Hall Geotechnical

ARCHITECT-ENGINEER:

SITE LOCATION: Florida Terrace, Montreat, Buncombe County

NORTHING: | EASTING: | STATION:

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION 100%

SURFACE ELEVATION

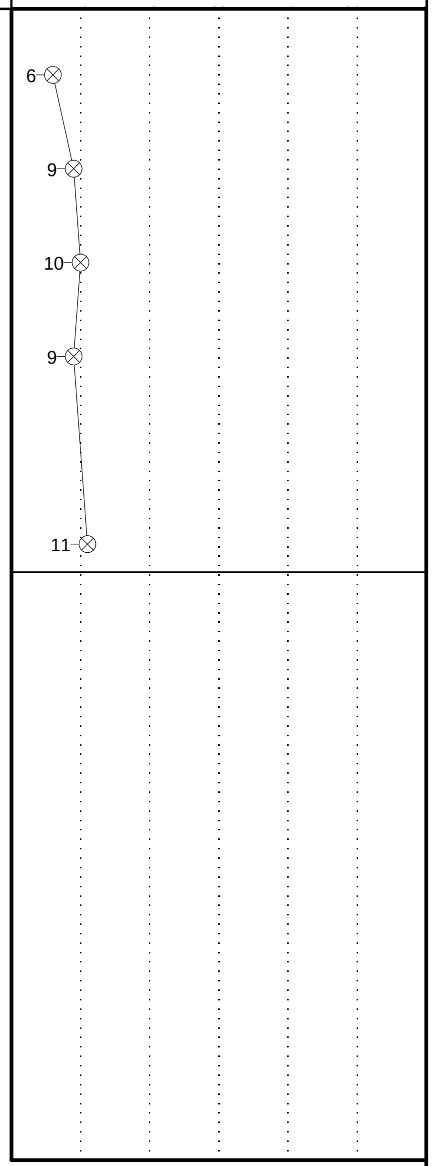
-○- CALIBRATED PENETROMETER TONS/FT²

ROCK QUALITY DESIGNATION & RECOVERY: RQD% – – – REC% ———

PLASTIC LIMIT% — WATER CONTENT% — LIQUID LIMIT%

⊗ STANDARD PENETRATION BLOWS/FT

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	STANDARD PENETRATION BLOWS/FT
0					(ML) SILT WITH SAND, Trace Clay, Contains Mica and Roots, Brown, Moist, Medium Stiff				
	S-1	SS	18	15				3 3 3	6
	S-2	SS	18	18	(SC) CLAYEY SAND, Contains Mica and Contains Slight Roots, Tan- Brown, Moist, Loose to Medium Dense			3 4 5	9
5									
	S-3	SS	18	16	(SM) SILTY SAND, Contains Mica, Tan-Brown, Moist, Loose to Medium Dense			6 5 5	10
	S-4	SS	18	15	(SP-SC) SAND WITH CLAY, Contains Mica, Tan, Moist, Loose to Medium Dense			3 4 5	9
10									
	S-5	SS	18	14				4 5 6	11
15					END OF BORING @ 15.00'				
20									
25									
30									



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL — WS ☐ WD ☐	BORING STARTED 11/24/14	
WL(BCR) — WL(ACR)	BORING COMPLETED 11/24/14	CAVE IN DEPTH @ 11.00'
WL	RIG 45C Tk. — FOREMAN B. Jordan	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Architectural Design Studio	2648-A	B-6	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montreat Town Hall Geotechnical	

SITE LOCATION: Florida Terrace, Montreat, Buncombe County

NORTHING	EASTING	STATION

-O- CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY — RQD% - - - REC% ———

PLASTIC LIMIT% — WATER CONTENT% — LIQUID LIMIT%

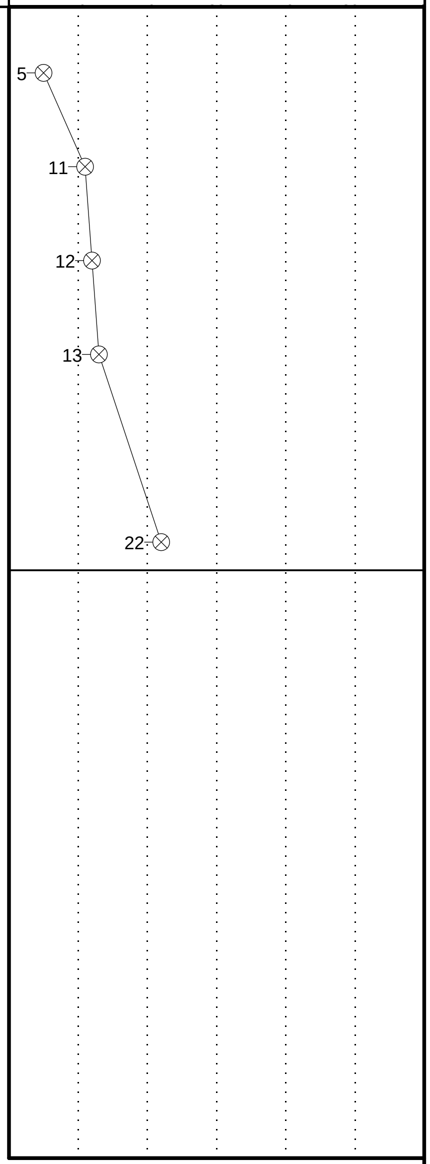
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					(SC) CLAYEY SAND, Contains Significant Mica, Brownish Red, Moist, Loose			
	S-1	SS	18	5				2 2 3
5	S-2	SS	18	11	(SP) COARSE SAND, Contains Rock Fragments, Tan to Pink, Moist, Medium Dense			7 6 5
	S-3	SS	18	12				7 4 8
10	S-4	SS	18	13				8 7 6
15	S-5	SS	18	9	(SM) SILTY MEDIUM SAND, Contains Rock Fragments, Brown, Moist, Medium Dense			13 12 10
					END OF BORING @ 15.00'			
20								
25								
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL — WS ☐ WD ☐	BORING STARTED 11/24/14	
WL(BCR) — WL(ACR)	BORING COMPLETED 11/24/14	CAVE IN DEPTH @ 10.00'
WL	RIG 45C Tk. — FOREMAN B. Jordan	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Architectural Design Studio	2648-A	B-7	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montreat Town Hall Geotechnical	

SITE LOCATION

Florida Terrace, Montreat, Buncombe County

NORTHING	EASTING	STATION

-O- CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY

RQD% — — — REC% ———

PLASTIC LIMIT% — WATER CONTENT% — LIQUID LIMIT%

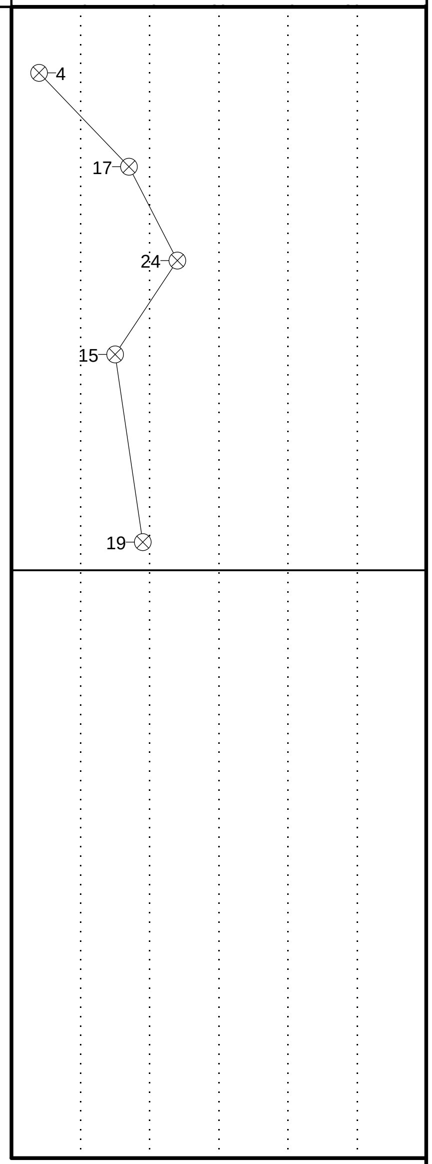
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION 100%

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"	SPT (BLOWS/FT)
0					(CL) LEAN CLAY, Contains Slight Mica and Contains Roots, Brown, Moist, Soft				
	S-1	SS	18	18				2 2 2	4
	S-2	SS	18	6	(CL) LEAN CLAY, Contains Slight Mica, Brown, Moist, Medium Stiff			7 9 8	17
5									
	S-3	SS	18	12	(SP-SC) FINE TO MEDIUM SAND WITH CLAY, Contains Significant Mica and Contains Rock Fragments, Tan- Brown, Moist, Medium Dense			8 12 12	24
	S-4	SS	18	10				10 7 8	15
10									
	S-5	SS	18	5	(SP-SC) FINE TO MEDIUM SAND WITH CLAY, Contains Significant Mica and Contains Rock Fragments, Red- Brown, Moist, Medium Dense			11 9 10	19
15					END OF BORING @ 15.00'				
20									
25									
30									



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS ☐ WD ☐	BORING STARTED 11/24/14	
WL(BCR) WL(ACR)	BORING COMPLETED 11/24/14	CAVE IN DEPTH @ 10.00'
WL	RIG 45C Tk. FOREMAN B. Jordan	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Architectural Design Studio	2648-A	B-8	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montreat Town Hall Geotechnical	

SITE LOCATION

Florida Terrace, Montreat, Buncombe County

NORTHING	EASTING	STATION

CALIBRATED PENETROMETER TONS/FT²

ROCK QUALITY DESIGNATION & RECOVERY — RQD% — REC%

PLASTIC LIMIT% — WATER CONTENT% — LIQUID LIMIT%

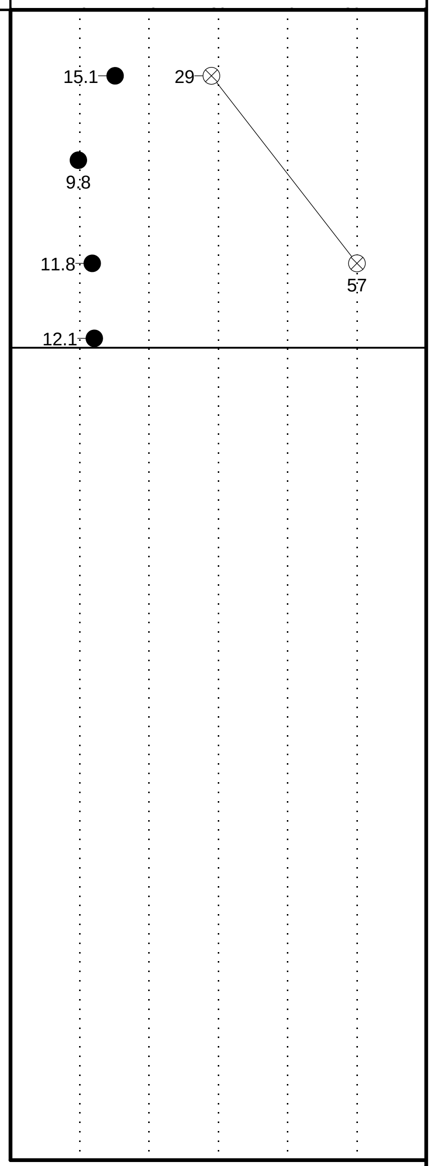
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					(SM) SILTY FINE TO MEDIUM SAND, Contains Significant Mica, Tan and Brown, Moist, Medium Dense to Extremely Dense			
	S-1	SS	18	13				11 12 17
	S-2	SS	12	4				25 50
5								
	S-3	SS	18	6				24 28 29
	S-4	SS	6	1				50
					SPOON REFUSAL @ 9.00'			
10								
15								
20								
25								
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS☐ WD☐	BORING STARTED 11/24/14	
WL(BCR) WL(ACR)	BORING COMPLETED 11/24/14	CAVE IN DEPTH @ 6.00'
WL	RIG 45C Tk. FOREMAN B. Jordan	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Architectural Design Studio	2648-A	B-9	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montreat Town Hall Geotechnical	

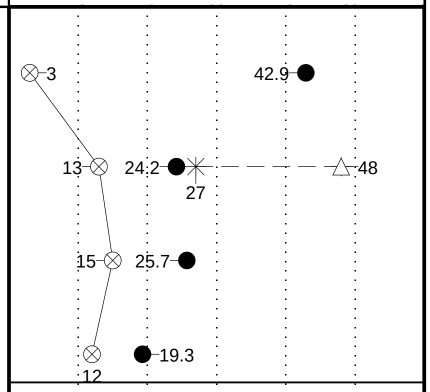
SITE LOCATION: Florida Terrace, Montreat, Buncombe County

NORTHING	EASTING	STATION

CALIBRATED PENETROMETER TONS/FT^2
ROCK QUALITY DESIGNATION & RECOVERY — RQD% — REC%
PLASTIC LIMIT% — WATER CONTENT% — LIQUID LIMIT%
STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS
BOTTOM OF CASING — LOSS OF CIRCULATION
SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					(CL) LEAN CLAY, Contains Roots, Dark Brown, Moist, Soft			
	S-1	SS	18	13				2 1 2
	S-2	SS	18	13	(SC) CLAYEY SAND, Contains Significant Mica, Brown to Red, Moist, Medium Stiff to Stiff			5 6 7
5								
	S-3	SS	18	18				6 7 8
	S-4	SS	18	12	(SP-SC) MEDIUM TO COARSE SAND WITH CLAY, Contains Mica and Rock Fragments, Pinkish Tan, Moist, Medium Dense			6 6 6
10					END OF BORING @ 10.00'			
15								
20								
25								
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS ☐ WD ☐	BORING STARTED 11/24/14	
WL(BCR) WL(ACR)	BORING COMPLETED 11/24/14	CAVE IN DEPTH @ 7.00'
WL	RIG 45C Tk. FOREMAN B. Jordan	DRILLING METHOD HSA

CLIENT	JOB #	BORING #	SHEET
Architectural Design Studio	2648-A	B-10	1 OF 1

PROJECT NAME	ARCHITECT-ENGINEER
Montreat Town Hall Geotechnical	

SITE LOCATION: Florida Terrace, Montreat, Buncombe County

NORTHING	EASTING	STATION

-O- CALIBRATED PENETROMETER TONS/FT^2

ROCK QUALITY DESIGNATION & RECOVERY: RQD% – – – REC% ———

PLASTIC LIMIT% — WATER CONTENT% — LIQUID LIMIT%

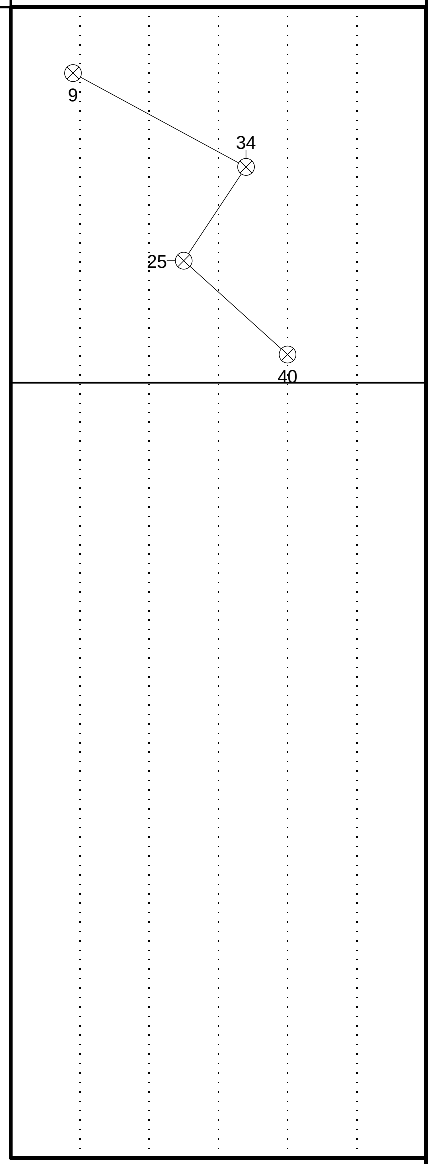
⊗ STANDARD PENETRATION BLOWS/FT

DESCRIPTION OF MATERIAL — ENGLISH UNITS

BOTTOM OF CASING — LOSS OF CIRCULATION

SURFACE ELEVATION

DEPTH (FT)	SAMPLE NO.	SAMPLE TYPE	SAMPLE DIST. (IN)	RECOVERY (IN)	DESCRIPTION OF MATERIAL	WATER LEVELS	ELEVATION (FT)	BLOWS/6"
0					(SM) SILTY FINE TO MEDIUM SAND, Contains Significant Mica, Black and Tan, Moist, Loose to Dense			
	S-1	SS	18	10				4 4 5
	S-2	SS	18	3				14 15 19
5								
	S-3	SS	18	2				10 13 12
	S-4	SS	18	6				15 19 21
10					END OF BORING @ 10.00'			
15								
20								
25								
30								



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL.

WL WS☐ WD☐	BORING STARTED 11/24/14	
WL(BCR) WL(ACR)	BORING COMPLETED 11/24/14	CAVE IN DEPTH @ 6.00'
WL	RIG 45C Tk. FOREMAN B. Jordan	DRILLING METHOD HSA

Laboratory Testing Summary

Sample Source	Sample Number	Depth (feet)	MC[1] (%)	Soil Type[2]	Atterberg Limits[3]			Percent Passing No. 200 Sieve[4]	Moisture - Density (Corr.)[5]		CBR Value[6]	Other
					LL	PL	PI		Maximum Density (pcf)	Optimum Moisture (%)		
B-2												
	S-1	1.00 - 2.50	31.6									
	S-2	3.50 - 5.00	28.6									
	S-3	6.00 - 7.50	22.4									
	S-4	8.50 - 10.00	21.3									
	S-5	13.50 - 15.00	21.2									
	S-6	18.50 - 20.00	20.4									
B-4												
	S-1	1.00 - 2.50	36.2									
	S-2	3.50 - 5.00	42.5									
	S-3	6.00 - 7.50	23.1	SM/ML	NP	NP	NP	49.2				
	S-4	8.50 - 10.00	21.0									
	S-5	13.50 - 15.00	17.3									
	S-6	18.50 - 20.00	18.3									
B-8												
	S-1	1.00 - 2.50	15.1	SM				22.8				
	S-2	3.50 - 4.50	9.8									
	S-3	6.00 - 7.50	11.8									
	S-4	8.50 - 9.00	12.1									
B-9												
	S-1	1.00 - 2.50	42.9									
	S-2	3.50 - 5.00	24.2	SC	48	27	21	42.9				
	S-3	6.00 - 7.50	25.7									
	S-4	8.50 - 10.00	19.3									

Notes: 1. ASTM D 2216, 2. ASTM D 2487, 3. ASTM D 4318, 4. ASTM D 1140, 5. See test reports for test method, 6. See test reports for test method

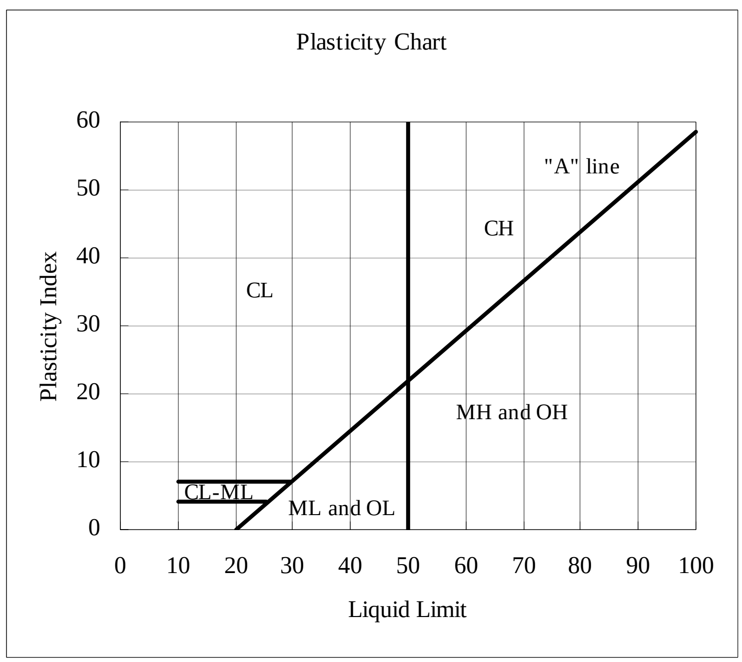
Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content (ASTM D 2974)

Project No.: 2648-A
Project Name: Montreat Town Hall Geotechnical
PM: David Marsh
PE: Matthew S. Fogleman
Printed On: Wednesday, January 07, 2015

ECS CAROLINAS, LLP
1900 Hendersonville Road, Suite 10
Asheville, NC 28803
Phone: (828) 665-2307
Fax: (828) 665-8128

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 size), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP; More than 12 percent GM, GC, SM, SC; 5 to 12 percent Borderline cases requiring dual symbols [b]	$C_u = D_{60}/D_{10}$ 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[a]	d	Silty gravels, gravel-sand mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line or P.I. less 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[a]	d	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or P.I. less than 4	Limits plotting in CL-ML zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. 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, organic silts			
	Highly Organic soils		Pt		Peat and other highly organic soils			



[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC,well-graded gravel-sand mixture with clay binder. (From Table 2.16 - Winterkorn and Fang, 1975)

REFERENCE NOTES FOR BORING LOGS

I. Drilling Sampling Symbols

SS	Split Spoon Sampler	ST	Shelby Tube Sampler
RC	Rock Core, NX, BX, AX	PM	Pressuremeter
DC	Dutch Cone Penetrometer	RD	Rock Bit Drilling
BS	Bulk Sample of Cuttings	PA	Power Auger (no sample)
HSA	Hollow Stem Auger	WS	Wash sample
REC	Rock Sample Recovery %	RQD	Rock Quality Designation %

II. Correlation of Penetration Resistances to Soil Properties

Standard Penetration (blows/ft) refers to the blows per foot of a 140 lb. hammer falling 30 inches on a 2-inch OD split-spoon sampler, as specified in ASTM D 1586. The blow count is commonly referred to as the N-value.

A. Non-Cohesive Soils (Silt, Sand, Gravel and Combinations)

Density		*Relative Properties*	
Under 4 blows/ft	Very Loose	Adjective Form	12% to 49%
5 to 10 blows/ft	Loose	With	5% to 12%
11 to 30 blows/ft	Medium Dense		
31 to 50 blows/ft	Dense		
Over 51 blows/ft	Very Dense		

Particle Size Identification		
Boulders		8 inches or larger
Cobbles		3 to 8 inches
Gravel	Coarse	1 to 3 inches
	Medium	½ to 1 inch
	Fine	¼ to ½ inch
Sand	Coarse	2.00 mm to ¼ inch (dia. of lead pencil)
	Medium	0.42 to 2.00 mm (dia. of broom straw)
	Fine	0.074 to 0.42 mm (dia. of human hair)
Silt and Clay		0.0 to 0.074 mm (particles cannot be seen)

B. Cohesive Soils (Clay, Silt, and Combinations)

Blows/ft	*Consistency*	*Unconfined Comp. Strength Q_p (tsf)*	*Degree of Plasticity*	*Plasticity Index*
Under 2	Very Soft	Under 0.25	None to slight	0 – 4
3 to 4	Soft	0.25-0.49	Slight	5 – 7
5 to 8	Medium Stiff	0.50-0.99	Medium	8 – 22
9 to 15	Stiff	1.00-1.99	High to Very High	Over 22
16 to 30	Very Stiff	2.00-3.00		
31 to 50	Hard	4.00–8.00		
Over 51	Very Hard	Over 8.00		

III. Water Level Measurement Symbols

WL	Water Level	BCR	Before Casing Removal	DCI	Dry Cave-In
WS	While Sampling	ACR	After Casing Removal	WCI	Wet Cave-In
WD	While Drilling	▽	Est. Groundwater Level	▼	Est. Seasonal High GWT

The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in a granular soil. In clay and plastic silts, the accurate determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally applied.