U.S. Department of Veterans Affairs
Washington, DC

Geotechnical Subsurface Investigation
Proposed
National Veterans Burial Grounds
Harrington Road
Machias (Jonesboro), Maine

June 2015

TTL associates inc
Environmental, Geotechnical Engineering & Testing

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June 26, 2015 **TTL Project No. 12571.03**

U.S. Department of Veterans Affairs
c/o Ms. Belinda Gamble-DiCupe
Savills Studley
1201 F Street, NW
Washington, DC 20004

Geotechnical Subsurface Investigation
Proposed National Veterans Burial Grounds
Harrington Road
Machias (Jonesboro), Maine

Dear Ms. Gamble-DiCupe:

Following is the report of the geotechnical subsurface investigation performed by TTL Associates, Inc. (TTL) for the referenced project conducted for Savills Studley on behalf of U.S. Department of Veterans Affairs (VA). This study was performed in accordance with TTL Proposal No. 12571.03, dated March 4, 2015, and authorized by you on May 1, 2015.

This report contains the results of our study, our engineering interpretation of the results with respect to the project characteristics, and our recommendations for installation and support of burial crypt fields, as well as design and construction of columbarium foundations, for the proposed national veterans burial grounds.

Soil samples collected during this investigation will be stored at our laboratory for 90 days from the date of this report. The samples will be discarded after this time unless you request that they be saved or delivered to you.

Should you have any questions regarding this report or require additional information, please contact our office.

Sincerely,

TTL Associates, Inc.

Christopher P. Iott, P.E. (OH 69734)
Senior Geotechnical Engineer

Curtis E. Roupe, P.E.
Vice President

STATE OF MAINE
CURTIS E. ROUPE
No. 12118
LICENSED
PROFESSIONAL ENGINEER

6/26/15

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GEOTECHNICAL SUBSURFACE INVESTIGATION
PROPOSED NATIONAL VETERANS BURIAL GROUNDS
HARRINGTON ROAD
MACHIAS (JONESBORO), MAINE

FOR

U.S. DEPARTMENT OF VETERANS AFFAIRS
811 VERMONT AVENUE, NW
WASHINGTON, DC

SUBMITTED

JUNE 26, 2015
TTL PROJECT NO. 12571.03

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1.0 INTRODUCTION

This geotechnical subsurface investigation report has been prepared for the proposed national veterans burial grounds to be constructed on the north side of Harrington Road (US Route 1), approximately 1,100 feet east of the crossing of Indian River and 1,800 feet west of Cassella Drive, in Jonesboro, Maine. The site is located approximately 11 miles southwest of Machias, Maine. The approximate site location is shown on the attached Site Location Map (Plate 1.0).

This report summarizes our understanding of the proposed construction, describes the investigative and testing procedures, presents the findings, discusses our evaluations and conclusions, and provides our recommendations for installation and support of burial crypt fields, as well as design and construction of columbarium foundations.

This study was performed in accordance with TTL Proposal No. 12571.03, dated March 4, 2015, and authorized by Ms. Belinda Gamble-DiCupe of Savills Studley on May 1, 2015.

The purpose of this investigation was to evaluate the subsurface conditions and laboratory data relative to installation and support of burial crypt fields, as well as design and construction of columbarium foundations at the referenced site. This investigation included six test borings, field and laboratory soil testing, a geotechnical engineering evaluation of the test results, and review of available geologic information.

This report includes:

- A description of the subsurface soil and groundwater conditions encountered in the borings.
- Design recommendations for columbarium foundations.
- Recommendations concerning soil- and groundwater-related construction procedures such as site preparation, excavation for burial crypt fields, earthwork, foundation construction, and related field testing.

A Phase I Environmental Site Assessment (ESA) and a NEPA Environmental Assessment will be performed by TTL at the project site, and the results will be provided in separate reports.

2.0 INVESTIGATIVE PROCEDURES

This subsurface investigation included six test borings, designated as B-1 through B-6, drilled on May 29, 2015. The borings were drilled in a grid pattern across the site. The borings were located in the field based on an aerial photograph showing site boundaries provided by Savills Studley and were completed by a local drilling contractor, New England Boring Contractors/Maine Test Borings, Inc. of Hermon, Maine, under the direction of TTL's geotechnical engineer. The approximate locations of the borings, as well as the approximate site boundaries are shown on the Test Boring Location Plan (Plate 2.0).

The test borings were performed in general accordance with geotechnical investigative procedures outlined in ASTM Standards D 1452 and D 5434. The test borings performed during this investigation were performed with a drilling rig utilizing 2¼-inch inside diameter hollow-stem augers. The borings were extended to the planned termination depth of 12 feet below existing grade.

During auger advancement, soil samples were collected continuously over 2-foot intervals. Split-spoon (SS) samples were obtained by the Standard Penetration Test (SPT) Method (ASTM D 1586), which consists of driving a 2-inch outside diameter split-barrel sampler into the soil with a 140-pound weight falling freely through a distance of 30 inches. The sampler was driven in four successive 6-inch increments with the number of blows per increment being recorded. The sum of the number of blows required to advance the sampler the second and third 6-inch increments is termed the Standard Penetration Resistance (N-value) and is presented on the Logs of Test Borings attached to this report. Cohesive soil samples were sealed in jars and granular soil samples were retained in sealed plastic bags. The samples were transported to our laboratory for further classification and testing. Topsoil samples collected using split-spoon samplers were retained for organic content testing as described below.

Soil conditions encountered in the test borings are presented in the Logs of Test Borings, along with information related to sample data, SPT results, water conditions observed in the borings, and laboratory test data. It should be noted that these logs have been prepared on the basis of laboratory classification and testing as well as field logs of the encountered soils.

All recovered samples of the subsoils were visually or manually classified in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 and D 2488). Approximately two-thirds of the samples were tested in our laboratory for moisture content (ASTM D 2216). Unconfined compressive strength estimates were obtained using a calibrated hand penetrometer for the intact cohesive samples. Additionally, organic content determinations by the loss-on-ignition (LOI) method (ASTM D 2974) were performed on the topsoil samples. An Atterberg limits test (ASTM D 4318) and a particle size analysis (ASTM D 422) were performed on a selected sample from Boring B-5 (SS-3) to determine soil classification and index properties. These test results are presented on the Logs of Test Borings, Tabulation of Test Data sheets, and Grain Size Distribution sheet attached to this report.

Two samples were selected for pH determinations (ASTM D 4972). These test results are summarized in Section 5.3 of this report. Additionally, the pH results are presented on the Tabulation of Test Data sheets.

Experience indicates that the actual subsoil conditions at a site could vary from those generalized on the basis of test borings made at specific locations. Therefore, it is essential that a geotechnical engineer be retained to provide soil engineering services during the site preparation, excavation, and foundation phases of the proposed project. This is to observe compliance with the design concepts, specifications, and recommendations, and to allow design changes in the event subsurface conditions differ from those anticipated prior to the start of construction.

3.0 PROPOSED CONSTRUCTION

It is our understanding that the project consists of development as a national veterans burial grounds of an approximately 6-acre site along the north side of Harrington Road (US Route 1) in Jonesboro, Maine, approximately 11 miles southwest of Machias, Maine.

The proposed development is planned to include burial crypt fields, which consist of a subsurface drainage system installed below 6-foot depth concrete crypts that are typically covered with 2 feet of fill then with topsoil. Specifications indicate that the crypts should either be above the water table or have ability for the subsurface drainage system to drain the groundwater such that the buried crypts remain dry. The new development may also include columbarium structures. Loads associated with the columbarium structures were not provided.

It is assumed that final site grades will approximate existing site grades.

4.0 GENERAL SITE AND SUBSURFACE CONDITIONS

4.1 General Site Conditions

The site is located along the north side of Harrington Road (US Route 1), approximately 1,100 feet east of the crossing of Indian River and 1,800 feet west of Cassella Drive, in Jonesboro, Maine.

Surface materials encountered at the boring locations consisted of topsoil, generally on the order of 5 inches in thickness. The topsoil encountered in Boring B-6 was approximately 18 inches in thickness. Moisture contents for the topsoil samples generally ranged from approximately 21 to 79 percent. Organic contents for the topsoil samples ranged from approximately 6 to 20 percent.

According to the US Department of Agriculture (USDA) Soils Survey for Washington County, the near-surface soils are mapped as Colton-Adams soils in the northern approximately half of the site, and Lamoine-Buxton-Scantic soils in the southern portion of the site. The Colton-Adams soils consist of gravelly, sandy soils formed along eskers and kame terraces. These soils exhibit moderately high to very high permeability. The Lamoine-Buxton-Scantic soils formed along coastal plains, and consist of silt loam and silty clay loam which exhibit very low to moderately high permeability.

4.2 General Soil Conditions

Based on the results of our field and laboratory tests, the encountered subsoils consisted of predominantly granular soils in the northern portion of the site (B-1 and B-2) and cohesive soils in the southern portion of the site (B-3 through B-6), which was expected based on the mapped site soils in the USDA Soil Survey. Boring B-3 was located in the northern, middle portion of the site, and encountered cohesive soils underlain by granular soils, indicating some transition of geologic deposits in the upper-soil profile in this area of the site.

4.2.1 Northern Portion of Site (B-1 and B-2)

Based on the results of our field and laboratory tests, the subsoils encountered underlying the topsoil in the northern portion of the site consisted of predominantly granular soils to the maximum explored depth of 12 feet below existing grade. The granular soils included poorly graded sand (SP and SP/SM) with varying amounts of gravel, as well as silty sand (SM). SPT

N-values for the sands in the upper 2 to 3½ feet ranged from 2 to 6 blows per foot (bpf), indicating **very loose** to **loose** compactness. Below these depths, SPT N-values ranged from 18 to 30 bpf, indicating medium dense compactness. Moisture contents varied from less than 1 percent to 22 percent.

4.2.2 Middle and Southern Portions of Site (B-3 through B-6)

Based on the results of our field and laboratory tests, the subsoils encountered underlying the topsoil in the middle and southern portions of the site predominantly consisted of cohesive soils to the maximum explored depth of 12 feet below existing grade. The cohesive soils consisted of lean clay (CL) with varying amounts of gravel. The cohesive soils can be generally described as three strata based on varying strength characteristics.

Stratum I consisted of predominantly **soft** to medium stiff cohesive soils underlying the topsoil to depths ranging from 1½ to 2 feet below existing grade. SPT N-values ranged from 4 to 8 blows per foot (bpf), unconfined compressive strengths were generally on the order of 500 pounds per square foot (psf) or less, and moisture contents varied from approximately 17 to 37 percent.

Stratum II consisted of predominantly very stiff to hard cohesive soils underlying Stratum I to depths ranging from 8 to 10 feet. SPT N-values ranged from 18 to 52 bpf, unconfined compressive strengths were generally greater than 9,000 psf (maximum reading obtainable using the hand penetrometer), and moisture contents ranged from approximately 19 to 25 percent. A liquid limit of 34 percent and a plasticity index of 13 percent were determined for a sample from this stratum obtained from Boring B-5 (SS-3). These values, along with particle size analysis results, are indicative of lean clay (CL) as determined in accordance with the Unified Soil Classification System (USCS).

Stratum III consisted of predominantly stiff to very stiff cohesive soils underlying Stratum II in Borings B-4 through B-6 to termination at a depth of 12 feet. SPT N-values ranged from 13 to 24 bpf, unconfined compressive strengths ranged from 2,000 to 5,500 psf, and moisture contents ranged from approximately 22 to 26 percent.

In Boring B-3, a zone of medium dense poorly graded sand with silt (SP/SM) was encountered underlying Stratum II to termination at a depth of 12 feet. This sand layer is likely from the same geological deposit as the sands encountered in Borings B-1 and B-2.

Additional descriptions of the stratigraphy encountered in the borings are presented on the Logs of Test Borings.

4.3 Groundwater Conditions

Groundwater was not initially encountered during drilling or observed upon completion of drilling operations in any of the borings. In Boring B-5, the tip of the split-spoon sampler advanced to the termination depth of 12 feet was damp. This borehole was left open for approximately 5 hours after completion of drilling , and no groundwater seepage occurred into the borehole prior to being backfilled. Boring B-2 was left open for approximately 3 hours after completion of drilling and caved at a depth of approximately 7½ feet, and Boring B-1 caved at a depth of approximately 8 feet immediately upon completion of drilling operations, although groundwater was not observed in these boreholes. It should be noted that the borings were drilled and backfilled within the same day. If groundwater was present within the explored depths, it is likely that it would have been observed in the granular soils in the northern portion of the site. In any case, instrumentation was not installed to observe long-term groundwater levels.

Based on the limited data available, such as the soil characteristics and the moisture conditions encountered in the borings, it is our opinion that the "normal" groundwater level may be encountered at depths on the order of 11 feet or greater below existing grades. However, this investigation did not include research of possible hydrological influences at the project site. It should be noted that groundwater elevations can fluctuate with seasonal and climatic influences. As mentioned in Section 4.1, according to the USDA Soils Survey for Washington County, the near-surface soils are mapped as Colton-Adams soils in the northern approximately half of the site, and Lamoine-Buxton-Scantic soils in the southern portion of the site. The Colton-Adams soils consist of gravelly, sandy soils. Seasonal high groundwater data was not reported for these soils. The Lamoine-Buxton-Scantic soils consist of silt loam and silty clay loam. Seasonal high groundwater levels for these soils are indicated to approach the ground surface, but could be on the order of 3 feet below grades, generally from October through June. Therefore, the groundwater conditions may vary at different times of the year from those encountered during this investigation.

5.0 DESIGN AND CONSTRUCTION RECOMMENDATIONS

The following conclusions and recommendations are based on our understanding of the proposed construction and on the data obtained during the field investigation. If the project information or location as outlined is incorrect or should change significantly, a review of these recommendations should be made by TTL. These recommendations are subject to the satisfactory completion of the recommended site and subgrade preparation and fill placement operations described in the following sections.

5.1 Burial Crypt Fields

The soils at the bearing depth for the crypts are anticipated to consist of predominantly medium dense granular soils in the northern portion of the site, transitioning to Stratum II very stiff to hard cohesive soils and Stratum III stiff to very stiff cohesive soils in the middle and southern portions of the site. These soils are considered generally suitable for support of the proposed crypts. Based on the borings, excavations for installation of crypts in the middle and southern portions of the site may encounter **soft** to medium stiff cohesive soils underlying the topsoil to depths on the order of 1½ to 2 feet, but these soils are not expected at crypt bearing depths.

The soils encountered during this investigation, within the anticipated depths of excavation, consist of the following OSHA Type soils:

- OSHA Type A soils (cohesive soils with unconfined compressive strengths of 3,000 pounds per square foot (psf) or greater),
- OSHA Type B soils (cohesive soils with unconfined compressive strengths greater than 1,000 psf but less than 3,000 psf), and
- OSHA Type C soils (cohesive soils with unconfined compressive strengths of 1,000 psf or less, and granular soils).

For temporary excavations in Type A, B, and C soils, side slopes must be no steeper than ¾ horizontal to 1 vertical (¾H:1V), 1H:1V, and 1½H:1V, respectively. For situations where a higher strength soil is underlain by a lower strength soil and the excavation extends into the lower strength soil, the slope of the entire excavation is governed by that required by the lower strength soil. In all cases, flatter slopes may be required if lower strength soils or adverse seepage conditions are encountered during construction.

Additional excavation recommendations are presented in Section 5.6.

It should be noted that the "normal" groundwater level is anticipated at depths on the order of 11 feet or greater below existing grades. As such, crypt installation excavations are not generally anticipated to encounter groundwater. However, if installation occurs during a wet seasonal period, groundwater may be encountered. Specifications indicate that the crypts should either be above the water table or have ability for the subsurface drainage system to drain the groundwater such that the buried crypts remain dry. We recommend that a groundwater drainage system be installed due to the potential for seasonal high groundwater within depths of the installed crypts. Additional recommendations for groundwater management during construction are presented in Section 5.5.

If a groundwater drainage system is not installed for the below-grade crypts, consideration should be given to buoyancy to evaluate whether the crypts will remain stable under high water conditions. If the weights of the crypts and overlying soil fill are not enough to resist uplift pressures associated with high water conditions, it may be necessary to tie the crypts to a ballast slab or provide additional fill over the crypts.

5.2 Shallow Columbarium Foundations

The soils encountered in the borings at the anticipated foundation bearing depth (a minimum of 4 feet below grade for protection from frost penetration) are expected to consist of predominantly **loose** to medium dense native granular soils in the northern portion of the site and Stratum II very stiff to hard cohesive soils in the middle and southern portions of the site. These soils are considered generally suitable for support of shallow foundations, although the loose granular soils will require in-place densification or removal and replacement with new engineered fill as described below to provide adequate bearing and reduce the risk of excessive settlement.

If the excavated subgrade reveals loose granular soils at footing bearing elevation, additional in-place modification must be performed using a backhoe-mounted vibratory compactor (hoe-pac) or similar equipment to achieve a consistent bearing stratum. Alternatively, the loose granular soils may be removed and replaced with new granular engineered fill.

Suitable compaction/bearing of granular foundation soils can be verified as:

- Exhibiting a compacted (in-situ) dry density of at least 100 percent of the maximum dry density determined by Standard Proctor (ASTM D 698) laboratory compaction,
- A dynamic cone penetrometer (DCP) reading of at least 8 blows per increment (average over three increments), or
- Other methods to demonstrate an equivalent SPT N-value of 10 bpf or greater.

If granular soils can not be modified in-place, or if other unsuitable foundation soils are encountered, over-excavation should extend through these materials to suitable bearing soils. Additionally, the base of the over-excavation should be widened one foot for every foot of depth and centered along the footing. The over-excavated areas should be backfilled with dense-graded aggregate, placed in controlled lifts, and compacted to not less than 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor). Alternatively, the over-excavated areas could be backfilled with flowable controlled-density fill having a minimum compressive strength of 300 pounds per square inch (psi). Undercut depths should be limited to one footing width. Although not anticipated to be required, if seasonal high groundwater is present and difficulty is encountered with controlling groundwater that hinders compaction efforts of granular soils, open graded stone, such as AASHTO No. 57, can be used as backfill. The No. 57 stone should be wrapped in filter fabric.

Following the satisfactory completion of the site preparation and footing excavation inspections outlined in this section of the report, the proposed structure may be supported on a conventional shallow spread foundation system consisting of wall (strip) and/or column (square) footings. Shallow foundations may be designed utilizing an allowable bearing pressure of 2,000 pounds per square foot (psf) for spread footings. The bearing materials should be field-verified as being native granular soils that exhibit compactness/density as described above, native cohesive soils with a minimum unconfined compressive strength of 2,000 psf, or properly placed and compacted new engineered fill.

We strongly recommend that the bearing surface at the bottom of all footing excavations be inspected during construction by a TTL geotechnical engineer or qualified representative. Inspection should be performed to verify that the exposed soil conditions at the bearing elevations are consistent with the subsurface conditions encountered in the test borings and have been suitably modified in-place. Additionally, the presence of our engineer will help facilitate the timely remediation of unsuitable soil conditions. If the results of DCP, hand penetrometer, or other strength tests indicate the exposed soil conditions are not suitable for the design bearing pressure, it may be necessary to increase the footing size to accommodate the lower bearing strengths or to over-excavate and backfill with engineered fill or flowable fill.

All exterior footings should be constructed at a minimum depth of 4 feet below finished exterior grades for protection from frost penetration. Wall (strip) footings should be at least 18 inches wide, regardless of sizing based on design loads and the allowable bearing pressure. It should be noted that use of trench footings (i.e., without forming) is not expected to be feasible in the northern portion of the site due to the predominantly granular bearing soils, along with the potential need for in-place densification. Forming of footings should be anticipated.

We recommend that the foundation excavations be concreted as soon as practical after they are excavated and that water not be allowed to pond in any excavation. If it is necessary to leave the bearing surface open for any extended period of time, we recommend that a thin mat of lean concrete be placed over the bottom of the excavation to reduce damage to the surface from weather or construction. Foundation concrete should not be placed on frozen or saturated subgrade.

Based on the above bearing pressure and proper foundation inspection techniques, the total settlement associated with each structure should not exceed 1 inch and differential settlement should not exceed ¾ inch.

5.3 Corrosion Considerations

Soil samples from Borings B-2 and B-6 were tested for pH. The pH results, per ASTM D 4972, are summarized as follows:

Boring No. (Sample No.)	Soil Type	pH
B-2 (SS-2)	Poorly Graded Sand w/Silt (SP/SM)	5.5
B-6 (SS-2)	Lean Clay (CL)	6.2

This range of pH is characterized as strongly acid to slightly acid soil reaction by the USDA Soil Conservation Service. Typically, soils with a pH range between 5 and 9 are not considered to represent a significant corrosion risk to buried structural concrete or underground utilities. Therefore, we do not expect that these soils will represent a significant corrosion risk to underground construction, although this assessment is based on limited data. In any case, we recommend that this data be reviewed by the pipe manufacturers, as the susceptibility to corrosion is a function of the type of pipe material used.

5.4 Groundwater Control and Drainage

Groundwater conditions for the borings performed for this investigation are summarized in Section 4.3. Based on the limited data available, such as the soil characteristics and the moisture conditions encountered in the borings, it is our opinion that the “normal” groundwater level may be encountered at depths on the order of 11 feet or greater below existing grades. However, groundwater elevations can fluctuate with seasonal and climatic influences. As mentioned in Section 4.3, seasonal high groundwater data was not reported in the USDA Soils Survey for Washington County for the granular soils in the northern portion of the site. Seasonal high groundwater levels for the cohesive soils in the middle and southern portions of the site were indicated to approach the ground surface, but could be on the order of 3 feet below grades, generally from October through June.

It is our experience that adequate control of groundwater seepage or surface water run-off into shallow excavations above the groundwater table should be achievable by minor dewatering systems, such as pumping from prepared sumps. If groundwater is encountered at shallower depths during wet seasonal periods in excavations within the granular soils at the site, it will likely be necessary to augment sump-and-pump operations with multiple wellpoints to facilitate construction dewatering. In the event excessive seepage is encountered during construction, TTL may be notified to evaluate whether other dewatering methods are required.

5.5 Excavations and Slopes

The sides of temporary excavations for burial crypt fields, columbarium foundations, utility installations, and other construction should be adequately sloped to provide stable sides and safe working conditions. Otherwise, the excavation must be properly braced against lateral movements. In any case, applicable Occupational Safety and Health Administration (OSHA) safety standards must be followed.

Un-braced excavations should meet the side-slope criteria presented in Section 5.1. For permanent excavation slopes, we recommend that grades be no steeper than 3 horizontal to 1 vertical (3H:1V) without a more extensive geotechnical evaluation of the proposed construction plans and site conditions.

5.6 Site and Subgrade Preparation

Prior to proceeding with construction operations, all topsoil, root mat, vegetation, and other deleterious non-soil materials should be removed from the proposed construction areas. Suitable topsoil may be stockpiled for later use in landscape areas. **Topsoil encountered at the boring locations was generally on the order of 5 inches, although topsoil thicknesses may vary across the site.** Organic contents for the topsoil samples ranged from approximately 6 to 20 percent. Dark soils having the appearance of topsoil but exhibiting only **root "hairs"** or trace organics less than approximately two or three percent may not require stripping for the full depth of the darkly colored zone. Additionally, there may be areas where stripping of soils with organics in excess of the thicknesses referenced in the borings is encountered. The actual amount of required stripping should be determined in the field by a geotechnical engineer or qualified representative.

It should be noted that the Washington County Soil Survey indicates that the mapped soils at the site exhibit somewhat to very limited suitability for lawns and landscaping, generally due to lack of water for the granular soils in the northern portion of the site and the potential for saturated conditions for the cohesive soils in the middle and southern portions of the site. In any case, the tested "topsoil" samples contained generally suitable organic contents.

5.7 Fill

Material for engineered fill or backfill required to achieve design grades may consist of any non-organic soils having a maximum dry density as determined by the Standard Proctor (ASTM D 698) of 90 pounds per cubic foot (pcf) or greater. On-site soils may be used as engineered fill materials provided that they are free of organic matter, debris, excessive moisture, and rock or stone fragments larger than 3 inches in diameter. Depending on seasonal conditions, the on-site soils may be wet of optimum and may require scarification and aeration to achieve satisfactory compaction. Moisture content modification by scarification and aeration may be readily achieved for the granular soils, but diligent scarification and aeration activities will likely be required for the cohesive soils. If the construction schedule does not allow for scarification and aeration activities, it may be more practical or economical to utilize imported granular fill.

Fill should be placed in uniform layers no more than 8 inches thick (loose measure) and adequately keyed into stripped and scarified soils. All fill within structure areas and pavement subgrades should be compacted to not less than 100 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor).

The subgrade soils the site consist of predominantly native granular soils in the northern portion of the site, and native cohesive soils in the middle and southern portions of the site. The contractor should be prepared to use a sheepsfoot roller to provide effective compaction of the cohesive subgrade soils. For granular soils or engineered fill consisting of granular materials, a vibratory smooth-drum roller would provide effective compaction of these materials. In narrow utility or footing excavations, the on-site cohesive soils may be difficult to compact; therefore, a clean granular material may be required in these areas.

Scarified subgrade soils and all fill material should be within 3 percent of the optimum moisture content to facilitate compaction. Furthermore, fill material should not be frozen or placed on a frozen base. It is recommended that all earthwork and site preparation activities be conducted under adequate specifications and properly monitored in the field by a qualified geotechnical testing firm.

6.0 QUALIFICATION OF RECOMMENDATIONS

Our evaluation of burial crypt field and columbarium foundation design and construction conditions has been based on our understanding of the site and project information and the data obtained during our field investigation. The general subsurface conditions were based on interpretation of the subsurface data obtained at the boring locations. Regardless of the thoroughness of a subsurface investigation, 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 observe earthwork and foundation construction to confirm that the conditions anticipated in design are noted. Otherwise, TTL assumes no responsibility for construction compliance with the design concepts, specifications, or recommendations.

The design recommendations in this report have been developed on the basis of the previously described project characteristics and subsurface conditions. If project criteria or locations change, a qualified geotechnical engineer should be permitted to determine whether the recommendations must be modified. The findings of such a review will be presented in a supplemental report.

The nature and extent of variations between the borings may not become evident until the course of construction. If such variations are encountered, it will be necessary to reevaluate the recommendations of this report after on-site observations of the conditions.

Our professional services have been performed, our findings derived, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. TTL is not responsible for the conclusions, opinions, or recommendations of others based on this data.

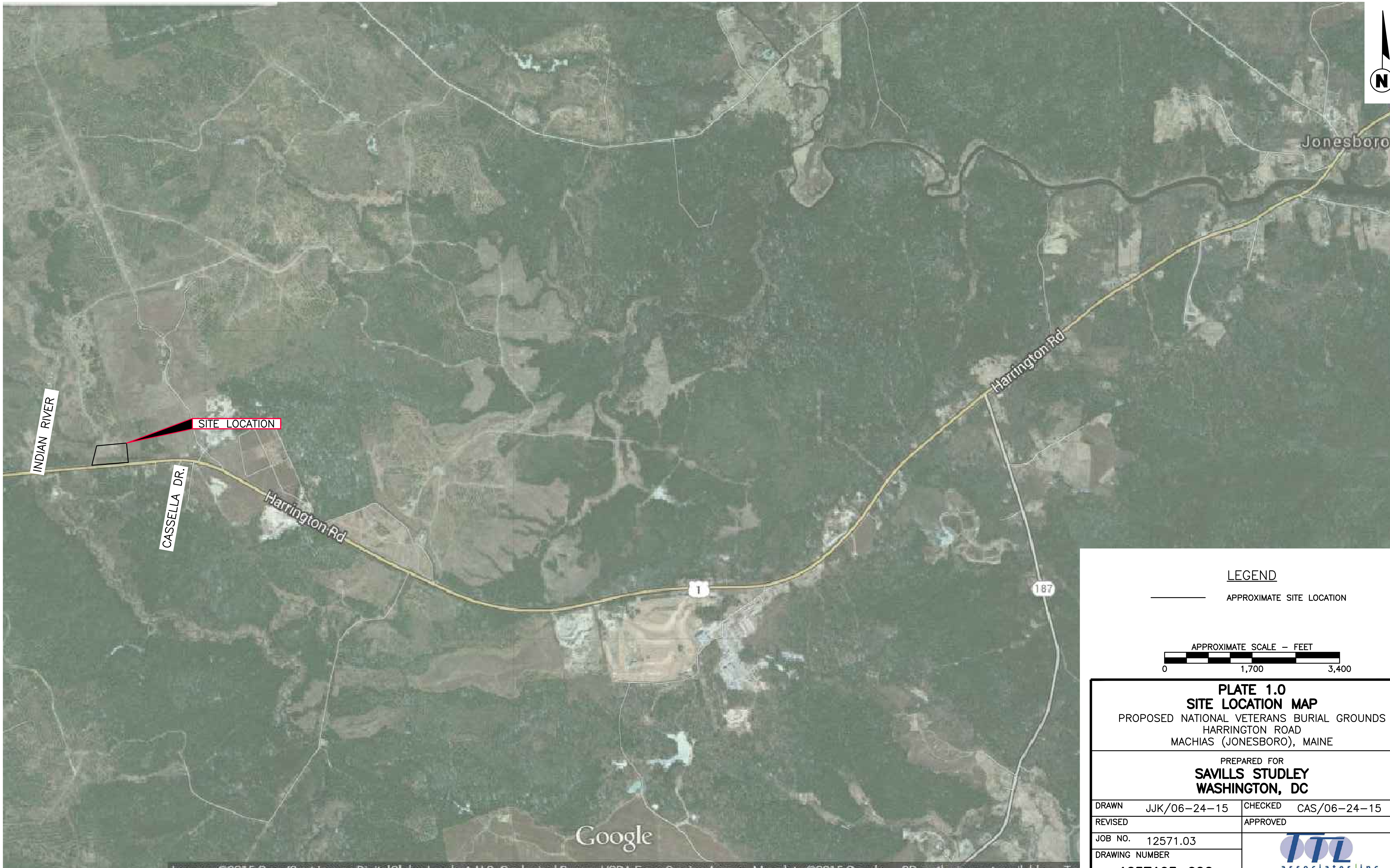

PLATE 1.0
SITE LOCATION MAP

PROPOSED NATIONAL VETERANS BURIAL GROUNDS
HARRINGTON ROAD
MACHIAS (JONESBORO), MAINE

PREPARED FOR
SAVILLS STUDLEY
WASHINGTON, DC

DRAWN	JJK/06-24-15	CHECKED	CAS/06-24-15
REVISED		APPROVED	
JOB NO.	12571.03		
DRAWING NUMBER	**1257103-02G**		

TTL associates inc
Environmental, Geotechnical Engineering & Testing

LEGEND

B–1 ⊕ APPROXIMATE TEST BORING LOCATION

—·–·— APPROXIMATE SITE LOCATION

APPROXIMATE SCALE – FEET

0 150 300

PLATE 2.0

TEST BORING LOCATION PLAN

PROPOSED NATIONAL VETERANS BURIAL GROUNDS
HARRINGTON ROAD
MACHIAS (JONESBORO), MAINE

PREPARED FOR

SAVILLS STUDLEY
WASHINGTON, DC

DRAWN	JJK/06–25–15	CHECKED	CAS/06–25–15
REVISED		APPROVED	
JOB NO.	12571.03		
DRAWING NUMBER	**1257103–02G**		

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BORING NUMBER B-1

CLIENT Savills Studley
PROJECT NAME Proposed National Veterans Burial Grounds
PROJECT NUMBER 12571.03
PROJECT LOCATION Machias (Jonesboro), ME
DRILLING CONTRACTOR Maine Test Borings, Inc. Jon Chris
RIG NO. Maine Test Boring, Inc.
GROUND ELEVATION
DRILLING METHOD 2-1/4 in. HSA
GROUND WATER LEVELS:
DATE STARTED 5/29/15 **COMPLETED** 5/29/15
AT TIME OF DRILLING None
LOGGED BY KKC **CHECKED BY** CPI
AT END OF DRILLING None
NOTES
0hrs AFTER DRILLING Caved at 8.1 ft. Backfilled w/Cuttings.

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL / MC / LL (20 40 60 80); ▲ SPT N VALUE ▲ (20 40 60 80)
	0.0		TOPSOIL - 5 Inches (0.4')						21
			Moist Loose Brown POORLY GRADED SAND w/Silt (SP/SM) (2.0')	SS 1	100	2-4-4-4 (8)	NP		13
	2.5		Moist Medium Dense Brown POORLY GRADED SAND w/Trace Silt and Gravel (SP)	SS 2	100	5-8-12-14 (20)	NP		
	5.0			SS 3	100	7-8-10-11 (18)	NP		3
	7.5			SS 4	100	8-8-10-11 (18)	NP		
				SS 5	100	6-7-12-14 (19)	NP		0
	10.0		(12.0')	SS 6	100	11-11-12-13 (23)	NP		

Bottom of hole at 12.0 feet.

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1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
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BORING NUMBER B-2

CLIENT Savills Studley
PROJECT NAME Proposed National Veterans Burial Grounds
PROJECT NUMBER 12571.03
PROJECT LOCATION Machias (Jonesboro), ME
DRILLING CONTRACTOR Maine Test Borings, Inc. Jon Chris
RIG NO. Maine Test Boring, Inc.
GROUND ELEVATION
DRILLING METHOD 2-1/4 in. HSA
GROUND WATER LEVELS:
DATE STARTED 5/29/15 **COMPLETED** 5/29/15
AT TIME OF DRILLING None
LOGGED BY KKC **CHECKED BY** CPI
AT END OF DRILLING None
NOTES
3hrs AFTER DRILLING Caved at 7.6 ft. Backfilled w/Cuttings.

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	MC (%)
0.0–0.4'	TOPSOIL - 5 Inches						30
0.4'–3.5'	Moist Very Loose Brown POORLY GRADED SAND w/Silt and Trace Organics (SP/SM)	SS 1	100	1-1-1-1 (2)	NP		20
	@2': Loose	SS 2	100	2-2-4-8 (6)	NP		16
3.5'–6.0'	Moist Medium Dense Brown POORLY GRADED SAND w/Silt (SP/SM)	SS 3	100	8-12-15-15 (27)	NP		16
	@5.5': Gray/Brown w/Trace Gravel						
6.0'–8.5'	Moist Medium Dense Gray/Brown SILTY SAND (SM)	SS 4	100	12-15-15-17 (30)	NP		22
8.5'–12.0'	Moist Medium Dense Brown POORLY GRADED SAND w/Trace Silt and Gravel (SP)	SS 5	100	7-9-11-11 (20)	NP		
		SS 6	100	11-16-13-14 (29)	NP		3

Bottom of hole at 12.0 feet.

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BORING NUMBER B-3

CLIENT Savills Studley
PROJECT NAME Proposed National Veterans Burial Grounds
PROJECT NUMBER 12571.03
PROJECT LOCATION Machias (Jonesboro), ME
DRILLING CONTRACTOR Maine Test Borings, Inc. Jon Chris
RIG NO. Maine Test Boring, Inc.
GROUND ELEVATION
DRILLING METHOD 2-1/4 in. HSA
GROUND WATER LEVELS:
DATE STARTED 5/29/15 **COMPLETED** 5/29/15
AT TIME OF DRILLING None
LOGGED BY KKC **CHECKED BY** CPI
AT END OF DRILLING None
NOTES
0hrs AFTER DRILLING Backfilled w/Cuttings.

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL / MC / LL (20 40 60 80); ▲ SPT N VALUE ▲ (20 40 60 80)
	0.0	TOPSOIL - 5 Inches (0.4')						49
		Moist Medium Stiff Brown LEAN CLAY w/Sand, Trace Gravel and Organics (CL) (2.0')	SS 1	100	1-1-4-11 (5)	2.75		17
	2.5	Moist Hard Brown LEAN CLAY w/Sand and Trace Gravel (CL)	SS 2	100	17-18-27-27 (45)	>4.5		19
		@4': Gray/Brown	SS 3	100	12-17-19-23 (36)	>4.5		
	5.0							
		@6': Brown/Gray w/Trace Iron Oxide Stain Seam	SS 4	100	15-17-19-19 (36)	1.00		25
	7.5	(9.0')						
		Moist Medium Dense Brown POORLY GRADED SAND w/Silt (SP/SM)	SS 5	100	5-6-9-9 (15)	NP		11
	10.0	@11.5': w/Trace Gravel (12.0')	SS 6	100	9-8-9-16 (17)	NP		

Bottom of hole at 12.0 feet.

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BORING NUMBER B-4

CLIENT Savills Studley
PROJECT NAME Proposed National Veterans Burial Grounds
PROJECT NUMBER 12571.03
PROJECT LOCATION Machias (Jonesboro), ME
DRILLING CONTRACTOR Maine Test Borings, Inc. Jon Chris
RIG NO. Maine Test Boring, Inc.
GROUND ELEVATION
DRILLING METHOD 2-1/4 in. HSA
GROUND WATER LEVELS:
DATE STARTED 5/29/15 **COMPLETED** 5/29/15
AT TIME OF DRILLING None
LOGGED BY KKC **CHECKED BY** CPI
AT END OF DRILLING None
NOTES
0hrs AFTER DRILLING Backfilled w/Cuttings.

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL / MC / LL (20 40 60 80); ▲ SPT N VALUE ▲ (20 40 60 80)
	0.0		TOPSOIL - 5 Inches 0.4'						79
			Moist Medium Stiff Brown SANDY LEAN CLAY w/Trace Organics (CL) 2.0'	SS 1	100	1-5-2-5 (7)	0.25		37
	2.5		Moist Very Stiff Gray/Brown LEAN CLAY w/Sand (CL)	SS 2	100	5-9-9-18 (18)	>4.5		21
	5.0		@4': w/Trace Iron Oxide Stain Seam 6.0'	SS 3	100	8-9-14-15 (23)	>4.5		
	7.5		Moist Hard Gray/Brown LEAN CLAY w/Sand, Trace Gravel, and Iron Oxide Stain Seam (CL)	SS 4	100	15-17-21-23 (38)	>4.5		24
	10.0		@8': Brown/Gray 10.0'	SS 5	100	12-16-15-15 (31)	1.50		
			Moist Stiff Brown/Gray LEAN CLAY w/Sand, Trace Gravel and Iron Oxide Stain Seam (CL) 12.0'	SS 6	100	7-7-8-9 (15)	2.00		26
			Bottom of hole at 12.0 feet.						

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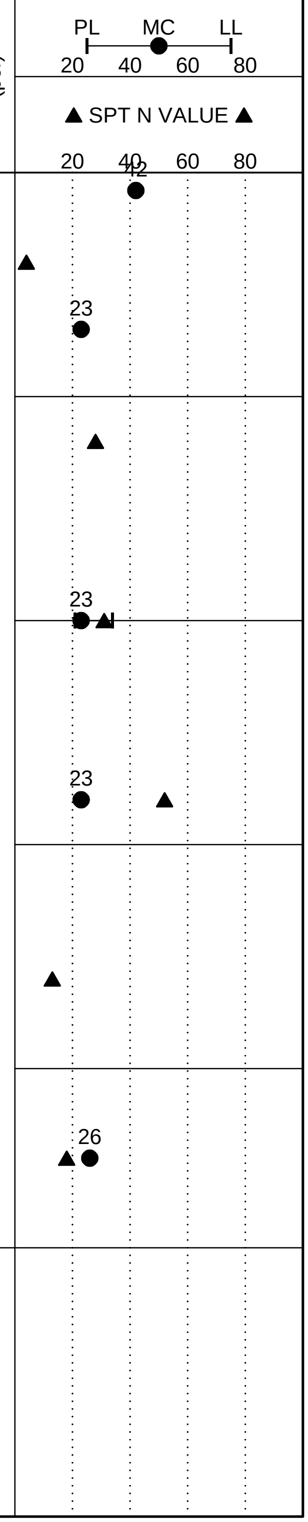
BORING NUMBER B-5

CLIENT Savills Studley
PROJECT NAME Proposed National Veterans Burial Grounds
PROJECT NUMBER 12571.03
PROJECT LOCATION Machias (Jonesboro), ME
DRILLING CONTRACTOR Maine Test Borings, Inc. Jon Chris
RIG NO. Maine Test Boring, Inc.
GROUND ELEVATION
DRILLING METHOD 2-1/4 in. HSA
GROUND WATER LEVELS:
DATE STARTED 5/29/15 **COMPLETED** 5/29/15
AT TIME OF DRILLING 12.0 ft. (Damp)
LOGGED BY KKC **CHECKED BY** CPI
AT END OF DRILLING None
NOTES
5hrs AFTER DRILLING No Groundwater. Backfilled w/Cuttings.

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	MC (%)
	0.0	TOPSOIL - 5 Inches (0.4')						42
		Moist Soft Brown LEAN CLAY w/Sand and Trace Organics (CL) (1.5')	SS 1	100	1-0-4-8 (4)			
		Moist Very Stiff Gray/Brown LEAN CLAY w/Sand (CL)				2.25		23
	2.5		SS 2	100	7-11-17-24 (28)	>4.5		
		(4.0')						
		Moist Hard Gray/Brown LEAN CLAY w/Trace Sand and Iron Oxide Stain Seam (CL)	SS 3	100	12-14-17-21 (31)	>4.5		23
	5.0							
		@6': Very Hard Brown/Gray w/Trace Gravel	SS 4	100	19-22-30-29 (52)	>4.5		23
	7.5	(8.0')						
		Moist Stiff Brown/Gray LEAN CLAY w/Sand, Trace Gravel and Iron Oxide Stain Seam (CL)	SS 5	100	4-5-8-11 (13)	2.75		
	10.0							
		@11': Very Stiff Gray (12.0')	SS 6	100	9-9-9-8 (18)	1.00		26
		Bottom of hole at 12.0 feet.						



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Toledo, Ohio 43624
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BORING NUMBER B-6

CLIENT Savills Studley
PROJECT NAME Proposed National Veterans Burial Grounds
PROJECT NUMBER 12571.03
PROJECT LOCATION Machias (Jonesboro), ME
DRILLING CONTRACTOR Maine Test Borings, Inc. Jon Chris
RIG NO. Maine Test Boring, Inc.
GROUND ELEVATION
DRILLING METHOD 2-1/4 in. HSA
GROUND WATER LEVELS:
DATE STARTED 5/29/15 **COMPLETED** 5/29/15
AT TIME OF DRILLING None
LOGGED BY KKC **CHECKED BY** CPI
AT END OF DRILLING None
NOTES
0hrs AFTER DRILLING Backfilled w/Cuttings.

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	UNCONF. COMP. STR. (tsf)	DRY UNIT WT. (pcf)	PL / MC / LL (20 40 60 80); ▲ SPT N VALUE ▲ (20 40 60 80)
	0.0		TOPSOIL - 18 Inches 1.5'	SS 1	100	1-0-0-4 (0)	<0.25		119 >>
			Moist Soft to Medium Stiff Brown LEAN CLAY w/Sand and Trace Organics (CL) 2.0'						
	2.5		Moist Hard Gray/Brown LEAN CLAY w/Sand and Trace Iron Oxide Stain Seam (CL) 4.0'	SS 2	100	7-15-21-22 (36)	>4.5		20
	5.0		Moist Very Stiff Brown/Gray LEAN CLAY w/Sand (CL) 6.0'	SS 3	100	9-11-18-23 (29)	>4.5		23
	7.5		Moist Hard Brown/Gray LEAN CLAY w/Sand, Trace Gravel and Iron Oxide Stain Seam (CL) 8.0'	SS 4	100	11-15-20-21 (35)	>4.5		
	10.0		Moist Very Stiff Brown/Gray LEAN CLAY w/Sand, Trace Gravel and Iron Oxide Stain Seam (CL)	SS 5	100	7-8-8-9 (16)	2.50		22
			12.0'	SS 6	100	12-12-12-12 (24)	2.00		
			Bottom of hole at 12.0 feet.						

LEGEND KEY

Unified Soil Classification System Soil Symbols

- GW - WELL GRADED GRAVEL Includes Gravel-Sand mixtures, little or no fines.
- GP - POORLY GRADED GRAVEL Includes Gravel-Sand mixtures, little or no fines.
- GM - SILTY GRAVEL Includes Gravel-Sand-Silt mixtures.
- GC - CLAYEY GRAVEL Includes Gravel-Sand-Clay mixtures.
- SW - WELL GRADED SAND Includes Gravelly Sands, little or no fines.
- SP - POORLY GRADED SAND Includes Gravelly Sands, little or no fines.
- SM - SILTY SAND Includes Sand-Silt mixtures.
- SC - CLAYEY SAND Includes Sand-Clay mixtures.
- ML - SILT Includes Silt with Sand and Sandy Silt.
- CL - LEAN CLAY Includes Sandy Lean Clay and Lean Clay with Sand and Gravel.
- MH - ELASTIC SILT Includes Sandy Elastic Silt and Elastic Silt with Sand.
- CH - FAT CLAY Includes Sandy Fat Clay and Fat Clay with Sand.
- CL-ML - SILTY CLAY Includes Clayey Silt of low plasticity.
- OL - ORGANIC SILT and ORGANIC CLAY of low plasticity.
- OH - ORGANIC SILT and ORGANIC CLAY of medium to high plasticity.
- Pt - PEAT Includes humus, swamp and other soils with high organic content.
- FILL MATERIAL - Includes controlled and non-controlled soil and non-soil materials.
- TOPSOIL
- ASPHALT - Bituminous Asphalt
- CONCRETE - Includes broken concrete rubble.

Sample Symbols

- SS - Split Spoon
- ST - Shelby Tube
- RC - Rock Core
- GS - Geoprobe Sleeve
- AU - Auger Cuttings
- GB - Grab

Notes:

1. Exploratory borings were drilled on May 29, 2015 using 2¼-inch inside diameter hollow-stem augers.
2. These logs are subject to the limitations, conclusions, and recommendations in the report and should not be interpreted separate from the report.
3. Boring locations were established in the field by New England Boring Contractors/Maine Test Borings, Inc. based on an aerial photograph provided by Savills Studley.
4. Unconfined Compressive Strength (tsf)
   NP = Non-Plastic

PROJECT: Proposed National Veterans Burial Grounds, Macias, ME	TTL Associates, Inc.	PROJECT NO: 12571.03

TABULATION OF TEST DATA

Boring Number	Sample Number	Sample Interval Depth (Feet)		Standard Penetration (Blows per Foot)	Natural Moisture Content (% of Dry Weight)	In-Place Dry Density (Pounds per Cubic Foot)	Unconfined Compressive Strength (Pounds per Square Foot)	Organic Content (percent)	Particle Size Distribution (%) Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Atterberg Limits (%) Liquid Limit	Plastic Limit	Plasticity Index	Unified Soil Classification
B-1	SS-1	0.0-0.4		8	21.0			6.0										
		0.4-2.0			12.6													
	SS-2	2.0-4.0		20														
	SS-3	4.0-6.0		18	3.4													
	SS-4	6.0-8.0		18														
	SS-5	8.0-10.0		19	0.4													
	SS-6	10.0-12.0		23														
B-2	SS-1	0.0-0.4		2	29.8			9.8										
		0.4-2.0			19.7													
	SS-2	2.0-4.0		6	16.4			pH = 5.5										
	SS-3	4.0-6.0		27	16.3													
	SS-4	6.0-8.0		30	22.5													
	SS-5	8.0-10.0		20														
	SS-6	10.0-12.0		29	3.0													

*Unconfined compressive strength derived from a calibrated hand penetrometer

PROJECT: Proposed National Veterans Burial Grounds, Macias, ME	TTL Associates, Inc.	PROJECT NO: 12571.03

TABULATION OF TEST DATA

Boring Number	Sample Number	Sample Interval Depth (Feet)		Standard Penetration (Blows per Foot)	Natural Moisture Content (% of Dry Weight)	In-Place Dry Density (Pounds per Cubic Foot)	Unconfined Compressive Strength (Pounds per Square Foot)	Organic Content (percent)	Particle Size Distribution (%)						Atterberg Limits (%)			Unified Soil Classification
									Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index	
B-3	SS-1	0.0-0.4		5	49.0			7.1										
		0.4-2.0			16.9		*5,500											
	SS-2	2.0-4.0		45	19.2		*9,000+											
	SS-3	4.0-6.0		36			*9,000+											
	SS-4	6.0-8.0		36	24.6		*2,000											
	SS-5	8.0-10.0		15	11.2													
	SS-6	10.0-12.0		17														
B-4	SS-1	0.0-0.4		7	79.3			20.6										
		0.4-2.0			37.0		*500											
	SS-2	2.0-4.0		18	21.3		*9,000+											
	SS-3	4.0-6.0		23			*9,000+											
	SS-4	6.0-8.0		38	24.0		*9,000+											
	SS-5	8.0-10.0		31			*3,000											
	SS-6	10.0-12.0		15	26.0		*4,000											

*Unconfined compressive strength derived from a calibrated hand penetrometer

PROJECT: Proposed National Veterans Burial Grounds, Macias, ME	TTL Associates, Inc.	PROJECT NO: 12571.03

TABULATION OF TEST DATA

Boring Number	Sample Number	Sample Interval Depth (Feet)		Standard Penetration (Blows per Foot)	Natural Moisture Content (% of Dry Weight)	In-Place Dry Density (Pounds per Cubic Foot)	Unconfined Compressive Strength (Pounds per Square Foot)	Organic Content (percent)	Particle Size Distribution (%)						Atterberg Limits (%)			Unified Soil Classification
									Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index	
B-5	SS-1	0.0-0.4		4	42.0			7.3										
		0.4-2.0			22.8		*4,500											
	SS-2	2.0-4.0		28			*9,000+											
	SS-3	4.0-6.0		31	22.9		*9,000+		0	0	0	4	28	68	34	21	13	CL
	SS-4	6.0-8.0		52	22.6		*9,000+											
	SS-5	8.0-10.0		13			*5,500											
	SS-6	10.0-12.0		18	25.9		*2,000											
B-6	SS-1	0.0-2.0		0	118.7		*<500	19.7										
	SS-2	2.0-4.0		36	20.2		*9,000+	pH = 6.2										
	SS-3	4.0-6.0		29	22.7		*9,000+											
	SS-4	6.0-8.0		35			*9,000+											
	SS-5	8.0-10.0		16	22.4		*5,000											
	SS-6	10.0-12.0		24			*4,000											

*Unconfined compressive strength derived from a calibrated hand penetrometer

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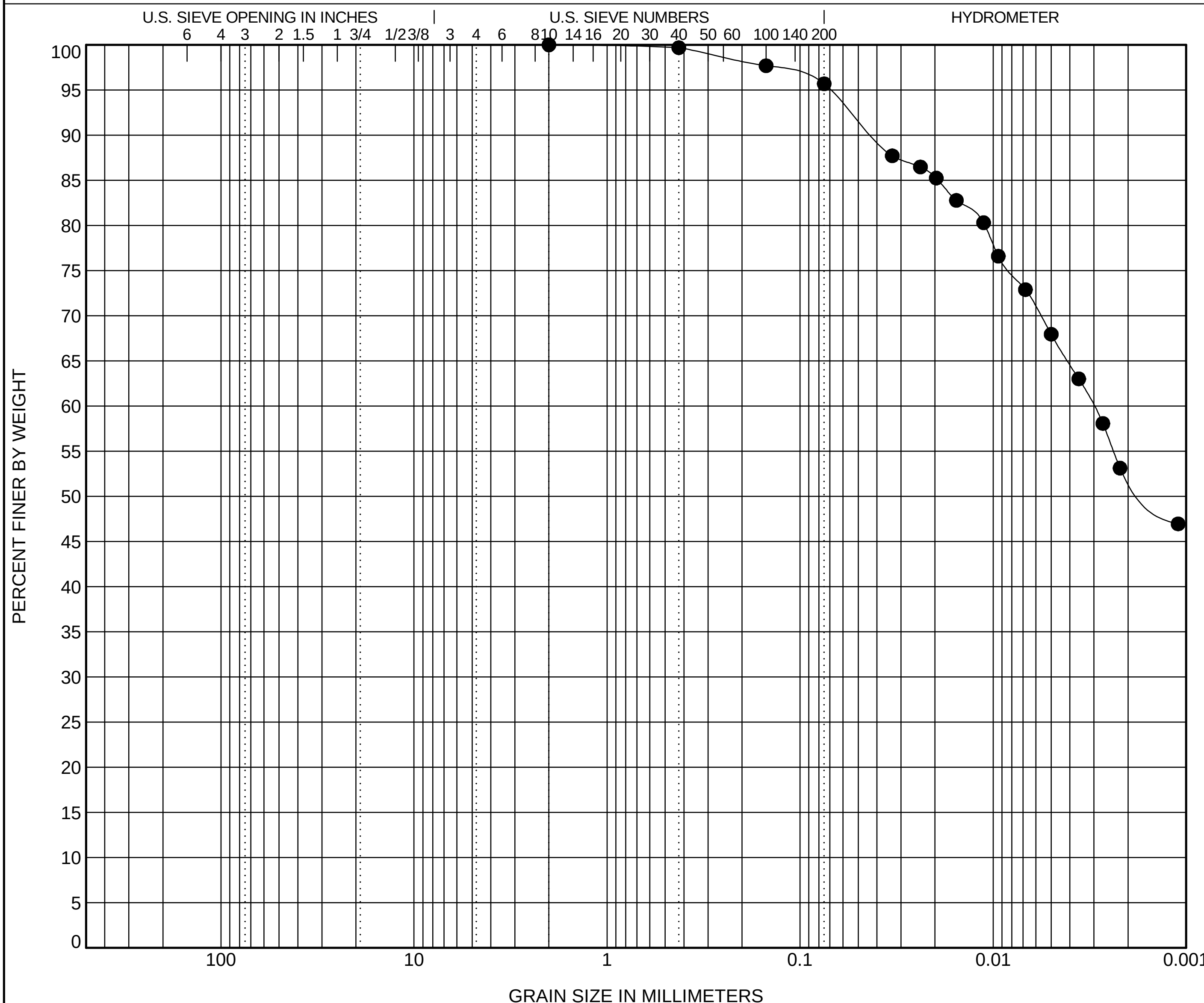
GRAIN SIZE DISTRIBUTION

CLIENT Savills Studley **PROJECT NAME** Proposed National Veterans Burial Grounds

PROJECT NUMBER 12571.03 **PROJECT LOCATION** Machias (Jonesboro), ME



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		USCS Classification	LL	PL	PI	Cc	Cu
● B-5	4.0	**LEAN CLAY (CL)**	**34**	**21**	**13**		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-5	4.0	**2**	**0.003**			**0.0**	**4.3**	**27.7**	**67.9**