

1.0 INTRODUCTION

This geotechnical subsurface investigation report has been prepared for the construction of a new Clinical & Administrative building at the US Department of Veterans Affairs Medical Center campus in Ann Arbor, Michigan. The general vicinity of the project is shown on the Site Location Map (Plate 1.0).

This investigation was performed in general accordance with TTL Proposal No.12948.06, dated June 12, 2015, and was authorized on October 12, 2015 via SSOE Purchase Order No. 16010228.

The purpose of this investigation was to evaluate the subsurface conditions relative to the design and construction of building foundations and floor slabs at the above referenced site. To accomplish this, four test borings, laboratory soils testing, and a geotechnical engineering evaluation of the test results were performed.

This report summarizes our understanding of the proposed construction, describes the investigative and testing procedures, presents the findings, and provides our design and construction recommendations for foundations and floor slabs. The report includes:

- A description of the subsurface soil and groundwater conditions encountered at the boring locations.
- Design recommendations for building foundations and floor slabs related to the proposed development.
- Recommendations concerning soil and groundwater related construction procedures such as site preparation, earthwork, foundation and floor slab construction, and related field testing.

This investigation did not include an Environmental Site Assessment of the subsurface materials at the site.

2.0 INVESTIGATIVE PROCEDURES

This subsurface investigation included three test borings, designated Borings B-1 through B-4, drilled by TTL on January 8, 2015. The borings were performed in the proposed building area and were located in the field by TTL in general accordance with the “Soil Boring Plan,” dated December 11, 2016, provided by SSOE Group (SSOE). The approximate boring locations 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 drilled with an ATV-mounted drilling rig utilizing 2¼-inch inside diameter hollow-stem augers. The test borings were terminated at the target completion depth of 30 feet below existing grades.

During auger advancement, soil samples were collected at 2½-foot intervals to a depth of 10 feet and at 5-foot intervals thereafter. 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 three 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. The samples were sealed in jars and transported to our laboratory for further classification and testing.

Two Shelby tube samples, designated ST on the Logs of Test Borings, were obtained from Borings B-1 (3 to 5 feet) and B-2 (6 to 8 feet). Each Shelby tube sample was obtained by hydraulically advancing a 3-inch diameter, thin-walled sampler approximately 24 inches beyond the hollow-stem auger into undisturbed soil, in accordance with ASTM D 1587. The Shelby tubes were then extracted from the subsoils, and the ends were capped and sealed. The samples were transported to our laboratory where they were extruded, classified, and tested.

Soil conditions encountered in the test borings are presented in the Logs of Test Borings, along with information related to sample data, SPT results, groundwater 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 samples of the subsoils were tested in the laboratory for moisture content (ASTM D 2216), and were visually or manually classified using the Unified Soil Classification System (ASTM D 2487 and D 2488). Dry density determinations and unconfined compressive strength tests by the constant rate of strain method (ASTM D 2166) were performed on all Shelby tube samples as well as selected intact cohesive split-spoon samples. Unconfined compressive strength estimates were performed on the remaining intact cohesive samples using a calibrated hand penetrometer. An Atterberg limits test (ASTM D 4318) and particle size analysis (ASTM D 422) was performed on a representative sample from Boring B-4 (SS-1) to determine soil classification and index properties. The results of these tests are presented on the Logs of Test Borings, Tabulation of Test Data sheets, and the Grain Size Distribution sheet attached to this report.

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, especially at previously developed sites such as this site. 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 construction of a new Clinical & Administrative building on the US Department of Veterans Affairs Medical Center campus located at 2215 Fuller Road in Ann Arbor, Michigan. We understand that the building will be a three-story structure, approximately 22,500 square feet in plan. It is assumed that the building will be constructed with a slab-on-grade or over a crawl space. Structural loads were not available at the time of preparing this report but are assumed to be moderate to heavy in magnitude. Maximum column loads are assumed to be 300 kips and maximum wall loads are assumed to be 4,000 pounds per lineal foot (plf).

An existing building, designated “Building 4” is located within the footprint of the proposed new building. It was indicated that Building 4 is two stories constructed on a crawl space. Additionally, a tank farm is located east of Building 4. It is presumed that the tank farm is located within the proposed new building footprint.

Final site grades are assumed to approximate existing site grades.

4.0 GENERAL SITE AND SUBSURFACE CONDITIONS

4.1 General Site Conditions

At the time of this investigation, the site contained a two-story building with associated lawn and sidewalk areas, as well as sporadic trees. Site grades were generally level.

The surface materials at Borings B-1, B-2, and B-3 consisted of topsoil ranging in thickness from 6 to 12 inches. The surface cover in Boring B-4 consisted of mulch approximately 6 inches in thickness.

Underlying the topsoil in Boring B-2, cohesive **fill** materials were encountered to a depth on the order of 8 feet below existing grade. The cohesive fill materials consisted of sandy lean clay (CL) with trace gravel. Non-soil materials in the sandy lean clay included organics and brick fragments, in trace quantities. SPT N-values of 10 bpf and 11 bpf, indicating stiff consistency, as well as moisture contents of 15 percent and 16 percent were determined for the recovered cohesive fill samples.

4.2 General Subsurface Conditions

Based on the results of our field and laboratory tests, the subsoils encountered underlying the surface materials generally consisted of two strata of cohesive soils underlain by granular soils to boring termination. It should be noted that the demarcations between cohesive soil strata can be transitional with respect to strength and moisture conditions, particularly where there are influences of fluctuating groundwater conditions.

Stratum I consisted of predominantly medium stiff cohesive soils encountered underlying the topsoil and mulch in Borings B-1, B-3, and B-4 to depths ranging from 6 to 8½ feet below existing grade. Stratum I was not encountered in Boring B-2. The Stratum I cohesive soils consisted of lean clay (CL) with varying amounts of sand and trace gravel. SPT N-values typically ranged from 6 to 9 blows per foot (bpf), although an N-value of 4 bpf indicating **soft** consistency was determined for a sample from 3½ to 5 feet in Boring B-4 (SS-2). Unconfined compressive strengths ranged from 1,000 to 4,000 pounds per square foot (psf). Moisture contents for these soils ranged from 14 to 26 percent.

Stratum II consisted of predominantly very stiff to hard cohesive soils encountered underlying the cohesive fill materials in Boring B-2 as well as underlying Stratum I in the remaining borings to depths ranging from 12 to 22 feet. The cohesive soils consisted of lean clay (CL) with varying amounts of sand and trace gravel. SPT N-values ranged from 9 to 28 bpf. Unconfined compressive strengths ranged from 5,000 psf to greater than 9,000 psf (the highest obtainable reading using a calibrated hand penetrometer). Moisture contents for these soils ranged from 8 to 22 percent.

Stratum III consisted of dense to very dense granular soils underlying Stratum II to boring termination at a depth of 30 feet. The granular soils consisted of poorly graded sand with silt (SP/SM) and gravel. SPT N-values generally ranged from 34 bpf to split-spoon refusal (SSR, 50 or more blows for 6 inches or less penetration). Moisture contents for these soils ranged from 15 to 16 percent.

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

4.3 Groundwater Conditions

Groundwater was initially encountered during drilling at depths ranging from 12 to 15 feet below existing grade, and was observed upon completion of drilling operations at depths ranging from 10½ to 13 feet. The observed groundwater conditions are summarized in Table 4.3. It should be noted that the boreholes were drilled and backfilled within the same day, and stabilized water levels may not have occurred over this limited time period. Instrumentation was not installed to observe long-term groundwater levels.

Table 4.3 Encountered Groundwater Conditions		
Boring Number	Depth of Groundwater Initially Encountered (feet)	Depth of Groundwater Upon Completion (feet)
B-1	13½	10½
B-2	12	11
B-3	13	11
B-4	15	13

Based on the soil characteristics and groundwater conditions encountered in the borings, it is our opinion that long-term “normal” groundwater levels at the site will generally be encountered at or below a depth of 12 feet below existing grade. However, it should be noted that groundwater

elevations can fluctuate with seasonal and climatic influences. Trapped or “perched” water may be encountered within the cohesive fill materials that are underlain by relatively impermeable native clay soils. Thus, the groundwater conditions at the site may vary at different times of the year from those encountered during this investigation.

5.0 DESIGN RECOMMENDATIONS

The following conclusions and recommendations are based on our understanding of the proposed construction and the data obtained during our 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 satisfactory completion of the recommended site and subgrade preparation and fill placement operations described in Section 6.0, “Construction Recommendations”.

5.1 Building Foundations

Based on the results of the field and laboratory testing for the borings performed for this investigation, the soils encountered at the anticipated foundation bearing depth (3½ feet for protection from frost penetration) are generally expected to consist of cohesive existing fill materials, as well as Stratum I predominantly medium stiff native cohesive soils. The Stratum I medium stiff or better native cohesive soils are considered generally suitable for support of the proposed building foundations. The existing fill materials and **soft** cohesive soils are not considered suitable for foundation support, including Borings B-2 and B-3 to a depth of approximately 8 feet and 6 feet, respectively, and will require removal and replacement with new granular engineered fill as described below.

Following the satisfactory completion of the site preparation and footing excavation inspections outlined in Section 6.0 of this 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 a net allowable bearing pressure of 2,000 pounds per square foot (psf) for strip footings and 2,500 psf for square footings. In using a net allowable soil pressure, the weight of the footings, backfill over the footings or floor slabs need not be included in the structural loads for dimensioning footings. The bearing materials should be field-verified as being native sandy lean clay (CL) with a minimum unconfined compressive strength of 2,000 psf, or properly placed and compacted new engineered fill.

It should be noted that foundation bearing materials may also consist of new engineered fill utilized to achieve design grades after removal of underground structures, foundations, and utilities within the planned new building footprint.

Where existing soft cohesive soils, existing fill materials, or other unsuitable foundation soils are encountered, or if existing fill is observed to be unstable by proof rolling, 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 below the planned bearing depth, with the excavation 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 lean concrete or other flowable controlled-density fill having a minimum compressive strength of 300 pounds per square inch (psi).

Due to the encountered soft cohesive soils, existing fill materials, and existing site development, 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 that new engineered fill is properly placed and compacted for suitable foundation bearing. Additionally, the presence of our engineer will help facilitate the timely remediation of unsuitable soil conditions. If the results of 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 and footings in unheated areas should be constructed at a minimum frost penetration depth of 3½ feet below finished exterior grades. Interior footings may bear at a convenient depth below the floor slab, provided they are supported on native soils as described above, or properly placed and compacted new engineered fill. Wall (strip) footings should be at least 18 inches wide and column (square) footings should be at least 30 inches square, regardless of sizing based on design loads and the allowable bearing pressure.

Based on the above bearing pressure, a maximum column loads assumed to be 300 kips, and maximum wall loads assumed to be 4,000 pounds per lineal foot, total settlement is not expected to exceed 1 inch, and differential settlement should not exceed ¾ inch.

5.2 Seismic Considerations

We have reviewed seismic design parameters in accordance with ASCE Minimum Design Loads for Buildings and Other Structures 7-05 (ASCE 7-05) criteria, with respect to the conditions encountered in the borings. Borings B-1 through B-4 were terminated at a depth of 30 feet below existing grade. It should be noted that the ASCE 7-05 seismic site characterization is based on the upper 100 feet of the geologic profile, so our analysis is limited to characterization based on the encountered overburden soil profile only. Based on the SPT N-values determined within the depths of exploration for this investigation, the average SPT N-value for the overall profile was calculated to be 19 blows per foot (bpf). This average SPT N-value is characterized as Site Class D, “Stiff Soil,” in accordance with ASCE 7-05 Section 11.4.3 criteria (i.e., average N-value ≥ 15 bpf and ≤ 50 bpf).

Using the USGS U.S. Seismic Design Maps web application, which is based on ASCE Figures 22-1 and 22-2, spectral response accelerations were determined as follows:

- S_s (mapped spectral acceleration for short periods) = 0.12g, and
- S_1 (mapped spectral acceleration for 1-sec period) = 0.045g,
where acceleration is expressed as a ratio of gravitational acceleration (g).

Using these spectral response accelerations, the site coefficients and response accelerations were determined based on ASCE 7-05 Section 11.4 for Site Class D, as follows:

Site Coefficients/Spectral Response Acceleration Parameters	Site Class D
F_a (site coefficient as defined in Table 11.4-1)	1.6
F_v (site coefficient as defined in Table 11.4-2)	2.4
S_{MS} (maximum considered earthquake spectral response acceleration for short periods): $S_{MS} = F_a S_s$	0.19
S_{M1} (maximum considered earthquake spectral response acceleration for 1-second period): $S_{M1} = F_v S_1$	0.11
S_{DS} (5 percent damped design spectral response acceleration at short periods): $S_{DS} = 2/3 S_{MS}$	0.13
S_{D1} (5 percent damped design spectral response acceleration at 1-second period): $S_{D1} = 2/3 S_{M1}$	0.07

These parameters may be used by the structural engineer to develop the design response spectrum in accordance with ASCE 7-05 Section 11.4.5, along with the fundamental period (T, in seconds) of vibration of the structure(s). Based on the response accelerations indicated above, and the criteria provided in ASCE 7-05 Tables 11.6-1 and 11.6-2 for Occupancy

Category II, a Seismic Design Category B would apply for a Site Class D designation. Regardless, the structure should not fall within Seismic Design Category C (or more critical categories D, E and F), and the provisions of International Building Code (IBC) Section 1803.5.12 do not apply for special investigations or evaluations regarding potential hazards resulting from earthquake motions concerning slope instability, liquefaction, and surface rupture due to faulting or lateral spreading.

5.3 Subgrades

5.3.1 Existing Subgrade

The subgrades that would result upon the satisfactory completion of the site preparation as described in Section 6.0 of this report are considered moderately acceptable for support of the proposed pavements and floor slabs. Based on field and laboratory data developed during this investigation, the soils anticipated to be exposed at subgrade levels consist of cohesive existing fill materials, as well as native cohesive soils. Laboratory analyses for Borings B-4 (SS-1), as well as visual descriptions of the upper soil profile, indicate that the subgrade soils may be classified as Group A-4 or A-6 in accordance with the American Association of State Highway Transportation Officials (AASHTO) system of soil classification. The cohesive soils are considered fair to poor as subgrade materials because they have relatively low permeabilities and a high percentage of silt and clay particles, which makes them susceptible to moisture, frost penetration, and frost heave. Therefore, the cohesive soils will dictate floor slab and pavement design.

At the time of this investigation, the moisture contents in the upper 2½ feet of the granular subgrade soils ranged from approximately 15 to 26 percent. These moisture contents are estimated to vary from near to significantly above the expected optimum moisture content for these soils. Therefore, remedial action should be anticipated to be required to adjust the moisture contents of the existing materials and achieve proper compaction of the subgrade. The extent of such remedial subgrade preparation will depend on seasonal conditions, the potential for perched groundwater, and final grade elevations in the pavement subgrade areas.

5.3.2 Modified Subgrade

Although not anticipated to be prevalent, if soils are dry of optimum, water should be uniformly mixed into the subgrade. More likely to be encountered are soils that are wet of optimum. Where soils wet of optimum are encountered, lowering the moisture content by scarification and

aeration (discing and exposure to sun and wind) may be required. However, this may not be feasible if construction occurs during wet seasonal conditions. Very moist to wet soils will “pump” under the operation of heavy equipment, resulting in deep rutting and perhaps rendering the operation of grading and paving equipment difficult or impossible.

Therefore, other methods of subgrade modification may be required in areas of high moisture content. Modification may be achieved by undercutting and replacement with granular subbase (possibly in combination with a geotextile separation layer or geogrid reinforcement), mixing stone into the subgrade, or treating the subgrade with cement. The method of subgrade modification should be determined at the time of construction (See Section 6.1, “Construction Recommendations - Site and Subgrade Preparation”).

5.4 Floor Slabs

It is recommended that all floor slabs be “floating”, that is, fully ground supported and not structurally connected to walls or foundations. This is to reduce the possibility of cracking and displacement of the floor slabs because of differential movements between the slab and the foundation. Such movements could be detrimental to slabs that are rigidly connected to the foundations. There may be certain areas where it will be difficult or impractical to make the slab floating. In such areas, it may be necessary to increase the slab thickness and reinforcement to prevent the foundation from cracking the slab and settling independently.

For properly prepared subgrade soils, a modulus of subgrade reaction (k) of 135 pounds per cubic inch (pci) may be used for floor slab design. It is recommended that the floor slab be supported on a minimum 6-inch layer of relatively clean granular material such as sand and gravel or crushed stone. This is to help distribute concentrated loads and provide more uniform subgrade support beneath the slab.

Based on the conditions encountered in the existing fill materials in Boring B-2, the existing fill materials appear to be suitable to provide adequate support for the slab on grade, provided they are properly prepared as described in Section 6.1 of this report. The floor slab subgrade materials should be confirmed as containing trace or less non-soil materials. As in any case of existing fills of unknown origin, there is potential for variable and less favorable conditions between boring locations that increase the risk for settlement of the floor slab. If this risk is unacceptable, partial or full depth removal of the existing fill materials or additional evaluations may be required.

5.5 Groundwater Control

As previously discussed, groundwater initially encountered during drilling at depths ranging from 12 to 15 feet below existing grade, and was observed upon completion of drilling operations at depths ranging from 10½ to 13 feet. Based on the soil characteristics and groundwater conditions encountered in the borings, it is our opinion that long term “normal” groundwater levels at the site will generally be encountered at or below a depth of 12 feet below existing grade. However, it should be noted that groundwater elevations can fluctuate with seasonal and climatic influences, and “perched” water may also be encountered within the existing fill materials.

It is our experience that adequate control of groundwater seepage or surface water run-off into shallow excavations should be achievable by minor dewatering systems, such as pumping from prepared sumps. If excavations extend below the groundwater table in granular soils, installation of multiple well points may be required in addition to pumping from prepared sumps. In the event excessive seepage is encountered during construction, TTL may be notified to evaluate whether other dewatering methods are required.

5.6 Excavations and Slopes

The sides of temporary excavations for building 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.

Based on the test borings, it is likely that excavations will encounter a range of soil conditions that include the following OSHA designations:

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

For temporary excavations in Type A, B, and C soils, side slopes must be no steeper than $\frac{3}{4}$ horizontal to 1 vertical ($\frac{3}{4}$ H: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 for the lower strength soil. In all cases, flatter slopes may be required if lower strength soils or adverse seepage conditions are encountered during construction.

For permanent excavations and slopes, we recommend that grades be no steeper than 3H:1V without a more extensive geotechnical evaluation of the proposed construction plans and site conditions.

6.0 CONSTRUCTION RECOMMENDATIONS

6.1 Site and Subgrade Preparation

Prior to proceeding with construction operations, all structures, pavements, topsoil, root mats, 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. The actual amount of required stripping should be determined in the field by a geotechnical engineer or qualified representative. However, topsoil quantities may be limited based on the existing development at the site.

With regard to removal of existing floor slabs and foundations, we recommend the following:

- The floor slab for the existing structure, constructed as a slab-on-grade, must be removed completely.
- Foundations for the existing structure which were constructed with a slab-on-grade must be removed completely in the proposed building area and should be removed down to the horizontal portion of the footing in proposed pavement areas, provided they will not interfere with installation of proposed underground utilities.

Due to the existing development at the site, the proof rolling and preparation of this site will require careful inspection. All voids remaining after footing removal and utility trench abandonment should be backfilled with engineered fill, placed in controlled lifts and tested for suitable compaction in accordance with the criteria in Section 6.2 of this report. If such excavations are randomly filled or graded without compaction control, excessive differential settlement could occur.

Upon completion of the stripping and clearing, the areas intended to support floor slabs and/or new fill should be carefully inspected by a geotechnical engineer. At that time, the engineer may require proof rolling/compaction of the granular subgrades utilizing a vibratory, smooth- drum roller. For the cohesive subgrade soils, proof rolling should be completed utilizing a 20- to 30-ton loaded truck or other pneumatic-tired vehicle of similar size and weight. The roller or truck should make a minimum of two passes covering the proposed development area, with additional passes as necessary to achieve required compaction and/or subgrade stabilization.

Any unsuitable materials observed during the inspection and proof-rolling operations should be undercut and replaced with compacted fill or stabilized in place utilizing conventional remedial measures such as discing, aeration, and recompaction. Once the site has been proof rolled, inspected, and stabilized, the proof-rolled or inspected subgrades should not be exposed to wet conditions. It should be recognized that during periods of wet weather, the silty and clayey soils that will be exposed at design subgrades will tend to pond water for short periods of time, with the potential to deteriorate the prepared subgrade.

The results of the inspection and proof-rolling operations will be partially dependent on construction operations, the moisture content of the soil, and the weather conditions prevalent at the time. If pumping or rutting is encountered and difficulty is experienced in the operation of construction equipment, TTL should be notified in order to determine which method of subgrade modification may be best suited for the conditions encountered. Should such conditions be experienced, we may recommend that a small test area be used to determine the necessary depth of undercutting and stone replacement or other remedial action necessary to achieve a stable subgrade condition.

6.2 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 could require scarification and aeration to achieve satisfactory compaction. 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 the building 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 upper soil profile at the site consists of cohesive existing fill materials and native granular soils. The contractor should be prepared to use a sheepsfoot roller to provide effective compaction of the cohesive subgrade soils. 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.

6.3 Foundation Excavations

As mentioned in Section 5.1, foundations used to support the structure should have a detailed footing inspection performed for each foundation. A geotechnical engineer or qualified representative should perform these inspections to verify that the exposed materials are similar to those encountered in the borings, loose granular soils have been suitably modified in-place, and that engineered fill has been properly placed and compacted such that it is capable of supporting the design bearing pressure.

Due to the encountered soft cohesive soils, existing fill materials, and existing site development, 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 are suitable for foundation bearing. Additionally, the presence of our engineer will help facilitate the timely remediation of unsuitable soil conditions. If the results of 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.

Where existing soft cohesive soils, existing fill materials, or other unsuitable foundation soils are encountered, or if existing fill is observed to be unstable by proof rolling, 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 below the planned bearing depth, with the excavation 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 lean concrete or other flowable controlled-density fill having a minimum compressive strength of 300 pounds per square inch (psi).

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.

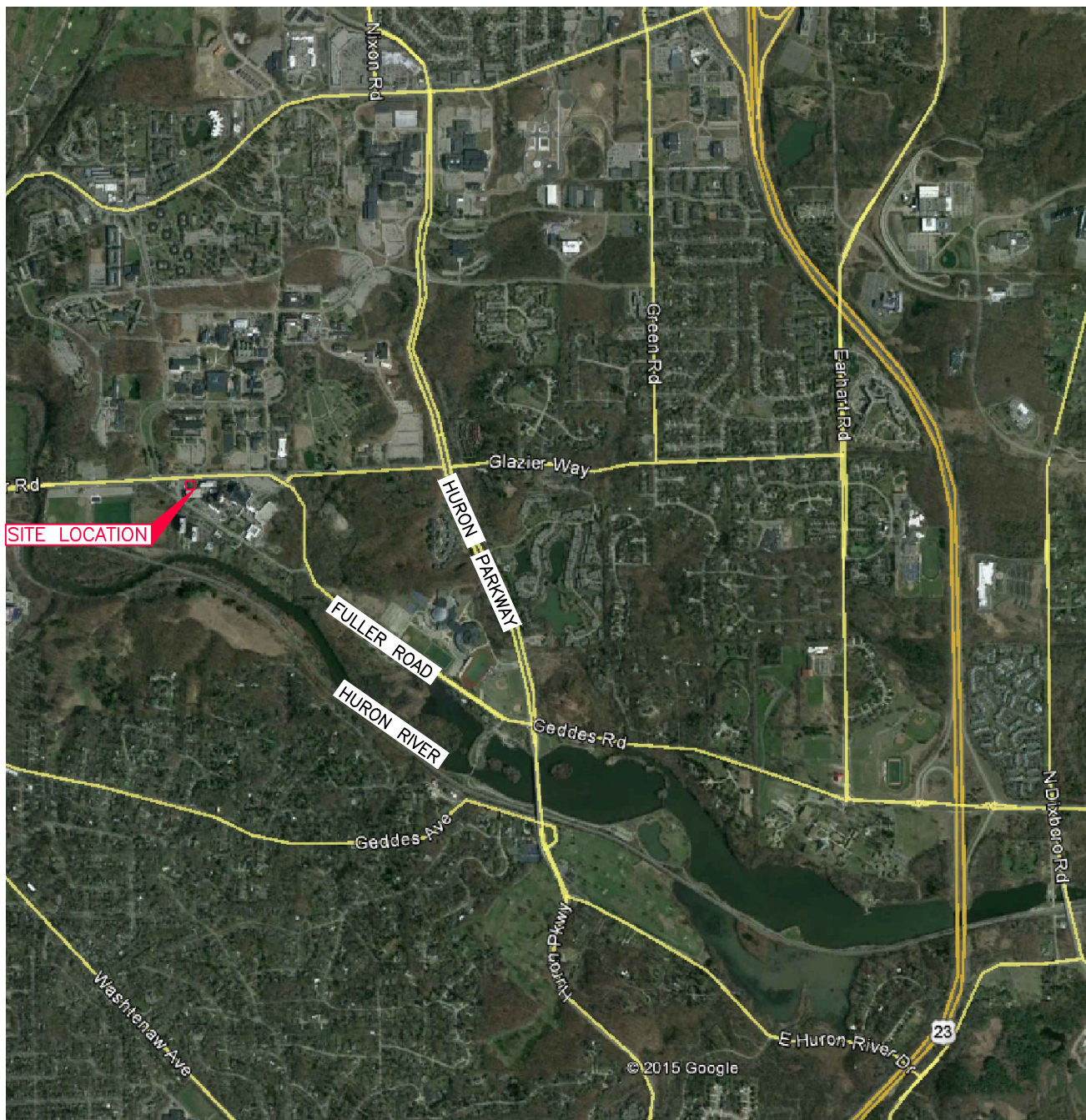
7.0 QUALIFICATION OF RECOMMENDATIONS

Our evaluations of foundation and floor slab design and construction conditions have been based on the data obtained during our field investigation and our understanding of the furnished site and project information. The general subsurface conditions were based on interpretation of the data obtained at specific 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. This is especially true of previously developed sites. 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, TTL 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.



LEGEND

— APPROXIMATE SITE LOCATION



APPROXIMATE SCALE — FEET

0 2,300 4,600

PLATE 1.0 SITE LOCATION MAP

PROPOSED NEW CLINICAL AND ADMINISTRATIVE BUILDING
US DEPARTMENT OF VETERANS AFFAIRS
ANN ARBOR, MICHIGAN

PREPARED FOR
SSOE GROUP
TOLEDO, OHIO

DRAWN TRR/1-11-16

CHECKED KDC/1-11-16

REVISED

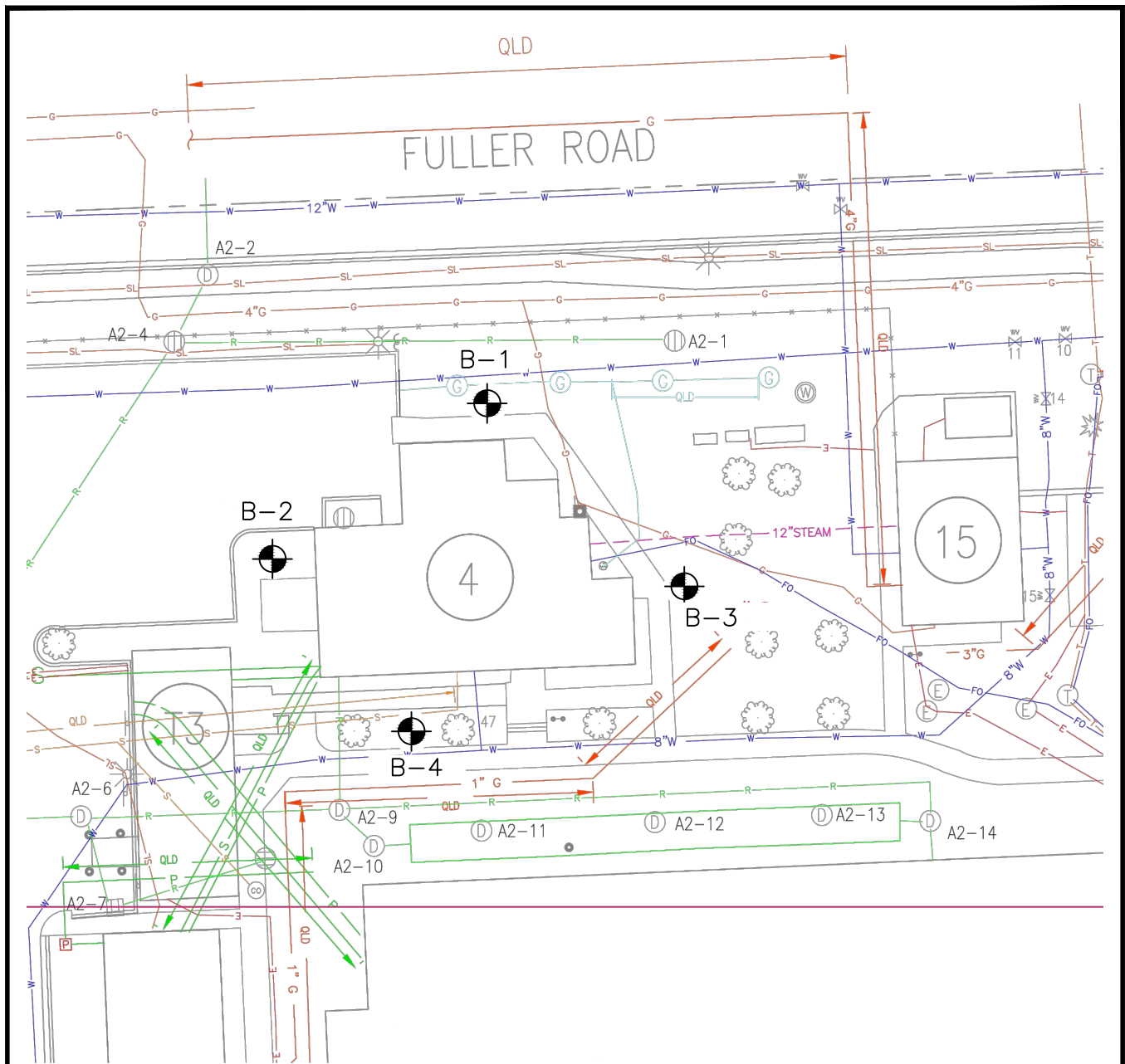
APPROVED

JOB NO. 12948.06

DRAWING NUMBER

1294806-01G





NOTE: BASE DRAWING "SOIL BORING PLAN" DATED 12-11-15, PROVIDED BY SSOE GROUP.

LEGEND

B-1 APPROXIMATE TEST BORING LOCATION

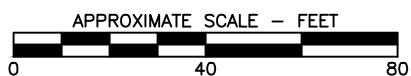


PLATE 2.0 TEST BORING LOCATION PLAN

PROPOSED NEW CLINICAL AND ADMINISTRATIVE BUILDING
US DEPARTMENT OF VETERANS AFFAIRS
ANN ARBOR, MICHIGAN

PREPARED FOR
SSOE GROUP
TOLEDO, OHIO

DRAWN TRR/1-11-16

CHECKED KDC/1-11-16

REVISED

APPROVED

JOB NO. 12948.06

DRAWING NUMBER

1294806-02G





TTL Associates, Inc.
1915 N 12th Street
Toledo, Ohio 43624
Telephone: 419-324-2222
Fax: 419-241-1808

BORING NUMBER B-1

PAGE 1 OF 1

CLIENT SSOE Group

PROJECT NAME Proposed New Clerical & Administrative Building

PROJECT NUMBER 12948.06

PROJECT LOCATION VAMC, Ann Arbor, MI

DRILLING CONTRACTOR TTL Associates NW JG

RIG NO. 45

GROUND ELEVATION

DRILLING METHOD 2-1/4 in. HSA

GROUND WATER LEVELS:

DATE STARTED 1/8/16

COMPLETED 1/8/16

▽ AT TIME OF DRILLING 13.5 ft

LOGGED BY KKC

CHECKED BY KDC

▼ AT END OF DRILLING 10.5 ft

NOTES

0hrs AFTER DRILLING Backfilled w/Cuttings and Bentonite Chips

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 20 40 60 80 MC LL	▲ SPT N VALUE ▲
	0		TOPSOIL - 12 Inches							
			1.0'							
			Moist Medium Stiff to Stiff Brown SANDY LEAN CLAY w/Trace Gravel (CL)	SS 1	100	6-5-4 (9)	0.75			15
			@3': Medium Stiff	ST 1	96		0.57	113		16
	5		6.0'							
			Moist Medium Stiff to Stiff Brown/Gray LEAN CLAY w/Sand and Trace Gravel (CL)	SS 2	100	2-3-3 (6)	1.50			20
			8.5'							
			Moist Very Stiff Brown SANDY LEAN CLAY w/Trace Gravel (CL)	SS 3	22	3-10-16 (26)	NI			22
	10		13.5'							
			Moist Stiff Gray LEAN CLAY w/Sand and Trace Gravel (CL)	SS 4	100	4-6-7 (13)	1.95	116		15
	15		18.5'							
			Moist Very Stiff to Hard Gray LEAN CLAY w/Sand and Trace Gravel (CL)	SS 5	100	5-10-18 (28)	>4.5			10
	20		20.0'							
			Wet Dense Brown POORLY GRADED SAND w/Silt and Gravel (SP/SM) (Free Water Noted in Jar)							
				SS 6	100	10-20-29 (49)	NP			10
	25		@28.5': (Free Water Noted in Jar)							
				SS 7	100	6-12-22 (34)	NP			9
	30		30.0'							
			Bottom of hole at 30.0 feet.							



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BORING NUMBER B-2

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CLIENT SSOE Group

PROJECT NAME Proposed New Clerical & Administrative Building

PROJECT NUMBER 12948.06

PROJECT LOCATION VAMC, Ann Arbor, MI

DRILLING CONTRACTOR TTL Associates NW JG

RIG NO. 45

GROUND ELEVATION

DRILLING METHOD 2-1/4 in. HSA

GROUND WATER LEVELS:

DATE STARTED 1/8/16 COMPLETED 1/8/16

▽ AT TIME OF DRILLING 12.0 ft

LOGGED BY KKC CHECKED BY KDC

▼ AT END OF DRILLING 11.0 ft

NOTES

0hrs AFTER DRILLING Backfilled w/Cuttings and Bentonite Chips

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 20 MC 40 LL 80 ▲ SPT N VALUE ▲ 20 40 60 80
	0		TOPSOIL - 6 Inches						
			0.5'						
			FILL - Moist Stiff Gray/Brown SANDY LEAN CLAY w/Trace Gravel and Brick Fragments (w/Trace Organics in SS-1 Sample)	SS 1	100	8-6-5 (11)	1.50		15
	5			SS 2	56	3-5-5 (10)	NI		16
			8.0'	ST 1	83		1.00	119	16
			Moist Stiff to Very Stiff Gray LEAN CLAY w/Sand and Trace Gravel (CL)	SS 3	78	3-4-5 (9)	2.50		18
	10								
			13.5'	SS 4	78	9-38-12 (50)	NP		19
	15								
			18.5'	SS 5	75	6-30-50/4"	NP		11
	20		Wet Very Dense Brown POORLY GRADED SAND w/Silt and Gravel (SP/SM) (Free Water Noted in Jar)						
				SS 6	78	16-19-26 (45)	NP		9
	25		@23.5': Dense, Gray, (Free Water Noted in Jar)						
				SS 7	100	20-27-33 (60)	NP		10
	30		@28.5': Very Dense, (Free Water Noted in Jar)						
			30.0'						
			Bottom of hole at 30.0 feet.						



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BORING NUMBER B-3

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PROJECT NAME Proposed New Clerical & Administrative Building

PROJECT NUMBER 12948.06

PROJECT LOCATION VAMC, Ann Arbor, MI

DRILLING CONTRACTOR TTL Associates NW JG

RIG NO. 45

GROUND ELEVATION

DRILLING METHOD 2-1/4 in. HSA

GROUND WATER LEVELS:

DATE STARTED 1/8/16 COMPLETED 1/8/16

▽ AT TIME OF DRILLING 13.0 ft

LOGGED BY KKC CHECKED BY KDC

▼ AT END OF DRILLING 11.0 ft

NOTES

0hrs AFTER DRILLING Backfilled w/Cuttings and Bentonite Chips

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 20 MC 40 LL 80 ▲ SPT N VALUE ▲
	0		TOPSOIL - 6 Inches						
			Moist Stiff Brown SANDY LEAN CLAY w/Trace Gravel and Organics (CL)	SS 1	44	3-4-5 (9)	NI		26
			Moist Soft to Medium Stiff Brown SANDY LEAN CLAY w/Trace Gravel (CL)	SS 2	100	2-2-2 (4)	0.50		15
			Moist Stiff Brown SANDY LEAN CLAY w/Trace Gravel (CL)	SS 3	100	3-4-6 (10)	NI	106	22
			@8': w/Gravel	SS 4	100	4-7-8 (15)	NI		8
			Moist Very Stiff Brown/Gray LEAN CLAY w/Sand and Trace Gravel (CL)	SS 5	100	8-10-10 (20)	3.25		18
			@18.5': Very Stiff to Hard	SS 6	100	4-7-13 (20)	>4.5		22
			Wet Dense Brown POORLY GRADED SAND w/Silt and Gravel (SP/SM) (Free Water Noted in Jar)	SS 7	78	24-23-18 (41)	NP		11
			@28.5': (Free Water Noted in Jar)	SS 8	100	12-16-24 (40)	NP		18
			Bottom of hole at 30.0 feet.						



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BORING NUMBER B-4

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PROJECT NUMBER 12948.06

PROJECT LOCATION VAMC, Ann Arbor, MI

DRILLING CONTRACTOR TTL Associates NW JG

RIG NO. 45

GROUND ELEVATION

DRILLING METHOD 2-1/4 in. HSA

GROUND WATER LEVELS:

DATE STARTED 1/8/16 COMPLETED 1/8/16

▽ AT TIME OF DRILLING 15.0 ft

LOGGED BY KKC CHECKED BY KDC

▼ AT END OF DRILLING 13.0 ft





















NOTES

0hrs AFTER DRILLING Backfilled w/Cuttings and Bentonite Chips







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 20 MC 40 LL 80 ▲ SPT N VALUE ▲
	0		MULCH - 6 Inches						
			0.5'	SS 1	56	2-3-4 (7)	2.00		16
			3.5'						
	5		Moist Medium Stiff to Stiff Brown SANDY LEAN CLAY w/Trace Gravel (CL)	SS 2	78	2-3-3 (6)	1.50	112	14
			6.0'	SS 3	78	3-3-4 (7)	1.00		20
			8.5'	SS 4	67	3-7-9 (16)	4.00		17
	10		12.0'						
			Moist Dense Brown POORLY GRADED SAND w/Silt and Gravel (SP/SM)	SS 5	56	13-19-20 (39)	NP		9
	15								
			@17.5': Wet, Very Dense						
			@18.5': (Free Water Noted in Jar)	SS 6	100	29-30-36 (66)	NP		7
	20								
			@23.5': Gray, (Free Water Noted in Jar)	SS 7	100	20-26-29 (55)	NP		7
	25								
			@28.5': (Free Water Noted in Jar)	SS 8	100	18-39-36 (75)	NP		8
	30		30.0'						
			Bottom of hole at 30.0 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 January 8, 2106, 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 TTL Associates, Inc in general accordance with the "Soil Boring Plan," dated December 11, 2016, provided by SSOE Group.
4. Unconfined Compressive Strength (tsf):
NI = Not Intact
NP = Non-Plastic

PROJECT: Proposed New Clinical & Admin. Building, Ann Arbor, Michigan							TTL Associates, Inc.								PROJECT NO: 12948.06			
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)		Particle Size Distribution (%)						Atterberg Limits (%)			Unified Soil Classification
									Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index	
B-1	SS-1	1.0-2.5		9	14.7		*1,500											
	ST-1	3.0-5.0			15.9	112.8	1,140											
	SS-2	6.0-7.5		6	19.9		*3,000											
	SS-3	8.5-10.0		26	22.0													
	SS-4	13.5-15.0		13	15.0	116.2	3,905											
	SS-5	18.5-20.0		28	9.7		*9,000+											
	SS-6	23.5-25.0		49	10.0													
	SS-7	28.5-30.0		34	9.0													
B-2	SS-1	1.0-2.5		11	15.2		*3,000											
	SS-2	3.5-5.0		10	16.5													
	ST-1	6.0-8.0			15.9	118.7	*2,000											
	SS-3	8.5-10.0		9	18.2		*5,000											
	SS-4	13.5-15.0		50	19.1													
	SS-5	18.5-20.0		SSR	10.7													
	SS-6	23.5-25.0		45	9.0													
	SS-7	28.5-30.0		60	9.8													

SSR = Split-Spoon Refusal

*Unconfined compressive strength derived from a calibrated hand penetrometer

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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)		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	1.0-2.5		9	26.0													
	SS-2	3.5-5.0		4	15.1		*1,000											
	SS-3	6.0-7.5		10	22.5	105.6												
	SS-4	8.5-10.0		15	8.0													
	SS-5	13.5-15.0		20	18.4		*6,500											
	SS-6	18.5-20.0		20	21.9		*9,000+											
	SS-7	23.5-25.0		41	11.0													
	SS-8	28.5-30.0		40	17.6													
B-4	SS-1	1.0-2.5		7	16.2		*4,000		3	4	9	28	45	11	25	16	9	CL
	SS-2	3.5-5.0		6	14.0	112.0	*3,000											
	SS-3	6.0-7.5		7	19.8		*2,000											
	SS-4	8.5-10.0		16	17.2		*8,000											
	SS-5	13.5-15.0		39	9.1													
	SS-6	18.5-20.0		66	6.6													
	SS-7	23.5-25.0		55	7.1													
	SS-8	28.5-30.0		75	7.6													

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GRAIN SIZE DISTRIBUTION

CLIENT SSOE Group

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