



Geotechnical Engineering Exploration and Analysis

**Proposed Residence
S69W17741 Wildwood Drive
Muskego, Wisconsin**

Prepared for:

**Michelle Weidenhamer
Pacific Grove, California**

**June 26, 2026
Giles Project No. 1G-2606016**



GILES
ENGINEERING ASSOCIATES, INC.



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GEOTECHNICAL, ENVIRONMENTAL & CONSTRUCTION MATERIALS CONSULTANTS

- Dallas, TX
- Los Angeles, CA
- Milwaukee, WI

June 26, 2026

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Subject: Geotechnical Engineering Exploration and Analysis
Proposed Residence
S69W17741 Wildwood Drive
Muskego, Wisconsin
Giles Project No. 1G-2606016

Dear Ms. Weidenhamer

As requested, Giles Engineering Associates, Inc. conducted a *Geotechnical Engineering Exploration and Analysis* for the proposed project. The accompanying report describes the services that were performed, and it provides geotechnical-related findings, conclusions, and recommendations that were derived from those services.

We sincerely appreciate the opportunity to provide geotechnical services for the proposed project. Please contact the undersigned if there are questions about the report or if we may be of further service.

Very truly yours,

GILES ENGINEERING ASSOCIATES, INC.

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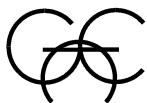
Appendix A - Figure (1), Test Boring Logs (3), Waukesha County Form A (1)

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GEOTECHNICAL ENGINEERING EXPLORATION AND ANALYSIS

PROPOSED RESIDENCE
S69W17741 WILDWOOD DRIVE
MUSKEGO, WISCONSIN
GILES PROJECT NO. 1G-2606016

1.0 SCOPE OF SERVICES

This report provides the results of the *Geotechnical Engineering Exploration and Analysis* that Giles Engineering Associates, Inc. ("Giles") conducted for the proposed residence. The *Geotechnical Engineering Exploration and Analysis* included a geotechnical subsurface exploration program, geotechnical laboratory services, and geotechnical engineering. The scope of each service area was narrow and limited, as directed by our client and based on our understanding and assumptions about the proposed project. Service areas are briefly described later. Environmental consulting was outside our scope of services.

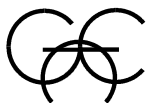
Geotechnical-related recommendations are provided in this report for design and construction of the foundations, basement, and at-grade floor for the proposed residence. Site preparation recommendations are also given but are only preliminary because the means and methods of site preparation will depend on factors that were unknown when this report was prepared. Those factors include, but are not limited to, the weather before and during construction, the subsurface conditions that are exposed during construction, and the final details of the proposed project.

2.0 SITE DESCRIPTION

The subject site is located at S69W17741 Wildwood Drive in Muskego, Wisconsin. A depiction of the site is shown on the *Test Boring Location Plan*, enclosed as Figure 1 in Appendix A. When the test borings (described later) were performed, the site was a vacant lot with a grassy groundcover. Based on aerial photographs, the previous residence was razed between the June 2025 and February 2026 photographs. Topographically, the site was relatively flat and level. Ground elevations at the test borings varied between $\pm$ El. 818.3 and $\pm$ El. 818.5; these elevations are referenced to Giles' adopted benchmark, shown on the *Test Boring Location Plan*.

3.0 PROJECT DESCRIPTION

The approximate location of the proposed residence is shown on the *Test Boring Location Plan*. It is assumed that the residence will be a two-story wood-frame structure with a basement and an attached garage. Bearing walls will assumedly support the residence along with steel columns in the basement. The maximum foundation loads were not provided to us and are, therefore, assumed to be 4,000 pounds per lineal foot (plf) from bearing walls and 10,000 pounds per column. It is assumed that ground-bearing floor slabs are planned for the basement and garage; the maximum floor load in these areas is assumed to be 100 pounds per square foot (psf).



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Proposed floor elevations were not provided to us; therefore, to complete this report, it was necessary to assume the floor elevations. Due to the relatively shallow water table, the proposed residence is recommended to be situated as high as practical. It is recommended that the lowest-level floor of the residence be at or above El. 814, which was approximately 2 feet above the highest estimated groundwater table (discussed later). Therefore, it is assumed the first floor of the residence will be at El. 821. It is recommended that Giles review the final plans for the proposed residence prior to its construction. Depending on that review, revision of this report might be necessary.

4.0 GEOTECHNICAL SUBSURFACE EXPLORATION PROGRAM

Test Borings

To explore subsurface conditions, three geotechnical test borings were performed at the site using a mechanical drill-rig. Test Borings 1 through 3 were within the general residence area and were drilled to ± 21 feet below-ground. Approximate locations of the test borings are shown on the *Test Boring Location Plan*. The test boring locations were positioned onsite relative to apparent property lines and existing site features, and by estimating right angles.

Samples were collected from each test boring, at certain depths, using the Standard Penetration Test (SPT), conducted with the drill rig. A brief description of the SPT is given in Appendix B along with descriptions of other field procedures. Immediately after sampling, select portions of the SPT samples were placed in containers that were labeled at the site for identification. A Standard Penetration Resistance value (N-value) was determined from each SPT. The measured N-values are reported on the Test Boring Logs, which are records of the test borings. N-values are used to estimate the in-place density of granular soil, such as the granular soil that was encountered at the test borings, as described below.

The boreholes were backfilled upon completion; however, backfill materials will likely settle or heave, creating a hazard that can injure people and animals. Borehole areas should, therefore, be carefully and routinely monitored by the property owner or by others; settlement and heave of backfill materials should be repaired immediately. Giles will not monitor or repair boreholes or borehole areas.

Ground elevations at the test borings were determined by differential leveling and are referenced to Giles' adopted benchmark. The benchmark location is shown on the *Test Boring Location Plan*. Test boring elevations are noted on the *Test Boring Logs* and are considered accurate within about one foot.

Groundwater Observation Well

To evaluate the water table, a temporary groundwater observation well was installed at Test Boring 3. The observation well was constructed with solid and slotted PVC pipe. The bottom of



the observation well was set at ± 12.7 feet below-ground. A Giles representative measured the water level within the observation well on June 19 and June 25, 2026. The groundwater measurements are reported in Section 7.0. The observation well should be abandoned before construction in accordance with Wisconsin Department of Natural Resources regulations. Giles can abandon the observation well upon request and authorization.

5.0 GEOTECHNICAL LABORATORY SERVICES

Soil samples that were retained from the test borings were transported to Giles' geotechnical laboratory where the samples were classified using the descriptive terms and particle-size criteria shown on the *General Notes* in Appendix D and by using the Unified Soil Classification System (ASTM D 2488) as a general guide. The classifications are shown on the *Test Boring Logs* along with horizontal lines that show estimated depths of material change. Field-related information pertaining to the test borings is also shown on the *Test Boring Logs*. For simplicity and abbreviation, terms and symbols are used on the *Test Boring Logs*; the terms and symbols are defined on the *General Notes*.

Calibrated penetrometer resistance, unconfined compressive strength (without controlled strain), and moisture content tests were performed on select cohesive samples to evaluate their general engineering properties. Test results are on the *Test Boring Logs*. Because the laboratory tests were conducted on SPT samples, which are classified as disturbed samples, results of the strength-related tests are considered to be approximations and were, therefore, used as supplemental information. Laboratory procedures are briefly described in Appendix C.

6.0 MATERIAL CONDITIONS

Because material sampling at the test borings was discontinuous, it was necessary for Giles to estimate conditions between sample intervals. Estimated conditions at the test borings are briefly discussed in this section and are described in more detail on the *Test Boring Logs*. The conclusions and recommendations in this report are based only on the estimated conditions shown on the *Test Boring Logs*.

6.1. Surface Materials

Topsoil was at the surface of the test borings and was between ± 4 and ± 6 inches thick. The topsoil consisted of sandy silt and silty sand with an estimated trace amount of organic matter.

6.2. Fill Material

Fill material was below the topsoil at each test boring to depths between about 3 and 4 feet below-ground. The fill material consisted of sandy clay and exhibited relatively low to moderate strength characteristics.



6.3. Native Soil

Native soil was encountered below the fill material and was present to the termination depth at each test boring. Native soil generally consisted of lean clay and silty clay, but sand (variable gradations), silty sand, and silt were also encountered. Based on laboratory testing, cohesive native soils had very stiff to hard comparative consistencies. Based on corrected SPT N-values, the native granular exhibited firm to dense relative densities.

7.0 GROUNDWATER CONDITIONS

A groundwater-observation well was installed to a depth of ± 12.7 feet below-ground at Test Boring 3 to evaluate groundwater conditions. A Giles representative monitored the well on June 19 and June 25, 2026. Groundwater observations at the well are reported in Table 1.

TABLE 1 RESULTS OF TEMPORARY OBSERVATION WELL MONITORING		
Date of Evaluation	Estimated Depth of Water Table	Estimated Elevation of Water Table
June 19, 2026	± 7.6 feet	$\pm$ El. 810.7
June 25, 2026	± 7.7 feet	$\pm$ El. 810.6
<ul style="list-style-type: none">• Depths are referenced to the site grades when the test borings were performed.• Elevations are referenced to Giles' adopted benchmark shown on the <i>Test Boring Location Plan</i>.		

Based on the observation well readings and the subsurface conditions at the test borings, it is estimated that, during our field services, the water table at the locations of the test borings and observation well was between $\pm$ El. 809.5 and $\pm$ El. 812. However, the site appears to be subject to shallower perched-groundwater conditions, where groundwater perches above the water table, especially within existing fill material and more permeable soil lenses. Groundwater conditions will likely fluctuate depending on precipitation, surface run-off, and other factors.

Additional observation-well monitoring could be performed to further evaluate the groundwater conditions. The longer the observation well is monitored, the more accurately the water table and its fluctuation can be defined. Giles can continue to monitor the observation well, upon request and authorization. If the observation well is monitored by others, Giles should be provided with the results, which may require revision of this report.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1. Seismic Design Considerations

A soil Site Class C is recommended for seismic design, if needed. By definition, Site Class is based on the average properties of subsurface materials to 100 feet below-ground. Because a 100-foot test boring was not performed, it was necessary to estimate Site Class based on the test borings, presumed area geology, and the International Building Code.



8.2. Foundation Recommendations

A spread-footing foundation is recommended for the proposed residence. Existing fill materials are unsuitable for direct or indirect support of new foundations. Each footing is recommended to be directly supported by suitable native soil, or by new engineered fill or lean-concrete backfill (both discussed below) placed on suitable native soil. The foundation is recommended to be designed using a 3,000 pound per square foot (psf) maximum, net, allowable soil bearing capacity. For geotechnical considerations and regardless of the calculated foundation-bearing stress, strip footings are recommended to be at least 18 inches wide and isolated footings are recommended to be at least 24 inches wide and long. From a geotechnical perspective, foundation/ basement walls are recommended to be constructed of reinforced cast-in-place concrete (rather than concrete masonry units). It is recommended and assumed that a structural engineer will provide specific foundation details, including footing dimensions, reinforcing, etc.

The local building code requires a minimum 48-inch foundation-embedment depth for frost protection. It is, therefore, recommended that footings for perimeter walls and other exterior elements of the proposed structure bear at least 48 inches below the adjacent (finished) exterior grade. Interior footings within residence areas that will be continuously heated may bear directly below the floor slab. Also, it is recommended that interior footings (if any) in the attached garage bear at least 48 inches below the surface of the garage floor.

A frictional coefficient of 0.32 is recommended to determine the ultimate lateral resistance at the base of footings. The recommended frictional coefficient is only for concrete cast directly on suitable native soil, or on new engineered fill or lean-concrete backfill (both discussed below) placed on suitable native soil. Lateral resistance due to friction should be determined based on dead load only. Also, the ultimate lateral resistance determined from the frictional coefficient is recommended to be factored to determine an allowable value. Furthermore, passive resistance is recommended to be neglected above the minimum 48-inch foundation-embedment depth.

The following table provides estimated depths and elevations of native soil that was suitable for direct foundation support (based on the recommended 3,000 psf bearing capacity) at the building-area test borings. Suitable native soil might be at deeper and more variable depths away from the building-area test borings, especially considering the existing fill material and that the site was formerly developed.



TABLE 2 ESTIMATED DEPTH AND ELEVATION OF SUITABLE-BEARING NATIVE SOIL		
Test Boring Number	Estimated Depth of Suitable Native Soil	Estimated Elevation of Suitable Native Soil
1	±6½ feet	±El. 812.0
2	±4 to ±6½ feet	±El. 811.9 to ±El. 814.4
3	±4 feet	±El. 814.3
<ul style="list-style-type: none"> For direct foundation support or for placement of engineered fill or lean-concrete backfill; based on a 3,000 psf maximum, net, allowable soil bearing capacity. Depths are referenced to the site grades when the test borings were conducted. Elevations are referenced to Giles' adopted benchmark shown on the <i>Test Boring Location Plan</i>. 		

Based on the depths to suitable-bearing native soil, some over-excavation below the planned foundation-bearing elevations may be necessary. Because of the existing fill and perched groundwater, it is recommended that a geotechnical engineer observe the foundation excavation procedures to evaluate the excavated material and to confirm that suitable native soil is at the base of each foundation excavation. If a geotechnical engineer does not observe the foundation-excavation operations, the proposed building could be improperly supported.

Foundation excavations are recommended to be dug with a smooth-edge excavator bucket to develop a relatively undisturbed bearing grade. A toothed bucket will likely disturb foundation-bearing soil more than a smooth-edge bucket thereby making soil at the excavation base more susceptible to saturation and instability, especially during adverse weather. It is critical that contractors protect support soil and the construction materials (concrete and reinforcing). Furthermore, engineered fill is recommended to be placed and compacted in benched excavations along foundation walls immediately after the walls can properly support lateral pressures from backfill, compaction, and compaction equipment.

Foundation Support-Soil Requirements

Existing fill is unsuitable for direct or indirect support of foundations. Each footing must bear on suitable native soil, or on new engineered fill or lean-concrete backfill (both discussed below) placed on suitable native soil. Based on the recommended 3,000 psf maximum, net, allowable soil bearing capacity, the in-situ unconfined compressive strength of cohesive native soil, such as silty clay or lean clay, within the foundation influence zone is recommended to be at least 1.5 tons per square foot (tsf). Granular native soil, such as sand, within the foundation influence zone is recommended to have an average corrected N-value (determined from SPTs and correlated from other in-situ tests) of at least 10. It is further recommended that the strength characteristics of native soil within the entire foundation influence zone (determined by a geotechnical engineer during construction) meet or exceed these recommended values unless Giles specifically approves lower values.

Because of the shallow groundwater, existing fill, and previous development, evaluation of foundation support soil by a geotechnical engineer during construction is critical. The purpose



of the evaluation is (1) to confirm that the foundations will be properly supported by suitable native soil, (2) to determine where over-excavation of unsuitable material is necessary, and (3) to confirm that the foundation-support soil is similar to the soil described on the *Test Boring Logs*. If a firm other than Giles performs the recommended evaluation, Giles must be notified if the composition or strength characteristics of foundation-support soil differ from those shown on the *Test Boring Logs*; revision of this report might be necessary. All pertinent OSHA requirements must be strictly followed when evaluating foundation-support materials; excavations that do not meet OSHA safety guidelines must not be entered.

Unsuitable material (if any) beneath proposed foundation areas could be replaced with engineered fill consisting of properly compacted dense-graded crushed stone that meets the gradation requirements of *dense-graded base* (1¼ inch) in Section 305 of the Wisconsin Department of Transportation Standard Specifications. Aggregate with other gradation characteristics could possibly be used but should be approved by a geotechnical engineer before the material is placed. If engineered fill is used as backfill, lateral over-excavation of unsuitable material will be required, in addition to the required vertical over-excavation. The overall width of lateral over-excavation will depend on the vertical over-excavation depth. For estimating purposes, the minimum lateral over-excavation could be determined by extending an imaginary line outward and downward at a ratio of 1(horizontal):2(vertical) from the bottom edges of a footing pad, but the actual lateral extents of over-excavation are recommended to be approved by a geotechnical engineer during construction.

Lean Portland cement concrete (minimum 28-day compressive strength of 500 psi) could also be used to replace unsuitable materials beneath foundation areas and is Giles' preferred backfill material considering the proximity to the groundwater table. Where lean concrete is used as backfill, footing construction must not begin until the lean concrete has gained sufficient strength. Also, over-excavations that are filled with lean concrete are recommended to be at least as wide (on all sides) as the footing pad that will be supported by the concrete, and excavation sidewalls are recommended to be plumb and parallel. To help control caving, lean-concrete backfill is recommended to be placed immediately after excavation. This trench-and-pour method requires close communication and scheduling between the general contractor, foundation contractor, concrete supply company, and geotechnical engineer. With a trench-and-pour method, a geotechnical engineer must observe excavations as they are made.

From a geotechnical perspective, footing pads can be stepped or thickened to extend through unsuitable materials, but stepped and thickened footings must be approved by the structural engineer. It is recommended that a geotechnical engineer provide specific recommendations pertaining to unsuitable materials within foundation areas at the time of construction.

Estimated Foundation Settlement

The post-construction total and differential settlements of a spread-footing foundation designed and constructed based on this report are estimated to be less than about 1 inch and ½ inch,



respectively. Estimated settlements assume that the recommendations provided in this report will be followed and that foundation-support soil will be evaluated and approved by a geotechnical engineer during construction.

8.3. Basement Recommendations

Geotechnical-related recommendations regarding the basement for the proposed residence are provided below. As previously discussed, it is recommended that the basement floor will be at or above El. 814. This report assumes that the basement floor will be at El. 814 and that foundations will bear at El. 813, except where stepped down to meet the minimum frost embedment depth. Giles must be notified if the basement floor will be lower than described; this report might need to be revised.

Also, it is important to note that water flow within the foundation drainage system (discussed below) will likely be frequent, even with the assumed basement floor elevation and foundation-bearing elevation. Consequently, sump pumps might operate frequently, which could be a nuisance to the homeowners.

Below-Grade Floor Slab

From a geotechnical perspective and assuming a maximum 100 psf floor load, the below-grade floor slab is recommended to be at least 4 inches thick; this thickness assumes that the 28-day compressive strength of concrete will be at least 3,500 pounds per square inch (psi). It is recommended and assumed that a structural engineer or architect will specify the actual thickness and reinforcing of the below-grade floor slab.

For moisture control only, a minimum 10-mil vapor retarder is recommended to be directly below the floor slab throughout the entire below-grade area. The vapor retarder should completely underlie the below-grade floor and extend to all foundation walls. Adjacent vapor retarder sheets are recommended to be overlapped at least six inches, and the overlaps are recommended to be continuously taped. The vapor retarder is recommended to be in accordance with ASTM E 1745, entitled *Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs*, and other relevant documents. If the base course includes sharp aggregate, protecting the retarder with geotextile or other means is recommended.

A minimum 6-inch-thick base course is recommended to be directly below the minimum 10-mil vapor retarder to serve as a capillary break and for sub-slab drainage. Because the base course will be a component of the recommended foundation drainage system (discussed below), it is recommended that the base material consist of free-draining crushed stone that meets the gradation requirements of ASTM No. 57 aggregate. Base material is recommended to be properly compacted. Also, it is recommended that a geotechnical engineer approve base material before it is placed. Geotextile might need to be below the base material to serve as a



separator. The need for geotextile should be determined with the assistance of a geotechnical engineer during construction.

The post-construction total and differential settlements of an isolated floor slab constructed in accordance with this report are estimated to be less than about $\frac{1}{2}$ inch and $\frac{1}{3}$ inch, respectively, over a distance of about 20 feet. Estimated settlements assume that support-soil will be thoroughly tested and approved by a geotechnical engineer.

Drainage System Recommendations

The basement is recommended to be equipped with a permanent drainage system. Continuous drainpipes are recommended to be along the interior and exterior sides of the perimeter footings, thereby creating interior and exterior drainage loops around the basement. Drainpipes could consist of conduits specifically manufactured for foundation drainage applications, such as Form-A-Drain® conduits. Manufactured foundation drains are recommended to be installed per the manufacturer's recommendations. Circular drainpipes could also be used and are recommended to be minimum 4-inch-diameter perforated pipes suitable for foundation drainage applications. Circular drains are recommended to be directly adjacent to the footing pads, not atop footing flanges. Interior drainpipes are to be properly situated within the base-course layer below the basement floor slab. Due to possible clogging, fabric socks are not recommended to be used with foundation drainpipes. It is recommended that a minimum 12-inch-thick layer of crushed stone surround exterior drainpipes, except that crushed stone must not extend below the foundation-bearing grade and into the foundation-influence zone. Along with the drainpipes, bleeder pipes are recommended to be cast in the perimeter strip footings to serve as water conduits between interior and exterior drainpipes. Bleeder pipes are recommended to be 3 inches in diameter and about 8 feet on-center, which is understood to be a State of Wisconsin building code. This report assumes that drainpipes for the basement will be above El. 813.

It is recommended that the drainage system discharge to a sump-basin situated within the crawl space. The location of the basin should be determined based on architectural and structural details of the residence. It is recommended that the basin have a sealed-and-bolted, airtight lid to prevent inflow of subsurface gases, such as radon. The basin should be equipped with a sump pump that has a sufficient capacity. Care must be taken when selecting the locations for the sump-pump discharge pipes since pumped water could pond, becoming a nuisance and hazard, especially during freezing weather when ponded water could freeze. Due to the groundwater conditions, water flow within the foundation drainage system might be relatively frequent. Consequently, sump pumps might operate frequently, which could be a nuisance to the homeowners. The sump pumps are recommended to be equipped with a battery or generator backup to maintain pump operation in the event of a power outage.



Drainage Backfill

Free-draining aggregate is recommended to be along the exterior side of basement walls to serve as drainage media for the recommended drainage system. It is recommended that the backfill material consist of free-draining crushed stone that meets the gradation requirements of ASTM No. 57 aggregate. The aggregate layer is recommended to be at least two feet wide, measured from the outside face of the basement walls. Also, the aggregate layer is recommended to be continuous along the length and height of the walls, except that pavement or a ± 6 -inch-thick layer of relatively impervious material is recommended to be above the drainage aggregate to reduce surface-water intrusion. Furthermore, the aggregate layer must extend to the base of the perimeter strip footings, thereby creating a continuous drainage path to the perimeter drainage conduits. However, drainage aggregate must not extend below the foundation-bearing grade and into the foundation-influence zone.

Drainage aggregate that is placed adjacent to basement walls is recommended to be compacted in relatively thin lifts that are also uniform in elevation, especially where drainage aggregate will support pavement or sidewalks. Use of manual compaction equipment must be in accordance with current OSHA excavation and trench safety standards and other applicable requirements. Manual compaction equipment should not be used within spaces that do not meet OSHA requirements. Drainage aggregate should not be excessively compacted. Where necessary, excavations for basement walls must be properly shored, sloped, or restrained. Also, basement walls are recommended to be adequately braced before placing backfill to prevent the walls from moving or possibly even overturning during backfilling. Bracing must remain in-place until the top and bottom of the basement walls are structurally restrained.

Lateral Pressure Design Parameters

Below-grade walls must be designed to resist lateral pressures from drainage backfill, adjacent soil, and any surface and subsurface surcharges. An equivalent "at-rest" fluid pressure of 65 pounds per square foot per foot of depth (psf/ft) is recommended for design of below-grade walls. The recommended "at-rest" value is based on Giles' assumption that drainage backfill will continuously abut the below-grade walls, and that the recommended drainage system will be installed and will remain functional. If drainage backfill and/or the drainage system are not installed, lateral pressures will likely exceed the recommended "at-rest" fluid pressure, possibly exceeding the lateral capacity of the walls.

Lateral pressures caused by surface and subsurface surcharge loads must be added to the "at-rest" fluid pressure. Giles could provide supplemental recommendations regarding surface and subsurface surcharge loads on a case-by-case basis, but would require specific structural information. Below-grade walls that are not designed to resist actual pressures could move laterally and possibly fail. It is recommended and assumed that a structural engineer will design the below-grade walls.



8.4. At-Grade Floor Slab Recommendations

With proper subgrade preparation, existing soil (including existing fill) is expected to be suitable to support ground-bearing concrete slabs for attached garage and at-grade floors in living areas, if any; new engineered fill that is placed on properly prepared existing soil is also expected to be suitable. However, subgrade improvement will likely be necessary to develop proper slab support, considering the existing fill and existing development. Consequently, the at-grade floor areas are recommended to be thoroughly evaluated and approved by a geotechnical engineer immediately before fill placement and before floor construction. Without a thorough evaluation of floor slab support materials, the at-grade floor slabs could be improperly supported, which could lead to excessive settlement. Proper preparation of the floor slab areas is critical.

From a geotechnical perspective and based on a maximum 100 psf floor load, the at-grade floor slab within the garage area is recommended to be at least 5 inches thick and 4 inches in the at-grade residential areas, if any; that thickness assumes that the 28-day compressive strength of the concrete will be at least 3,500 pounds per square inch (psi). Assuming proper site preparation, the at-grade floor slabs may be designed using a *Modulus of Subgrade Reaction* (K_{v1}) value of 100 pounds per square inch per inch (psi/in). It is recommended that a structural engineer specify the floor slab thickness, reinforcing, joint details, and other parameters.

For moisture control only, a minimum 10-mil vapor retarder is recommended to be directly below the at-grade floor slabs within all living areas of the residence (non-garage areas). The vapor retarder should completely underlie the entire floor and extend to all foundation walls. Vapor retarder sheets are recommended to be overlapped at least six inches, and the overlaps are recommended to be continuously taped. Vapor retarder is recommended to be in accordance with ASTM E 1745, entitled *Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs*, and other relevant documents. If the base course (discussed below) includes sharp aggregate, protecting the retarder with geotextile or other means is recommended.

A minimum 4-inch-thick base course is recommended to be below the vapor retarder to serve as a capillary break and for support considerations. It is recommended that the base course consist of free-draining aggregate, such as ASTM No. 57 aggregate, that has been tested and approved by a geotechnical engineer. Depending on aggregate gradation and the subgrade conditions, geotextile might need to be below the base material to serve as a separator. The need for geotextile should be determined during construction with the assistance of a geotechnical engineer.

Due to the frost-susceptible site soil and perched groundwater, the at-grade floor slabs might be susceptible to freeze-thaw related movement. Installation of insulation (or other protective measures against freeze-thaw movement) should be considered to prevent floor movement due to frost heave. Pavement and ground grades are recommended to be sloped away from the building and sidewalks to reduce water infiltration and potential freeze-thaw problems.



Estimated Floor Slab Settlement

The post-construction total and differential settlements of an at-grade floor slab constructed in accordance with this report are estimated to be less than about ½ inch and ⅜ inch, respectively, over about 20 feet. These estimated settlements assume that floor slab support materials will be thoroughly tested and approved by a geotechnical engineer immediately before floor slab construction.

8.5. Generalized Site Preparation Recommendations

This section deals with site preparation including preparation of floor slab and engineered fill areas. The means and methods of site preparation will greatly depend on the weather conditions before and during construction, the subsurface conditions that are exposed during earthwork operations, and the finalized details of the proposed development. Therefore, only generalized site preparation recommendations are given.

In addition to being generalized, the following site preparation recommendations are abbreviated; the *Guide Specifications* in Appendix D gives further recommendations. The *Guide Specifications* should be read along with this section. Also, the *Guide Specifications* are recommended to be used as an aid to develop the project specifications.

Stripping and Removal

Surface vegetation, trees and bushes, topsoil with adverse organic content, and otherwise unsuitable materials are recommended to be removed from the proposed building area. Stripping and removal operations should extend at least several feet beyond the proposed building areas, where feasible.

Evaluation and Fill Placement

After the recommended stripping and removal, and once the building area is cut (lowered) as needed, the subgrade is recommended to be evaluated by a geotechnical engineer. Subgrade evaluation could consist of proof-rolling and/or in-situ testing. Depending on the results of the evaluation, the subgrade might need to be improved. Specific recommendations regarding subgrade improvement should, however, be provided by a geotechnical engineer based on their observations during construction.

After a geotechnical engineer confirms that the subgrade is stable, the building area is recommended to be raised, where necessary, to the planned finished grade with fill material that has been approved by the geotechnical engineer. Fill material is recommended to be placed in uniform layers (lifts) that are a maximum of about 6 to 8 inches thick. Each layer of engineered fill is recommended to be compacted to at least 95 percent of the fill material's maximum dry density determined from the Standard Proctor compaction test (ASTM D698). Also, the water



content of fill material is recommended to be uniform and within a narrow range of the optimum moisture content, also determined by the Standard Proctor compaction test. It is recommended that a geotechnical engineer monitor (on a full-time basis) the placement and compaction of fill material. It is also recommended that the geotechnical engineer determine when the fill materials are sufficiently compacted.

Engineered fill that does not meet the density and water content requirements is recommended to be replaced with new fill, or scarified to a sufficient depth (likely 6 to 12 inches, or more), moisture-conditioned, and compacted to the required density. A subsequent lift of fill should only be placed after a geotechnical engineer confirms that the previous lift was properly placed and compacted. Subgrade soil will likely need to be improved immediately before construction since equipment traffic and adverse weather may damage the subgrade and reduce soil stability.

Use of Site Soil as Engineered Fill

Site soil that does not contain adverse organic content or other deleterious materials, as noted in the *Guide Specifications*, could be used as engineered fill. Site soil that is used as engineered fill will likely need to be moisture conditioned (uniformly moistened or dried). If construction is during adverse weather (discussed in the following section), drying site soil will likely not be feasible. In that case, aggregate fill (or other fill material with a low water-sensitivity) will likely need to be imported to the site. Additional recommendations regarding fill selection, placement, and compaction are given in the *Guide Specifications*.

8.6. Generalized Construction Considerations

Adverse Weather

Site soil is moisture sensitive and will become unstable when exposed to adverse weather such as rain, snow, and freezing temperatures. Therefore, it might be necessary to remove or stabilize the upper 6 to 18 inches (or more) of soil due to adverse weather, which commonly occurs during late fall, winter, and early spring. At least some over-excavation and/or stabilization of unstable soil should be expected if construction is during or after adverse weather. Because site preparation is weather dependent, bids for site preparation, and other earthwork activities, should consider the time of year that construction will be conducted.

Dewatering

It is expected that excavations (including the basement excavation) will be above the water table, but water could collect in excavations due to precipitation or if perched groundwater is encountered. Water that accumulates in construction areas is recommended to be removed, along with unstable soil, as soon as possible. Filtered sump pumps, drawing water from sump pits excavated in the bottom of construction excavations, are expected to be adequate to remove water that collects in shallow excavations. Excavated sump pits should be fully-lined



with geotextile and filled with open-graded, free-drain aggregate. Water generated from dewatering activities should be directed to appropriate drainage areas.

Excavation Stability

Excavations are recommended to be made in accordance with current OSHA excavation and trench safety standards and other applicable requirements. Sides of excavations must be sloped, benched, or braced to develop and maintain a safe work environment. Temporary shoring must be designed according to applicable regulatory requirements. Contractors are responsible for excavation safety.

Questionable Materials

Questionable materials, if encountered, are recommended to be evaluated by a geotechnical engineer to determine if removal and replacement with engineered fill is necessary. Disposal of unsuitable material should be in accordance with local, state, and federal regulations for the material type. This report might need to be revised if the encountered subsurface conditions differ from those noted on the *Test Boring Logs*.

8.7. Recommended Construction Materials Testing Services

This report was prepared assuming that a geotechnical engineer will perform Construction Materials Testing ("CMT") services during construction of the proposed development. It might be necessary for Giles to provide supplemental geotechnical recommendations based on the results of CMT services and specific details of the project not known at this time.

9.0 BASIS OF REPORT

This report is strictly based on the project description given in Section 3.0. Giles must be notified if the project description or our assumptions about the project are not accurate so that this report can be amended, if needed. This report assumes that the building will be designed and constructed according to the codes that govern construction at the site.

The conclusions and recommendations in this report are based on the estimated subsurface conditions shown on the *Test Boring Logs*. Giles must be notified if the subsurface conditions that are encountered during construction of the proposed development differ from those shown on the *Test Boring Logs*; revision of this report might be necessary. General comments and limitations of this report are given in the appendix.

The conclusions and recommendations in this report have been promulgated in accordance with generally accepted professional engineering practices in the field of geotechnical engineering. No other warranty is either expressed or implied.

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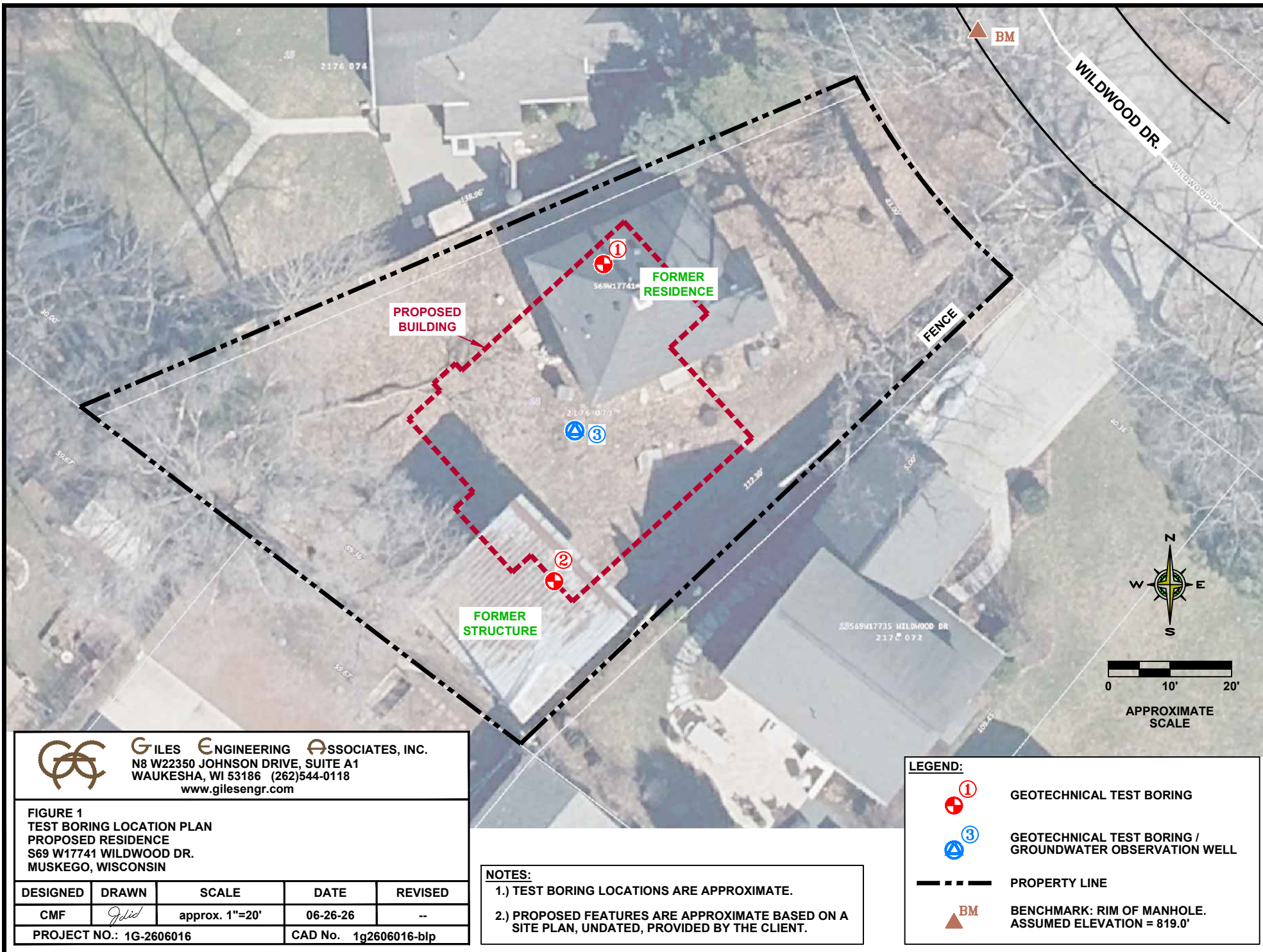


APPENDIX A

FIGURES AND TEST BORING LOGS

The Test Boring Location Plan contained herein was prepared based upon information supplied by *Giles'* client, or others, along with *Giles'* field measurements and observations. The diagram is presented for conceptual purposes only and is intended to assist the reader in report interpretation.

The Test Boring Logs and related information enclosed herein depict the subsurface (soil and water) conditions encountered at the specific boring locations on the date that the exploration was performed. Subsurface conditions may differ between boring locations and within areas of the site that were not explored with test borings. The subsurface conditions may also change at the boring locations over the passage of time.

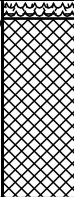
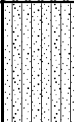


		<h1>TEST BORING LOG</h1>		BORING #	
				1	
		PROJECT Proposed Residence		GENERAL LOCATION S69 W17741 Wildwood Drive	
PROJECT NO. 1G-2606016		PROJECT CITY, STATE Muskego, Wisconsin		DATE COMPLETED 06/17/2026	
DRILLER/PM Keith Flowers	RIG TYPE CME-550X	DRILLING CONTRACTOR Giles Engineering Associates, Inc.		LATITUDE -	LONGITUDE -

Material Description	Graphic Log	Depth (ft)	Elevation (ft)	Sample Type / No.	N-Value	Compressive Strength	Q _p (tsf)	Vane Shear (tsf)	WC (%)	Notes
±6" TOPSOIL: Dark Gray Sandy Silt, trace Organic Matter - Moist				1-SS	5		4.5+		13	
FILL: Brown Sandy Clay - Moist				2-SS	10		3.5		15	
		815								
FILL: Brown fine to coarse Sand, trace Silt and Gravel - Moist				3-SS	14					
		5								
Grayish Brown Silty Clay, little Sand - Moist				4-SS	28		3.0		15	
		810								
Gray lean Clay - Moist				5-SS	22	5.6	4.5+		21	
		10								
				6-SS	20				15	
		805								
				7-SS	20	4.1	4.0		17	
		15								(a)
				8-SS	17	3.7	3.5		14	
		800								
		20								
Boring terminated at 21'										

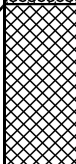
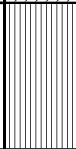
REMARKS (a) No SPT Sample Recovery - Auger Sample Obtained		Water Levels <div>  - _____ </div> <div>  - _____ </div>	
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		<h1>TEST BORING LOG</h1>		BORING #	
				<h2>2</h2>	
		PROJECT Proposed Residence		GENERAL LOCATION S69 W17741 Wildwood Drive	
PROJECT NO. 1G-2606016		PROJECT CITY, STATE Muskego, Wisconsin		DATE COMPLETED 06/17/2026	
DRILLER/PM Keith Flowers	RIG TYPE CME-550X	DRILLING CONTRACTOR Giles Engineering Associates, Inc.		LATITUDE -	LONGITUDE -

Material Description	Graphic Log	Depth (ft)	Elevation (ft)	Sample Type / No.	N-Value	Compressive Strength	Q _p (tsf)	Vane Shear (tsf)	WC (%)	Notes		
±4" TOPSOIL: Dark Brown Silty fine to medium Sand, trace Organic Matter - Moist FILL: Brown Sandy Clay - Moist			815	1-SS	5		3.5		12			
				2-SS	8		2.8		19			
POSSIBLE FILL: Brown Silty fine Sand - Moist		5		3-SS	11				13			
Brown lean Clay, little Sand, trace Gravel - Moist			810	4-SS	20	6.2	4.5+		10			
Brown lean Clay, trace Sand and Gravel - Moist					10	5-SS	23	8.2	4.5+			15
						6-SS	24	8.3	4.5+			16
Brown lean Clay, trace Sand and Gravel - Moist			805	7-SS	16	6.6	4.5+		16			
					15		800					
Gray lean Clay - Moist				8-SS	15	4.0	3.8		15			
Boring terminated at 21'												

<div>REMARKS</div>	<div>Water Levels</div> <div> <div>▽</div> <div>▼</div> </div> <div> <div>-</div> <div>-</div> </div>

		<h1>TEST BORING LOG</h1>		BORING #	
				<h2>3</h2>	
		PROJECT Proposed Residence		GENERAL LOCATION S69 W17741 Wildwood Drive	
PROJECT NO. 1G-2606016		PROJECT CITY, STATE Muskego, Wisconsin		DATE COMPLETED 06/17/2026	
DRILLER/PM Keith Flowers	RIG TYPE CME-550X	DRILLING CONTRACTOR Giles Engineering Associates, Inc.		LATITUDE -	LONGITUDE -

Material Description	Graphic Log	Depth (ft)	Elevation (ft)	Sample Type / No.	N-Value	Compressive Strength	Q _p (tsf)	Vane Shear (tsf)	WC (%)	Notes	
±8" TOPSOIL: Dark Brown Sandy Silt, trace Organic Matter - Moist				1-SS	5		1.0		11		
FILL: Brown Sandy Clay - Moist			815	2-SS	7	1.7	1.5		20		
Brown Silty Clay, little Sand - Very Moist		5		3-SS	6		2.3		23		
Brown lean Clay, little Sand and Gravel - Moist			810	4-SS	8		3.0		18		
		10		5-SS	13		3.5		19		
			805	6-SS	10	2.2	2.0		22		
		15		7-SS	21		4.5+		19		
Brown Silt - Moist			800								
Gray Silt - Wet			20	8-SS	40		4.5		17		
Boring terminated at 21'											

REMARKS	Water Levels
	▽ Water encountered @ 20'
	▽
	-

Form A – Highest Groundwater Table Determination Report

Project/Plat Name: Proposed Residence (Tax Key: MSKC2176073)

Date: June 26, 2026

Project Location (PLS/CSM#): S69W17741 Wildwood Drive, Muskego, Wisconsin

The following table summarizes my interpretation of the soil profile evaluations conducted on the above noted site. The purpose of this report is to demonstrate compliance with a Waukesha County ordinance requirement to maintain basement floor elevations at least 1 foot above the highest groundwater table. I understand that the definition for highest groundwater table means the upper limit of the zone of soil saturation caused by underlying groundwater at its highest level. I certify that the information presented in this report represents my best professional judgment in estimating the highest groundwater table elevation based on soil and site evaluations in accordance with the procedures contained in SPS 385 Wisconsin Administrative Code.



Interpreters Signature: _____

Colleen Finley

Interpreters Printed Name/Credentials/Lic.#: Colleen M. Finley, P.E. No. 100150-6

Interpreters CompanyName/Address: Giles Engineering Associates, Inc., N8 W22350 Johnson Drive, Suite A1, Waukesha, WI 53186

Site Benchmark/Elevation (Co. Stds.): Manhole in road on edge of lot is benchmark; benchmark elevation based on Waukesha County Land Information System Interactive Map Application, accessed online.

References: The following references apply to the data presented here: (1) Figure 1 for the soil test boring location; (2) National Cooperative Soil Survey (Web Soil Survey); (3) Waukesha County GIS Map

Lot #	Soil Observ. (#)	Surface Elev.	Bottom Elev. of Soil Profile	Soil Map Unit Symbol (NRCS)	Depth to Highest Ground-Water Table (Feet)	Proposed Basement Floor Elevation	Notes: List information used to determine the highest groundwater table, including any soil color pattern exemptions under SPS 385.30(3) for a basement floor proposed less than 1-foot above redoximorphic features shown in the referenced soil evaluation reports.
1	B1	818.5	797.5	OzaB	9	≥El. 814	Test Boring No. 1 (See attached Test Boring Logs)
1	B2	818.4	797.4	OzaB	18	≥El. 814	Test Boring No. 2 (See attached Test Boring Logs)
1	B3	818.3	797.3	OzaB	6.5	≥El. 814	Test Boring No. 3 (See attached Test Boring Logs)
Notes: (1) Lot No. above is referenced by the Waukesha County GIS (2) See attached Test Boring Location Plan (Figure 1) for test boring locations. (3) Surface elevation based on Giles' adopted benchmark shown on the <i>Test Boring Location Plan</i> . (4) NCRS Map Symbol per USDA Web Soil Survey (Current): 7530B= Ozaukee silt loam (5) Proposed lowest level basement floor elevation, provided above, is recommended by Giles Engineering Associates, Inc. The proposed lowest level basement floor elevation is 2 feet above the bottom elevation of the soil profile.							

APPENDIX B

FIELD PROCEDURES

The field operations were conducted in general accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) designation D

420 entitled "Standard Guide for Sampling Rock and Rock" and/or other relevant specifications. Soil samples were preserved and transported to *Giles'* laboratory in general accordance with the procedures recommended by ASTM designation D 4220 entitled "Standard Practice for Preserving and Transporting Soil Samples." Brief descriptions of the sampling, testing and field procedures commonly performed by *Giles* are provided herein.

GENERAL FIELD PROCEDURES

Test Boring Elevations

The ground surface elevations reported on the Test Boring Logs are referenced to the assumed benchmark shown on the Boring Location Plan (Figure 1). Unless otherwise noted, the elevations were determined with a conventional hand-level and are accurate to within about 1 foot.

Test Boring Locations

The test borings were located on-site based on the existing site features and/or apparent property lines. Dimensions illustrating the approximate boring locations are reported on the Boring Location Plan (Figure 1).

Water Level Measurement

The water levels reported on the Test Boring Logs represent the depth of “free” water encountered during drilling and/or after the drilling tools were removed from the borehole. Water levels measured within a granular (sand and gravel) soil profile are typically indicative of the water table elevation. It is usually not possible to accurately identify the water table elevation with cohesive (clayey) soils, since the rate of seepage is slow. The water table elevation within cohesive soils must therefore be determined over a period of time with groundwater observation wells.

It must be recognized that the water table may fluctuate seasonally and during periods of heavy precipitation. Depending on the subsurface conditions, water may also become perched above the water table, especially during wet periods.

Borehole Backfilling Procedures

Each borehole was backfilled upon completion of the field operations. If potential contamination was encountered, and/or if required by state or local regulations, boreholes were backfilled with an “impervious” material (such as bentonite slurry). Borings that penetrated pavements, sidewalks, etc. were “capped” with Portland Cement concrete, asphaltic concrete, or a similar surface material. It must, however, be recognized that the backfill material may settle, and the surface cap may subside, over a period of time. Further backfilling and/or re-surfacing by *Giles’* client or the property owner may be required.



FIELD SAMPLING AND TESTING PROCEDURES

Auger Sampling (AU)

Soil samples are removed from the auger flights as an auger is withdrawn above the ground surface. Such samples are used to determine general soil types and identify approximate soil stratifications. Auger samples are highly disturbed and are therefore not typically used for geotechnical strength testing.

Split-Barrel Sampling (SS) – (ASTM D-1586)

A split-barrel sampler with a 2-inch outside diameter is driven into the subsoil with a 140-pound hammer free-falling a vertical distance of 30 inches. The summation of hammer-blows required to drive the sampler the final 12-inches of an 18-inch sample interval is defined as the “Standard Penetration Resistance” or N-value is an index of the relative density of granular soils and the comparative consistency of cohesive soils. A soil sample is collected from each SPT interval.

Shelby Tube Sampling (ST) – (ASTM D-1587)

A relatively undisturbed soil sample is collected by hydraulically advancing a thin-walled Shelby Tube sampler into a soil mass. Shelby Tubes have a sharp cutting edge and are commonly 2 to 5 inches in diameter.

Bulk Sample (BS)

A relatively large volume of soils is collected with a shovel or other manually-operated tool. The sample is typically transported to *Giles’* materials laboratory in a sealed bag or bucket.

Dynamic Cone Penetration Test (DC) – (ASTM STP 399)

This test is conducted by driving a 1.5-inch-diameter cone into the subsoil using a 15-pound steel ring (hammer), free-falling a vertical distance of 20 inches. The number of hammer-blows required to drive the cone 1¾ inches is an indication of the soil strength and density, and is defined as “N”. The Dynamic Cone Penetration test is commonly conducted in hand auger borings, test pits and within excavated trenches.

- Continued -



GILES ENGINEERING ASSOCIATES, INC.

Ring-Lined Barrel Sampling – (ASTM D 3550)

In this procedure, a ring-lined barrel sampler is used to collect soil samples for classification and laboratory testing. This method provides samples that fit directly into laboratory test instruments without additional handling/disturbance.

Sampling and Testing Procedures

The field testing and sampling operations were conducted in general accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) and/or other relevant specifications. Results of the field testing (i.e. N-values) are reported on the Test Boring Logs. Explanations of the terms and symbols shown on the logs are provided on the appendix enclosure entitled "General Notes".



APPENDIX C

LABORATORY TESTING AND CLASSIFICATION

The laboratory testing was conducted under the supervision of a geotechnical engineer in accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) and/or other relevant specifications. Brief descriptions of laboratory tests commonly performed by *Giles* are provided herein.

LABORATORY TESTING AND CLASSIFICATION

Photoionization Detector (PID)

In this procedure, soil samples are “scanned” in *Giles’* analytical laboratory using a Photoionization Detector (PID). The instrument is equipped with an 11.7 eV lamp calibrated to a Benzene Standard and is capable of detecting a minute concentration of **certain** Volatile Organic Compound (VOC) vapors, such as those commonly associated with petroleum products and some solvents. Results of the PID analysis are expressed in HNu (manufacturer’s) units rather than actual concentration.

Moisture Content (w) (ASTM D 2216)

Moisture content is defined as the ratio of the weight of water contained within a soil sample to the weight of the dry solids within the sample. Moisture content is expressed as a percentage.

Unconfined Compressive Strength (qu) (ASTM D 2166)

An axial load is applied at a uniform rate to a cylindrical soil sample. The unconfined compressive strength is the maximum stress obtained or the stress when 15% axial strain is reached, whichever occurs first.

Calibrated Penetrometer Resistance (qp)

The small, cylindrical tip of a hand-held penetrometer is pressed into a soil sample to a prescribed depth to measure the soils capacity to resist penetration. This test is used to evaluate unconfined compressive strength.

Vane-Shear Strength (qs)

The blades of a vane are inserted into the flat surface of a soil sample and the vane is rotated until failure occurs. The maximum shear resistance measured immediately prior to failure is taken as the vane-shear strength.

Loss-on-Ignition (ASTM D 2974; Method C)

The Loss-on-Ignition (L.O.I.) test is used to determine the organic content of a soil sample. The procedure is conducted by heating a dry soil sample to 440°C in order to burn-off or “ash” organic matter present within the sample. The L.O.I. value is the ratio of the weight loss due to ignition compared to the initial weight of the dry sample. L.O.I. is expressed as a percentage.



Particle Size Distribution (ASTB D 421, D 422, and D 1140)

This test is performed to determine the distribution of specific particle sizes (diameters) within a soil sample. The distribution of coarse-grained soil particles (sand and gravel) is determined from a "sieve analysis," which is conducted by passing the sample through a series of nested sieves. The distribution of fine-grained soil particles (silt and clay) is determined from a "hydrometer analysis" which is based on the sedimentation of particles suspended in water.

Consolidation Test (ASTM D 2435)

In this procedure, a series of cumulative vertical loads are applied to a small, laterally confined soil sample. During each load increment, vertical compression (consolidation) of the sample is measured over a period of time. Results of this test are used to estimate settlement and time rate of settlement.

Classification of Samples

Each soil sample was visually-manually classified, based on texture and plasticity, in general accordance with the Unified Soil Classification System (ASTM D-2488-75). The classifications are reported on the Test Boring Logs.

Laboratory Testing

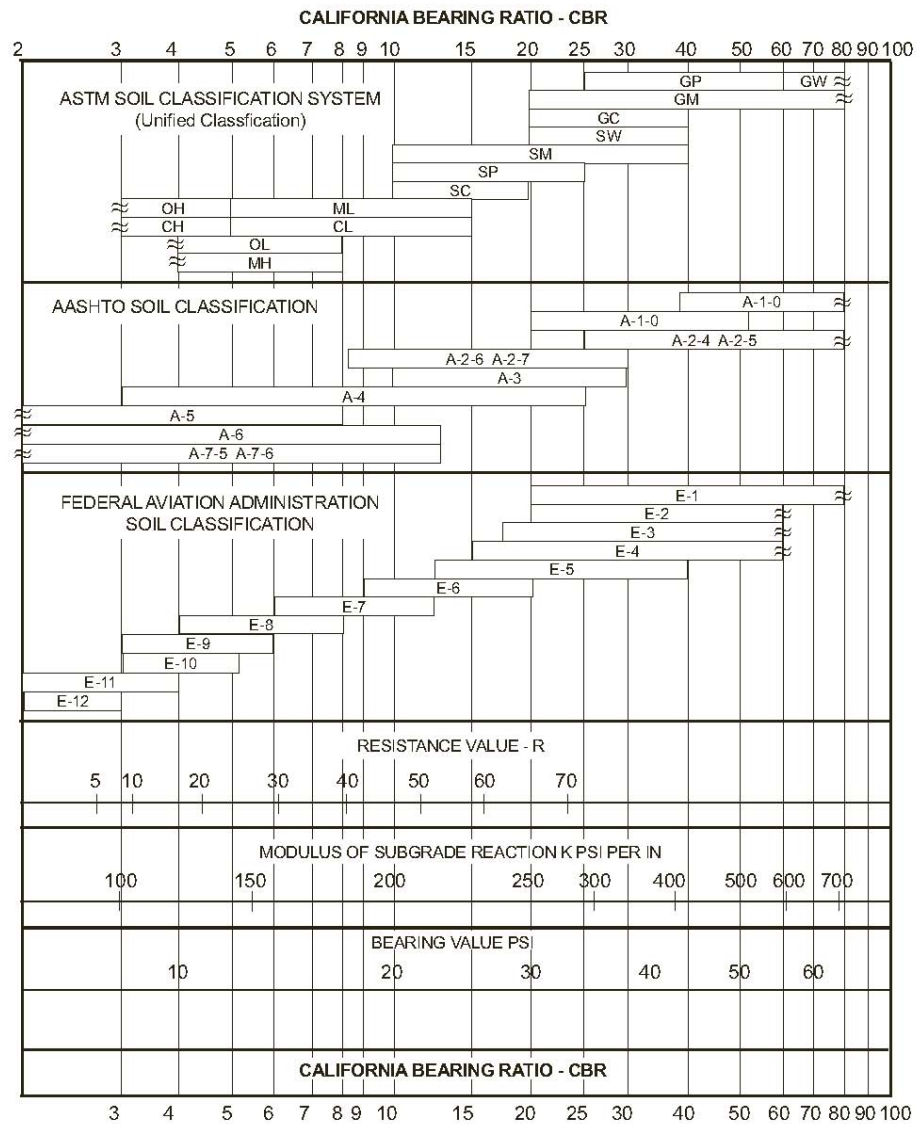
The laboratory testing operations were conducted in general accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) and/or other relevant specifications. Results of the laboratory tests are provided on the Test Boring Logs or other appendix enclosures. Explanation of the terms and symbols used on the logs is provided on the appendix enclosure entitled "General Notes."



California Bearing Ratio (CBR) Test ASTM D-1833

The CBR test is used for evaluation of a soil subgrade for pavement design. The test consists of measuring the force required for a 3-square-inch cylindrical piston to penetrate 0.1 or 0.2 inch into a compacted soil sample. The result is expressed as a percent of force required to penetrate a standard compacted crushed stone.

Unless a CBR test has been specifically requested by the client, the CBR is estimated from published charts, based on soil classification and strength characteristics. A typical correlation chart is below.



APPENDIX D

GENERAL INFORMATION

AND

IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL REPORT

GENERAL COMMENTS

The soil samples obtained during the subsurface exploration will be retained for a period of thirty days. If no instructions are received, they will be disposed of at that time.

This report has been prepared exclusively for the client in order to aid in the evaluation of this property and to assist the architects and engineers in the design and preparation of the project plans and specifications. Copies of this report may be provided to contractor(s), with contract documents, to disclose information relative to this project. The report, however, has not been prepared to serve as the plans and specifications for actual construction without the appropriate interpretation by the project architect, structural engineer, and/or civil engineer. Reproduction and distribution of this report must be authorized by the client and *Giles*.

This report has been based on assumed conditions/characteristics of the proposed development where specific information was not available. It is recommended that the architect, civil engineer and structural engineer along with any other design professionals involved in this project carefully review these assumptions to ensure they are consistent with the actual planned development. When discrepancies exist, they should be brought to our attention to ensure they do not affect the conclusions and recommendations provided herein. The project plans and specifications may also be submitted to *Giles* for review to ensure that the geotechnical related conclusions and recommendations provided herein have been correctly interpreted.

The analysis of this site was based on a subsoil profile interpolated from a limited subsurface exploration. If the actual conditions encountered during construction vary from those indicated by the borings, *Giles* must be contacted immediately to determine if the conditions alter the recommendations contained herein.

The conclusions and recommendations presented in this report have been promulgated in accordance with generally accepted professional engineering practices in the field of geotechnical engineering. No other warranty is either expressed or implied.



**GUIDE SPECIFICATIONS FOR SUBGRADE AND GRADE PREPARATION
FOR FILL, FOUNDATION, FLOOR SLAB AND PAVEMENT SUPPORT;
AND SELECTION, PLACEMENT AND COMPACTION OF FILL SOILS
USING STANDARD PROCTOR PROCEDURES**

1. Construction monitoring and testing of subgrades and grades for fill, foundation, floor slab and pavement; and fill selection, placement and compaction shall be performed by an experienced soils engineer and/or his representatives.
2. All compaction fill, subgrades and grades shall be (a) underlain by suitable bearing material; (b) free of all organic, frozen, or other deleterious material, and (c) observed, tested and approved by qualified engineering personnel representing an experienced soils engineer. Preparation of subgrades after stripping vegetation, organic or other unsuitable materials shall consist of (a) proof-rolling to detect soil, wet yielding soils or other unstable materials that must be undercut, (b) scarifying top 6 to 8 inches, (c) moisture conditioning the soils as required, and (d) recompaction to same minimum in-situ density required for similar materials indicated under Item 5. Note: compaction requirements for pavement subgrade are higher than other areas. Weather and construction equipment may damage compacted fill surface and reworking and retesting may be necessary to assure proper performance.
3. In overexcavation and fill areas, the compacted fill must extend (a) a minimum 1 foot lateral distance beyond the exterior edge of the foundation at bearing grade or pavement subgrade and down to compacted fill subgrade on a maximum 0.5(H):1(V) slope, (b) 1 foot above footing grade outside the building, and (c) to floor subgrade inside the building. Fill shall be placed and compacted on a 5(H):1(V) slope or must be stepped or benched as required to flatten if not specifically approved by qualified personnel under the direction of an experienced soil engineer.
4. The compacted fill materials shall be free of deleterious, organic, or frozen matter, shall contain no chemicals that may result in the material being classified as "contaminated", and shall be low-expansive with a maximum Liquid Limit (ASTM D-423) and Plasticity Index (ASTM D-424) of 30 and 15, respectively, unless specifically tested and found to have low expansive properties and approved by an experienced soils engineer. The top 12 inches of compacted fill should have a maximum 3-inch-particle diameter and all underlying compacted fill a maximum 6-inch-diameter unless specifically approved by an experienced soils engineer. All fill materials must be tested and approved under the direction of an experienced soils engineer prior to placement. If the fill is to provide non-frost susceptible characteristics, it must be classified as a clean GW, GP, SW or SP per the Unified Soil Classification System (ASTM D-2487).
5. For structural fill depths less than 20 feet, the density of the structural compacted fill and scarified subgrade and grades shall not be less than 95 percent of the maximum dry density as determined by Standard Proctor (ASTM-698) with the exception of the top 12 inches of pavement subgrade which shall have a minimum in-situ density of 100 percent of maximum dry density, or 5 percent higher than underlying fill materials. Where the structural fill depth is greater than 20 feet, the portions below 20 feet should have a minimum in-place density of 100 percent of its maximum dry density of 5 percent greater than the top 20 feet. The moisture content of cohesive soil shall not vary by more than -1 to +3 percent and granular soil ± 3 percent of the optimum when placed and compacted or recompacted, unless specifically recommended/approved by the soils engineer monitoring the placement and compaction. Cohesive soils with moderate to high expansion potentials ($PI > 15$) should, however, be placed, compacted and maintained prior to construction at a moisture content 3 ± 1 percent above optimum moisture content to limit further heave. The fill shall be placed in layers with a maximum loose thickness of 8 inches for foundations and 10 inches for floor slabs and pavement, unless specifically approved by the soils engineer taking into consideration the type of materials and compaction equipment being used. The compaction equipment should consist of suitable mechanical equipment specifically designed for soil compaction. Bulldozers or similar tracked vehicles are typically not suitable for compaction.
6. Excavation, filling, subgrade and grade preparation shall be performed in a manner and sequence that will provide drainage at all times and proper control of erosion. Precipitation, springs and seepage water encountered shall be pumped or drained to provide a suitable working platform. Springs or water seepage encountered during grading/foundation construction must be called to the soil engineer's attention immediately for possible construction procedure revision or inclusion of an underdrain system.
7. Non-structural fill adjacent to structural fill should typically be placed in unison to provide lateral support. Backfill along walls must be placed and compacted with care to ensure excessive unbalanced lateral pressures do not develop. The type of fill material placed adjacent to below-grade walls (i.e. basement walls and retaining walls) must be properly tested and approved by an experienced soils engineer with consideration for the lateral pressure used in the wall design.
8. Whenever, in the opinion of the soils engineer or the Owner's Representatives, an unstable condition is being created either by cutting or filling, the work shall not proceed into that area until an appropriate geotechnical exploration and analysis has been performed and the grading plan revised, if found necessary.



CHARACTERISTICS AND RATINGS OF UNIFIED SOIL SYSTEM CLASSES FOR SOIL CONSTRUCTION *									
Class	Compaction Characteristics	Max. Dry Density Standard Proctor (pcf)	Compressibility and Expansion	Drainage and Permeability	Value as an Embankment Material	Value as Subgrade When Not Subject to Frost	Value as Base Course	Value as Temporary Pavement	
								With Dust Palliative	With Bituminous Treatment
GW	Good: tractor, rubber-tired, steel wheel or vibratory roller	125-135	Almost none	Good drainage, pervious	Very stable	Excellent	Good	Fair to poor	Excellent
GP	Good: tractor, rubber-tired, steel wheel or vibratory roller	115-125	Almost none	Good drainage, pervious	Reasonably stable	Excellent to good	Poor to fair	Poor	
GM	Good: rubber-tired or light sheepsfoot roller	120-135	Slight	Poor drainage, semipervious	Reasonably stable	Excellent to good	Fair to poor	Poor	Poor to fair
GC	Good to fair: rubber-tired or sheepsfoot roller	115-130	Slight	Poor drainage, impervious	Reasonably stable	Good	Good to fair **	Excellent	Excellent
SW	Good: tractor, rubber-tired or vibratory roller	110-130	Almost none	Good drainage, pervious	Very stable	Good	Fair to poor	Fair to poor	Good
SP	Good: tractor, rubber-tired or vibratory roller	100-120	Almost none	Good drainage, pervious	Reasonably stable when dense	Good to fair	Poor	Poor	Poor to fair
SM	Good: rubber-tired or sheepsfoot roller	110-125	Slight	Poor drainage, impervious	Reasonably stable when dense	Good to fair	Poor	Poor	Poor to fair
SC	Good to fair: rubber-tired or sheepsfoot roller	105-125	Slight to medium	Poor drainage, impervious	Reasonably stable	Good to fair	Fair to poor	Excellent	Excellent
ML	Good to poor: rubber-tired or sheepsfoot roller	95-120	Slight to medium	Poor drainage, impervious	Poor stability, high density required	Fair to poor	Not suitable	Poor	Poor
CL	Good to fair: sheepsfoot or rubber-tired roller	95-120	Medium	No drainage, impervious	Good stability	Fair to poor	Not suitable	Poor	Poor
OL	Fair to poor: sheepsfoot or rubber-tired roller	80-100	Medium to high	Poor drainage, impervious	Unstable, should not be used	Poor	Not suitable	Not suitable	Not suitable
MH	Fair to poor: sheepsfoot or rubber-tired roller	70-95	High	Poor drainage, impervious	Poor stability, should not be used	Poor	Not suitable	Very poor	Not suitable
CH	Fair to poor: sheepsfoot roller	80-105	Very high	No drainage, impervious	Fair stability, may soften on expansion	Poor to very poor	Not suitable	Very poor	Not suitable
OH	Fair to poor: sheepsfoot roller	65-100	High	No drainage, impervious	Unstable, should not be used	Very poor	Not suitable	Not suitable	Not suitable
Pt	Not suitable		Very high	Fair to poor drainage	Should not be used	Not suitable	Not suitable	Not suitable	Not suitable

* "The Unified Classification: Appendix A - Characteristics of Soil, Groups Pertaining to Roads and Airfields, and Appendix B - Characteristics of Soil Groups Pertaining to Embankments and Foundations," Technical Memorandum 357, U.S. Waterways Experiment Station, Vicksburg, 1953.

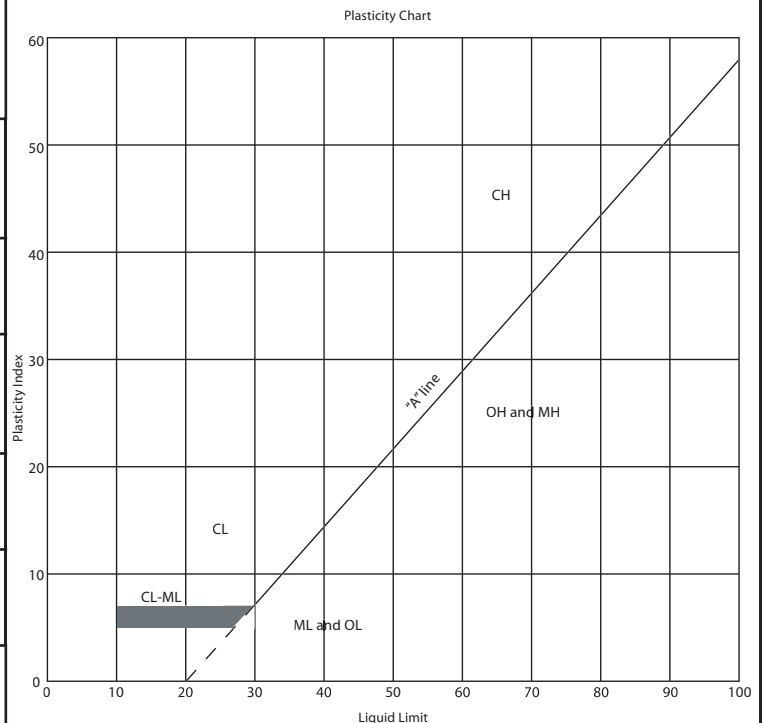
** Not suitable if subject to frost.



UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

Major Divisions		Group Symbols	Typical Names	Laboratory Classification Criteria	
Coarse-grained soils (more than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Not meeting all gradation requirements for GW
		Gravels with fines (appreciable amount of fines)	GM ^a d	Silty gravels, gravel-sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 Limits plotting within shaded area, above "A" line with P.I. between 4 and 7 are <i>borderline</i> cases requiring use of dual symbols
			GM ^a u		
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits above "A" line or P.I. greater than 7
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3
			SP	Poorly graded sands, gravelly sands, little or no fines	Not meeting all gradation requirements for SW
		Sands with fines (Appreciable amount of fines)	SM ^a d	Silty sands, sand-silt mixtures	Atterberg limits below "A" line or P.I. less than 4 Limits plotting within shaded area, above "A" line with P.I. between 4 and 7 are <i>borderline</i> cases requiring use of dual symbols
			SM ^a u		
			SC	Clayey sands, sand-clay mixtures	Atterberg limits above "A" line or P.I. greater than 7
Fine-grained soils (More than half material is smaller than No. 200 sieve size)	Sils and clays (Liquid limit less than 50)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity		
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays		
		OL	Organic silts and organic silty clays of low plasticity		
	Sils and clays (Liquid limit greater than 50)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
		CH	Inorganic clays of high plasticity, fat clays		
		OH	Organic clays of medium to high plasticity, organic silts		
	Highly organic soils	Pt	Peat and other highly organic soils		

Determine percentages of sand and gravel from grain-size curve.
 Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:
 Less than 5 percent: GW, GP, SW, SP
 More than 12 percent: GM, GC, SM, SC
 Borderline cases requiring dual symbols^b



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

^b Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example GW-GC, well-graded gravel-sand mixture with clay binder.

GENERAL NOTES

SAMPLE IDENTIFICATION

All samples are visually classified in general accordance with the Unified Soil Classification System (ASTM D-2487-75 or D-2488-75)

DESCRIPTIVE TERM (% BY DRY WEIGHT)

Trace:	1-10%
Little:	11-20%
Some:	21-35%
And/Adjective	36-50%

PARTICLE SIZE (DIAMETER)

Boulders:	8 inch and larger
Cobbles:	3 inch to 8 inch
Gravel:	coarse - ¾ to 3 inch fine - No. 4 (4.76 mm) to ¾ inch
Sand:	coarse - No. 4 (4.76 mm) to No. 10 (2.0 mm) medium - No. 10 (2.0 mm) to No. 40 (0.42 mm) fine - No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt:	No. 200 (0.074 mm) and smaller (non-plastic)
Clay:	No 200 (0.074 mm) and smaller (plastic)

SOIL PROPERTY SYMBOLS

Dd:	Dry Density (pcf)
LL:	Liquid Limit, percent
PL:	Plastic Limit, percent
PI:	Plasticity Index (LL-PL)
LOI:	Loss on Ignition, percent
Gs:	Specific Gravity
K:	Coefficient of Permeability
w:	Moisture content, percent
qp:	Calibrated Penetrometer Resistance, tsf
qs:	Vane-Shear Strength, tsf
qu:	Unconfined Compressive Strength, tsf
qc:	Static Cone Penetrometer Resistance (correlated to Unconfined Compressive Strength, tsf)
PID:	Results of vapor analysis conducted on representative samples utilizing a Photoionization Detector calibrated to a benzene standard. Results expressed in HNU-Units. (BDL=Below Detection Limit)

N:	Penetration Resistance per 12 inch interval, or fraction thereof, for a standard 2 inch O.D. (1½ inch I.D.) split spoon sampler driven with a 140 pound weight free-falling 30 inches. Performed in general accordance with Standard Penetration Test Specifications (ASTM D-1586). N in blows per foot equals sum of N-Values where plus sign (+) is shown.
Nc:	Penetration Resistance per 1¾ inches of Dynamic Cone Penetrometer. Approximately equivalent to Standard Penetration Test N-Value in blows per foot.
Nr:	Penetration Resistance per 12 inch interval, or fraction thereof, for California Ring Sampler driven with a 140 pound weight free-falling 30 inches per ASTM D-3550. Not equivalent to Standard Penetration Test N-Value.

DRILLING AND SAMPLING SYMBOLS

SS:	Split-Spoon
ST:	Shelby Tube - 3 inch O.D. (except where noted)
CS:	3 inch O.D. California Ring Sampler
DC:	Dynamic Cone Penetrometer per ASTM Special Technical Publication No. 399
AU:	Auger Sample
DB:	Diamond Bit
CB:	Carbide Bit
WS:	Wash Sample
RB:	Rock-Roller Bit
BS:	Bulk Sample
Note:	Depth intervals for sampling shown on Record of Subsurface Exploration are not indicative of sample recovery, but position where sampling initiated

SOIL STRENGTH CHARACTERISTICS

COHESIVE (CLAYEY) SOILS

COMPARATIVE CONSISTENCY	BLOWS PER FOOT (N)	UNCONFINED COMPRESSIVE STRENGTH (TSF)
Very Soft	0 - 2	0 - 0.25
Soft	3 - 4	0.25 - 0.50
Medium Stiff	5 - 8	0.50 - 1.00
Stiff	9 - 15	1.00 - 2.00
Very Stiff	16 - 30	2.00 - 4.00
Hard	31+	4.00+

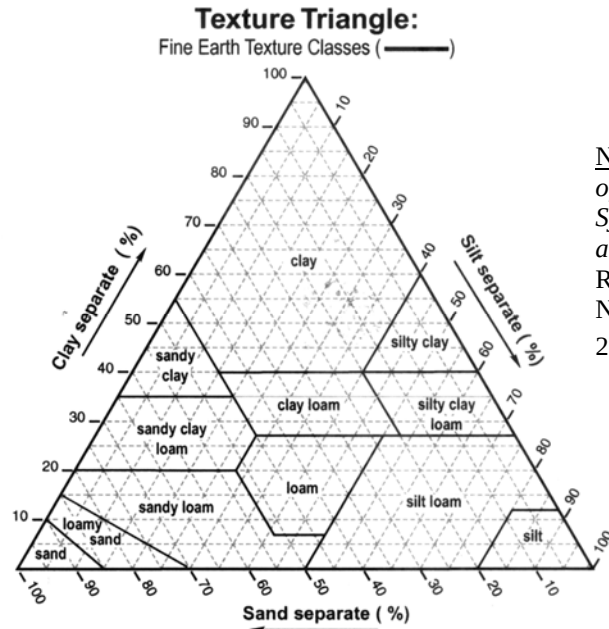
NON-COHESIVE (GRANULAR) SOILS

RELATIVE DENSITY	BLOWS PER FOOT (N)
Very Loose	0 - 4
Loose	5 - 10
Firm	11 - 30
Dense	31 - 50
Very Dense	51+

DEGREE OF PLASTICITY	PI	DEGREE OF EXPANSIVE POTENTIAL	PI
None to Slight	0 - 4	Low	0 - 15
Slight	5 - 10	Medium	15 - 25
Medium	11 - 30	High	25+
High to Very High	31+		



SOIL CLASSIFICATION NOTES



Note: Texture Triangle and Comparison of Particle Size Classes in Different Systems from *Field Book for Describing and Sampling Soil*, USDA Natural Resources Conservation Service National Soil Survey Center (September 2002).

Comparison of Particle Size Classes in Different Systems

	FINE EARTH										ROCK FRAGMENTS									
	Clay ²		Silt		Sand						Gravel			Cob- bles		Stones	Boulders			
USDA ¹	fine	co.	fine	co.	v. fi.	fi.	med.	co.	v. co.	fine	medium	coarse								
	150	380	600 mm																	
millimeters:	0.0002	.002 mm			.02	.05	.1	.25	.5	1	2 mm	5	20	76	250	600 mm				
U.S. Standard Sieve No. (opening):																				

- Soil Survey Staff. 1995. Soil survey Laboratory information manual. USDA, Natural Resources Conservation Service, Soil Survey Investigations Report No. 45, Version 1.0, National Soil Survey Center, Lincoln, NE. 305 p.
- Soil Survey Staff. 1995. Soil Survey Lab information manual. USDA-NRCS, Soil Survey Investigation Report #45, version 1.0, National Soil Survey Center, Lincoln, NE. Note: Mineralogy studies may subdivide clay into three size ranges; fine (<0.08µm), medium (0.08-0.2µm), and coarse (0.2-2µm); Jackson, 1969.
- The Soil Survey Lab (Lincoln, NE) uses a no. 300 sieve (0.047 mm opening) for the USDA-sand/silt measurement. A no. 270 sieve (0.053 mm opening) is more readily available and widely used.
- International Soil Science Society. 1951. *In: Soil Survey Manual*. Soil Survey Staff, USDA-Soil Conservation Service, Agricultural Handbook No. 18, U.S. Gov. Print. Office, Washington, D.C. 214 p.
- ASTM. 1993. Standard classification of soils for engineering purposes (Unified Soil Classification System). ASTM designation D2487-92. *In: Soil and rock; dimension stone; geosynthetics*. Annual book of ASTM standards-Vol. 04.08.
- AASHTO. 1986a. Recommended practice for the classification of soils and soil-aggregate mixtures for highway construction purposes. AASHTO designation M145-82. *In: Standard specifications for transportation materials and methods of sampling and testing; Part 1: Specifications* (14th ed.). American Association of State Highway and Transportation Officials, Washington, D.C.
- AASHTO. 1986b. Standard definitions of terms relating to subgrade, soil-aggregate, and fill materials. AASHTO designation M146-70 (1980). *In: sampling and testing; Part 1: Specifications* (14th ed.). American Association of State Highway and Transportation Officials, Washington, D.C.
- Ingram, R.L. 1982. Modified Wentworth scale. *In: Grain-size scales*. AGI Date Sheet 29.1. *In: Dutro, J.T., Dietrich, R.V., and Foote, R.M.* 1989. AGI data sheets for geology in the field, laboratory, and office, 3rd edition. American Geological Institute, Washington, D.C.



Important Information about This Geotechnical-Engineering Report

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

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer

will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the “Findings” Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site’s subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual site-wide subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report’s Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals’ misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals’ plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note*

conspicuously that you’ve included the material for information purposes only. To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a “phase-one” or “phase-two” environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer’s services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer’s recommendations will not of itself be sufficient to prevent moisture infiltration.* Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. *Geotechnical engineers are not building-envelope or mold specialists.*



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