Capital Geotechnical Services PLLC

STATE OF TEXAS
7/23/24
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Subsurface Exploration and Geotechnical Evaluation

New Masjid at 800 N. Heatherwilde Blvd.
Pflugerville, Texas

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Capital Geotechnical Services Project # 24-0034

July 23, 2024

New Masjid at 800 N. Heatherwilde Blvd., Pflugerville, Texas
Capital Geotechnical Services Project #24-0034

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SCOPE

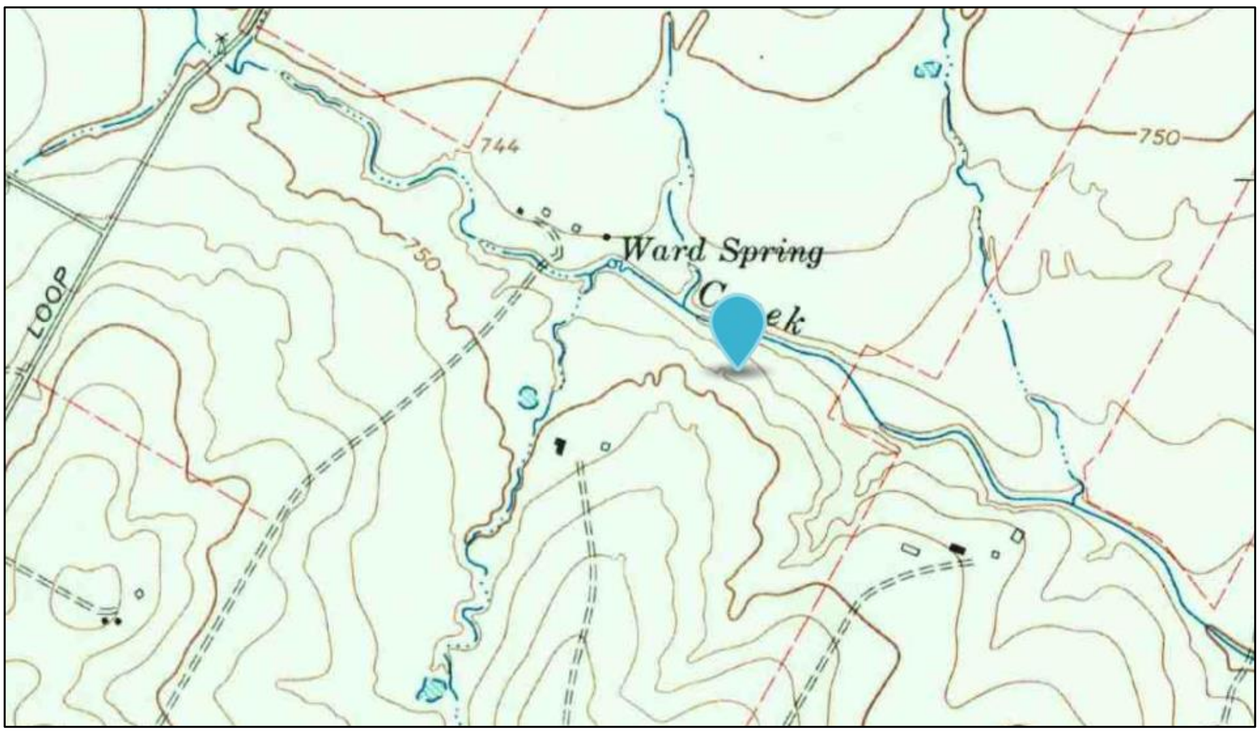
This report presents the results of a geotechnical evaluation for a new masjid (mosque) building on an urban lot in Pflugerville, Texas. Our services were performed to evaluate generalized subsurface conditions, provide recommendations for the design and construction of the foundation system, and to provide recommendations for site preparation design and pavement thickness design. Capital Geotechnical Services PLLC performed this subsurface exploration and geotechnical evaluation in accordance with our proposal #23-098 authorized (signed) on February 22, 2024. The scope of services included the determination of generalized subsurface conditions based on the results of soil sampling and laboratory testing, an evaluation of the subsurface conditions relative to the proposed construction, and the preparation of a geotechnical report. This report includes results, evaluations, and recommendations concerning earthwork, foundations, groundwater, pavement, retaining walls, quality control testing, and other geotechnical related aspects of the project.

The scope of services did not include an environmental site assessment (ESA) for the presence or absence of wetland or hazardous or toxic materials in the soil, air, surface water, or groundwater at this site.

SITE LOCATION AND CONDITIONS

The project site is a 4.73-acre lot located on the west side of Heatherwilde Blvd. in the central area of Pflugerville in Travis County, Texas (Figure 1 and Figure 2). The site was commonly a clear field with scattered trees. The topography slopes gently down toward the north-northeast toward Gilleland Creek.


The USGS topographic map shows no indication of any potentially backfilled pre-existing pond, quarry pit, or landfill at the site at the time the map was made (see graphic).



LANDFILL LITERATURE REVIEW

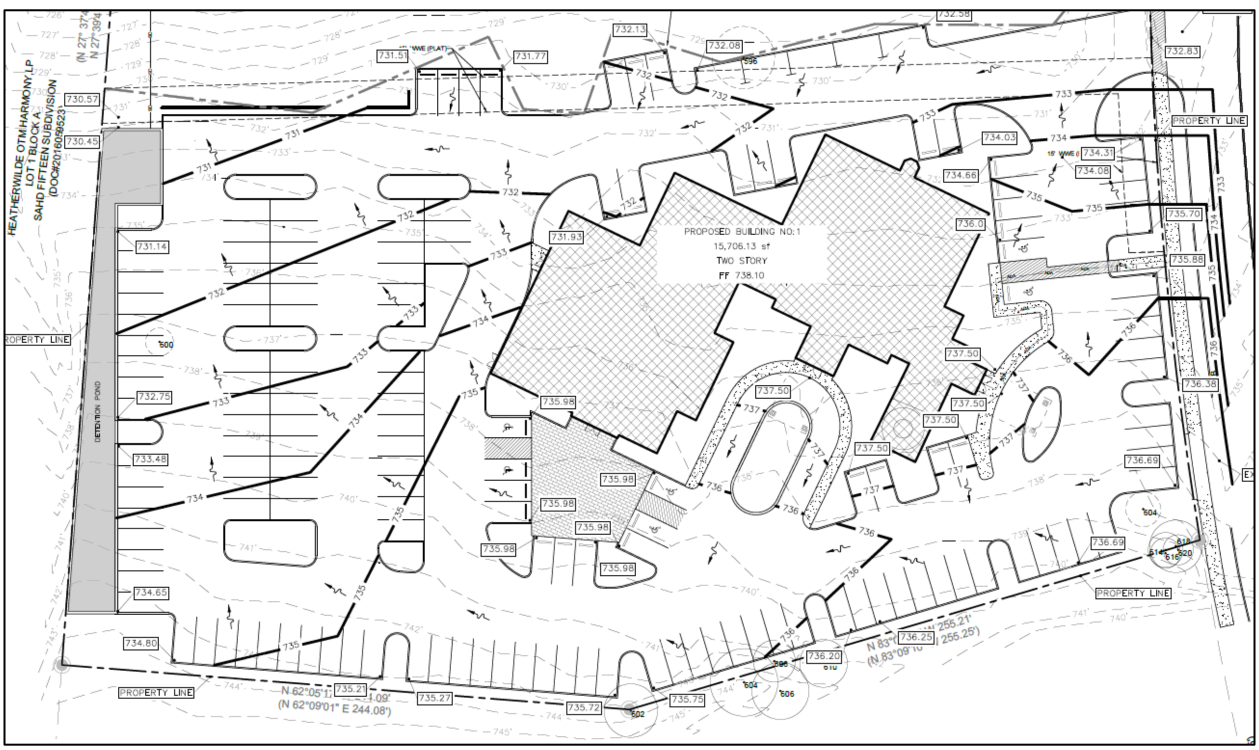
The City of Austin 2004 Supplemental Assessment: *Landfills in the Vicinity of Austin, Texas,* and the 2002 CAPCO (Capital Area Planning Council; now the Capital Area Council of Governments) *Closed and Abandoned Landfill Inventory* report (and the 2010 update) for Travis

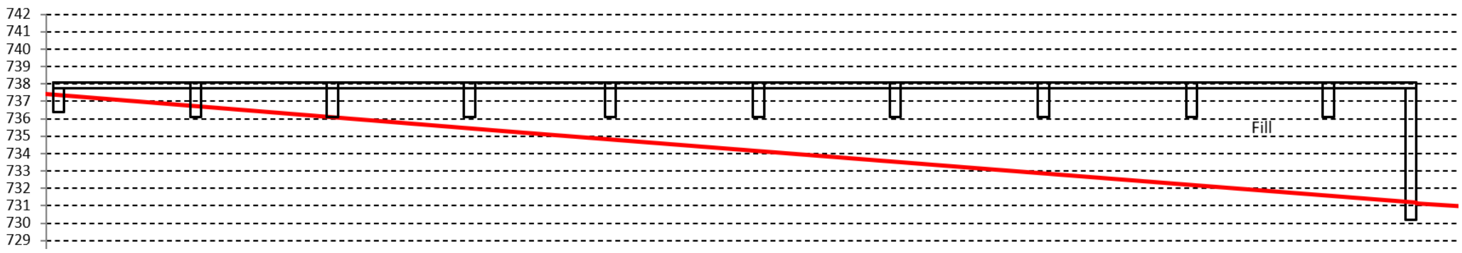
County were reviewed and there were no small landfills (dumps) identified in the area of the subject property.

PROPOSED DEVELOPMENT AND CONSTRUCTION

The planned development includes a tall 1-story mosque (masjid) building with associated parking lot paving and new perimeter retaining walls. A site plan was provided to Capital Geotechnical Services and was used for the boring location plan (Figure 4). Information concerning structural loads was not provided to Capital Geotechnical Services. We understand the building will include CMU walls, interior wood framing, and some steel framing. We expect steel column loads to not exceed 100,000 lbs. We expect perimeter CMU wall loads to not exceed 4,000 lbs per foot.

Based on the planned finished floor (FF) elevation of 738.1 feet, 4 inches to 6 ½ feet of fill will be required in the building area to reach the proposed slab subgrade elevation. A conceptual elevation profile for the slab area is presented on the following page. Minor fill grading will be required along the north pavement area and northeast pavement area, and deep cuts will be required at the southwest and south regions of the property. A retaining wall will likely be required along the south edge of the south property line or south pavement area where 6 to 8 feet of cut appears required.





If the planned construction varies from what is described in this report, Capital Geotechnical Services must be contacted to determine if revisions to our recommendations are required.

GEOLOGY AND SOIL MAPPING INFORMATION

According to the USDA Natural Resources Conservation Service shallow soil mapping information (*Soil Survey of Travis County, Texas)*, the shallow soils of the project site might be a member of the “Eddy” soil series across most of the site and the “Oakalla” series along the stream valley. The “Eddy” soil generally classifies according to the USCS as clayey gravel (GC), is only 3 to 15 inches thick (essentially a topsoil) and is mapped over limestone formation materials (i.e. dark brown to gray topsoil with pale colored rock fragments). The “Oakalla” soil is a clay (CL, CH) that is stated to commonly be several feet thick and is mapped as alluvial clay in drainage valleys. This thicker clay is likely present in the north area of site beyond the planned pavement area.

According to available geology mapping information by the U.T. Bureau of Economic Geology, the site is located in the east area of the “Balcones Escarpment” (fault zone) geologic physiographic province and consists of possible clay, chalky clay-marl, marly limestone chalk, and limestone chalk rock sedimentary deposits categorized as the “Austin Group” geologic formation (also known as “Austin Chalk” formation). A geology map is provided in Figure 3.

SUBSURFACE EXPLORATION

Thirteen (13) exploratory borings were drilled to evaluate soil conditions and depth to hard chalk rock. The boring locations were selected and staked in the field by Capital Geotechnical Services by using a hand-held GPS receiver. The borings were drilled on April 1, April 6, and April 8, 2024, to depths ranging from 4.5 feet to 12.2 feet below existing grades at the approximate locations indicated in Figure 4. Drilling was performed using a truck-mounted drill rig equipped with 4-inch diameter continuous flight solid stem augers, a steel tube sampler, and a split-spoon sampler. A hammer weighing 140 pounds falling 30 inches was used to drive the split-spoon sampler and Texas Cone Penetrometer. Standard penetration tests (SPT) and TCPs were performed using an auto-hammer. Boreholes were backfilled with available auger cuttings and imported soil. The soil samples were delivered to our laboratory where they were visually classified by a Geotechnical Engineer and selected samples were subjected to laboratory testing. Detailed boring logs are provided as Figures 5 through 17.

LABORATORY TESTING

Representative soil samples were selected and tested to assist the visual classifications and to determine pertinent engineering and physical characteristics. Tests were performed in general accordance with applicable ASTM standards. Results of the laboratory tests are included on the boring logs. Specialized testing to determine the presence of chemicals in soil samples (e.g., sulfates, chlorides) was not requested. A Geotechnical Engineer classified each soil sample on the basis of texture and plasticity in accordance with the Unified Soil Classification System (USCS). The USCS group symbols for each soil type are indicated in parentheses following the soil descriptions on the boring logs.

Expansive properties of 3 samples of clay soil were evaluated by performing swell tests. The test consists of placing a relatively undisturbed sample or a remolded specimen in a rigid ring after some air-drying of the initial bulk sample, applying a light seating load or a surcharge pressure simulating overburden pressure, allowing the sample to absorb water, and measuring the vertical heave of the sample while not allowing horizontal (lateral) strain. The results of such testing are used by the Geotechnical Engineer to help properly evaluate the clay mineralogy and the shrink-swell behavior of the clay soil.

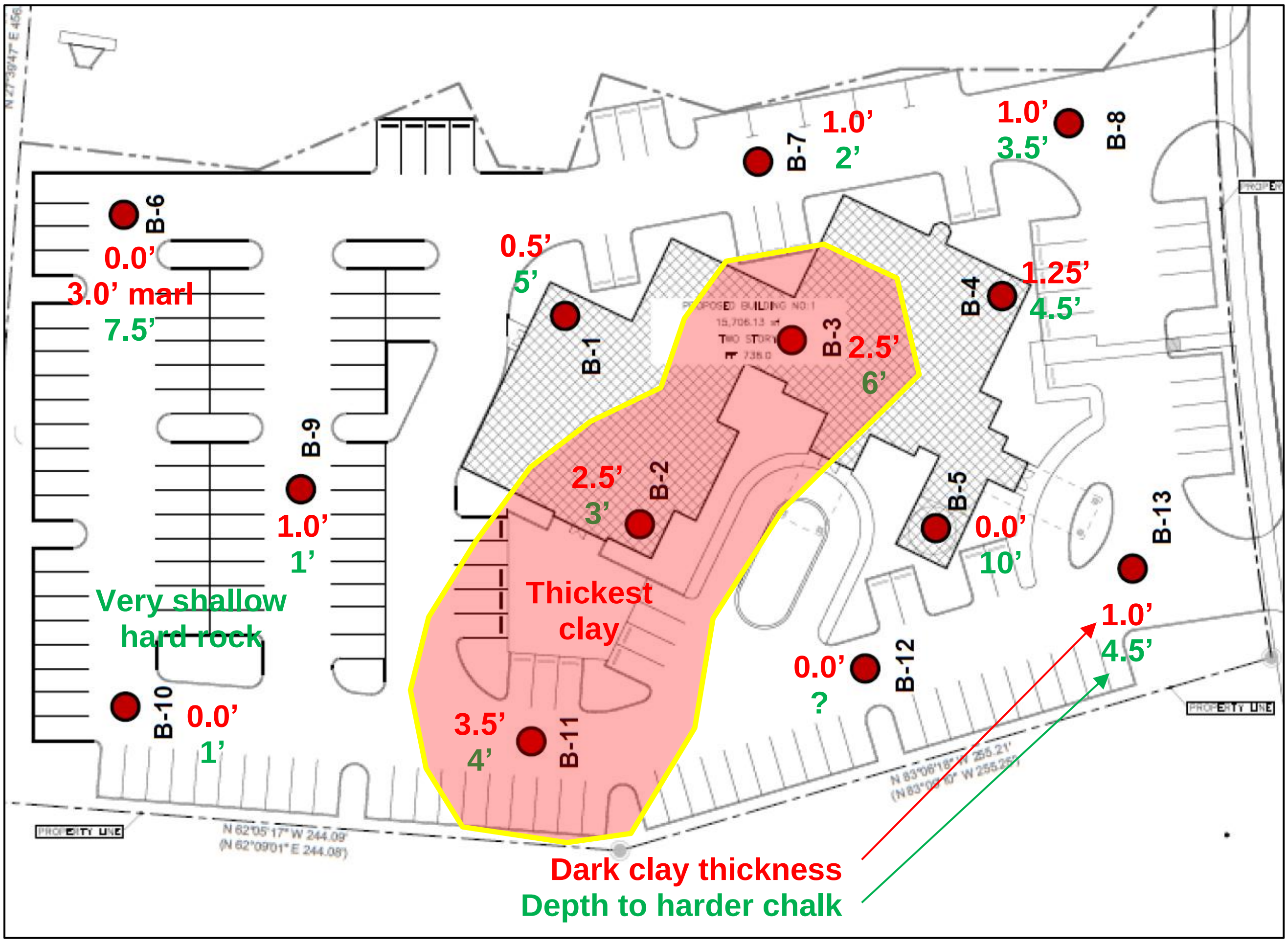
Soil samples that remain after testing will be kept for 3 weeks after the date of this report. Samples will then be discarded unless we receive instructions regarding their disposition.

SUBSURFACE CONDITIONS

Information from the exploratory borings indicates that the subsurface stratigraphy might generally consist of 3 and occasionally 4 distinguishable strata above a depth of 15 feet. The characteristics of these strata are summarized in the following paragraphs.

Stratum A: Dark Clay

Some of the site (9 to 13 locations explored) is covered with 1 to 3 ½ feet of dark brown and dark grayish brown moderately plastic clay (CH) with occasional or variable sand content and trace rock fragment content. The locations of the thicker soil are presented in the following graphic. Four samples were tested to determine plasticity (Atterberg limits) and yielded a liquid limit (LL) of 55%, 59% (x2) and 60%, and a plasticity index (PI) of 29 (x2) and 31 (x2).



One remolded specimen was subjected to swell testing under 62 psf seating pressure and exhibited 11.3% vertical swell (Figure 19) from an initially very stiff condition (PP=4.5+ tsf) and low moisture condition (LI = -0.379), indicating the clay mineralogy has relatively moderate swelling (and shrinkage) potential. One relatively undisturbed sample was subjected to swell testing under 125 psf surcharge pressure and exhibited 7.0% vertical swell (Figure 20) from an initially very stiff condition and low moisture condition, indicating the clay mineralogy has relatively moderate swelling and shrinkage potential.

Stratum B1: Weathered Limestone Chalk Materials

The dark clay topsoil and surface stratum soil is underlain by very pale brown, white, pale yellowish brown, pale brown, and pale gray weathered limestone chalk materials. The chalk materials are occasionally exposed at the surface. The material is hard as evident by the TCP results and one SPT result. One sample of disturbed material (e.g. processed material) was tested to determine plasticity and yielded a LL of 39% and a PI of 21. One disturbed sample was tested to determine basic gradation of processed material and yielded 68% fines content (silt and clay), 27% sand, and 5% rock fragments. The hard residual soil and weathered material is expected to classify as mixtures of GM, GC, SM, SC, ML-CL, and CL class soils.

Stratum B2: Clay-Marl

At B-6 only, a layer of pale gray and pale brown moderately plastic clay-marl (CH) was encountered 3 to 6 feet below existing grade. One sample was tested to determine plasticity and yielded a LL of 54% and a PI of 33. One remolded specimen was subjected to swell testing under 625 psf simulated overburden pressure and exhibited 2.5% vertical swell (Figure 19) from an initially very stiff condition and moderate moisture condition, indicating the clay mineralogy has relatively moderate swelling and shrinkage potential if unloaded, or low potential under the overburden pressure.

Stratum C: Limestone Chalk Rock

Hard chalk rock was encountered at all boring locations. The thickness of the weathered or occasionally marly chalk zone, varies across the site. Hard chalk was evident as shallow as 1 foot to as deep as 10 feet, but very hard chalk rock (auger refusal) was 4 ½ to 12 feet deep depending on location. TCP results were frequently 50/0.5" to 50/0", and occasionally 50/1". The chalk rock is white, very pale brown, and pale brownish gray.

The stream valley north of the site exposed the hard to very hard limestone chalk rock along the bed and lower banks.

The above descriptions are of a generalized nature to highlight the major subsurface stratification features and soil and rock characteristics. The boring logs provided in the Appendix should be reviewed for specific information at each location. The stratification of the soil and rock represents our interpretation of the subsurface conditions at the boring locations based on observations of the soil and rock cuttings samples by a Geotechnical Engineer. Variations from the conditions shown on the boring logs could occur in areas in between borings or in areas around the borings. The stratification lines shown in the boring logs represent approximate boundaries between soil and rock types and condition, and the transitions might be gradual rather than distinct. It is sometimes difficult to identify changes in stratification within narrow limits. It might also be difficult to distinguish between fill and discolored natural soil deposits if foreign substances are not present.

Groundwater was not encountered in our exploratory borings at the time of drilling. Groundwater, however, can be temporary instead of perennial. Although groundwater was not encountered during the drilling and sampling operation, our experience requires us to emphasize that groundwater can still appear later (e.g. during construction). The Owner and General

Contractor should not be surprised if groundwater appears and requires temporary mitigation measures. Groundwater can develop after periods of rain and can develop after construction in response to landscaping irrigation or changes to nearby drainage conditions. Groundwater presence can fluctuate seasonally in the project area due to variations in precipitation, runoff, evaporation, irrigation on nearby properties, and other factors that affect groundwater recharge such as water levels in nearby creeks, ponds, and streams. Perched groundwater can be encountered in localized zones of the subsurface profile because of the presence of relatively low permeability rock. Perched groundwater can be encountered on top of hard rock after periods of heavy rainfall. Seasonal variations in precipitation and changes in site grading could influence the groundwater precense at the site. Water levels at later dates could be different from those observed during the subsurface exploration.

POTENTIAL MOVEMENT OF THE CLAY SOILS

The clay soils within the zone of seasonal moisture change (or within a potential active zone) will experience changes in condition due to changes in environmental conditions (rainfall quantities and frequency; temperature; evaporation; tree roots) and man-made conditions (leaking water lines; irrigation; poor drainage) that affect the moisture content of the clay soils. The clay soil near the surface (Stratum A) will harden, shrink, and crack when subjected to drying, swell when subjected to wetting, and soften when subjected to saturation. Where clay-marl is occasionally present (e.g. B-6) the marl can increase the PVR.

The TxDOT Potential Vertical Rise (PVR) index (Tex-124-E) considering existing conditions and existing overburden pressure was calculated to be 0 to ½ inch across much of the site but up to 1 to 1 ¼ inches at the surface where the Stratum A clay is 2 ½ to 3 ½ feet thick. It was assumed that the clay would be in an initially “dry” condition as defined by the method at the time of construction. Note that the TxDOT PVR method assumes limited wetting occurs and should only be used as an index tool for comparing sites. The TxDOT PVR value should not be considered an estimate of maximum potential vertical heave.

Using reasonable estimates of relatively dry and relatively moist moisture content profiles and physical properties of the clay soil discerned from swell testing, the swelling potential of the clay soils was calculated to be less than 1 inch in many areas and up to 1 ¼ inches at the surface where the clay is 2 ½ to 3 ½ feet thick and if the moisture content changes between a relatively dry condition and a relatively moist condition. The design PVR does not consider extreme moisture change conditions (i.e. 200-year to 500-year drought, rainfall, or groundwater event, etc.) but does consider significant changes in moisture condition due to man-made and environmental factors or conditions.

The potential amount of total and differential heave or shrinkage is difficult to accurately predict because it will depend on the extent of impervious cover, seasonal changes in climate conditions, drainage conditions, presence of leaking water pipes, groundwater conditions, landscape watering, vegetation planting, thickness of clay soil affected, and varying physical characteristics and mineralogy of the clay soils. The PVR is not a static value because it depends on how the soil behavior and the boundary conditions are modeled such as what changes in moisture content to consider and what initial moisture condition to consider at the time of construction.

SITE PREPARATION AND EARTHWORK

Stripping and Clearing

All areas that will support foundations, pavement, or newly placed fill must be properly prepared. All of the grass topsoil (soil with high organic content or significant root content), tree roots and root bulbs, vegetation, degradable forest materials (downwood, litter, duff) deleterious to soil compressibility, wet soils, and any soft or loose soils must be removed from the planned building, flatwork, and pavement areas. Deep stripping might be required to remove deep root bulbs of mature trees. Disturbed (loose) subgrade within stump and root bulb removal areas must be compacted and proof-rolled before placing any overlying fill, slab materials, or pavement materials. Alternatively the loose material can be removed and replaced with properly compacted select fill. Stripping should be observed and documented to record that unsuitable materials were removed prior to placement of fill, slab, or pavement materials.

Soil Improvement in the Building Area

The potential soil movement due to shrinkage and swelling of clay soil can be reduced by using soil improvement techniques to change the characteristics and properties of the subgrade soils. For this scale of project and for the unique subsurface conditions of the site, we recommend for the building area removal and replacement of “Stratum A” clay (dark brown clay) with imported “properly compacted” select fill. The removal of clay and the use of compacted select fill will permit the use of integrated footings or deeper spread footings independent of the foundation slab.

Subgrade Evaluation

After stripping and cut grading or a soil improvement excavation has been completed, the exposed subgrade soil stiffness in building and pavement areas should be evaluated. Proof-rolling should be performed where possible with a heavy (minimum 20 ton) rubber-tired vehicle such as a loaded dump truck or water truck to provide a thorough evaluation of the subgrade stiffness, except where limestone chalk rock is exposed (i.e. deep cut areas). Soils that are observed to rut or deflect excessively under the moving load should be scarified, air-dried, and compacted as necessary to achieve a stiff subgrade condition, or soft soil can be under-cut and replaced with compacted select fill that meets the requirements of this report. All proof-rolling and under-cutting activities should be observed, documented, and performed during periods of dry weather.

Subgrade inspections must be followed immediately by placement of select fill, pavement materials, or slab formwork and the moisture barrier to protect the approved subgrade condition. Soil conditions change when exposed to environmental conditions and man-made disturbance, therefore approvals of subgrade conditions are only valid for a short period of time. If rainfall events in particular occur before installing impervious cover, the subgrade inspection results are no longer valid and re-inspection, re-testing, and possible re-working and compaction of the subgrade and/or initial lifts of fill might be required.

Field observations and testing should be performed during the earthwork operation to verify and document proper construction. Field observation and inspection should include final approval of subgrade prior to placement of compacted fill, slabs, or pavement.

Backfilling of Buried Utilities

Water and sewer lines are typically constructed beneath parking lots. Compaction of trench backfill or lack thereof can have a significant effect on the performance of the pavement. Trench backfill should be placed in lifts not exceeding four to six (4 to 6) inches in compacted lift thickness if using lightweight compaction tooling or equipment (walk-behind or remote controlled rollers, mechanical tampers, vibratory plate compactors, boom-mounted trench rollers), and eight (8) inches if using heavy trench rollers. Low plasticity backfill soils should be moisture conditioned to between -1 and +3 percentage points of optimum at the time of compaction, and compacted to achieve a relative compaction of 95% or higher based on the Standard Proctor method (ASTM D 698). The placement and compaction of the backfill should be observed, tested, and documented as part of the overall QC or QA testing and inspections program.

Utility trenches within or above clay soils or clay-marl, backfilled with “clean” sand or gravel can function as post-construction conduits for water below the building or pavement. This can result in swelling of clay soils affected by the water along the trench and result in development of cracking and heaving in the pavement or slab near and along the trench. Capital Geotechnical Services recommends using fine-grained backfill such as on-site trench cuttings or imported low to medium plasticity clay (CL) or clayey sand (SC) to backfill utility trenches (do not use clean sand or clean gravel).

Fill Placement

Select fill that is re-used or imported to the site for use under the building foundation slab should be classified according to the Unified Soil Classification System (USCS) as SM-SC, SM, SC, GM-GC, GM, or GC, and should meet the following criteria:

- Percent passing the #4 sieve: 40% to 80% (20% to 60% gravel)
- Percent passing the #200 sieve: 15% to 45%
- PI of soil passing the #40 sieve: 2 to 19 (if % passing the #200 sieve ≥ 30%)
- PI of soil passing the #40 sieve: 2 to 22 (if % passing the #200 sieve < 30%)
- Maximum size of gravel or rock fragments: 3 inches in any dimension

The cut grading spoils from the southwest and south area of the site can generally be re-used as low plasticity grading fill or even select fill under the building slab and under pavement or flatwork depending on the gradation of the field-processed material. The initial strippings (“dirty” cuttings) should not be re-used (i.e. with organic content, expansive clay content). The “clean” cuttings can be re-used. If any pale colored clay-marl is excavated it should be diluted into the overall spoils. Due to the nature of using field-processed limestone chalk formation materials as fill, scattered or occasional oversize rock is expected in the fill mass. Rock size must not exceed 6 inches and any such cobbles must be relatively infrequent within the fill mass.

Grading fill in pavement areas must not consist of imported silty fine-grained soils (ML, CL w/ PI<15, CL-ML, silty fine SC w/ PI<15, fine SM, etc) within 2 feet of the bottom of the pavement materials section. If any field processed material is very fine and silty (e.g. ML, ML-CL) it must not be used within 2 feet of the bottom of the pavement section.

"Properly compacted" select fill is defined as meeting specific gradation and plasticity requirements ("select fill") and is subjected to strict quality control and documentation measures (compacted lifts, moisture-density testing, and documentation of compaction equipment, range of number of passes, and lift thickness). "Forming fill" is defined as meeting specific gradation and plasticity requirements ("select fill") but is not subjected to strict quality control measures or expectations of high density condition (i.e. place in variable lifts with "nominal" compaction and moisture-conditioning with earth moving equipment or compaction equipment without testing and documented inspections). Fill under the building slab must be "properly compacted". Foundation slabs have wide spans between perimeter beams and can deflect in the interior if the interior beams are placed on uncompacted forming fill that settles after initial wetting events.

The soil improvement excavation and compacted select fill pad must extend horizontally beyond the edge of the foundation slab footprint a minimum distance equal to the thickness of the fill between the bottom of the perimeter beam and the bottom of the fill pad (i.e. if there is going to be approximately 2 feet of fill beneath the perimeter beam in one area, then the granular select fill pad must extend horizontally at least 2 feet beyond the edge of the slab). The project team should also consider extending the pad horizontally to include immediately adjacent flatwork. Note that joint faulting or crack faulting can impact ADA compliance associated with tripping hazards, therefore the clay removal excavation must include the abutting flatwork.

Select fill and any wide (> 2 feet) plumbing trench backfill should be placed in horizontal loose lifts of not more than 6 to 12 inches in thickness (4 to 10 inch thick compacted lifts) depending on the size and weight of the compaction equipment. Select fill under the building slab should be moisture treated and compacted to achieve a minimum relative compaction of 97% based on the maximum dry unit weight as determined by the Standard Proctor method (ASTM D 698). Moisture content of select fill material should be within -1 and +3 percentage points of the optimum moisture content at the time of compaction (-1% to +3%). Some wetting or drying might be required to produce the necessary moisture content at the time of compaction.



The performance of slabs or shallow foundations and pavement placed on new fill material is influenced by the quality of the compaction and materials selection of the fill material. Capital

Geotechnical Services should be retained to perform quality control testing and inspection during selection, placement, and compaction of the fill material. Appropriate laboratory tests such as Proctor moisture-density testing and soil classification tests should be performed on samples of proposed fill material and pavement base course material. Field moisture-density tests and visual observation of lift thickness and material types should be performed during compaction operations to verify that the construction satisfies material and compaction requirements. In-place moisture-density tests and lift thickness observations must be performed on every lift of fill.

Fill materials should not be placed on soils that have been recently subjected to precipitation or saturation. All wet soils should be removed, or reworked, or stabilized, or allowed to dry prior to continuation of fill placement operations. Fill soil must be free of wood debris (organics).

Boulders and cobbles must be removed from the fill mass during placement. Soil around the edges of such stones cannot be properly compacted, and unfilled voids might be created due to bridging of soil over adjacent boulders or cobbles. Loose soil can compress when wetted, and soil above voids can migrate into the void space, causing settlement.

If any problems are encountered during the earthwork operations, or if newly exposed soil and site conditions are different from those encountered during our subsurface exploration, the Geotechnical Engineer must be notified immediately to determine the effect on recommendations expressed in this report.

Certain construction practices can reduce the magnitude of problems associated with moisture content increases of subgrade soil for pavement, slabs, and areas to receive compacted fill. If rainfall appears imminent, the contractor should seal exposed subgrade areas at the end of the workday with a smooth drum roller to reduce the amount of water infiltration into the subgrade. Site grading should be continuously evaluated to assure that surface runoff will drain away from pavement, slab, and fill areas, and construction sequencing (construction schedule) should be planned and adjusted based on weather forecasting.

In pavement areas, final grading of the subgrade must be carefully controlled so that low spots in the subgrade that could trap water in the base course or under a concrete joint are eliminated.

FOUNDATIONS

The following recommendations have been developed on the basis of the previously described project characteristics and subsurface conditions. If there are any changes to the project characteristics or if different subsurface conditions are encountered during construction, Capital Geotechnical should be consulted to determine if any changes to our recommendations are required.

Based on the subsurface conditions encountered and our experience with similar construction, the proposed building structure can be constructed on a ground-supported stiffened slab foundation system (foundation slab). Integrated footings (e.g. spread footings) can be added to support steel column loads. CMU walls can be supported by wide perimeter grade beams. Recommendations concerning the design and construction of the foundation slab are presented in the following paragraphs.

Stiffened Slab w/ Integrated Footings

1. The building structure can be constructed on a monolithically-cast, grid-type grade beam and slab foundation system (“foundation slab” or “stiffened slab”) with integrated footings to support column loads. Because of the anticipated use of integrated footings, the Stratum A clay must be removed from the building footprint to prevent bearing footings on, or close to, the dark clay.

2. The stiffness of a foundation slab will limit the effects of differential soil movement caused by settlement of fill, swelling and shrinkage of clay-marl soils, and compression of soils due to structural loads. However, minor discernible cracking in brittle construction materials can still occur. This type of slab should be designed with perimeter grade beams and interior stiffening grade beams adequate to provide sufficient stiffness to the slab element. The foundation slab grade beams supporting wall loads can be designed considering an allowable bearing pressure of 2,500 psf across the grade beam contact area for grade beams placed on firm native weathered chalk material (or dense residual soil) in shallow fill areas and/or properly compacted select fill in thick fill areas. Interior grade beams and integrated footings are expected to bear on fill across much of the footprint. Any square integrated spread footings can be designed using 2,700 psf if bearing on properly compacted select fill.

3. Perimeter grade beams should bear at least 18 inches below final adjacent exterior grade and have a minimum width of 18 inches or as required by the structural design to support CMU walls. Perimeter and interior integrated footings should have a width of 36 inches or larger. The grade beam width and depth and integrated footing width and depth will be determined and detailed by the project Structural Engineer. The grade beam details must specify minimum beam height and minimum beam penetration below exterior grade (ground surface) (i.e. emphasize that a uniform total beam height is not expected if the

perimeter grade varies due to sloping topography, therefore some stepped trenching will be required from upslope to downslope.

4. If relatively granular (gravel content > 50%, % passing #200 sieve < 30%) select fill is not used, a 4-inch thick layer of aggregate base material should be placed beneath the slab and moisture barrier to prevent capillary rise of moisture through fine-grained soils up to the bottom of the moisture-vapor barrier. The capillary barrier is optional if a geosynthetic moisture barrier is installed but provides redundancy in case any of the barrier has punctures or tears that were not taped, or improperly taped pipe penetrations, or damaged areas from future cuts from plumbing repair work or other modifications requiring slab cut-outs, etc.

5. Floor coverings (carpet, tile, wood, laminate, vinyl) can be damaged or subject to mold growth by moisture penetrating the slab, and exposed concrete can exhibit efflorescence, therefore a moisture vapor barrier (i.e. 10 mil or thicker geosynthetic geomembrane; ASTM E1745 -17 “Class A”) must be placed on top of the select fill and properly sealed to limit the migration of moisture to and through the slab, and to serve as a separator between the granular select fill (potentially high friction) and concrete slab. We recommend lapping the sheets of vapor barrier 12 inches and taping the joints/laps. The moisture barrier must be included across the base and sides of the interior grade beam trenches and the perimeter beam trenches. Since field crews might not force membranes down to make continuous contact with the trench walls and bottom to maintain proper rectangular beam cross section, if a single sheet of geomembrane is placed across a trench, we recommend cutting the membrane at the bottom of the grade beam trench to prevent the poured cross section area from being reduced (prevent bridging at bottom corners), and installing a separate strip of vapor barrier along the bottom to overlap the cut membrane on either side of the trench. The moisture barrier must be properly sealed (tape all pipe penetrations; tape all seams; tape all tears and punctures).

6. The foundation slab can be post-tensioned or conventionally reinforced. However due to the irregular shape of the building we recommend conventional reinforcement design. The foundation slab should be designed using the PTI, WRI, or BRAB soil-related design parameter values provided in the subsequent paragraphs.

7. Guidelines for the design of a conventionally reinforced foundation slab are provided by resources such as the Wire Reinforcement Institute (WRI), the International Building Code (IBC), the 1968 FHA BRAB report, and ACI 360R.

8. We recommend the following foundation slab stiffness soil-related design parameter values when designing a conventionally reinforced stiffened slab using traditional BRAB or WRI guidelines. All of the dark brown clay must be removed from the building footprint, and this initial cut depth is expected to vary from 6 inches to 2 ½ feet deep. The building structure must be designed to accommodate some minor potential vertical soil and slab movement (i.e. increased slab stiffness attempts to limit the effects on deflection to tolerable levels). The acceptable design deflection value will be determined by the Structural Engineer.

• Potential differential settlement:	¾ inch
• BRAB Climate Rating (C_w):	17
• BRAB and WRI Design PI:	21
• BRAB Support Index (C):	0.94 (1-C=0.06)
• BRAB maximum beam spacing:	15 feet
• WRI overconsolidation correction factor for design PI (C_o):	1.0 (none)
• WRI slope correction factor (C_s):	1.0 (none)
• WRI cantilever length (l_c):	2 ¾ feet
• WRI maximum beam spacing:	21 feet

   For foundation slabs designed using the BRAB or WRI type methods, long term deflection of flexural beams resulting from creep and shrinkage of concrete under sustained loading can be determined using ACI 318-19: 24.2.4.1.1.

9. Guidelines for the design of post-tensioned foundation slabs can be found in the 2019 PTI manual *Standard Requirements for Design and Analysis of Shallow Post-Tensioned Concrete Foundations on Expansive and Stable Soils* (PTI DC10.5-19). We recommend the following foundation slab stiffness soil-related design parameter values if using a PTI method of design. All of the dark brown clay must be removed from the building footprint, and this initial cut depth is expected to vary from 6 inches to 2 ½ feet deep. The building structure must be designed to accommodate some potential settlement (i.e. increased slab stiffness attempts to limit the effects on deflection to tolerable levels). The acceptable design deflection value will be determined by the Structural Engineer.

Edge moisture variation distance (e_m):	9 feet (center lift or edge settlement condition) 5 ½ feet (edge lift or center settlement condition)
Differential vertical soil movement (y_m):	¾ inch (center lift or edge settlement condition) ¾ inch (edge lift or center settlement condition)
PTI maximum beam spacing:	15 feet

   Vertical modulus of elasticity (E_s) of shallow subgrade under slab for determination of the PTI beta parameter value: 125 tsf (1,736 psi)

10. The occupants might perceive excessive movement when they see cracking in brittle elements such as drywall, hard tile, and exterior brittle veneer (brick, stucco, stone masonry). The acceptable design slab deflection must therefore be carefully selected. The foundation slab can be designed for some minor movement if an acceptable slab deflection can be achieved by the design, if drainage conditions are properly designed and constructed, and if certain architectural and structural detailing is properly designed. Some potential angular distortion, however, cannot generally be avoided, and the effects are uncertain. Removal of the Stratum A clay and installation of properly compacted select fill will significantly reduce the risk of soil and foundation slab or footing movement.

11. If the “shape factor” exceeds 24, note that the PTI design guidelines recommend performing soil improvement to reduce the potential differential vertical soil movement to 1 inch (edge lift) or less. Unusual foundation slab layouts (i.e. irregular shape; or multiple foundation slabs separated at ground level but connected by framed breezeways) require special attention. Independently moving slabs or slab areas tied to common elements can cause damage to the common elements. Therefore removal of the dark brown Stratum A clay is important, particularly in the shallow fill area of the building slab footprint.

12. Perimeter grade beams and integrated footings can be designed to transfer horizontal column reaction loads or shear wall reaction loads into the soil. Passive resistance from the upper 6 inches of soil along unpaved edges however should be ignored because of the potential to have poorly placed backfill along the perimeter beam or because of the potential for future excavation, erosion, or prolonged saturation softening. Beam or footing faces penetrating beyond 6 inches can be assumed to develop an equivalent fluid unit weight of 375 pcf for “passive” earth pressure conditions.

13. Integrated footings should not be placed within 2 footing widths of another footing (e.g. a 3-ft wide integrated spread footing should not be within 6 feet edge-to-edge of another footing) without reducing the allowable bearing pressure.

14. Exposure to the environment can weaken the soils (previously compacted select fill or firm native residual soil or weathered chalk material) at the grade beam and integrated footing bearing level if the foundation excavations remain open for an extended duration. Foundation slab concrete should be placed within 2 weeks of the completion of trench excavations and the moisture barrier should be installed before any notable rainfall event. If the bearing soils are softened by surface water intrusion or disturbance, the softened soils must be removed from the foundation excavation bottom prior to concrete placement.

15. Note that perched groundwater can be seasonally encountered in any excavations at the subject site. Water can perch on top of the limestone chalk rock or appear within fissures in the soil and rock surrounding the excavation. The General Contractor must plan and adjust the construction schedule and soil improvement excavation based on the weather forecast, or be prepared to install temporary groundwater mitigation measures if groundwater appears during the soil improvement excavation and fill placement operation. Groundwater mitigation can consist of temporary deep sump pits or an interceptor trench emptied with submersible pump and hose and constructed upslope (upgradient) of the excavation. The dewatering should proceed until the roof loads are added to the foundation slab, beams, and integrated footings.

16. If all of the Stratum A dark brown clay is removed, we do not expect footing excavations to expose any clay subgrade. If clay is encountered at the footing subgrade elevation, the clay should be excavated from below the foundation subgrade elevation. The planned footing subgrade elevation can be deepened, or restored by placing cementitious flowable fill or CLSM approved by the Structural Engineer and Geotechnical Engineer.

17. If an integrated footing excavation must remain open overnight, and if rainfall becomes imminent while the bearing soils are exposed, Capital Geotechnical Services recommends that a 1-inch thick grout or concrete “mud mat” (i.e. bag mix) be placed to protect the subgrade and provide a working surface before the placement of reinforcement steel. Alternatively the excavation can be covered and the ground surface sloped away from the excavation to prevent exposure to rainfall and runoff.

18. Grade beam dimensions and reinforcing steel should be observed and documented as-built (“pre-pour” inspection by the Structural Engineer; or by the geotechnical engineering firm if performing QC/QA testing services for the project).

19. Prior to installation of reinforcing steel and the moisture-vapor barrier, Capital Geotechnical Services should be retained to inspect the grade beam and integrated footing subgrade to determine if the foundations are being placed on suitable materials and to document that loose material has been removed. Dynamic Cone Penetrometer (DCP) tests can be performed to help evaluate subgrade condition. In areas where the subgrade is soft or loose, the soil should be removed and foundations lowered to bear on firm soil or foundation subgrade elevations can be restored using cementitious flowable fill or CLSM approved by the Structural Engineer and Geotechnical Engineer.

20. Concrete material should be sampled and tested for compressive strength, and placement operations should be monitored to record concrete slump, temperature, and age at time of placement. Concrete batch tickets should be provided by the supplier and collected by

the General Contractor to permit documentation of water-cement ratio, cement content, and other mix design ingredients.

21. We recommend that a floor flatness survey be performed by the General Contractor within 2 weeks after the concrete is poured to document the initial condition of the slab. Such information will be useful if future soil and slab movement is suspected and must be compared with the initial elevation differences.

TALL PERIMETER BEAM-WALLS

The planned construction includes 4-ft to 6-ft tall perimeter beam-walls along the downslope side of the building. Such walls function as retaining walls supporting the fill mass earth pressure, and as stem walls or beams supporting the structure above. Since cut grading will be performed into the slope outside the building at the southwest corner area of the building, a drainage system should be placed behind the tallest perimeter beam-wall segments to collect and remove any groundwater infiltrating into the fill, prevent the buildup of water pressures behind the wall and seepage under or through the wall, and prevent perennial humid conditions beneath the slab above. A minimum 12-inch wide drainage zone of clean gravel should be placed immediately behind the tallest walls (deepest fill points) and should extend down to the bottom of the wall and connect to a 4-inch diameter slotted or perforated PVC drainage collector pipe. A geosynthetic geotextile filter should be installed between the drainage zone (clean gravel) and surrounding backfill soil. The drainage system must be designed to discharge to an acceptable outfall area downslope of the building.

The beam-wall is anticipated to retain properly compacted select fill and can be designed considering an equivalent fluid unit weight of 55 pcf (compacted select fill) for “at-rest” earth pressure conditions. The walls must consider potential slab surcharge loads in their design. Surcharge loads applied within a 45 degree angle from the bottom of the wall must be considered. The coefficient of friction between a cast-in-place concrete beam or integrated footing and the anticipated subgrade (select fill in some areas, native weathered chalk material in other areas) can be estimated to be 0.34 (18.8 degrees). The equivalent fluid unit weight to calculate passive earth pressure resistance can be estimated to be 375 pcf. The upper 6 inches of embedment below grade should not be considered when calculating passive earth pressure resistance due to the potential for excavation, erosion, or saturation softening.

If a properly compacted fill pad is installed after the tall perimeter beam-walls are poured, it will be necessary to use walk-behind (lightweight) compaction tooling near the perimeter to achieve the proper degree of compaction in those areas. Relatively large compaction effort or heavy compaction equipment must not be used behind poured cast-in-place rigid walls because of the potential to permanently increase the earth pressure on the wall to a value higher than considered in design.

RETAINING WALLS

The planned construction includes a retaining wall along the south property line to support cut slopes or cut faces where the planned cut grading is 4 to 8 feet deep. Typical options for retaining walls include (1) concrete cantilever (with or without an architectural design finish), (2) large cut stone block gravity type retaining walls, (3) pre-cast concrete modular block (PMB) type walls (gravity type wall), (4) mortared small block gravity type retaining walls, or (5) segmental small stone block type mechanically stabilized earth (MSE) walls with a reinforced backfill zone tied to the wall. Due to space limitations we assume concrete cantilever or large cut limestone block gravity type walls will be used.

Retaining walls cannot generally be designed to resist horizontal clay swelling pressure. We therefore recommend that any clay exposed in the cut face (i.e. Stratum A clay or any Stratum B2 clay) be removed from behind the walls a horizontal distance equal to at least the height of the retained clay soil (e.g. where the wall is retaining 2 feet of clay soil, the backfill zone must be at least 2 feet wide) and replaced with properly compacted select fill. If a concrete cantilever wall is used, the construction of the strip footing will inherently produce a wide backfill zone, but the minimum horizontal dimension requirement must be checked and accommodated during construction and addressed in the structural wall details.

A minimum 12-inch wide “drainage zone” of clean durable river gravel should be installed immediately behind the wall up to within 18 inches of the surface. A geosynthetic geotextile filter fabric must be placed between the gravel and surrounding soil to prevent migration of fine-grained soil into the free-draining zone. Capital Geotechnical recommends constructing a foundation drainage system along the wall footing within the base of the drainage zone. This will prevent water from collecting along the wall where it can build additional pressure against the wall and cause unacceptable movement strain, seepage into the parking lot, and seepage staining. A 4-inch diameter perforated or slotted PVC collector pipe should be used within the base of the drainage zone and should drain the water to an acceptable outfall area.

The retaining wall is expected to retain the narrow drainage zone, possible bag-fill, a narrow backfill zone of low plasticity soil or select fill (wider at top if clay removed), and a cut face in weathered limestone chalk materials and chalk rock under the soil surface stratum, and can therefore be designed considering an equivalent fluid unit weight of 55 pcf for “at-rest” earth pressure conditions along the upper 3 feet and 45 pcf across the lower elevations of the retained zone. Potential surcharge loads must be considered in retaining wall design. If wall backfill is to support loads such as structural loads, vehicle loads, or a dumpster load on the adjacent property, wall design and stability analyses must include the additional loading conditions. Surcharge loads within a 45 degree angle from the base of the retaining wall must be considered in the design.

Retaining wall strip footings, expected to be 3 to 6 feet wide depending on wall height, can be designed to apply a maximum allowable bearing pressure of 4,000 psf if placed on weathered but hard limestone chalk material, or chalk rock. The retaining wall footing must be embedded at least 18 inches below exterior grade at the toe of the wall unless deeper penetration is required by the structural design to produce adequate “passive” earth pressure resistance. The “passive” earth pressure equivalent fluid unit weight for a footing embedded into weathered limestone chalk rock material can be estimated to be 375 pcf although resistance within the upper 6 inches of grade should not be considered due to the potential for erosion or future excavation. The coefficient of sliding friction (mass concrete on weathered chalk) can be estimated to be 0.38 ($\delta = 20.8^0$).

The wall designer is responsible for analyzing local stability (sliding, overturning, shear and bending moments of the structural elements, etc).

It will be necessary to use walk-behind (lightweight) compaction tooling near the walls to achieve the proper degree of compaction near the wall. Relatively large compaction effort or heavy compaction equipment should not be used very close to retaining walls because of the potential to permanently increase the earth pressure on the wall to levels above those considered in design.

SEISMIC DESIGN

The subject site is located in a region of low seismicity. The region has relatively low spectral response acceleration and can be assigned to “*Seismic Design Category A”* according to ASCE 7-05 and Section 1613 of the 2018 IBC guidelines. The subject site can be categorized as a “Class C” site for determination of design soil shear wave velocities.

POND WALLS

The planned construction includes a detention pond at the west edge of the property. The planned grading for the abutting pavement area appears to require 4 feet to 8 ½ feet of cut grading (excavation) that will expose limestone chalk rock formation materials. The pond subgrade will be sloped down toward the north to the outlet structure. The planned pond depth below the pavement level was not known at the time of this report but we assume the pond subgrade might be a few feet (≈ 4 feet) below the pavement level, therefore the retaining walls might be a few feet tall at the south end and up to 8 feet tall at the north end.

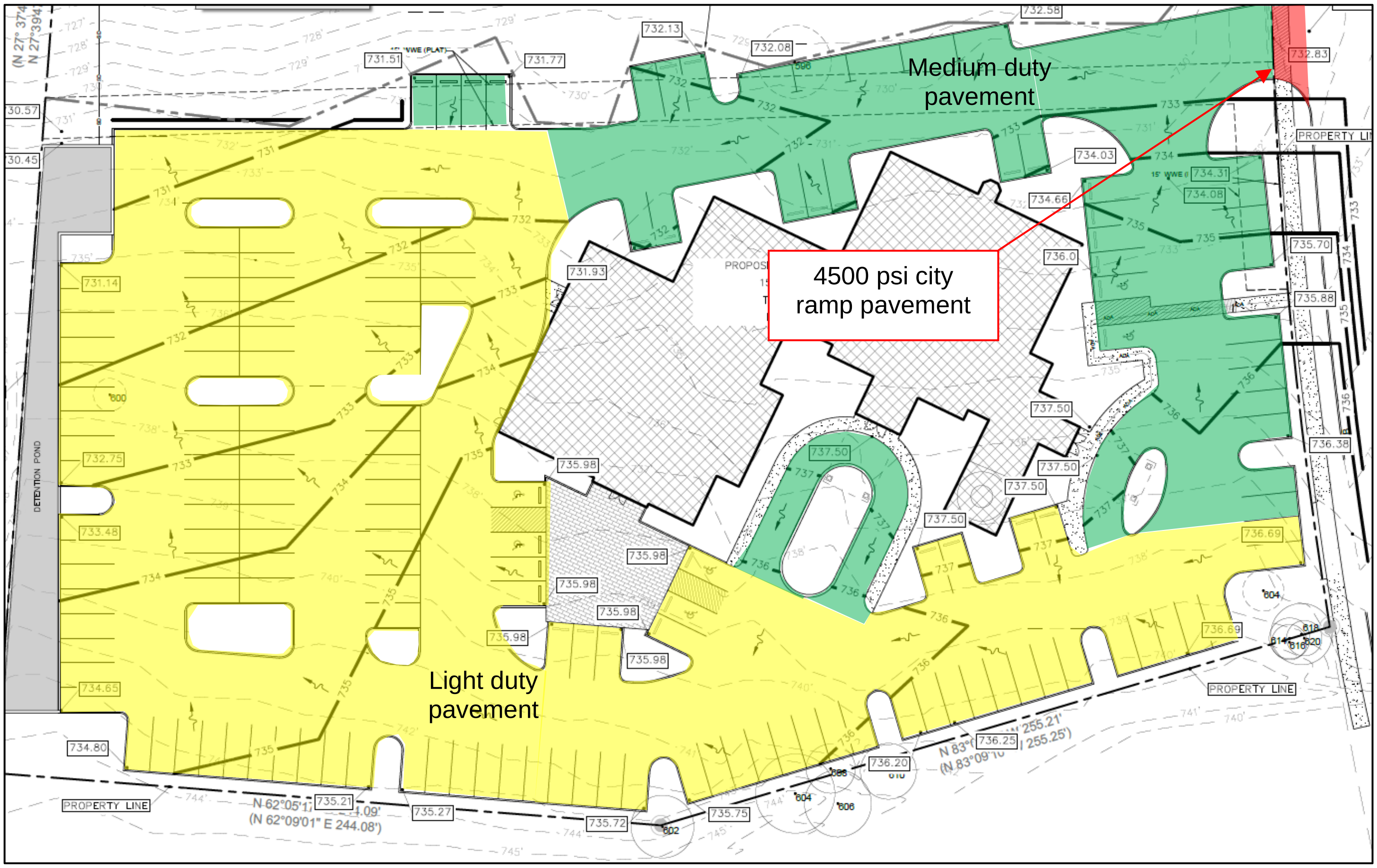
The pond wall strip footings are expected to bear on limestone chalk rock because of the depth of the excavation after cut grading for the pavement area, and can be designed to apply a bearing pressure of up to 4,000 psf if 4 to 8 feet wide, although such capacity will not be required. An equivalent fluid unit weight of 400 pcf can be used for strip footings poured against a limestone chalk rock cut face.

The pond walls are expected to retain a narrow backfill zone and subsequent cut face into limestone chalk rock materials and can be designed considering an equivalent fluid unit weight of 45 pcf for "at-rest" earth pressure conditions.

PAVEMENT THICKNESS DESIGN

Estimates of traffic loads were not provided to Capital Geotechnical Services by the time of this report. A daily traffic volume of 409 vehicle trips per day was estimated using an average trip generation rate of 55 vehicles per day per 1076 square feet of prayer area (per 100 square meters) for a mosque, with a 50% lane distribution (one lane each way used for traffic, curb lanes used for parking only). We assume approximately 8,000 square feet of the 15,706 square foot building footprint will be prayer room area.

Pavement subgrade composition will vary across the site. The planned grading will expose cut graded material across the west area of the site and south area of the site, and fill material or native soil across the northeast and east areas of the site. Subgrade in the cut areas is expected to consist of weathered limestone chalk materials and in the deep cut areas hard limestone chalk. Where planned pavement surface grade is at existing grade or above, the subgrade will consist of minor grading fill (low plasticity granular soil?) overlying remnant Stratum A clay and weathered limestone chalk material. Different pavement sections will be required, or the General Contractor can choose to use the thicker pavement design option for simplicity. Options for pavement thickness design are presented in the following pages.



Light Duty Pavement Option A: Asphalt Pavement

- 2.0 inches hot-mix-asphalt (HMA) Type D
- 7.0 inches crushed stone flexible base course Type A Grade 1 or Grade 2

Light Duty Pavement Option B: Concrete Pavement with Base

- 5.5 inches jointed reinforced concrete pavement (JRCP) (3,500 psi mix)
- 4.0 inches crushed stone base Type A Grade 1 or Grade 2
- Chalk rock or successfully compacted and proof-rolled weathered chalk subgrade

Medium Duty Pavement Option A: Asphalt Pavement

- 2.25 inches hot-mix-asphalt (HMA) Type D
- 10.0 inches crushed stone flexible base course Type A Grade 1 or Grade 2
- Successfully proof-rolled soil subgrade

Medium Duty Pavement Option B: Asphalt Pavement w/ Geogrid

- 2.0 inches hot-mix-asphalt (HMA) Type D
- 8.0 inches crushed stone flexible base course Type A Grade 1 or Grade 2
- Geosynthetic geogrid: Tensar InterAx NX850

Medium Duty Pavement Option C: Concrete Pavement with Base and High Strength Mix

- 6.0 inches jointed reinforced concrete pavement (JRCP) (4,000 psi mix)
- 4.0 inches crushed stone base Type A Grade 1 or Grade 2
- Successfully compacted and proof-rolled subgrade

Curb Ramp to Heatherwilde Blvd: Concrete Pavement with Base and High Strength Mix

- 7.0 inches jointed reinforced concrete pavement (JRCP) (4,500 psi mix)
- 6.0 inches crushed stone base Type A Grade 1 or Grade 2
- Successfully compacted and proof-rolled subgrade

Subgrade preparation and stiffness is a critical aspect of concrete pavement design. The above designs will not be adequate if the subgrade is not successfully compacted and proof-rolled before placing the base layer, particularly for the medium duty pavement areas (soil subgrade in lieu of chalk rock subgrade).

For asphalt pavement, surface drainage design is critical to good performance (do not allow ponding of water along edges of pavement; do not allow curb-and-gutter to not be properly backfilled; etc).

For concrete pavement, the granular subbase (crushed stone base layer) functions to provide durably stiff immediate subgrade support and provide drainage of water that can be deleterious to concrete subgrade performance. The crushed stone base layer (subbase) also helps reduce the propagation of clay shrinkage cracking up into the concrete for the medium duty section. The subbase layer (base material) must be gently sloped (i.e. match slope of pavement surface) to allow water to drain out of the system toward the edges where pervious ground cover allows evaporation. The base layer must not be confined by impermeable vertical barriers at the downslope edges of the base system.

If the assumptions concerning traffic volume and loads are not reasonably correct, Capital Geotechnical Services must be notified so that recommendations can be revised if necessary. Geometric pavement design should conform to any locally developed guidelines.

Some cracking should be expected where Stratum A clay is left in place in pavement areas (i.e. medium duty areas where cut grading is not initially planned) because of the potential for vertical movements of the clay soil.

If curb-and-gutter is used, the detail must include reinforcing steel, particularly along “medium duty” pavement areas. Expansive clay soil of Stratum A that heaves curb elements can cause severe separation cracking in curb-and-gutter. Reinforcing steel will limit crack widths and the associated aesthetic damage.

CONCRETE PAVEMENT COMMENTARY

Jointed reinforced concrete pavement (JRCP) or doweled jointed plain concrete pavement (JPCP) can be considered to provide a more durable pavement system than asphaltic pavement. Relative to HMA, the disadvantages of concrete paving might be its initial higher cost, susceptibility to joint faulting (affects ride quality), the larger amount of effort required to install future utility trenches (open cut), and the cost of maintenance efforts such as joint cleaning, joint sealing, and grinding. The advantages of concrete paving might include less frequent maintenance efforts, more durable ride quality, no deterioration caused by oil leaks, good light reflectivity that enhances pedestrian and vehicle safety at night and in rainstorms, and relatively good skid resistance.

Concrete pavement design by the Civil Engineer and General Contractor should conform to recognized design methods such as the *ACI Manual of Concrete Practice, ACI PRC 330-21: Commercial Concrete Parking Lots and Site Paving Design and Construction Guide.*

Producing a more uniform subgrade under concrete (e.g. use of a crushed stone granular base layer) is recommended to provide long term stiff subgrade under concrete. Otherwise as moisture content increases in soil under concrete occur over time, the untreated fine-grained soil will lose stiffness and lead to forced displacement of soil along edges and through cracks or joints with cycles of heavy vehicle loads (delivery trucks, etc), and lead to slab deflection and cracking in those areas and possible joint faulting between panels. Compaction and proof-rolling of grading fill and subgrade before placing base material is also critical to concrete pavement performance (i.e. failure to properly prepare subgrade, and failure to inspect and test subgrade preparation, has led to severe cracking in concrete pavements and required replacement of concrete paving).

Joint patterns should be carefully designed to avoid irregular shapes and to provide a sufficient number of joints to control cracking associated with concrete expansion and contraction. Capital Geotechnical Services recommends that saw-cut spacing for JRCP, or full depth joint spacing for JPCP, not exceed 12 feet for any panel. As reported by the FHWA and SHRP, in relatively warm and dry climates like central Texas, short joint spacing is generally desired to reduce the effects of climate. The greater the joint spacing, the greater the occurrence of shrinkage cracking. FHWA recommends that expansion joint (full depth joint) spacing not exceed 30 feet for optimum performance. Spacing of 40 to 80 feet is commonly used but results in reduced performance or requires more reinforcing steel. Joint layout and detailing should be included on the site civil plans by the project Civil Engineer, or a joint plan can be submitted by the General Contractor during the submittal process.

JRCP must include steel reinforcement to limit shrinkage cracking, limit the width of transverse cracks, and limit long term deterioration common in cracked unreinforced concrete pavement. The alternative JPCP system will be exposed to the risk of widening of cracks and of crack faulting in expansive clay soil environments (i.e. medium duty pavement area), therefore we recommend JRCP. The 5.5-inch to 6-inch thick concrete parking lot pavement can be designed to have #3 steel reinforcement bars at 18-inch spacing in both directions unless the expansion joint spacing is 60 feet or more in any direction then 14-inch spacing should be used. The 7-inch thick concrete pavement can be designed to have #3 size reinforcing steel at 16-inch spacing in both directions.

Steel reinforcement must ideally be interrupted at the planned saw-cut contraction joints (not passed into adjacent panel) except between perimeter panels and the next row of interior panels where alternating bars can cross the joint to serve as tie-bars. However, this is not commonly performed by General Contractors (would have to layout planned saw-cut locations). At joint locations (other than those between perimeter panels and interior panels where tie-bars are used), if steel is placed through (under) contraction joints, then the pavement becomes more similar to a CRCP (continuously reinforced concrete pavement) and becomes more susceptible to shrinkage cracking, punchouts, and spalling. Note that steel reinforcement should have at least 2 inches of cover. Ideally, the reinforcement should be placed 2 inches below top of pavement (upper one third of pavement per ACI PRC-330-21 3.8.3; ACI 325.12R.4.6). Construction joints might have to be formed if necessary during construction and should line up with a planned expansion joint.

Saw-cut joints should cut to a depth equal to at least 1 ½ inches if reinforcing steel runs through the joint as tie-bars or general reinforcement mat. If the steel mat is cut at planned saw-cut joints, these doweled joints should be saw-cut to a depth equal to at least 1 inch. Saw cutting should be performed within 4 to 12 hours after the concrete was placed unless an “early entry saw” is used. Early entry sawing can permit a saw-cut depth of 1 inch to 1 ¼ inches deep in lieu of 1 ½ inches. Optimum time to cut depends on air, ground, and concrete temperatures at the time of construction, concrete mix design (strength with time, admixtures, aggregate rock type), and the saw used. Trial cutting can be considered and if raveling occurs the saw cutting must be delayed.

Dowels should be used at full depth joints to transfer load between concrete panels, to reduce the chance of joint faulting, and to limit deflections and damage to panel edges when supporting truck loads. Minimum 24-inch long, 3/4-inch diameter smooth steel dowels, spaced apart to match the panel reinforcement bar spacing, should be placed between panels. Dowels are typically placed in the middle of the vertical pavement section and must be properly horizontally aligned. One side of the dowels must be sleeved or greased.

Reinforcement, dowel, and joint details should be in accordance with the American Concrete Institute (ACI) or Portland Cement Association (PCA) guidelines.

Curb-and-gutter concrete elements must be tied to the concrete pavement using tie-bars wherever there is a downward slope behind the curbline. Clay slopes will creep downhill over time, causing severe separation cracking between the curb and the concrete pavement unless the two elements are tied together.

PAVEMENT MAINTENANCE

Flexible pavements are generally designed by geotechnical engineers to provide a 20-year service life before requiring an extensive rehabilitation, and only if proper maintenance is performed. The actual service life of a pavement until full reconstruction is actually performed by the Owner, however, is commonly longer. Regular maintenance can help extend the design 20-year service life.

Depending on the moisture content fluctuations within the subgrade, the flexible pavement might develop cracks or separations prematurely. Periodic crack sealing, fog seals, and slurry seals are to be expected and must be performed to maintain the service life and maintain the quality of the pavement by preventing water from infiltrating into the subgrade and by maintaining the quality of the surface.

The 20-year service life assumes that the Owner will perform at a minimum an evaluation every two (2) years and perform crack sealing as necessary. It is also assumed that a thick asphalt seal coat or “slurry coat” will be placed as needed but at least three times during the 20 year service life. Pavements in Central Texas are generally designed to resist rutting but not asphalt fatigue over the 20 year service life if proper maintenance is not performed. Corrective maintenance such as full depth patching or even milling and overlay (e.g. 2 inches) should be anticipated sooner than 20 years after initial construction to replace fatigued asphalt if proper maintenance is not performed.

A primary cause for deterioration of hot mix asphalt pavement is oxidative aging that results in brittle HMA. Preventative maintenance (crack sealing, fog seals, fine slurry seals) will provide a protective seal or rejuvenate the asphalt binder to extend the life of the HMA.

If concrete pavement is used, the Owner should anticipate performing a crack and joint cleaning and sealing operation at least twice during the first 20 years of service (e.g. every 7 years). Diamond grinding can be considered at 8 to 10 year intervals if pavement smoothness needs to be restored (re-leveling areas that exhibit joint faulting or other irregularities) and there are no issues with drainage, inadequate doweling (load transfer), structural integrity, weak subgrade with an inadequate pavement section design, D-cracking, and reactive aggregates, since such issues would have to be addressed (repaired) before spending time, money, and effort on grinding to restore levelness.

PAVEMENT MATERIAL RECOMMENDATIONS AND TESTING

Selection, transportation, placement, and compaction of pavement materials should be performed in accordance with Texas Department of Transportation standards and guidelines (e.g: *TxDOT Standard Specifications for Construction of Highways, Streets, and Bridges*) and locally developed guidelines (e.g. City of Pflugerville specifications, Series 200 and 300). Material properties and construction criteria for the pavement alternatives are provided in the municipal and state specifications and some in this section. If the proposed materials cannot meet these specifications, then the pavement design must be re-evaluated based upon available material. All proposed materials must be submitted and applicable laboratory tests performed to verify compliance with these requirements.

Subgrade Preparation

1. Pavement subgrade must be clear of organic matter.

2. Immediately before placement of grading fill, select fill, or base course material, except where rock is exposed, the exposed subgrade should be proof-rolled to identify any localized areas of soft soil that could lead to premature rutting or deflection of the pavement. Soft soils must be stabilized or removed and replaced with properly compacted granular select fill or crushed stone base material.

3. Pavement subgrade that has local depressions resulting from uneven cut grading or filling or from equipment traffic (ruts) can lead to ponding of water within the base layer in that area and subsequent premature loss of subgrade support. Forming and maintaining a subgrade that is level, smooth, and constructed to required grade is important to produce proper drainage of the base layer above the less permeable soil subgrade. The General Contractor and the earthwork or paving subcontractor must inspect the subgrade for any depressions before placing the base material.

Base Material

1. Crushed stone base material should be selected, placed, and compacted in accordance with Item 247 of the TxDOT *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges*. Base material should be a crushed stone meeting the gradation requirements for a TxDOT Item 247 “Type A” Grade 1 or Grade 2 material, or a well-graded mix meeting the requirements of Series 200, Section 210S, of the City of Pflugerville specifications. Placement should not start until the subgrade is properly prepared and inspected.

2. Base material should extend to the outside edge of the curbline.

3. Base material should be compacted to achieve a relative compaction of 100% or higher if using the maximum dry density determined by the Tex-113-E method, or 97% if the overall base thickness is 6 inches or less. Moisture content of the base material should be within two percentage points of the optimum moisture content at the time of compaction (-2% to +2%). Section 247.3(1)(d) of the TxDOT *Standard Specifications for Construction of Highways, Streets, and Bridges,* and Section 210S.5 of Series 200 of the City of Pflugerville specifications address compaction of crushed limestone base material.

4. Base material should be tested during placement to document thickness, moisture content, and density at the time of compaction.

5. Crushed recycled concrete can only be considered if the recycled concrete was not contaminated by calcium sulfate industrial by-products.

Hot Mix Asphalt

1. Hot mix asphalt should be selected, placed, and compacted in accordance with Item 340 of the TxDOT specifications: *Dense-Graded Hot-Mix Asphalt* or Item 340 of the City of Pflugerville specifications. Hot mix asphalt surface course can be a TxDOT Type D gradation (“fine surface” mix) for parking lots. Item 340 addresses specific material ingredient properties and gradations, as well as production and placement of HMA. A TxDOT approved supplier should be used (well-defined and controlled mix design and production).

2. A prime coat should be applied on the underlying flexible base.

3. HMA paving should only be performed when the air temperature is above 40 degrees Fahrenheit and rising, or above 50 degrees F if the temperature is falling. TxDOT specification 340(4.6.1) requires that the roadway temperature (base temperature) be 60 degrees F or higher to permit HMA placement. HMA placement should not be performed if the air temperature will drop to 32 degrees F or lower within 12 hours of paving (TxDOT 340(4.6.1)).

4. Roller patterns on test sections of HMA can be performed by the contractor to help determine required compaction effort. The Tex-207-F Part IV method briefly describes the roller pattern method for determining required compaction effort for hot mix asphalt.

5. Hot mix asphalt should be compacted to achieve a relative compaction between 91.5% to 96.2% of maximum theoretical density (3.8% to 8.5% total voids).

6. For thin asphalt sections, inspection of hot-mix-asphalt can simply include placement temperatures, thickness, documenting rolling efforts, and use of the nuclear gauge backscatter method to help evaluate void content.

7. Asphalt should meet the requirements of the Superpave performance graded binders (PG). The minimum performing asphalt in this climate should be PG-64-22.

8. Hot mix asphalt should not be placed at a mixture temperature lower than 245^0 F for mixtures containing PG 64-22 asphalt. The breakdown compaction must be completed before the temperature of the mixture drops by 20 degrees.

9. Compaction must be completed before the mix cools to below 175^0 F, although finish rolling (sealing) can continue.

<u>Concrete Pavement</u>

The critical factors affecting the performance of concrete pavement are the strength and quality of the concrete, proper placement of reinforcing steel for crack control, proper jointing for crack control, and the uniformity and stiffness of the subgrade.

A. Concrete mixing, batching, forming, placing, finishing, and curing should generally conform to the guidelines described in specification item 360 in the TxDOT *Standard Specifications for Construction of Highways, Streets, and Bridges* (2014) or the City of

Pflugerville specifications Series 300 Item 360S: *Concrete Pavement*. Placement should not start until the subgrade is properly prepared and inspected.

B. Concrete for the parking lot pavement should consist of a minimum 550 psi flexural strength concrete at 28 day age. To achieve this flexural strength, a mix with a 28-day compressive strength of 3,500 psi or 4,000 psi might be required (i.e. do not order 3,000 psi concrete), and the mix selected must also accommodate the strength requirement of the pavement thickness design option selected. The ramp to the city street must have a 4,500 psi design strength mix.

C. Curing and protection procedures should be implemented to protect the pavement from moisture loss, rapid temperature change, and physical disturbance.

D. Concrete should be sampled and field tested by a representative of Capital Geotechnical Services as part of the overall QC/QA testing and inspection program.

E. Portland cement should be Type II “low alkali” and should conform to ASTM C 150.

F. All joints should be properly sealed with a backer rod and approved joint sealant.

SURFACE DRAINAGE, VEGETATION, AND PLUMBING

Performance of foundation slabs, pavement, and flatwork is influenced by changes in soil moisture conditions. Carefully planned and unaltered surface grading can reduce the level of wetting experienced by the soil under the impervious cover elements, particularly where cut grading is not being performed (northeast and east pavement areas; building footprint). We recommend the following precautions be implemented during construction:

A. Utility structures that connect to the building should be designed to be flexible enough to tolerate some differential settlement. Water supply pipes and sanitary sewer pipes beneath the slab should be placed in long sections with as few joints (leak-prone) as possible and should be of durable size and material. Utilities that penetrate the foundation slab should be designed with either some degree of flexibility or with sleeves in order to prevent damage or leaking should vertical movement occur, although if soil improvement excavation is performed and if all fill lifts are properly compacted this is not necessary. Water supply and sanitary sewer systems should be leak tested after installation. If site improvement does not reduce the design PVR to 1 inch or less under the slab, telescoping joint or swivel joint (ball joint) pipe fittings can be considered, as can flexible pipe expansion joint couplings, and for water lines the designer can consider flexible lines in lieu of rigid pipe. However, we recommend that all of the dark brown Stratum A clay be removed from the building footprint at the start of construction (soil improvement excavation). Expansive clay soil can damage (crack, break) plumbing and leaks can lead to additional swelling and damage to the structure and fixtures. The mechanical engineer (MEP) must account for the expansive clay soil environment in their design if a soil improvement excavation is not performed.

B. The ground surface and flatwork around the building should be sloped away from the building to provide drainage away from the building perimeter. Soil improvement will reduce the risk of changes to flatwork grades and reduce the risk of flatwork being moved and sloped down toward the building. A minimum drop of 6 inches over the first 10 feet from the edge of the slab is recommended (IBC 2018: 1804.4) except for flatwork near doors and handicap ramps where flatter slopes are required.

C. Roof drains should be designed and placed to discharge stormwater at least 2 feet away from the building unless pavement abuts the edge of the building. Roof drain downspouts should be concentrated on the downslope side of the building.

D. Cracks in pavement or sidewalks should be routinely sealed to prevent surface water from infiltrating into the soil.

E. If root barriers are not installed, trees should not be planted near pavement or exterior flatwork.

F. Plants placed close to the perimeter of the building or close to the edges of pavement or flatwork should be limited to those with low moisture requirements (do not encourage high rates of irrigation).

G. Air conditioner condensation outlet pipes should not discharge immediately adjacent to the foundation slab (perimeter beam) or flatwork or pavement. The pipes should be extended to discharge water at least 2 feet away from the foundation slab and preferably on the downslope side of the house, or discharge into a rain barrel.

H. If shrubs must be placed adjacent to the building, flatwork, or pavement, the landscape beds or planters should not be recessed (place at grade or elevate above grade and drain properly to prevent ponding adjacent to the structures or flatwork).

I. Leak tests should be periodically performed on water supply, sprinkler, and sewer systems to determine if a leak exists. Any leaking pipes should be repaired as soon as possible to stop the increase in moisture content in the underlying clay soils. The water supply system can be easily checked by monitoring the water meter when no water is being used.

J. Landscape islands in parking lot pavement, or nearby sloping topography down toward the curbline, are sources of water infiltration into adjacent pavement subgrade and base course. Islands in the “medium duty” pavement areas should consist of self-contained planters (geomembrane liner or concrete cutoff elements), or drains should be installed to collect excess rainwater and discharge to the storm sewer system. Curb cutouts, or weep holes drilled through the curb, can be used to help prevent ponding of water behind the curbline and limit water infiltration into the subgrade under the pavement. If curb cutouts are not used in a curbline near the base of a slope, a drainage swale or buried drainage system should be installed to intercept perched groundwater and surface water and limit infiltration into pavement subgrade near the base of the slope.

STORMWATER MANAGEMENT POND

The planned detention pond will require cut grading that is likely to exposed limestone chalk rock or where the cut is shallow, weathered limestone chalk materials. The chalk rock is likely fractured. Water infiltration will be relatively slow. For design purposes, if water infiltration through the weathered chalk to chalk rock is required to help meet pond recovery requirements, the average vertical permeability can be estimated to be similar to low permeability clay at 1×10^{-7} cm/sec under saturated conditions. Pond storage (volume) and outlet structure elevation design will be more critical because of the very low infiltration rate.

LIMITATIONS

This report is subject to the limitations and assumptions presented in the report. Should conditions change or if assumptions are not accurate, we must be contacted to review our recommendations.

Borings were spaced to obtain a reasonable indication of subsurface conditions. The data from the borings is only accurate at the exact boring locations. Variations in the subsurface conditions not indicated by our borings are possible. The recommendations in this report were developed considering conditions exposed in the exploratory borings and our understanding of the type of structures planned.

We believe that the geotechnical services for this project were performed with a level of skill and care ordinarily used by geotechnical engineers practicing in this area at this time. No warranty, express or implied, is made.

Capital Geotechnical Services should be retained to review plans and specifications related to geotechnical elements of the construction to check that our recommendations have been properly interpreted. Capital Geotechnical Services cannot be responsible for incorrect interpretations of our recommendations, particularly if we are not retained to review plans and specifications, and if we are not retained to perform QC or QA testing and inspections during construction.

This report is valid until site conditions change due to disturbance (cut and fill grading) or changes to nearby drainage conditions, or for 3 years from the date of this report, whichever occurs first. Beyond this expiration date, Capital Geotechnical Services shall not accept any liability associated with the engineering recommendations in the report, particularly if the site conditions have changed. If this report is desired for use for design purposes beyond this expiration date, we recommend drilling additional borings so that we can verify the subsurface conditions and validate the recommendations in this report.

The geotechnical recommendations in this report as associated with foundation slabs do not guarantee that distress will not occur for a certain level of movement. The geotechnical report attempts to estimate potential movement due to reasonable changes in moisture condition within reasonable thicknesses of clay, and the report provides a rationale for designing foundations and structures to tolerate the potential movement. This report must be read in its entirety by the responsible design parties (Architect, Structural Engineer, Owner, Civil Engineer) to properly understand the intent and limitations of the geotechnical recommendations.

INSPECTIONS

Capital Geotechnical must be retained to perform the field observations, field testing, and laboratory testing recommended in this report because of our familiarity with the project and site conditions. Quality control (QC) inspections (by Capital Geotechnical Services) must include the following activities (as applicable), and the General Contractor is responsible for scheduling the inspections and testing (building code “special inspections”).

- Document soil improvement excavation perimeter depths.

- Inspect proof-rolling of subgrade before placing fill, slab formwork, or pavement materials.

- Sampling and lab testing of proposed grading fill in pavement and flatwork areas, building pad fill, and utility trench backfill material to check and document classification.

- Testing of compacted fill in place to check and document proper compaction and moisture-conditioning (building pad fill, pavement area grading fill, flatwork area grading fill, retaining wall backfill, wide utility trench backfill, etc).

- Pre-pour inspection of concrete retaining wall strip footings.

- Pre-pour inspection of concrete retaining walls.

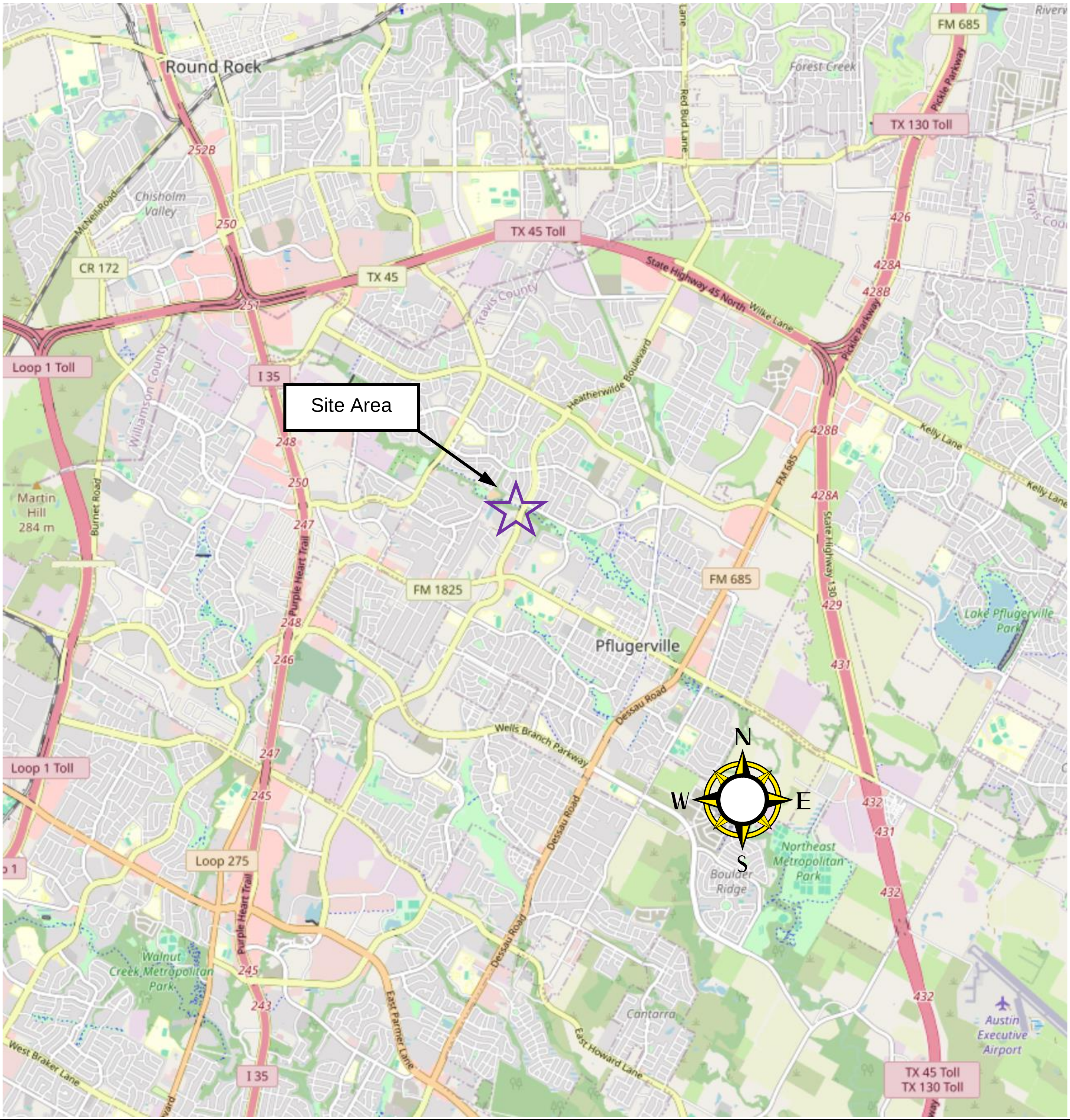
- Inspection and documentation of drilled shaft construction for any light poles.

- Pre-pour inspection of foundation slab and integrated footings to check and document grade beam dimensions, subgrade condition, reinforcing steel installation, and moisture vapor barrier installation (if not performed by Structural Engineer).

- Concrete sampling and testing to document as-built condition of newly mixed concrete and to document that the supplier provided an adequate mixture to the site.

- Moisture-density testing of compacted crushed stone base material for pavement.

- Pre-pour inspection of concrete pavement construction (reinforcing steel, joint layout, joint doweling, thickness).



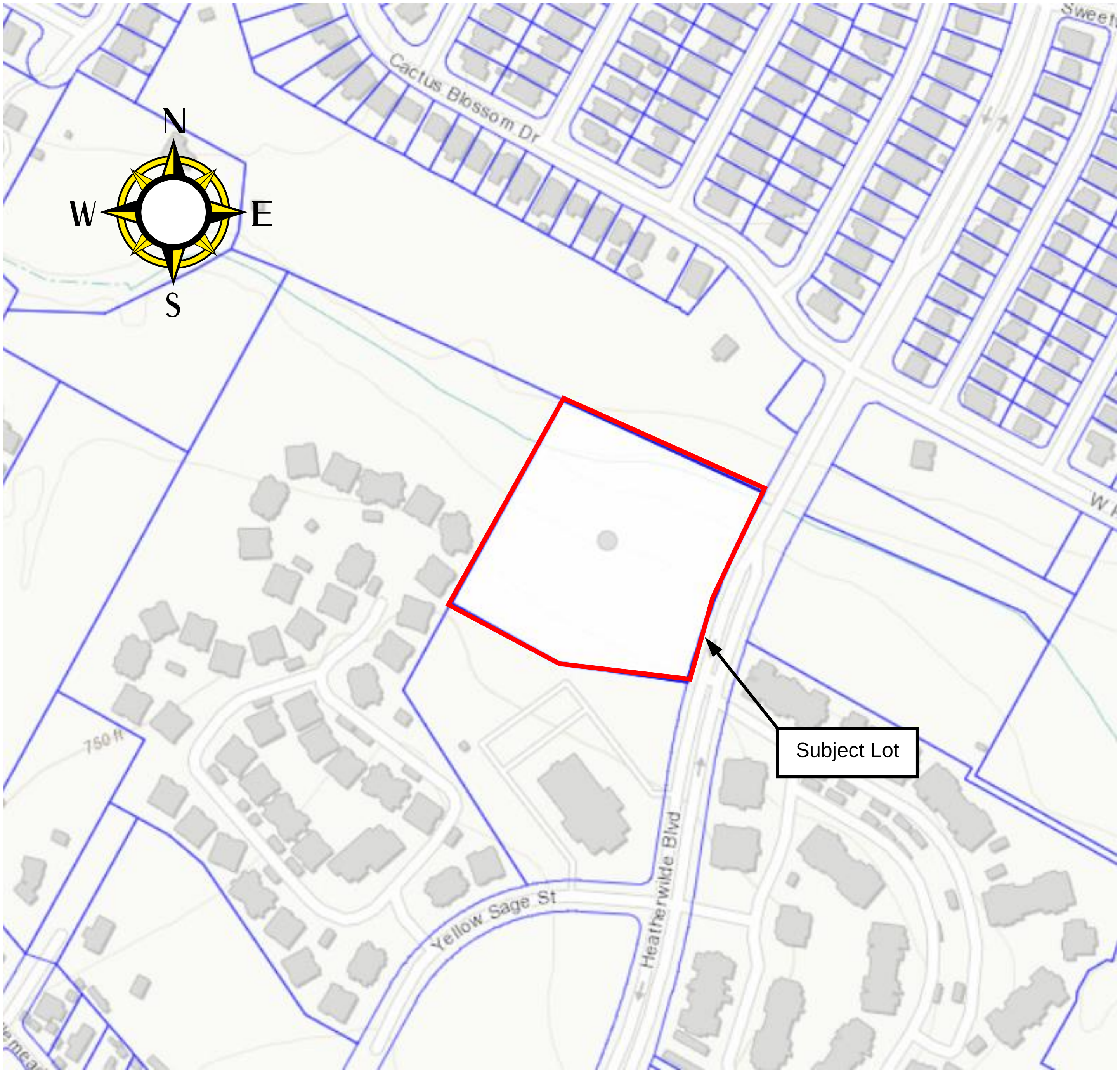
Vicinity Map

800 N. Heatherwilde Blvd

Pflugerville
Travis County, Texas

Capital Geotechnical Services PLLC
Austin, Texas

Prepared By: ON / NK	Scale: -	Project #: 24-0034
Base Map By: City of Pflugerville	Date: May 2024	Figure #: 1



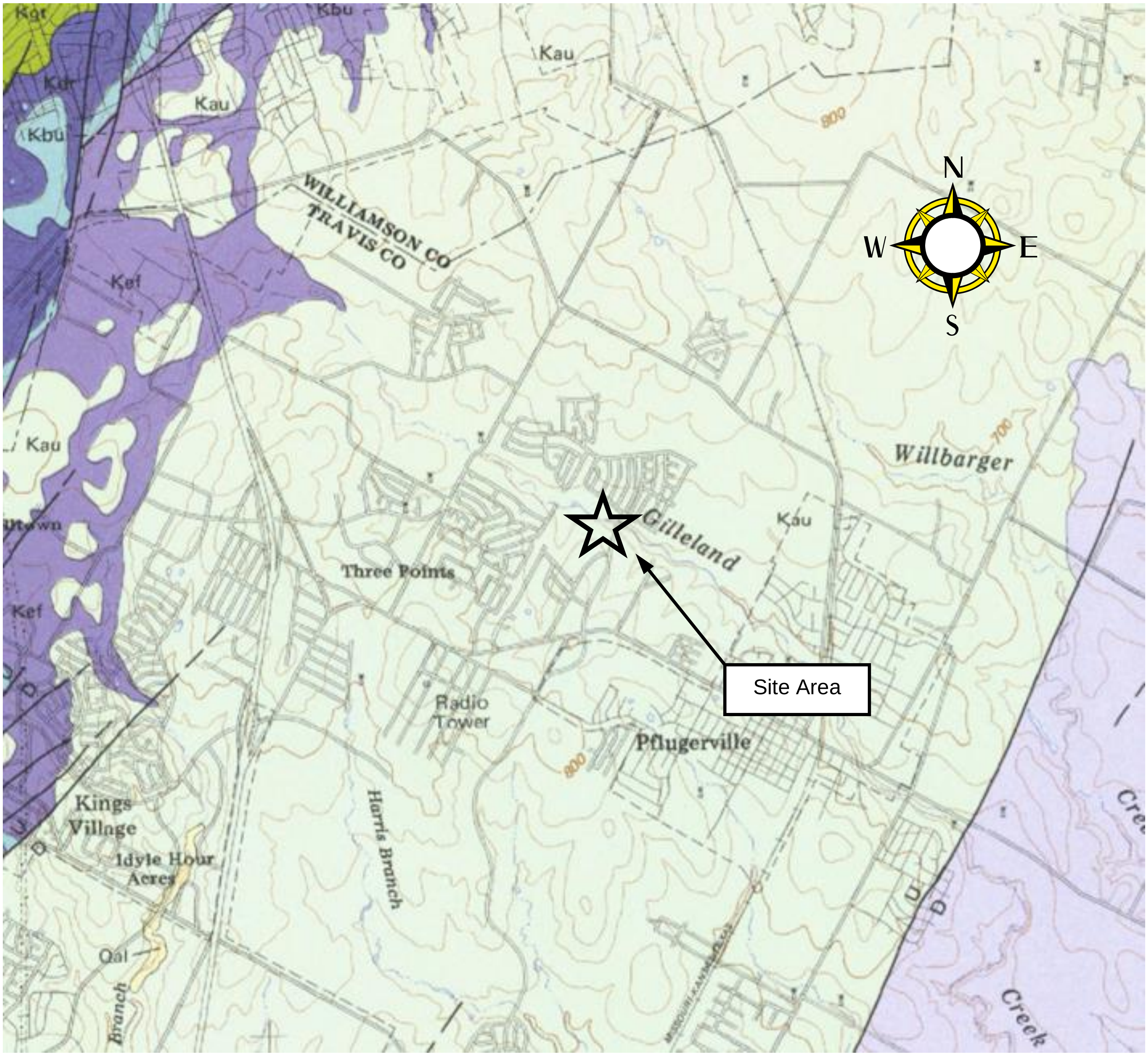
Local Lot Plan

800 N Heatherwilde Blvd

Pflugerville
Travis County, Texas

Capital Geotechnical Services PLLC
Austin, Texas

Prepared By:	Scale:	Project #:
ON	-	24-0034
Base Plan By:	Date:	Figure #:
Travis County	May 2024	2



"Kau": Inter-bedded clay, chalky clay-marl, marly limestone chalk, and limestone chalk rock sedimentary deposits categorized as the "Austin Group" geologic formation.

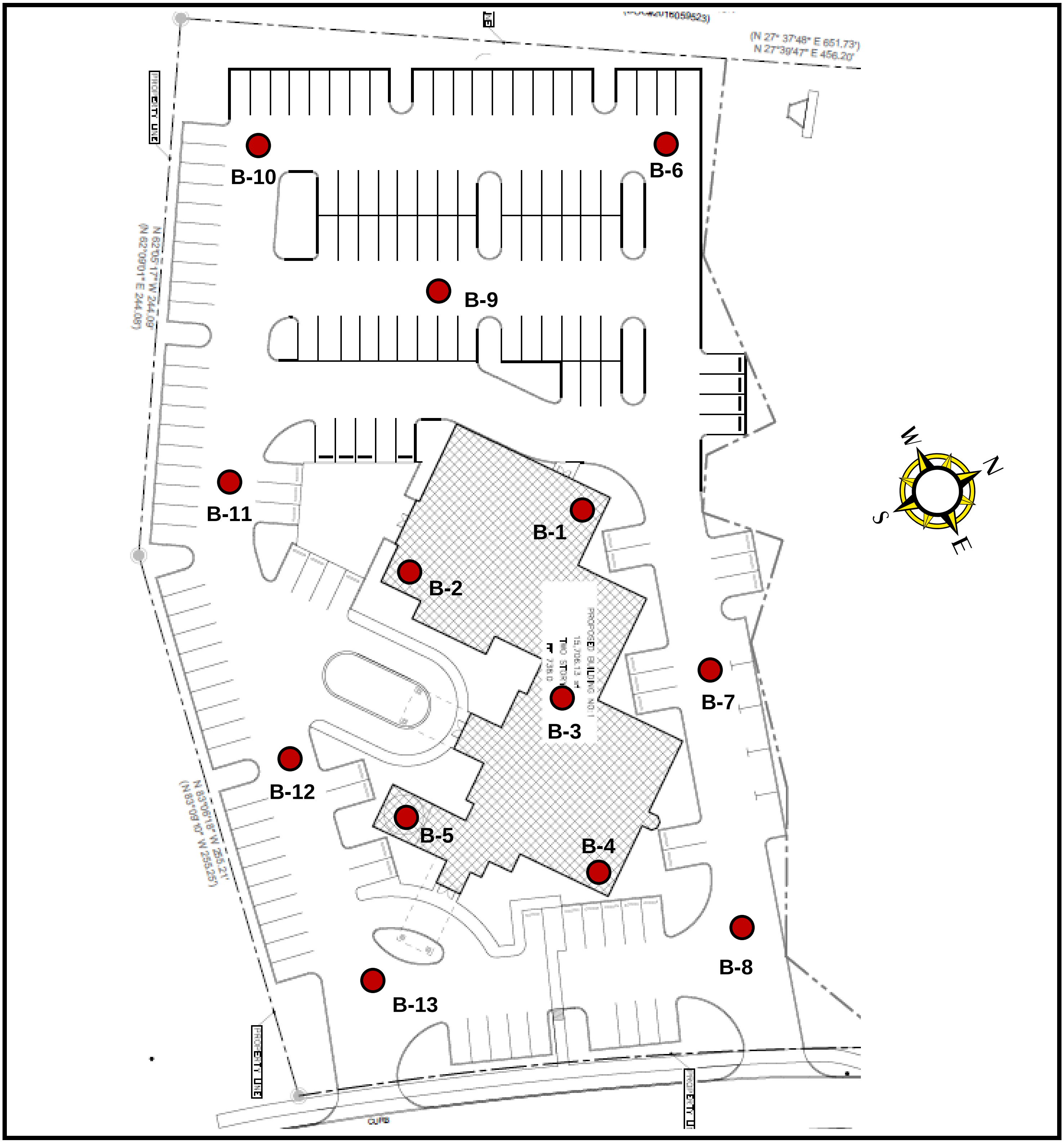
Geology Map

800 N. Heatherwilde Blvd

Plugerville
Travis County, Texas

Capital Geotechnical Services PLLC
Austin, Texas

Prepared By: ON / NK	Scale: -	Project #: 24-0034
Base Map By: U.T. Bureau of Econ. G.	Date: June 2024	Figure #: 3



Approximately Locations of Exploratory Borings

800 N. Heatherwilde Blvd

Pflugerville
Travis County, Texas

Capital Geotechnical Services PLLC
Austin, Texas

Prepared By: ON / NK	Scale: -	Project #: 24-0034
Base Plan By: PSCE	Date: April 2024	Figure #: 4

Project: **800 N. Heatherwilde Blvd**	Log of Boring B-1	**Capital Geotechnical Services**
Project Location: **Plugerville, Texas**		13200 Pond Springs Rd, Suite G56
Project Number: **24-0034**		Austin, Texas 78729

Date(s) Drilled **April 8, 2024**	Logged By **Max, Sandy**	Checked By **NK**
Drilling Method **SSA**	Drill Bit Size/Type **4 inch diam.**	Total Depth of Borehole **7.2 feet**
Drill Rig Type **Giddings truck-mounted**	Drilling Contractor **N/A (in-house)**	Approximate Surface Elevation
Groundwater Level and Date Measured **N/A**	Sampling Method(s) **Steel tube, auger cuttings**	Hammer Data **140 lbs**
Borehole Backfill **Auger cuttings and imported soil**	Location **See Figure 4**	

Elevation (feet)	Depth (feet)	Sample Type		SPT (blows per 6")	Material Type	Graphic Log	MATERIAL DESCRIPTION	PP (tsf)	Moisture Content (%)	% Fines (clay+silt)	LL	PI	% Swell or % Shrinkage
	0		1		CH w/ SD		FAT CLAY w/ SAND, very stiff, dry, dark grayish brown, trace calcareous concretions, trace roots, (CH)		17				
					WLSM		WEATHERED CHALK, hard, dry, light gray						
	1				WLSR		WEATHERED LIMESTONE CHALK, hard, dry, very pale brown to white						
	2												
	3												
	4		2	TCP: 12/1" 50/0.5" 50/0.5"					7				
			-										
	5				LS		LIMESTONE CHALK ROCK, very hard auger effort, cuttings are dry, very pale brown to white						
	6												
			3	TCP: 12/2" 50/0.25" 50/0.125"									
	7		-										
							Bottom of boring at 7.3 feet (auger refusal at 7 ft, TCP to 7.3')						
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												

Figure 5

Project: **800 N. Heatherwilde Blvd** Project Location: **Plugerville, Texas** Project Number: **24-0034**	Log of Boring B-2	**Capital Geotechnical Services** 13200 Pond Springs Rd, Suite G56 Austin, Texas 78729

Date(s) Drilled **April 8, 2024**	Logged By **Max, Sandy**	Checked By **Nick**
Drilling Method **Solid Stem**	Drill Bit Size/Type **4 inch diam.**	Total Depth of Borehole **10.1 feet**
Drill Rig Type **Giddings truck-mounted**	Drilling Contractor **N/A (in-house)**	Approximate Surface Elevation
Groundwater Level and Date Measured **N/A**	Sampling Method(s) **Shelby tube**	Hammer Data **140 lbs**
Borehole Backfill **Auger cuttings and imported soil**	Location **See Figure 4**	

Elevation (feet)	Depth (feet)	Sample Type		SPT (blows per 6")	Material Type	Graphic Log	MATERIAL DESCRIPTION	PP (tsf)	Moisture Content (%)	% Fines (clay+silt)	LL	PI	% Swell or % Shrinkage
	0				CH		FAT CLAY, very stiff, moist, dark brown, trace sand, trace roots, (CH)						
			1					3.5	22				
	1						- hard, moist, dark brown, trace sand, trace roots						
			2					4.5+	21		59	29	11.3
	2						- hard, moist, dark brown						
			3		SC		WEATHERED CHALK MATERIAL, white, w/ dark brown clay in matrix	4.5+	20				
	3				LS		LIMESTONE CHALK ROCK, very hard, cuttings are mostly fine, dry, very pale brown, white						
	4												
	5												
			4	TCP: 12/1" 50/0.5" 50/0"					9				
	6		-				- very hard						
	7												
	8												
	9						- very hard, dry, very pale brown						
			5	TCP: 12/1" 50/0.25 50/0"									
	10		-				Bottom of boring at 10.1 feet						
	11												
	12												
	13												
	14												
	15												

Figure 6

Project: **800 N. Heatherwilde Blvd** Project Location: **Plugerville, Texas** Project Number: **24-0034**	Log of Boring B-3	**Capital Geotechnical Services** 13200 Pond Springs Rd, Suite G56 Austin, Texas 78729

Date(s) Drilled **April 6, 2024**	Logged By **Max, Sandy**	Checked By **Nick**
Drilling Method **SSA**	Drill Bit Size/Type **4 inch diam.**	Total Depth of Borehole **7 feet**
Drill Rig Type **Giddings truck-mounted**	Drilling Contractor **N/A (in-house)**	Approximate Surface Elevation
Groundwater Level and Date Measured **N/A**	Sampling Method(s) **Split-spoon, auger cuttings,**	Hammer Data **140 lbs**
Borehole Backfill **Auger cuttings and imported soil**	Location **See Figure 4**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	SPT (blows per 6"), or rock REC/RQD	Material Type	Graphic Log	MATERIAL DESCRIPTION	PP (tsf)	Moisture Content (%)	% Fines (clay+silt)	LL	PI	% Swell or % Shrinkage
	0–2		1	5 9 31	Sandy CH		SANDY FAT CLAY, very stiff, dry, dark brown, pale brown, white (clay topsoil in residual chalk material) (CH/SC)	4.5+	12				
	2.5–6		2 -	TCP: 12/1" 50/0.25" 50/0.25"	WLSR		WEATHERED LIMESTONE CHALK, hard, cuttings are mostly fine, dry, very pale brown, trace white						
	6–7		3		LS		LIMESTONE CHALK ROCK, very hard, cuttings are mostly fine, very pale brown						
	7						Bottom of boring at 7 feet (auger refusal)						

Depth scale (feet): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

Figure 7

Project: **800 N Heatherwilde Blvd** Project Location: **Plugerville, Texas** Project Number: **24-0034**	Log of Boring B-4	**Capital Geotechnical Services** 13200 Pond Springs Rd, Suite G56 Austin, Texas 78729

Date(s) Drilled **April 1, 2024**	Logged By **Max, Sandy**	Checked By **Nick**
Drilling Method **SSA**	Drill Bit Size/Type **4 inch diam auger**	Total Depth of Borehole **8.7 feet**
Drill Rig Type **Giddings truck**	Drilling Contractor **N/A (in-house)**	Approximate Surface Elevation
Groundwater Level and Date Measured **N/A**	Sampling Method(s) **Steel tube, auger cuttings, split-spoon sampler**	Hammer Data **140 lbs**
Borehole Backfill **Auger cuttings and imported soil**	Location **See Figure 4**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	SPT (blows per 6"), or rock REC/RQD	Material Type	Graphic Log	MATERIAL DESCRIPTION	PP (tsf)	Moisture Content (%)	% Fines (clay+silt)	LL	PI	% Swell or % Shrinkage
	0		1		CH		FAT CLAY, moderately stiff, moist, dark brown, trace roots, (CH)	2.5	19		59	31	
	1						- very stiff, dry, dark brown	4.0					
			2		WLS		WEATHERED LIMESTONE CHALK, dry, pale brown, pale gray		9				
	2												
			3	50/2"	WLSR		WEATHERED LIMESTONE CHALK ROCK, hard, dry, white, pale yellowish brown, fine to coarse cuttings		9				
	3						- hard, cuttings are dry, pale brown, trace white						
	4		4						9				
			-	TCP: 12/0.5" 50/0.5" 50/0.25"	LS		LIMESTONE CHALK ROCK, very hard, cuttings are white, very pale brown						
	5												
	6												
	7												
	8		5										
			-	TCP: 12/2" 50/0.5" 50/0"			- very hard						
	9						Bottom of boring at 8.7 feet						
	10												
	11												
	12												
	13												
	14												
	15												

Figure 8

Project: **800 N. Heatherwilde Blvd** Project Location: **Plugerville, Texas** Project Number: **24-0034**	Log of Boring B-5	**Capital Geotechnical Services** 13200 Pond Springs Rd, Suite G56 Austin, Texas 78729

Date(s) Drilled **April 1, 2024**	Logged By **Max, Sandy**	Checked By **NK**
Drilling Method **SSA**	Drill Bit Size/Type **4 inch diam.**	Total Depth of Borehole **12.2 feet**
Drill Rig Type **Giddings truck**	Drilling Contractor **N/A (in-house)**	Approximate Surface Elevation
Groundwater Level and Date Measured **N/A**	Sampling Method(s) **Steel tube, auger cuttings**	Hammer Data **140 lbs**
Borehole Backfill **Auger cuttings and imported soil**	Location **See Figure 4**	

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	SPT (blows per 6")	Material Type	Graphic Log	MATERIAL DESCRIPTION	PP (tsf)	Moisture Content (%)	% Fines (clay+silt)	LL	PI	% Swell or % Shrinkage
	0		1		GC w/ SD		CLAYEY GRAVEL w/ SAND (weathered chalk material), dry, white, w/ dark brown topsoil in matrix, (GC)		9				
	1		2				- dry, white, pale brown, trace dark brown		8				
	3				WLSR		WEATHERED LIMESTONE CHALK, fine to coarse dry cuttings, very pale brown, trace white						
	4		3						9				
			4	TCP: 12/1" 50/1" 50/0.5"									
	7				WLSR		Possible MARLY CHALK, hard, moist, pale brown, light yellowish brown						
	8		5						13	68	39	21	
			6	TCP: 12/2" 50/1" 50/1"									
	10				LS		LIMESTONE CHALK ROCK, very hard auger effort, cuttings are dry, very pale brown						
			7						10				
	12		8	TCP: 12/1" 50/1" 50/0.125"									
	12.2						Bottom of boring at 12.2 feet						
	13												
	14												
	15												

Figure 9

Project: **800 N. Heatherwilde Blvd** Project Location: **Plugerville, Texas** Project Number: **24-0034**	# Log of Boring B-6	**Capital Geotechnical Services** 13200 Pond Springs Rd, Suite G56 Austin, Texas 78729

Date(s) Drilled **April 8, 2024**	Logged By **Max, Sandy**	Checked By **NK**
Drilling Method **Solid Stem Auger (SSA)**	Drill Bit Size/Type **4 inch diam auger**	Total Depth of Borehole **7.7 feet**
Drill Rig Type **Giddings truck**	Drilling Contractor **N/A (in-house)**	Approximate Surface Elevation
Groundwater Level and Date Measured **N/A**	Sampling Method(s) **Steel tube, auger cuttings, split-spoon sampler**	Hammer Data **140 lbs**
Borehole Backfill **Auger cuttings and imported soil**	Location **See Figure 4**	

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	SPT (blows per 6")	Material Type	Graphic Log	MATERIAL DESCRIPTION	PP (tsf)	Moisture Content (%)	% Fines (clay+silt)	LL	PI	% Swell or % Shrinkage
	0		1		FLS		WEATHERED LIMESTONE ROCK w/ TOPSOIL, dry, white, trace dark grayish brown topsoil in fractures - softer at 3 feet						
	3				CH w/ SD		FAT CLAY w/ SAND (marl?), hard, moist, pale brown, pale gray, (CH)						
	5		2						17		54	33	+2.5
	6				Sandy CL w/ RF		LEAN CLAY w/ SAND and ROCK FRAGMENTS (marl), very stiff, dry to moist, very pale yellowish brown, light gray, (CL)						
	7		3	5 15 50/2					9	57			
					LS		LIMESTONE CHALK						
	7.7						Bottom of boring at 7.7 feet						

Figure 10

Project: **800 N. Heatherwilde Blvd** Project Location: **Plugerville, Texas** Project Number: **24-0034**	# Log of Boring B-7	**Capital Geotechnical Services** 13200 Pond Springs Rd, Suite G56 Austin, Texas 78729

Date(s) Drilled **April 8, 2024**	Logged By **Max, Sandy**	Checked By **Nick**
Drilling Method **SSA**	Drill Bit Size/Type **4 inch diam. auger**	Total Depth of Borehole **4.6 feet**
Drill Rig Type **Giddings truck-mounted**	Drilling Contractor **N/A (in-house)**	Approximate Surface Elevation
Groundwater Level and Date Measured **N/A**	Sampling Method(s) **Shelby tube, auger cuttings, split-spoon sample**	Hammer Data **140 lbs**
Borehole Backfill **Auger cuttings and imported soil**	Location **See Figure 4**	

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	SPT (blows per 6")	Material Type	Graphic Log	MATERIAL DESCRIPTION	PP (tsf)	Moisture Content (%)	% Fines (clay+silt)	LL	PI	% Swell or % Shrinkage
	0–1		1		Sandy CL SC w/ GV		SANDY LEAN CLAY, medium grayish brown, trace roots, trace calc. concretions and nodules, (CL) - very pale brown, white, med. grayish brown	2.5	9				
	1–2		2		CH w/ SD		FAT CLAY w/ FINE to COARSE SAND, trace rock fragments, hard, dry to moist, dk. brown, trace roots, (CH)	4.5+	15		55	29	
	2–4.6		3		LS		LIMESTONE CHALK ROCK, very hard auger effort, cuttings are dry and very pale brown		7				
	4.6		-	TCP: 12/1" 50/0" 50/0"			Boring terminated at 4.6 feet						

Figure 11

Project: **800 N. Heatherwilde Blvd** Project Location: **Plugerville, Texas** Project Number: **24-0034**	Log of Boring B-8	**Capital Geotechnical Services** 13200 Pond Springs Rd, Suite G56 Austin, Texas 78729

Date(s) Drilled **April 8, 2024**	Logged By **Max, Sandy**	Checked By **Nick**
Drilling Method **Solid Stem**	Drill Bit Size/Type **4 inch diam. auger**	Total Depth of Borehole **4.7 feet**
Drill Rig Type **Giddings truck-mounted**	Drilling Contractor **N/A (in-house)**	Approximate Surface Elevation
Groundwater Level and Date Measured **N/A**	Sampling Method(s) **Shelby tube, auger cuttings, split-spoon sample**	Hammer Data **140 lbs**
Borehole Backfill **Imported soil**	Location **See Figure 4**	

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	SPT (blows per 6")	Material Type	Graphic Log	MATERIAL DESCRIPTION	PP (tsf)	Moisture Content (%)	% Fines (clay+silt)	LL	PI	% Swell or % Shrinkage
	0		1		GC w/ SD (fat)		CLAYEY GRAVEL w/ SAND, dry, dark brownish gray, with pale gray rock fragments and white calcareous concretions and nodules, w/ roots, (GC)	4.25	11				
	1		2		GC w/ SD				9	40			
	2												
	3												
	4		3		LS		LIMESTONE CHALK ROCK, very hard auger efforts, cuttings are dry, very pale brownish gray		7				
			-	TCP: 12/1" 50/1" 50/0.5"									
	5						Boring terminated at 4.7 feet (very hard effort)						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												

Figure 12

Project: **800 N. Heatherwilde Blvd** Project Location: **Plugerville, Texas** Project Number: **24-0034**	Log of Boring B-9	**Capital Geotechnical Services** 13200 Pond Springs Rd, Suite G56 Austin, Texas 78729

Date(s) Drilled **April 8, 2024**	Logged By **Max, Sandy**	Checked By **Nick**
Drilling Method **Solid Stem Auger**	Drill Bit Size/Type **4 inch diam. auger**	Total Depth of Borehole **4.8 feet**
Drill Rig Type **Giddings truck-mounted**	Drilling Contractor **N/A (in-house)**	Approximate Surface Elevation
Groundwater Level and Date Measured **N/A**	Sampling Method(s) **Shelby tube, auger cuttings**	Hammer Data **140 lbs**
Borehole Backfill **Imported soil**	Location **See Figure 4**	

Elevation (feet)	Depth (feet)	Sample Type		SPT (blows per 6")	Material Type	Graphic Log	MATERIAL DESCRIPTION	PP (tsf)	Moisture Content (%)	% Fines (clay+silt)	LL	PI	% Swell or % Shrinkage
	0		1		CH		FAT CLAY, hard, dry, dark brown, trace roots, trace white calc. nodules, (CH)	4.5+	18				
	1				LS		LIMESTONE CHALK ROCK, very hard auger effort, cuttings are dry, white, and very pale brown, and mostly fine						
	2												
	3												
	4		2						11				
			-	TCP: 12/2" 50/1" 50/1"									
	5						Boring terminated at 4.8 feet						
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												

Figure 13

Project: **800 N. Heatherwilde Blvd** Project Location: **Plugerville, Texas** Project Number: **24-0034**	# Log of Boring B-10	**Capital Geotechnical Services** 13200 Pond Springs Rd, Suite G56 Austin, Texas 78729

Date(s) Drilled **April 8, 2024**	Logged By **Max, Sandy**	Checked By **Nick**
Drilling Method **SSA**	Drill Bit Size/Type **4 inch diam.**	Total Depth of Borehole **4.5 feet**
Drill Rig Type **Giddings truck-mounted**	Drilling Contractor **N/A (in-house)**	Approximate Surface Elevation
Groundwater Level and Date Measured **N/A**	Sampling Method(s) **Steel tube, auger cuttings**	Hammer Data **140 lbs**
Borehole Backfill **Imported soil**	Location **See Figure 4**	

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	SPT (blows per 6")	Material Type	Graphic Log	MATERIAL DESCRIPTION	PP (tsf)	Moisture Content (%)	% Fines (clay+silt)	LL	PI	% Swell or % Shrinkage
	0 – 1		1		GC w/ SD		CLAYEY GRAVEL w/ SAND, dry, dark brownish gray, white, (GC)		10				
	1 – 4.5		2		LS		LIMESTONE CHALK ROCK, very hard auger effort, cuttings are dry, white, and very pale brown		8				
	4.5						Boring terminated at 4.5 feet (very hard)						

Figure 14

Project: **800 N. Heatherwilde Blvd** Project Location: **Plugerville, Texas** Project Number: **24-0034**	# Log of Boring B-11	**Capital Geotechnical Services** 13200 Pond Springs Rd, Suite G56 Austin, Texas 78729

Date(s) Drilled **April 8, 2024**	Logged By **Max, Sandy**	Checked By **Nick**
Drilling Method **SSA**	Drill Bit Size/Type **4 inch diam. auger**	Total Depth of Borehole **6 feet**
Drill Rig Type **Giddings truck-mounted**	Drilling Contractor **N/A (in-house)**	Approximate Surface Elevation
Groundwater Level and Date Measured **N/A**	Sampling Method(s) **Steel tube, auger cuttings**	Hammer Data **N/A**
Borehole Backfill **Imported soil**	Location **See Figure 4**	

Elevation (feet)	Depth (feet)	Sample Type	Sample No.	SPT (blows per 6")	Material Type	MATERIAL DESCRIPTION	PP (tsf)	Moisture Content (%)	% Fines (clay+silt)	LL	PI	% Swell or % Shrinkage
	0				CH	FAT CLAY, trace sand, very stiff, moist, dark brown, (CH)						
			1				3.75	23				
	1		2				3.5	21		60	31	
	2		3				4.0	22				7.0
	3.5		4		GC w/ SD	CLAYEY GRAVEL w/ SAND, moist, pale gray, white, pale yellowish brown, trace medium brown, trace lt. yellowish brown, (GC)		20				
	4				LS	LIMESTONE CHALK ROCK, very hard auger effort, cuttings are dry, white, and pale brownish gray						
	5		5					10				
	6					Boring terminated at 6 feet						

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

Project: **800 N. Heatherwilde Blvd** Project Location: **Plugerville, Texas** Project Number: **24-0034**	Log of Boring B-12	**Capital Geotechnical Services** 13200 Pond Springs Rd, Suite G56 Austin, Texas 78729

Date(s) Drilled **April 1, 2024**	Logged By **Max, Sandy**	Checked By **Nick**
Drilling Method **Solid Stem**	Drill Bit Size/Type **4 inches**	Total Depth of Borehole **8.8 feet**
Drill Rig Type **Giddings truck-mounted**	Drilling Contractor **N/A (in-house)**	Approximate Surface Elevation
Groundwater Level and Date Measured **N/A**	Sampling Method(s) **Shelby tube, auger cuttings**	Hammer Data **140 lbs**
Borehole Backfill **Imported soil**	Location **See Figure 4**	

Elevation (feet)	Depth (feet)	Sample Type		SPT (blows per 6")	Material Type	Graphic Log	MATERIAL DESCRIPTION	PP (tsf)	Moisture Content (%)	% Fines (clay+silt)	LL	PI	% Swell or % Shrinkage
	0		1		GC w/ SD		CLAYEY GRAVEL w/ SAND, dark brown clay topsoil within white weathered chalk material, (GC)						
	1				WLSR		WEATHERED LIMESTONE CHALK, hard auger effort, cuttings are dry and pale gray						
	2												
	3												
	4		2	TCP: 12/1" 50/0" 50/0"									
			-										
	5												
	6												
	7												
	8		3	TCP: 12/2" 50/0.5" 50/0.25"			- cuttings are dry, white, and pale gray						
			-										
	9						Boring terminated at 8.8 feet						
	10												
	11												
	12												
	13												
	14												
	15												

Project: **800 N Heatherwilde Blvd** Project Location: **Plugerville, Texas** Project Number: **24-0034**	# Log of Boring B-13	**Capital Geotechnical Services** 13200 Pond Springs Rd, Suite G56 Austin, Texas 78729

Date(s) Drilled **April 8, 2024**	Logged By **Max, Sandy**	Checked By **NK**
Drilling Method **Solid Stem**	Drill Bit Size/Type **4 inch diam. auger**	Total Depth of Borehole **4.5 feet**
Drill Rig Type **Giddings truck**	Drilling Contractor **N/A (in-house)**	Approximate Surface Elevation
Groundwater Level and Date Measured **N/A**	Sampling Method(s) **Shelby tube, auger cuttings, split-spoon sample**	Hammer Data **N/A**
Borehole Backfill **Imported soil**	Location **See Figure 4**	

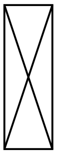
Elevation (feet)	Depth (feet)	Sample Type		SPT (blows per 6")	Material Type	Graphic Log	MATERIAL DESCRIPTION	PP (tsf)	Moisture Content (%)	% Fines (clay+silt)	LL	PI	% Swell or % Shrinkage
	0		1		CH		FAT CLAY, trace sand, very stiff, moist, dark brown, trace fine roots, (CH)		16				
	1		2		SC w/ GV		CLAYEY SAND w/ GRAVEL, moist, dark grayish brown, pale brown, white, (SC)		13				
	2				WLSR		WEATHERED LIMESTONE CHALK, dry, pale brown, mostly fine cuttings						
	3												
	4		3						10				
	4.5						Boring terminated at 4.5 feet.						
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												

Figure 17

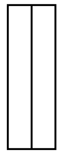
Capital Geotechnical Services PLLC

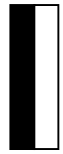
STANDARD REFERENCE NOTES FOR BORING LOGS

I. Sampling & Testing Symbols:

 Shelby Tube

 Auger sample

 Rock core

 Split-spoon sample (SPT)

 Percussion tube

II. Correlations of Penetration Resistance to Soil Properties:

Relative Density of Sand and Sandy Silt		Consistency of Clay and Clayey Silt		
Relative Density	SPT N-value	Consistency	SPT N-value (qualitative measure)	Unconfined Compressive Strength (tsf)
Very loose	0 to 4	Very soft	0 to 3	Under 0.25
Loose	5 to 10	Soft	4 or 5	0.25 – 0.5
Medium dense	11 to 30	Medium stiff	6 to 10	0.5 – 1.0
Dense	31 to 50	Stiff	11 to 15	1.0 – 2.0
Very Dense	> 50	Very stiff	16 to 30	2.0 – 4.0
		Hard	> 30	4.0 – 8.0

III. Unified Soil Classification Symbols:

GP - Poorly Graded Gravel
GW - Well Graded Gravel
GM - Silty Gravel
GC - Clayey Gravel
OH - High Plasticity Organics

SP - Poorly Graded Sand
SW - Well Graded Sand
SM - Silty Sand
SC - Clayey Sand
OL - Low Plasticity Organics

ML - Low Plasticity Silt
MH - High Plasticity Silt
CL - Low to Medium Plasticity Clay
CH - High Plasticity Clay

IV. Rock Quality Designation index (RQD):

RQD:	Description of Rock Quality: (if all natural fractures and discontinuities)
0-25 %	Very poor
25-50 %	Poor
50-75 %	Fair
75-90 %	Good
90-100%	Excellent

V. Natural moisture content:

"Dry"	No apparent moisture, crumbles
"Moist"	Damp but no visible water
"Very Moist"	Notably softer
"Wet"	Visible water and soft

VI. Grain size terminology:

Cobble: 3-inches to 12-inches
Gravel: #4 sieve size (4.75 mm) to 3-inches
Coarse sand: #10 to #4 sieve size
Medium sand: #40 to #10 sieve size
Fine sand: #200 to #40 sieve size
Silt or clay: smaller than #200 sieve size

VIII. Descriptive terms or symbols:

"Mottled": occasional/spotted presence of that color
"- […]": identifies change in soil characteristics
LL: Liquid Limit (moisture content as % of dry weight)
PL: Plastic Limit (moisture content as % of dry weight)
WOH: Weight of hammer
"with […]": item identified within that sample only

VII. Descriptive terms for soil composition:

"Trace" . . . . 1 to 9%
"Some" . . . . 10 to 29%
(with suffix –y, e.g. sandy, clayey …) . . . . . 30 to 49%

IX. Plasticity of cohesive soil:

(function of PI and clay mineral types)

Plasticity Index (PI):	*Plasticity*:
0 to 20	Low
20 to 30	Medium
30 +	High

Fig. 18

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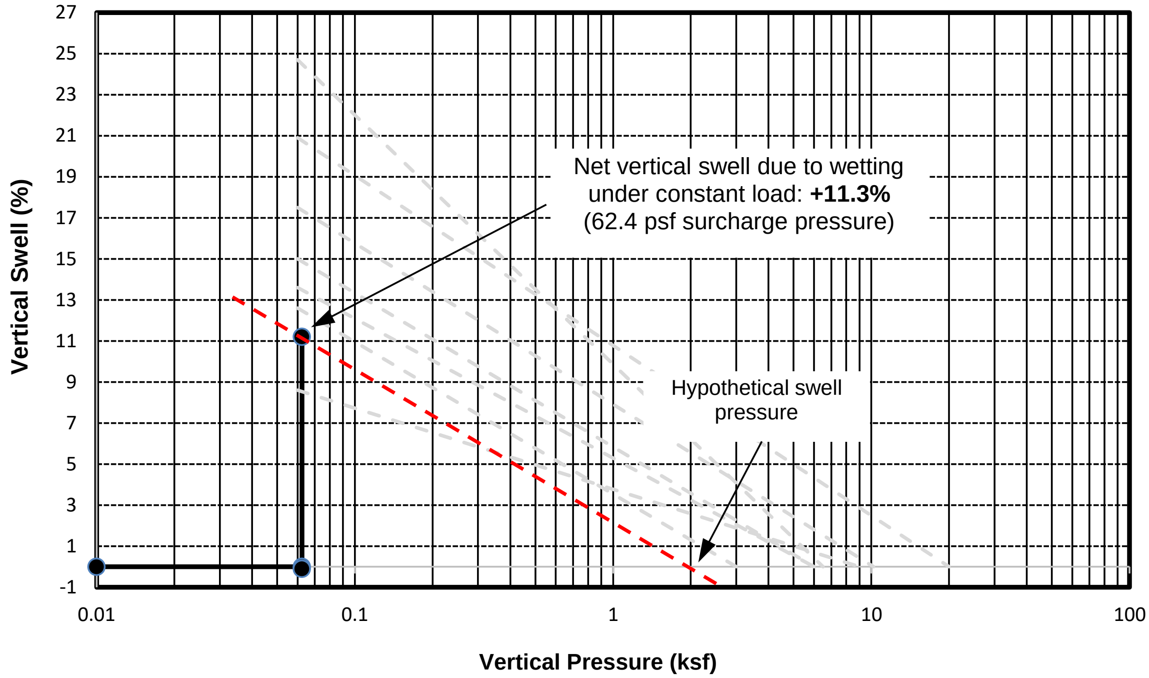
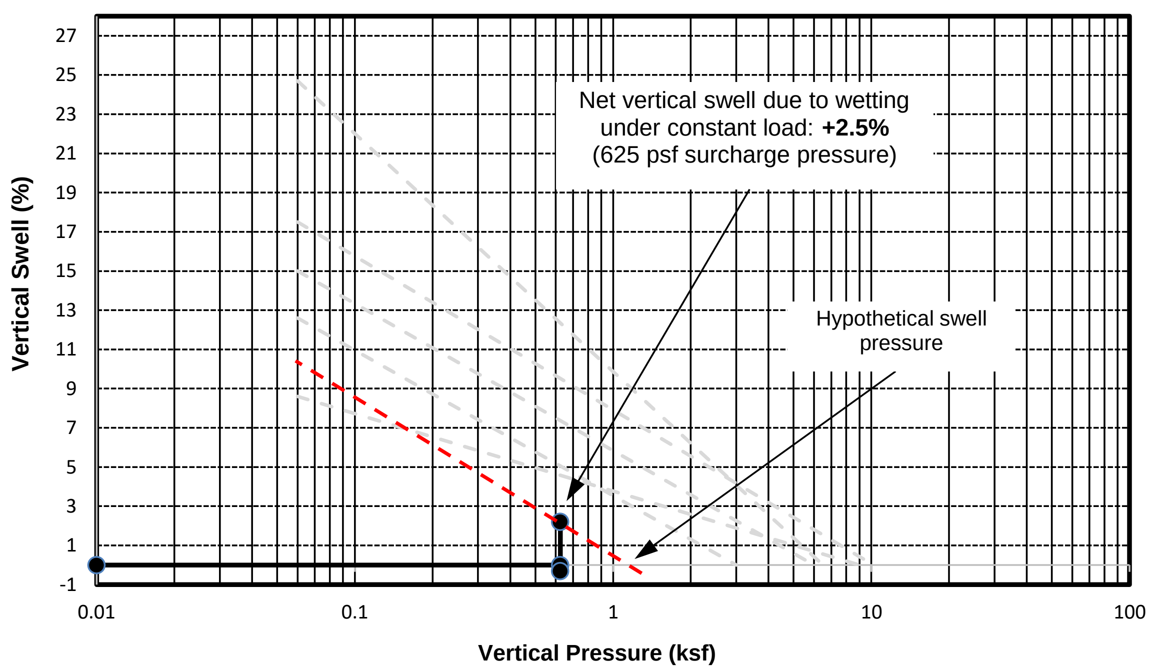
Swell Test Results



B-2, 1'-2'
Dark brown
PP= 4.5+ tsf
Initial liquidity index (LI): -0.379
Remolded specimen, initially slighty air-dried

Dry unit weight =	81	pcf
Initial moisture content =	19	%
Final moisture content =	43	
Days soaking:	16	
Final PP:	1.25	tsf



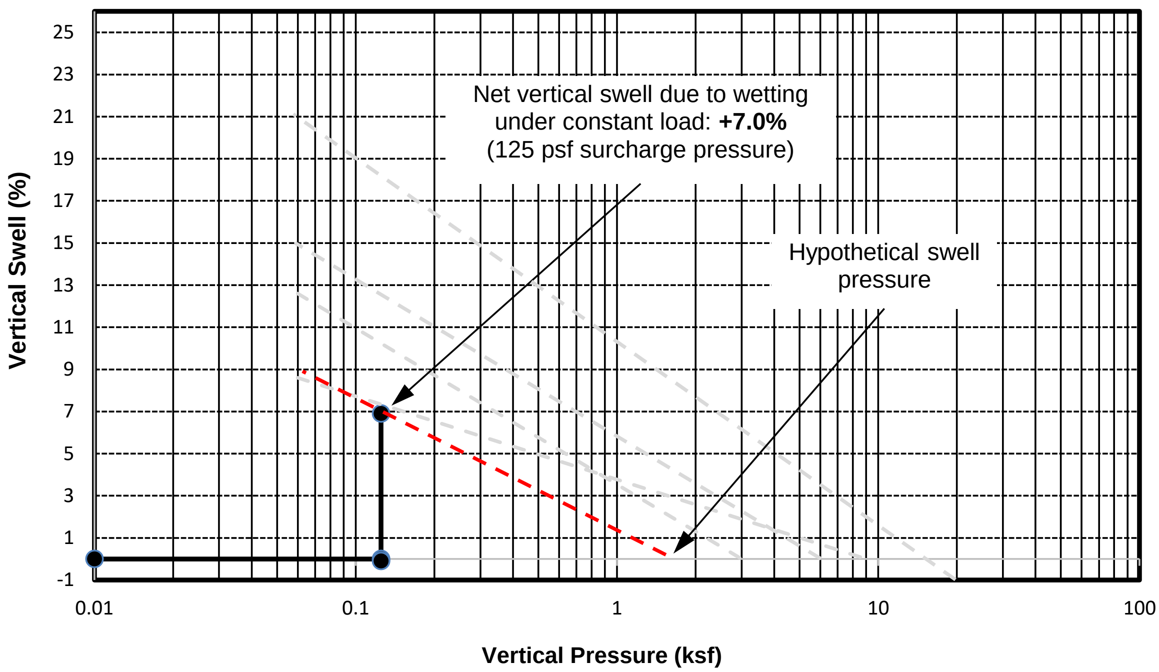
B-6, 5'-6'
Pale brown, pale gray
PP=4.5+ tsf
Initial liquidity index (LI): -0.152
Remolded specimen, initially slightly air-dried

Dry unit weight =	107	pcf
Initial moisture content =	16	%
Final moisture content =	22	%
Days soaking:	3	
Final PP:	3.50	tsf

Figure 19

Capital Geotechnical Services PLLC

Swell Test Results



B-11, 2'-3'		Dry unit weight =	90	pcf
dark brown		Initial moisture content =	20	%
PP= 4.5+ tsf		Final moisture content =	32	%
Initial liquidity index (LI):	-0.290	Days soaking:	2	
Undisturbed sample, initially slightly air-dried		Final PP:	2.50	tsf