Subsurface Exploration, Foundation Recommendations and Pavement Recommendations
Proposed Monarch PUD
Highway 183
Leander, Williamson County, Texas

Terradyne Project No.: A251077

Mr. Venkat Dubhakula
Sweetwater Investments, LLC
5304 Cipriano Drive
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April 11, 2025

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April 11, 2025

Sweetwater Investments LLC
5304 Cipriano Drive
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Attn: Mr. Venkat Dubhakula

Re: **Subsurface Exploration, Foundation Recommendations and Pavement Recommendations**
Proposed Monarch PUD
Highway 183
Leander, Williamson County, Texas
Terradyne Project No.: A251080

Dear Mr. Dubhakula:

Terradyne Engineering, Inc. has completed a soil and foundation engineering report at the above referenced project site. The results of the exploration are presented in this report.

We appreciate and wish to thank you for the opportunity to service you on this project. Please do not hesitate to contact us if we can be of additional assistance during the Construction Materials Testing and Quality Control phases of construction.

Respectfully Submitted,

Terradyne Engineering, Inc.
Texas Firm Registration No. F-6799

STATE OF TEXAS
JOHN A. GUNTER
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EXECUTIVE SUMMARY

The soil conditions at the site of the proposed commercial building (Monarch PUD) at Highway 183 in Leander, Williamson County, Texas were explored by drilling four (4) test borings to a maximum depth of ten (10) feet. Borings B-1 and B-2 were terminated prior to their proposed depths due to limestone. Laboratory tests were performed on selected specimens to evaluate the engineering characteristics of various soil strata encountered in our borings.

The results of our exploration, laboratory testing and engineering evaluation indicate the soils underlying this site have low swell potential. Potential vertical movement on the order of one (1) inch was estimated for dry to wet moisture conditions at the existing grade level.

Straight shaft drilled piers, founded at minimum depths of three (3) feet into limestone below existing grade, may be considered to support the proposed structures and may be designed for an allowable end-bearing capacity of 12,000 psf. Drilled piers may require the use of casing or slurry drilling depending on the amount of groundwater conditions at the time of construction.

The structures may also be supported on conventional strip and spread footings. Footings supported on competent limestone may be sized for an allowable bearing capacity of 5,000 pounds per square foot.

If it is desired a slab foundation can be used instead of conventional footings and drilled piers. The proposed structure may be supported by stiffened grid type beam and slab foundations, either conventionally reinforced or post tensioned. The grade beams, founded at the recommended depths below the finished grade elevation on proof-rolled in-situ soils or compacted select fill, may be sized for an allowable bearing capacity value of 1,000 or 1,500 pounds per square foot respectively.

The floor slab, used with the drilled pier foundations or shallow foundations, may be supported on existing subgrade. Building pad subgrade modification will be required if a grade supported floor is used. Subgrade modifications are presented in the site preparation section of the report.

Groundwater seepage was not encountered in our borings at the time of our field exploration. Detailed descriptions of subsurface conditions and foundation design recommendations are included in this report.

This summary does not contain all the information that is included in the full report. The report should be read in its entirety to obtain a more complete understanding of the information provided.

1.0 PROJECT AUTHORIZATION AND SCOPE OF SERVICES

The services of Terradyne Engineering, Inc. were authorized on March 27, 2025 by Mr. Venkat Dubhakula, Managing Partner of of Sweetwater Investments LLC by approving our proposal No: AP251080 dated March 25, 2025.

Our scope of services included drilling four (4) soil test borings at the site to maximum depths of approximately 15 feet below the existing ground surface, limited laboratory testing of select soil samples to evaluate pertinent physical properties, and to perform engineering analysis to develop foundation and pavement design criteria.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air on or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes. Prior to development of this site, an environmental assessment is advisable.

2.0 PROJECT AND SITE DESCRIPTION

2.1 Project Description

The proposed project consists of a single-story retail building having a footprint area of approximately 8,5330 square feet. Structural loading information is currently not available; however for the purpose of this report it is assumed that maximum wall loads on perimeter grade beams will be less than 2 kips per linear foot and maximum concentrated loads will be less than 40 kips. Detailed site grading information is not currently available; therefore we have assumed that the building will be constructed at or slightly above existing grades.

The foundation recommendations presented in this report are based on the available project information, project location, and the subsurface materials described in this report. If any of the noted information is incorrect, please inform Terradyne in writing so that we may amend the recommendations presented in this report, if appropriate and, if desired by the client. Terradyne will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

2.2 Site Location and Description

The subject property is located on the north side of Fairway Road and Oak Grove Road intersection in Leander, Williamson County, Texas. The subject site slopes moderately down towards the east with small trees and grass covered ground. Borings B-1 through B-4 were drilled at/near the following GPS location (Lat. 30.607901°, Long. -97.861795°). An aerial map of the GPS location is included in Figure 1-B.

3.0 SUBSURFACE CONDITIONS

3.1 Field and Laboratory Testing

The site subsurface conditions were explored with four (4) soil test borings advanced to maximum depths of about nine (9) feet below the existing ground surface. The approximate boring locations are indicated on the Boring Location Plan enclosed in the Appendix. Copies of the Logs of Borings are also enclosed in the Appendix.

The borings were advanced utilizing continuous flight auger drilling methods and soil samples were routinely obtained during the drilling process. Drilling and sampling techniques were accomplished generally in accordance with ASTM procedures. Select soil samples were tested in the laboratory to determine material properties for our evaluation. Laboratory testing was accomplished generally in accordance with ASTM procedures.

3.2 Subsurface Conditions

A review of the *Geological Atlas of Texas, Austin Sheet*[1], indicates that this site is naturally underlain with the soils and rock of the Comanche Peak Limestone (Kc) formation and Keys Valley Marl (Kkv) formation. The Comanche Peak Limestone is part of the Fredericksburg Group, is typically fine to very fine grained, fairly hard, and light brown to light gray in color and weathers white. The thickness of this formation is up to 80 feet. The Keys Valley Marl (Kkv) formation consists of brown to tan clay and sandy clay which transitions to alternating layers and beds of marl and nodular, fossiliferous limestone with increasing depth.

The engineering characteristics of the underlying soils, based on our field and laboratory test results, are summarized and presented in Table No. 1.

Table No. 1- Soil Stratum Summary

Stratum	Depth Range Feet	Liquid Limit Range	Plasticity Index	Blows Per Foot
Clayey Sand with Gravel (SC)	0 – 3.5	32 – 35	8 – 10	24 – 50/4”
Limestone	3.5 – 10	--	--	TCP: T=1”-0”

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the appendix should

[1] Source: United States Geological Survey, Geologic Atlas of Texas [Austin Sheet], Bureau of Economic Geology, Texas Natural Resource Information System; http://txpub.usgs.gov/DSS/texasgeology/ (2007).\

be reviewed for specific information at individual boring locations. These records include soil/rock descriptions, stratifications, penetration resistances, and locations of the samples and laboratory test data. The stratifications shown on the boring logs represent the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual and indistinct. Water level information obtained during field operations is also shown on these boring logs. The samples, which were not altered by laboratory testing will be retained for 30 days from the date of this report and then will be discarded.

3.3 Groundwater

Ground water was not encountered in the borings upon completion of drilling, indicating that the continuous ground water level at the boring locations at the time of the exploration was either below the terminated depths of the borings, or that the soils encountered are relatively impermeable. Although groundwater was not encountered in the borings at this time, it is possible for a groundwater table to be present within the depths explored during other times of the year depending upon climatic and rainfall conditions. In relatively impervious soils, an accurate determination of groundwater elevation may not be possible even after several days of observation. Seasonal variations, temperatures and recent rainfall conditions may influence the level of the groundwater table and the volume of water encountered will depend on the permeability of the soils. The groundwater levels presented in this report are the levels that were measured at the time of our field activities. We recommend that the Contractor determine the actual groundwater levels at the site at the time of the construction activities.

4.0 EVALUATION AND RECOMMENDATIONS

4.1 Vertical Movements

High plasticity clay soils encountered in the borings have potential for volume change with changes in moisture content. The volume change is normally evidenced by the heaving and cracking of concrete floor slabs. Based on TXDOT method TEX-124-E and our experience with the shrink/swell characteristics of similar soils, the Potential for Vertical Rise (PVR) is estimated to be on the order of one (1) inch, for slab on grade construction at existing grades.

If a non-seasonal moisture source becomes available, such as a plumbing or drainage leak or poor surface drainage, swell in excess of the estimated PVR may occur. Therefore it is recommended that positive drainage away from the building should be provided. If positive drainage is not provided, water will pond around or below the building and excessive total and differential movements may occur.

The estimated PVR values are based on the current site grades. If cut and fill operations are performed, the PVR values could change significantly. If the existing grade is to be raised to attain finish grade elevation, select structural fill should be placed in lifts and properly compacted as recommended under Fill Materials section of this report.

Remedial measures associated with swelling soils typically consist of either using a structurally suspended floor slab system utilized in conjunction with drilled pier foundation system or reducing the swell potential by removing some of the high plasticity soils and replacing them with low swell potential select fill materials.

The most positive remedial measure associated with swelling soils would consist of a structurally suspended floor slab utilized in conjunction with drilled pier foundation system. If the option of a structurally suspended floor slab is utilized, the remedial measures described above will not be required, additionally any fill required to achieve final subgrade elevation may consist of on-site or similar soils.

The performance of a grade supported floor slab or a shallow foundation system can be significantly influenced by yard maintenance, recessed landscaping additions near the building, utility leaks and any other free water sources, and deep-rooted trees and shrubs. Deep-rooted trees and shrubs located near the structure, within an approximate distance equal to about their ultimate mature height, could cause foundation settlement due to ground shrinkage as a result of long-term moisture absorption of the roots. It is also imperative that moist soil conditions be maintained within 10 feet of the foundation perimeter during prolonged periods of dry weather to prevent deep desiccation crack development and associated settlement due to ground shrinkage. Providing flatwork around the buildings will help in reducing moisture variation under the buildings. In areas where flatwork does not abut the building, a moisture barrier may be provided at a shallow depth below the ground surface to prevent moisture variation below the building.

The following design recommendations have been developed on the basis of the previously described project characteristics and subsurface conditions encountered. If there are any changes in these project criteria, including project location on the site, a review must be made by Terradyne to determine if any modifications in the recommendations will be required. The findings of such a review should be presented in a supplemental report.

4.2 Site Preparation

To reduce the potential for moisture induced movement of the site soils, it is important that consideration is given to reducing the potential for moisture changes of the site soils. As a minimum, positive drainage away from the building should be provided. If positive drainage is not provided, water will pond around or below the building and excessive total and differential movements may occur.

Initially, all topsoil and deleterious materials, including any dumped soils, trees, tree roots and any existing foundation and utilities must be removed from the areas proposed for construction. After stripping and excavating to the proposed subgrade level, as required and prior to placing fill, the exposed subgrade should be proof-rolled with a tandem axle dump truck or similar rubber tired vehicle. Soils, which are observed to rut or deflect excessively under the moving load, should be undercut and replaced with properly compacted fill. The proof-rolling and undercutting activities should be witnessed by a representative of the geotechnical engineer and should be performed during a period of dry weather. After proof-rolling, the subgrade soils should be scarified and re-compacted to between 93 to 98 percent of the standard Proctor maximum dry density ASTM D698, in the moisture range of at least 3% or more above optimum, for a depth of at least 8 inches below the surface.

After subgrade preparation and observation have been completed, fill placement may begin. The first layer of fill material should be placed in a relatively uniform horizontal lift and be adequately keyed into the stripped and scarified subgrade soils.

Existing Trees: During our site visit it was noted that several mature existing trees are located in the potential area of the new building. The soil around the existing trees is likely to be drier than the soil further from the trees. These drier soils have the potential for greater soil movement even if the trees are removed. If trees are removed from the new building location the excavation from the tree removal should be properly backfilled with either select fill or on site soils. The backfill should be compacted as recommended in the Site Preparation Section at a moisture content above optimum.

4.3 Foundation Recommendations

The most positive means of limiting movements due to swelling soils is to support the building structure on drilled pier foundation system. The use of a shallow foundation system is feasible, provided that the recommended subgrade modification, as outlined in the options 1 through 3 of Site Preparation section of this report, is performed.

The floor slab, utilized with the drilled pier foundation system or shallow spread footings, may consist of a structurally suspended floor system, or a soil supported floor slab may be considered if some floor movement can be tolerated and the recommended site work activities to reduce the swell potential are performed.

4.3.1 Drilled Pier Foundations

Straight shaft drilled piers, founded at minimum depths of three (3) feet below existing grade, may be considered to support the proposed structures and may be designed for an allowable end-bearing capacity of 12,000 psf based on dead load plus design live load considerations. The piers may also be designed for an allowable skin friction value of 2,000 pounds per square foot in axial compression for the portion of the pier in contact with limestone. Embedment into the clay should be neglected for skin friction resistance. In no case should piers be designed with a shaft diameter less than 12 inches. Piers should have a minimum clear spacing at least equal to or larger than twice the diameter of the end bearing area of the largest adjacent pier.

. For straight shaft piers skin friction should be neglected for the shaft above the shaft bottom for a distance equal to the shaft diameter.

Uplift Forces: Moisture variation in the expansive soils at this site can cause vertical movements of the subsurface soils. This potential vertical movement can mobilize uplift force along the shaft of a drilled pier. The uplift force acting on the shaft may be estimated by using the Equation No. 1.

Equation No. 1: $\mathbf{F_u = 5D}$

Where: F_u = Uplift force in kips

D = Diameter of the shaft in feet

Tension steel will be required in each pier shaft to withstand a net force equal to the uplift force plus external uplift force due to wind load etc., minus the sustained compressive load carried by that footing. We recommend that each pier be reinforced with tension steel to withstand this net force or one percent of the cross-sectional area of that shaft, whichever is greater.

Settlements of less than ½ inch with differential settlements (between adjacent piers) of less than ¼ inch should be considered. The piers should be reinforced for their full depth to resist potential, tensile forces, which may develop due to swelling of the site soils, and due to structural loads. Resistance to uplift for straight shaft piers can be provided by the dead load on the pier and an allowable adhesion of 2,000 pounds per square foot on the portion of the shaft below 10 feet.

It is recommended that the design and construction of drilled piers should generally follow methods outlined in the manual titled Drilled Shafts: Construction Procedures and Design Methods (Publication No: FHWA-IF-99-025, August 1999).

Detailed inspection of pier construction should be made to verify that the piers are vertical and founded in the proper bearing stratum, and to verify that all loose materials have been removed prior to concrete placement. Temporary casing must be used where necessary to stabilize pier holes and to control water inflow.

Any accumulated water must be removed prior to the placement of concrete. A hopper and tremie should be utilized during concrete placement to control the maximum free fall of the wet concrete to less than five feet unless the mix is designed so that it does not segregate during free fall and provided the pier excavation is dry.

If the pier hole has been cased, sufficient concrete should remain in the casing as the casing is withdrawn to prevent any discontinuities from forming within the concrete section. Concrete placed in drilled piers should be placed at slumps between six to eight inches. Concrete, which is placed in piers at a slump less than six inches, increases the potential for honeycombing. Concrete used in piers should be designed to achieve the required strength at the higher slumps as referenced above. For any given pier, excavation, placement of steel and concreting should be completed within the same workday. Where water inflow or caving soils are encountered, excavation of piers and placement of concrete within a very short time frame will frequently aid in proper pier construction.

Floor Slab and Grade Beams: If drilled piers are used to support the structure the floor slab and grade beams do not need to be structurally suspended above the soil to be isolated from the swelling clay soils. No void space would be necessary for the amount of PVR at this site. Cardboard carton forms can typically be used to form the void spaces. Care is needed to make sure that the cardboard forms do not collapse as concrete is placed thus placing the floor slab or grad beams in contact with the soil.

4.3.2 Spread and Strip Footings

Spread footings for building columns and continuous wall footings for load bearing walls may be supported on competent limestone. Spread footings, bearing on competent limestone below existing grade may be designed for allowable net bearing pressures of 5,000 pounds per square foot for column footings and for continuous wall footings, based on dead load plus design live load considerations. Spread and continuous footings should have minimum widths of 24 inches and 18 inches, respectively, even if the actual bearing pressure is less than the design value.

Based on the anticipated loads and subsurface condition, we anticipate that properly designed and constructed footings supported on the recommended materials should experience maximum total and differential settlements of about one (1) inch to one-half (½) inch, respectively. Footings should be properly reinforced. If soft or loose soils are encountered at the design bearing level, they should be undercut to stiff or dense soils and the excavation backfilled with concrete.

Horizontal loads acting on shallow foundations are resisted by friction along the foundation base and by passive pressure against the footing face, which is perpendicular to the line of applied force. For lateral loads, the coefficient of friction between the base of the footing and the subgrade soils is 0.35. For sustained loads the ultimate passive earth pressure, in psf, can be computed by using an equivalent fluid pressure of 240 pcf/ft. For transient loads, the ultimate passive earth pressure, in psf, can be taken as 2,000 psf. Passive resistance should be neglected in the top 2 feet depth. A minimum factor of safety of 3 is recommended for sustained loading conditions, and 2 for transient loading conditions.

Uplift resistance of shallow foundations formed in an open excavation should be taken as the weight of the foundation and soil above it. For design purposes, the uplift resistance should be based on effective unit weights of 120 and 150 pounds per cubic foot (pcf) for soil and concrete respectively. In areas where ground water is anticipated or in areas prone to flooding, the uplift resistance should be based on submerged unit weights of 57 and 87.5 pounds per cubic foot (pcf) for soil and concrete respectively. A factor of safety of 3 is recommended for sustained loading conditions, and 2 for transient loading conditions.

It is important that footings be excavated, bearing soils observed by the soils engineer or his representative, formwork and reinforcing steel installed, and concrete placed as quickly as possible. If footings are to remain open for more than a day or if rain is expected, then the use of concrete mud mats to reduce moisture changes or other damage to the bearing soils should be considered. Extreme care should be taken to prevent the weakening of the foundation bearing materials because of prolonged atmospheric exposure, construction activity disturbance or an increase in moisture content. Backfill placed above footings should be placed and compacted under controlled conditions. Failure to properly compact the backfill will promote ponding of water in the backfilled excavation which will most likely result in undesirable movement of the foundations.

Floor Slab and Grade Beams: If shallow spread footings are used to support the structure the floor slab and grade beams do not need to be structurally suspended above the soil to be isolated from the swelling clay soils. No void space would be necessary for the amount of PVR at this site. Cardboard carton forms can typically be used to form the void spaces. Care is needed to make sure that the cardboard forms do not collapse as concrete is placed thus placing the floor slab or grad beams in contact with the soil.

4.3.3 Stiffened Grid Type Beam and Slab Foundation

A stiffened grid type beam and slab foundation may be considered to support the proposed buildings provided the anticipated vertical movement will not impair the performance of the structures.

It is desirable to design the foundation systems using an assumption that the beams carry the loads. An allowable bearing pressure of 1,000 pounds per square foot should be used for beams founded at a minimum depth of 12 inches below the existing undisturbed soils. If the existing grade of the structure has to be raised to achieve design grade, select structural fill should be placed, compacted and tested. An allowable bearing pressure of 1,500 pounds per square foot should be used for beams bearing on a minimum of 12 inches of compacted select structural fill. Beams should be at least 12 inches deep and 10 inches wide to prevent local shear failure of the bearing soils. A design plasticity index value of 15 is recommended for slabs bearing on compacted natural subgrade soils for the lot.

4.3.4 Post-Tensioned Beam and Slab Foundation

A post-tensioned slab-on-grade foundation may also be considered to support the structure provided the anticipated movement will not impair the performance of the structure. Pertinent design parameters were evaluated and are presented in the following paragraphs.

Differential vertical movements should be expected for a shallow type foundation at this site due to the expansive soil conditions that were encountered. Differential vertical movements have been estimated for both the center lift and edge lift conditions for post-tensioned slab-on grade construction at this site. These movements were estimated using the procedures and criteria discussed in the Post-Tensioning Institute Manual entitled "Design and Construction of Post-Tensioned Slabs-on-Ground", 3rd Edition. This procedure uses the soils data obtained from both the field and laboratory tests performed on the soil samples.

Differential vertical movements have been estimated for the center lift and edge lift conditions. The PTI Design Parameters are presented in Table No. 2. Refer to the Stiffened Grid Type Beam and Slab Foundation section for allowable bearing capacities.

Table No. 2- PTI 3rd Edition

Soil Conditioning Method		Minimum Grade Beam Depth (Inches)	PVR (Inches)	Design Plasticity Index	Differential Vertical Movement, (Y_m) Inches		Edge Moisture Variation Distance, (E_m) feet	
Type	Depth				Center Lift	Edge Lift	Center Lift	Edge Lift
Dry to Wet Condition	----	12	1	15	0.8	1.2	7.5	3.4

4.3.5 Floor Slab

Floor slabs utilized in conjunction with the drilled pier foundation system may consist of soil supported floor slabs or structurally suspended floor slabs. It should be noted that greater potential for floor slab movements is associated with soil supported floor slabs.

If some differential movement can be tolerated, the floor slab may consist of an independent slab-on-grade, supported on modified subgrade. If the floor slab is rigidly connected to the building walls, then it is likely that a hinge crack will develop in the slab parallel to the wall at a short distance from the wall. The severity of the cracking will be dependent on the amount of movement that occurs, the rigidity of the floor slab and the rigidity of the connection.

If the floor slab is constructed on the existing site soils, the design Potential Vertical Rise (PVR) is on the order of **one (1) inch**, assuming that the soils are allowed to increase in moisture content from a relatively dry condition to a relatively wet condition. The design PVR may be reduced to by preparing the building subgrade in accordance with methods described in the site preparation section of this report.

It is recommended that a vapor barrier such as polyethylene sheeting be provided directly beneath the soil supported slabs if moisture migration through the floor concrete is a concern. Adequate construction joints and reinforcement should be provided to reduce the potential for cracking of the floor slab due to differential movement. Proper expansion and control joints in the slab should be provided to reduce the potential for cracking.

4.4 Fill Materials

Fill should be free of organic or other deleterious materials and should have a maximum particle size of 3 inches. Low swell potential select fill should have a maximum liquid limit of 35 and plasticity index between 5 and 15.

Select fill should be placed in maximum 8-inch loose lifts and compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D 698 (Standard Proctor). The moisture content at the time of compaction should be in the range of optimum to 4 percent above the optimum value as defined by ASTM D 698. On-site moisture conditioned fill should be placed in maximum 8-inch loose lifts and compacted to between 93% to 98% of the maximum dry density as determined by ASTM D 698 (Standard Proctor) in the moisture content range of 3 percent or more above the optimum value as defined by ASTM D 698.The referenced moisture content and density should be maintained until construction is complete.

4.5 Seismic Considerations

Based on the 2012 International Building Code, Table 1613.3.2 Site Class Definitions read in conjunction with and Table 20.3-1, chapter 20 of ASCE 7. The site soils can be characterized as Site Class C.

4.6 Additional Considerations and Recommendations

The following information has been developed after review of numerous problems concerning foundations throughout the area. It is presented here for your convenience. If these features are incorporated in the overall design and specifications for the project, performance of the project will be improved.

1) Prior to construction, the area to be covered by buildings should be prepared so that water will not pond beneath or around the buildings after periods of rainfall. In addition, water should not be allowed to pond on or around pavements;
2) Roof drainage should be collected and transmitted by pipe to a storm drainage system or to an area where the water can drain away from buildings and pavements without entering the soils supporting buildings and pavements;
3) Sidewalks should not be structurally connected to buildings. They should be sloped away from buildings so that water will be drained away from structures;
4) Paved areas and the general ground surface should be sloped away from buildings on all sides so that water will always drain away from the structures. Water should not be allowed to pond near buildings after the floor slabs and foundations have been constructed;
5) Backfill for utility lines that are located in pavement, sidewalk and building areas should consist of low swell potential fill. The backfill should be compacted as described in the "Fill Material" section of this report. Lesser lift thickness may be required to obtain adequate compaction;
6) Care should be exercised to make sure that ditches for utility lines do not serve as conduits that transmit water beneath structures or pavements. The top of the ditch should be sealed to inhibit the inflow of surface water during periods of rainfall;
7) Flower beds and planting areas should not be constructed along building perimeters. Constructing sidewalks or pavements adjacent to buildings would be preferable. If required, flower beds and planting areas could be constructed beyond the sidewalks away from the buildings. If it is desired to have flower beds and planting areas adjacent to a building, the use of above grade concrete box planters, or other methods which reduce the likelihood of large changes in moisture content of soils adjacent to or below structures should be considered;
8) Water sprinkling systems should not be located where water will be sprayed onto building walls and subsequently drain downward and flow into the soils beneath foundations;
9) Trees in general, should not be planted closer to a structure than the mature height of the tree. A tree planted closer to a structure than the recommended distance may extend its roots beneath the structure, allowing removal of subgrade moisture and/or causing structural distress; and
10) Utilities which project through slab-on-grade floors, particularly where expansive soils or soils subject to settlement are present, should be designed with some degree of flexibility and/or with a sleeve to reduce the potential for damage to the utilities should movement occur.

4.7 Pavement Recommendations

4.7.1 Subgrade Soil Preparation

Initially, all topsoil including any deleterious materials must be removed from the areas proposed for pavement construction. After stripping and excavating to the proposed pavement subgrade level, and prior to placing fill, the exposed subgrade should be proof-rolled with a tandem axle dump truck or similar rubber tired vehicle. Soils, which are observed to rut or deflect excessively under the moving load, should be undercut and replaced with properly compacted fill. The proof-rolling and undercutting activities should be witnessed by a representative of the geotechnical engineer and should be performed during a period of dry weather. The pavement subgrade soils should then be scarified and compacted to at least 95 percent of the standard Proctor maximum dry density ASTM D698, in the moisture range of optimum to 4% above optimum, for a depth of at least 6 inches below the surface.

After subgrade preparation and observation have been completed, fill placement if required may begin. The fill may consist of on-site or similar soils. The first layer of fill material should be placed in a relatively uniform horizontal lift and be adequately keyed into the stripped and scarified subgrade soils. Fill materials should be free of organic or other deleterious materials and have a maximum particle size less than 3 inches. Fill should be compacted to at least 95 percent of standard Proctor maximum dry density as determined by ASTM Designation D 698. Fill should be placed in maximum lifts of 8 inches of loose material and should be compacted within the range of optimum to 4% above optimum moisture content value.

Utility trench excavation, construction traffic, desiccation and wet weather conditions may disturb the pavement subgrade. As such the pavement subgrade should be evaluated at the time of pavement construction. If subgrade disturbance has occurred, the pavement subgrade should be reworked and compacted. The pavement subgrade at final elevation should be tested within 72 hours prior to placement of paving concrete.

4.7.2 Pavement Design

Pavement areas for the proposed building are expected to include parking areas for cars and light trucks and driveways. The following recommendations are presented as a guideline for pavement design and construction. These recommendations are based on a) our previous experience with subgrade soils like those encountered at this site and b) that final pavement grades will provide adequate drainage for the pavement areas and that water will not be allowed to enter the pavement system by either edge penetration adjacent to landscape areas or penetration from the surface due to surface ponding, or inadequate maintenance of pavement joints, or surface cracks that may develop. Specific design traffic types and volumes for this project were not available at the issuance of this report. This traffic information is typically used to determine the number of 18–kip Equivalent Single

Axle Loads (ESAL) that is applied to the pavement over its design life. In lieu of project specific design parameters, general trafficking and subgrade parameter assumptions were used for this design.

4.7.3 Pavement Sections

Parking areas, driveways may be designed with either a rigid or flexible pavement. Pavement sections for both rigid and flexible types are recommended as follows for driveways and parking areas in Table No. 3 through Table No. 6:

Table No. 3 - Parking Area
Design ESALS: 35,000

Flexible Pavement Section	Thickness in Inches		
	Alt 1	Alt 2	Alt 3
Hot Mix Asphaltic Concrete	2.0	2.0	2.0
Aggregate Base	8.0	8.0	12.0
Lime Stabilized Subgrade	6.0	---	--
Tensar HX5.5 Geogrid	No	Yes	No
Compacted Subgrade	----	8.0	8.0

Table No. 4 -Drives and Fire Lanes
Design ESALS: 150,000

Flexible Pavement Section	Thickness in Inches		
	Alt 1	Alt 2	Alt 3
Hot Mix Asphaltic Concrete	3.0	3.0	3.0
Aggregate Base	8.0	8.0	14.0
Lime Stabilized Subgrade	8.0	---	--
Tensar HX5.5 Geogrid	No	Yes	No
Compacted Subgrade	---	8.0	--

Table No. 5 - Parking Area
Design ESALS: 35,000

Rigid Pavement Section	Thickness in Inches	
	Alt 1	Alt 2
Portland Cement Concrete	7.0	6.0
Lime Stabilized Subgrade	--	6.0
Compacted Subgrade	8.0	--

Table No. 6- Drives and Fire Lanes
Design ESALS: 150,000

Rigid Pavement Section	Thickness in Inches	
	Alt 1	Alt 2
Portland Cement Concrete	7.0	8.0
Lime Stabilized Subgrade	8.0	--
Compacted Subgrade	--	8.0

4.7.4 Base Course

Based on the surveys of available materials in the area, a base course of crushed limestone aggregate or gravel appears to be the most practical material for asphalt pavement project. The base course should conform to Texas State Department of Highways and Public Transportation Standard Specifications, Item 247, Type A, Grade 1-2.

The base course should be moisture conditions within ± 2 percentage points of optimum moisture content and compacted in two lifts to at least 95 percent of maximum dry density as determined by test method TxDOT 113-E test method.

4.7.5 Lime Stabilized Subgrade

The lime stabilization of the subgrade should meet the performance standards found in TxDOT Item 260. In addition, gradation requirements outlined in Item 260, the lime stabilized clay should also have a minimum of 60 percent, on a weight basis, of the stabilized soil passing the No. 4 sieve at moisture content at or above optimum. The lime stabilized clay soil should have a plasticity index equal to or less than 20 based on a dry method of sample preparation, ASTM D 421. The lime stabilized subgrade should be compacted to at least 95 percent of the standard Proctor maximum dry density ASTM D 698 between optimum and 2 percentage points of optimum moisture content. Lime content of 6 percent of the dry unit weight of the clays to be stabilized may be used for planning purposes (it should be verified by performing a lime series test at the time of construction). Using a value of 98 pcf for dry unit weight of clays, 35 lbs per square yard for 8 inches depth stabilization is required. **Prior to the use of lime, the exposed subgrade should be tested for sulfate contents to determine the levels of sulfates are low enough for the use of lime.**

4.7.6 Asphaltic Concrete

The asphaltic concrete surface course should conform to Texas State Department of Highways and Public Transportation Standard Specifications, Item 340, Type D. The asphaltic concrete should be designed for a stability of at least 40. The asphaltic concrete should be compacted to between 92 and 97 percent of the theoretical density as determined by ASTM D 2041.

4.7.7 Reinforced Concrete

Concrete should be designed to exhibit a flexural strength (3 point loading) of at least 550 psi at 28 days. As an option, a 28 day compressive strength requirement of 3500 psi may be utilized. The concrete should also be designed with 5 ± 1 percent entrained air to improve workability and durability.

4.7.8 Concrete Pavement

Concrete pavement slabs should be provided with adequate steel reinforcement. Proper finishing of concrete pavements requires the use of sawed and sealed joints which should be designed in accordance with current Portland Cement Association guidelines. Joints should be sealed to reduce the potential for water infiltration into pavement joints and subsequent infiltration into the supporting soils. The design of steel reinforcement should be in accordance with accepted codes, Minimum reinforcement consisting of #3 bars placed at 18" centers is recommended. Dowel bars should be used to transfer loads at transverse joints. Related civil design factors such as drainage, cross-sectional configurations, surface elevations and environmental factors which will significantly affect the service life must be included in the preparation of the construction drawings and specifications. Normal periodic maintenance will be required, especially for open jointed areas which may allow surface water infiltration into the subgrade.

4.7.9 Continuous Repetitive Traffic Areas and Trash Dump Area, and Loading Dock Area

Large front-loading trash dump trucks frequently impose concentrated front-wheel loads on pavements during loading. This type of loading typically results in rutting of the pavement and ultimately, pavement failures. Therefore, we recommend that the pavement in trash pickup areas and loading dock areas should consist of a minimum 7-inch thick, reinforced concrete slab.

5.0 <u>CONSTRUCTION CONSIDERATION</u>

It is recommended that Terradyne be retained to provide observation and testing of construction activities involved in the foundations and pavements, earthwork, and related activities of this project. Terradyne cannot accept any responsibility for any conditions, which deviated from those, described in this report, nor for the performance of the foundations and pavements if not engaged to also provide construction observation and testing for this project.

The upper fine-grained soils encountered at this site may be sensitive to disturbances caused by construction traffic and changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils, which become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather. Depth of tan limestone is relatively shallow in some areas; accordingly difficulty in underground utility trench excavation should be anticipated.

Due to the plastic nature of on-site soils, some of which may be left in place, consideration should be given to these soils to reduce their shrink/swell potential. Simply stated, clays expand or shrink by absorbing or losing moisture. Controlling the moisture content variation of a soil will therefore reduce its variation in volume. During construction, a positive surface drainage scheme should be implemented to prevent ponding of water on the subgrade. The pavement subgrades should not be allowed to dry out during construction. Drainage from the building's roof/gutter system should not be allowed to drain and/or pond behind the pavement curbs.

6.0 SHORING

Shoring of excavations and design of shoring systems are governed by federal, state, and local regulations. The design of shoring systems on this project is beyond the scope of our services. The owner or the contractor should retain a shoring design professional to design shoring systems for excavations on this site.

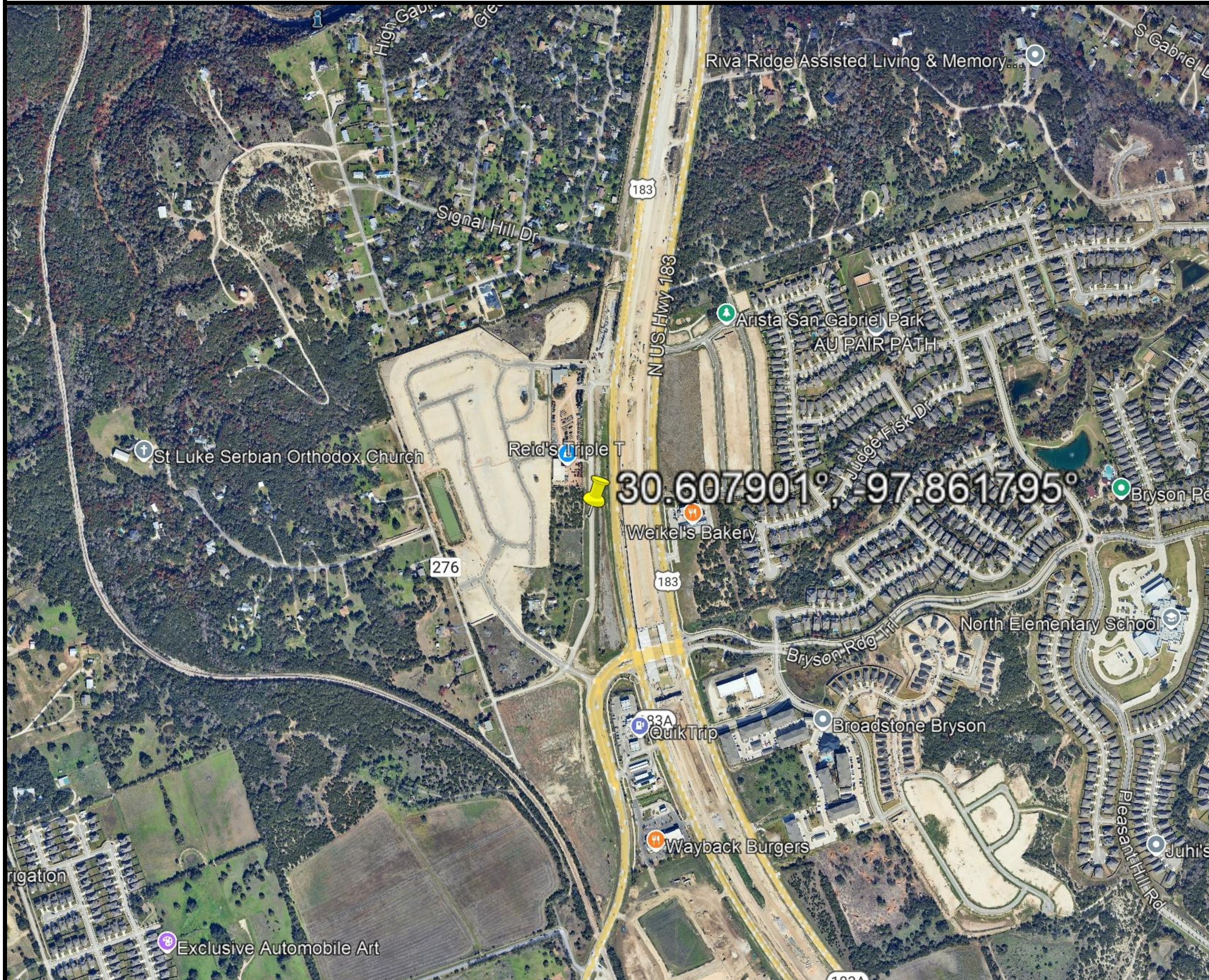
7.0 LIMITATIONS

The analysis and recommendations submitted in this report are based upon the data obtained from the four (4) borings drilled at the site. This report may not reflect the exact variations of the soil conditions across the site. The nature and extent of variations across the site may not become evident until construction commences. If variations appear evident, it will be necessary to re-evaluate our recommendations after performing on-site observations and tests to establish the engineering significance of any variations. The project geotechnical engineer should review the final plan for the proposed building so that he may determine if changes in the foundation recommendations are required. The project geotechnical engineer declares that the findings, recommendations or professional advice contained herein have been made and this report prepared in accordance with generally accepted professional engineering practice in the fields of geotechnical engineering and engineering geology. No other warranties are implied or expressed.

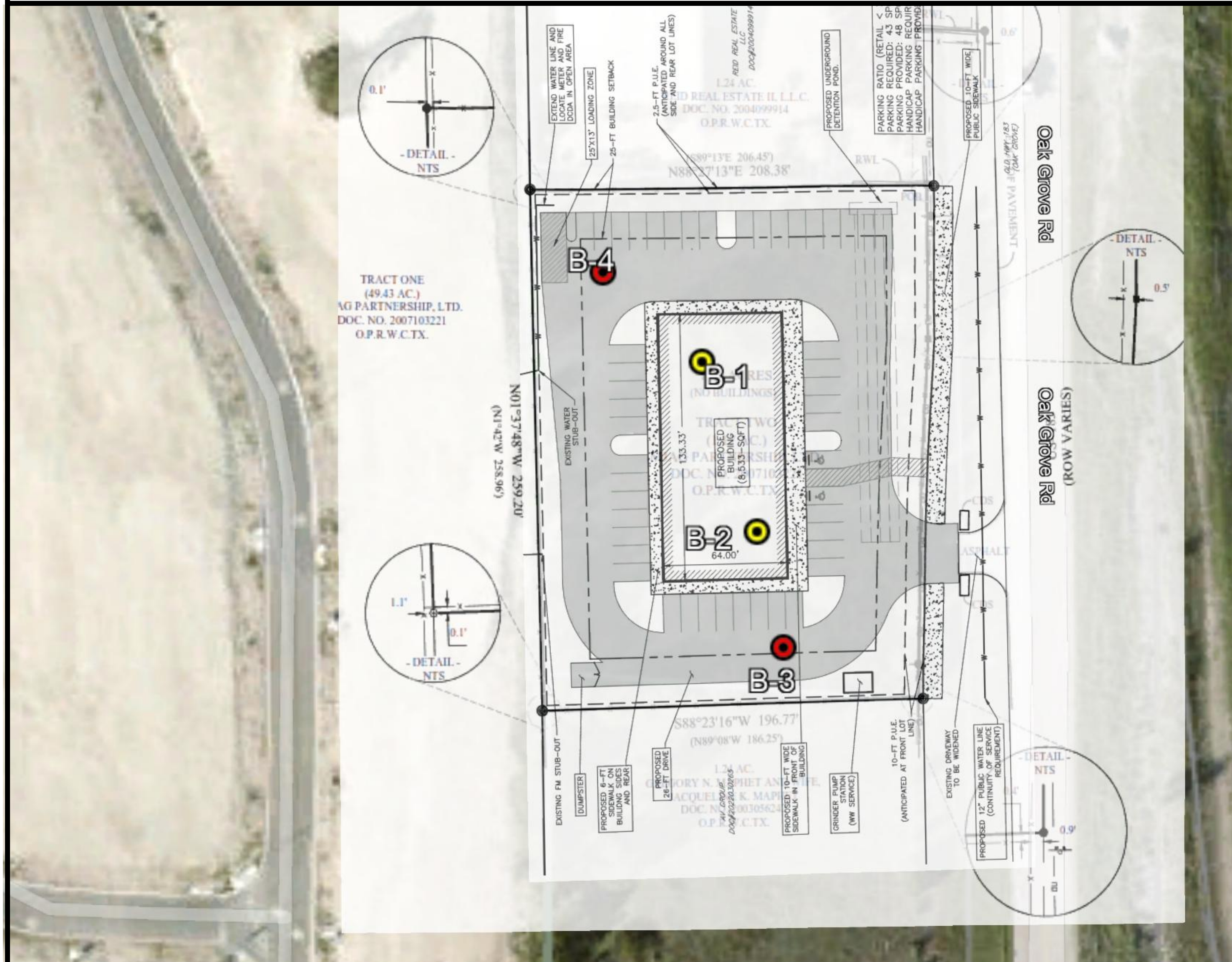
This report is valid until site conditions change due to disturbance (cut and fill grading) or changes to nearby drainage conditions or for 3 years from the date of this report, whichever occurs first. Beyond this expiration date, Terradyne shall not accept any liability associated with the engineering 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 highly recommend drilling additional borings so that we can verify the subsurface conditions and validate the recommendations in this report.

This report has been prepared for the exclusive use of Sweetwater Investments LLC for the specific application to the proposed Monarch PUD at Highway 183 in Leander, Williamson County, Texas.

APPENDIX



Site Latitude and Longitude Proposed Monarch PUD Highway 183 Leander, Williamson County, Texas	TERRADYNE Engineers, Geologists & Environmental Scientists		TERRADYNE AUSTIN, TEXAS
	Prepared By: LD	Scale: Not to Scale	Project # A251077
	Verified By: JAG	Date: April 2025	Figure # 1-A



Approximate Location of Exploratory Borings

Proposed Monarch PUD
Highway 183
Leander, Williamson County, Texas

TERRADYNE
AUSTIN, TEXAS

Prepared By: LD	Scale: Not to Scale	Project # A251077
Base Plan By: Other	Date: April 2025	Figure # 1-B

Project: **Proposed Commercial Building - Monarch PUD**	Log of Boring B-1
Project Location: **Leander, Williamson County, Texas**	
Terradyne Project Number: **A251077**	

Date(s) Drilled **April 4, 2025**	TERRADYNE Engineers, Geologists & Environmental Scientists	
Drilling Method		Total Depth of Borehole **9 feet bgs**
Drill Rig Type **Simco 1**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Auger, SPT, TCP**	
Borehole Backfill **Soil Cuttings**	Location **SEE BLP**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0		39			Clayey Sand with Gravel (SC)- Brown, Dense	9		46	35	25	10		
		T=1/2"			Limestone	4							
5						7							
		T=0"				8							
					Auger Refusal at 9 feet								
10													
15													
20													

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Project: **Proposed Commercial Building - Monarch PUD** Project Location: **Leander, Williamson County, Texas** Terradyne Project Number: **A251077**	# Log of Boring B-2

Date(s) Drilled **April 4, 2025**	TERRADYNE Engineers, Geologists & Environmental Scientists	
Drilling Method		Total Depth of Borehole **8.5 feet bgs**
Drill Rig Type **Simco 1**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Auger, SPT, TCP**	
Borehole Backfill **Soil Cuttings**	Location **SEE BLP**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0		24, 50/4"			Clayey Sand with Gravel (SC)- Brown, Dense	4							
		T=1/4"			Limestone	5							
5						5							
		T=0"			Auger Refusal at 8.5 feet	6							
10													
15													
20													

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Figure 3

Project: **Proposed Commercial Building - Monarch PUD**	**Log of Boring B-3**
Project Location: **Leander, Williamson County, Texas**	
Terradyne Project Number: **A251077**	

Date(s) Drilled: **April 4, 2025**	TERRADYNE Engineers, Geologists & Environmental Scientists	
Drilling Method		Total Depth of Borehole: **10 feet bgs**
Drill Rig Type: **Simco 1**		Approximate Surface Elevation: **Existing Ground Surface**
Groundwater Level and Date Measured: **Not Encountered**	Sampling Method(s): **Auger, SPT, TCP**	
Borehole Backfill: **Soil Cuttings**	Location: **SEE BLP**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0		25, 50/4"			Clayey Sand with Gravel (SC)- Brown, Very Dense	6		35	32	24	8		
		T=1/4"			Limestone	5							
5						5							
		T=0"				6							
10					End of Borehole								
15													
20													

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Figure 4

Project: **Proposed Commercial Building - Monarch PUD**	Log of Boring B-4
Project Location: **Leander, Williamson County, Texas**	
Terradyne Project Number: **A251077**	

Date(s) Drilled **April 4, 2025**	TERRADYNE Engineers, Geologists & Environmental Scientists	
Drilling Method		Total Depth of Borehole **10 feet bgs**
Drill Rig Type **Simco 1**		Approximate Surface Elevation **Existing Ground Surface**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **Auger, SPT, TCP**	
Borehole Backfill **Soil Cuttings**	Location **SEE BLP**	

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	Passing #200 Sieve, %	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
0		40			Clayey Sand with Gravel (SC)-Brown, Dense	7							
		T=1"			Limestone	8							
5						8							
		T=1/4"				6							
10					End of Borehole								
15													
20													

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TERRADYNE
Engineers, Geologists & Environmental Scientists

Depth (feet)	Sample Type	N=blows/ft (SPT) T=inches/100 blows (THD)	PP (tsf)	Graphic Log	MATERIAL DESCRIPTION	Water Conte	Dry Unit We	Passing #20	LL, %	PL, %	PI, %	UC, ksf	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8	9	10	11	12	13	14

COLUMN DESCRIPTIONS

1 Depth (feet): Depth in feet below the ground surface.
2 Sample Type: Type of soil sample collected at the depth interval shown.
3 N=blows/ft (SPT) T=inches/100 blows (THD) : N: Number of blows to advance SPT sampler 12 inches or distance shown, OR T: Penetration in inches of THD Cone for 100 blows
4 PP (tsf): The Relative Consistency of the soil, measured by Pocket Penetrometer in tons/square foot
5 Graphic Log: Graphic depiction of the subsurface material encountered.
6 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
7 Water Content, %: Water content of the soil sample, expressed as percentage of dry weight of sample.
8 Dry Unit Weight, pcf: Dry weight per unit volume of soil sample measured in laboratory, in pounds per cubic foot.
9 Passing #200 Sieve, %: The percent fines (soil passing the No. 200 Sieve) in the sample.
10 LL, %: Liquid Limit, expressed as a water content
11 PL, %: Plastic Limit, expressed as a water content.
12 PI, %: Plasticity Index, expressed as a water content.
13 UC, ksf: Unconfined compressive strength.
14 REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

SPT: Standard Penetration Test
THD: Texas Dept. of Transportation Cone Penetrometer Test
LL: Liquid Limit, percent
PL: Plastic Limit, percent
PI: Plasticity Index, percent
PP: Pocket Penetrometer
UC: Unconfined compressive strength test, Qu, in ksf

TYPICAL MATERIAL GRAPHIC SYMBOLS

Limestone

Clayey SAND (SC)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Bulk Sample
3-inch-OD California w/ brass rings
CME Sampler
Grab Sample
2.5-inch-OD Modified California w/ brass liners
Pitcher Sample
Rock Core
2-inch-OD unlined split spoon (SPT)
Texas Cone Penetrometer
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting, AW)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
? Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.