GEOTECHNICAL ENGINEERING SERVICES
PROPOSED RESIDENTIAL ROADWAY
SQUAW VALLEY SUBDIVISION
GLEN ROSE, TEXAS

Presented to:

Oaktree Assets, LLC

August 2022

PROJECT NO. 2982-22-01 (Revised)

CMJ Engineering

August 4, 2022
Report No. 2982-22-01 (Revised)

Oaktree Assets, LLC
P.O. Box 1726
Glen Rose, Texas 76043

Attn: Mr. Ron Hampton

GEOTECHNICAL ENGINEERING SERVICES
PROPOSED RESIDENTIAL ROADWAY
SQUAW VALLEY SUBDIVISION
GLEN ROSE, TEXAS

Dear Mr. Hampton:

Submitted here are the results of a geotechnical engineering study for the referenced project. This study was performed in general accordance with our Proposal No. 22-8614 dated April 20, 2022. The geotechnical services were authorized on April 22, 2022.

Engineering analyses and recommendations are contained in the text section of the report. Results of our field and laboratory services are included in the appendix of the report. We would appreciate the opportunity to be considered for providing the construction consultation services during the construction phase of this project.

We appreciate the opportunity to be of service. Please contact us if you have any questions or if we may be of further service at this time.

Respectfully submitted,
CMJ ENGINEERING, INC.
TEXAS FIRM REGISTRATION NO. F-9177

STATE OF TEXAS
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APPENDIX A

1.0 INTRODUCTION

1.1 Project Description

The project site is located on the west side of Farm to Market 200, approximately 1,800 feet north of US Highway 67 in Glen Rose, Texas. The project, as currently planned will consist of approximately 2,500 linear feet of new residential roadway to serve a proposed 27 lot single-family development. This geotechnical study is for the pavement design for the proposed street only. This investigation is not intended to address residential foundations. Plate A.1, Plan of Borings, depicts the project vicinity and location of exploration borings.

1.2 Purpose and Scope

The purpose of this geotechnical engineering study has been to determine the general subsurface conditions, evaluate the engineering characteristics of the subsurface materials encountered, develop recommendations for the type or types of pavement subgrade preparation and modification, provide pavement design guidelines, and provide earthwork recommendations.

To accomplish its intended purposes, the study has been conducted in the following phases: (1) drilling sample borings to determine the general subsurface conditions and to obtain samples for testing; (2) performing laboratory tests on appropriate samples to determine pertinent engineering properties of the subsurface materials; and (3) performing engineering analyses, using the field and laboratory data to develop geotechnical recommendations for the proposed construction.

The design is currently in progress. Once the final design is near completion (80-percent to 90-percent stage), it is recommended that CMJ Engineering, Inc. be retained to review those portions of the construction documents pertaining to the geotechnical recommendations, as a means to determine that our recommendations have been interpreted as intended.

1.3 Report Format

The text of the report is contained in Sections 1 through 7. All plates and large tables are contained in Appendix A. The alpha-numeric plate and table numbers identify the appendix in which they appear. Small tables of less than one page in length may appear in the body of the text and are numbered according to the section in which they occur.

Units used in the report are based on the English system and may include tons per square foot (tsf), kips (1 kip = 1,000 pounds), kips per square foot (ksf), pounds per square foot (psf), pounds per cubic foot (pcf), and pounds per square inch (psi).

2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 Field Exploration

Subsurface materials at the project site were explored by a total of five (5) borings drilled to a depth of 8 feet below existing grade. The borings were drilled using truck-mounted drilling equipment at the approximate locations shown on the Plan of Borings, Plate A.1. The boring logs are included on Plates A.4 through A.8 and keys to classifications and symbols used on the logs are provided on Plates A.2 and A.3.

Undisturbed samples of cohesive soils were obtained with nominal 3-inch diameter thin-walled (Shelby) tube samplers at the locations shown on the logs of borings. The Shelby tube sampler consists of a thin-walled steel tube with a sharp cutting edge connected to a head equipped with a ball valve threaded for rod connection. The tube is pushed into the soil by the hydraulic pulldown of the drilling rig. The soil specimens were extruded from the tube in the field, logged, tested for consistency with a hand penetrometer, sealed, and packaged to limit loss of moisture.

The consistency of cohesive soil samples was evaluated in the field using a calibrated hand penetrometer. In this test a 0.25-inch diameter piston is pushed into the relatively undisturbed sample at a constant rate to a depth of 0.25 inch. The results of these tests, in tsf, are tabulated at respective sample depths on the logs. When the capacity of the penetrometer is exceeded, the value is tabulated as 4.5+.

Ground-water observations during and after completion of the borings are shown on the upper right of the boring logs. Upon completion of the borings, the bore holes were backfilled with soil cuttings and plugged at the surface by hand tamping.

2.2 Laboratory Testing

Laboratory soil tests were performed on selected representative samples recovered from the borings. In addition to the classification tests (liquid limits, plastic limits and percent passing the No.

200 sieve), moisture content, and unit weight tests were performed. Results of the laboratory tests conducted for this project are included on the boring logs.

Eades and Grim Lime Series tests were performed on selected samples to identify the appropriate concentration of lime to add to soils for stabilization purposes. The results of the lime series tests are presented on Plate A.9.

The above laboratory tests were performed in general accordance with applicable ASTM procedures, or generally accepted practice.

3.0 SUBSURFACE CONDITIONS

3.1 Soil Conditions

Specific types and depths of subsurface strata encountered at the boring locations are shown on the boring logs in Appendix A. The generalized subsurface stratigraphies encountered in the borings are discussed below. Note that depths on the borings refer to the depth from the existing grade or ground surface present at the time of the investigation, and the boundaries between the various soil types are approximate.

Soils encountered in the borings consist of dark brown, brown, reddish brown, tan, and gray clays, silty clays, sandy clays, and clayey sands. The various surficial soils occasionally contain ironstone nodules and calcareous nodules. The various soils encountered in the borings had tested Liquid Limits (LL) of 31 to 56 with Plasticity Indices (PI) of 10 to 36 and are classified as SC, CL and CH by the USCS. The various clays were generally stiff to hard (soil basis) in consistency with pocket penetrometer readings of 1.75 to over 4.5 tsf. Tested unit weight values tested ranged from 98 to 106 pcf.

The Atterberg Limits tests indicate the various clays encountered at this site vary from slightly active to highly active with respect to moisture induced volume changes while the clayey sands are stable to slightly active with respect to moisture induced volume changes. Active clays can experience volume changes (expansion or contraction) with fluctuations in their moisture content.

3.2 Ground-Water Observations

The borings were drilled using continuous flight augers in order to observe ground-water seepage during drilling. Ground-water seepage was not encountered during drilling and all borings were dry at completion of drilling operations.

Fluctuations of the ground-water level can occur due to seasonal variations in the amount of rainfall; site topography and runoff; hydraulic conductivity of soil strata; and other factors not evident at the time the borings were performed. The possibility of ground-water level fluctuations should be considered when developing the design and construction plans for the project. During wet periods of the year, seepage can occur in the sandy more granular soils or in joints in the clays, particularly after periods of heavy or extended rainfall.

4.0 PAVEMENT DESIGN

4.1 Pavement Subgrade Considerations

4.1.1 *General*

Anticipated subgrade soils vary from clayey sands and sandy clays to highly plastic clays present at the surface. Site grading can affect actual subgrade soil types. The success of the pavement subgrade is subgrade soil strength and control of water. Adequate subgrade performance can be achieved by stabilizing existing soils used to construct the pavement subgrade.

The most appropriate stabilization agent and concentration will depend directly on the type of subgrade soil. Sands and clayey sands normally are best stabilized using Portland cement. Clays are normally best stabilized using hydrated lime. Based on the borings, the majority of the surface soils appear to be more moderately to plastic clays, more amenable to lime as the stabilization agent. Although Portland cement also could also be used to stabilize clay soils, such stabilization requires some special techniques in order to pulva mix/cement modify/moisten/compact the pavement subgrade using Portland cement in a short period of time in order to attain the initial set of the cement modified material.

The higher plasticity clays, those with a Plasticity Index (PI) of 20 or greater, are subject to loss in support value with the moisture increases which occur beneath pavement sections. They react with hydrated lime, which serves to improve and maintain their support value. Treatment of these soils with hydrated lime will improve their subgrade characteristics to support area paving.

Due to variable site conditions, observation during construction by qualified geotechnical personnel is recommended to determine pavement subgrade areas containing sufficient quantities of clay to warrant lime stabilization.

In lieu of a lime or cement stabilized subgrade for pavement consisting of Portland cement concrete, the recommended Portland cement concrete (PCC) pavement thicknesses presented in Section 4.3 may be increased by 1 inch (for a total PCC pavement thickness of 7 inches), and placed atop a properly compacted subgrade.

Alternatively, in lieu of cement or lime treatment, consideration can be given to substituting a suitable flexible base on an equal basis and placed atop a properly compacted subgrade. A 6-inch flex base meeting requirements of TxDOT Item 247, Type A, Grade 1 or 2 is recommended. The option of using a flexible base in lieu of stabilizing the subgrade presents a relatively quick, straight forward solution to preparing the subgrade prior to pavement placement.

4.2 Potential Vertical Movements

Estimates of expansive movement potential have been estimated using TxDOT Test Method Tex 124-E. Potential vertical movements ranging from on the order of 2 to 3½ inches are estimated. Movements in excess of these estimates can occur if poor drainage, excessive water collection, leaking pipelines, etc. occur. Any such excessive water conditions should be rectified as soon as possible. In order to minimize rainwater infiltration through the pavement surface, and thereby minimizing future upward movement of the pavement slabs, all cracks and joints in the pavement should be sealed on a routine basis after construction.

4.3 Pavement Subgrade Preparation

4.3.1 *Lime Stabilization*

Prior to lime addition, the subgrade should be proofrolled with heavy pneumatic equipment. Any soft or pumping areas should be undercut to a firm subgrade and properly backfilled as described in Earthwork section. The subgrade should be scarified to a minimum depth of 6 inches and uniformly compacted to a minimum of 95 percent of Standard Proctor density (ASTM D 698), between minus 2 to plus 4 percentage points of the optimum moisture content determined by that test. It should then be protected and maintained in a moist condition until the pavement is placed.

It is recommended a minimum of 6 percent hydrated lime be used to stabilize clay subgrade soils, those with a Plasticity Index (PI) of 20 or greater. The amount of hydrated lime required to stabilize the subgrade should be on the order of 27 pounds per square yard based on a soil dry unit weight of 100 pcf. The hydrated lime should be thoroughly mixed and blended with the upper 6 inches of the clay subgrade (TxDOT Item 260). The hydrated lime should meet the requirements of Item 260 (Type A) in the Texas Department of Transportation (TxDOT) Standard Specifications for Construction of Highways, Streets and Bridges, 2014 Edition. Lime treatment should extend beyond exposed pavement edges to reduce the effects of shrinkage and associated loss of subgrade support.

4.3.2 *Cement Stabilization*

As previously discussed, more granular, lower plasticity clayey sands are normally best stabilized using Portland cement. The clayey sands, those with a Plasticity Index (PI) of 20 or less, can be mixed with Portland cement, which serves to improve and maintain their support value. Treatment of these soils with cement will improve their subgrade characteristics to support area paving.

Prior to cement stabilization, the subgrade should be proofrolled with heavy pneumatic equipment. Any soft or pumping areas should be undercut to a firm subgrade and properly backfilled as described in the Earthwork section.

It is recommended a minimum of 5 percent Portland cement be used to modify the subgrade soils. The estimated amount of cement required to stabilize the subgrade should be on the order of 23 pounds per square yard for a 6-inch depth based on a dry unit weight of 100 pcf. The cement should be thoroughly mixed and blended with the upper 6 inches of the subgrade (TxDOT Items 275). The Portland cement should meet the requirements of Item 275 in the Texas Department of Transportation (TxDOT) Standard Specifications for Construction of Highways, Streets and Bridges, 2014 Edition.

The stabilized subgrade should be scarified to a minimum depth of 6 inches and uniformly compacted to a minimum of 98 percent of ASTM Standard Test Method for Moisture-Density Relations of Soil-Cement Mixtures (ASTM D 558), to minus 3 to plus 1 percentage points of the optimum moisture content determined by that test. It should then be protected and maintained in a moist condition until the pavement is placed via curing compound or sprinkling. Proper curing of the cement treated base is paramount in order to reduce the potential for undue shrinkage cracking.

The Texas Transportation Institute has performed studies to reduce “block cracks” common to cement-treated base materials. Microcracking is the application of several vibratory roller passes to a treated subgrade after a short curing stage, typically after one to three days, to create a fine network of cracks. Microcracking is one technique to help reduce the risk of shrinkage cracks in the subgrade reflecting through the pavement surfacing. The goal of microcracking is to form a network of fine cracks and prevent the wider, more severe cracks from forming.

After placement and satisfactory compaction of the cement treated subgrade, the base should be moist cured by sprinkling for 48 to 72 hours before microcracking. If performing construction during winter months when average daily temperatures are 60^{o} F or below, moist cure the base at least 96 hours before microcracking. Microcracking should be performed with the same (or equivalent tonnage) steel wheel vibratory roller used for compaction. A minimum 12-ton roller should be used. Typically three full passes (one pass is down and back) with the roller operating at maximum amplitude and traveling approximately 2 to 3 mph will satisfactorily microcrack the section. After satisfactory completion of microcracking, the subgrade should be moist cured by sprinkling to a total cure time of at least 72 hours from the day of placement.

4.3.2 *Subgrade Preparation Considerations*

It is recommended that subgrade stabilization extend to at least one foot beyond pavement edges to aid in reducing pavement movements and cracking along the curb line due to seasonal moisture variations after construction. Each construction area should be shaped to allow drainage of surface water during earthwork operations, and surface water should be pumped immediately from each construction area after each rain and a firm subgrade condition maintained. Water should not be allowed to pond in order to prevent percolation and subgrade softening, and subgrade treatments should be added to the subgrade after removal of all surface vegetation and debris. Where clays are present as the subgrade materials sands should be specifically prohibited beneath pavement areas, since these more porous soils can allow water inflow, resulting in heave and strength loss of subgrade soils (lime stabilized soil will be allowed for fine grading). After fine grading each area in preparation for paving, the subgrade surface should be lightly moistened, as needed, and recompacted to obtain a tight non-yielding subgrade.

Surface drainage is critical to the performance of this pavement. Water should be allowed to exit the pavement surface quickly.

4.4 Pavement Sections

The project is understood to include the construction of residential drives. At the time of this investigation, vehicle traffic studies were not available. Therefore, rigid and flexible pavement sections are presented for a 20-year design life based on our experience with similar facilities for Residential Drive Areas. In general, these areas are defined as follows:

> Residential Drive Areas are those drives subjected to a variety of light-duty vehicles to medium-duty vehicles and an occasional heavy-duty truck including 85 kip fire apparatus or garbage truck (1 to 2 per week).

We recommend that rigid pavements be utilized at this project whenever possible, since they tend to provide better long-term performance when subjected to significant slow moving and turning traffic.

If asphaltic concrete pavement is used, we recommend a full depth asphaltic concrete section having a minimum total thickness of 6 inches for residential drive areas. A minimum surface course thickness of 2 inches is recommended for asphaltic concrete pavements. If Portland cement concrete pavement is used, a minimum thickness of 6 inches is recommended for residential drive areas.

A California Bearing Ratio or other strength tests were not performed because they were not within the scope of our services on this project. A subgrade modulus of 100 psi was considered appropriate for the near-surface soils. If heavier vehicles are planned, the above cross sections can be confirmed by performing strength tests on the subgrade materials once the traffic characteristics are established. Periodic maintenance of pavement structures normally improves the durability of the overall pavement and enhances its expected life.

The above sections should be considered minimum pavement thicknesses and higher traffic volumes and heavy trucks may require thicker pavement sections. Additional recommendations can be provided after traffic volumes and loads are known. Periodic maintenance should be anticipated for minimum pavement thickness. This maintenance should consist of sealing cracks and timely repair of isolated distressed areas.

Proper surface drainage in the shoulders and ditches is also critical to long term performance of the pavement. Water allowed to pond adjacent to the pavement will be detrimental resulting in loss of edge and subgrade support and an increase in post construction heave of the pavement.

4.5 Pavement Material Requirements

Material and process specifications developed by the Texas Department of Transportation (TxDOT) have been utilized. These specifications are outlined in the TxDOT Standard Specifications for Construction of Highways, Streets and Bridges, 2014 Edition. Specific construction recommendations for flexible pavements are given below.

Reinforced Portland Cement Concrete: Reinforced Portland cement concrete pavement should consist of Portland cement concrete having a 28-day compressive strength of at least 3,500 psi. The mix should be designed in accordance with the ACI Code 318 using 3 to 6 percent air entrainment. The pavement should be adequately reinforced with temperature steel and all construction joints or expansion/contraction joints should be provided with load transfer dowels. The spacing of the joints will depend primarily on the type of steel used in the pavement. We recommend using No. 3 steel rebar spaced at 18 inches on center in both the longitudinal and transverse direction. Control joints formed by sawing are recommended every 12 to 15 feet in both the longitudinal and transverse direction. The cutting of the joints should be performed as soon as the concrete has "set-up" enough to allow for sawing operations.

Hot Mix Asphaltic Concrete Surface Course: Item 340, Type D, Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, 2014 Edition.

Hot Mix Asphaltic Concrete Base Course: Item 340, Type A or B, Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, 2014 Edition.

Lime Stabilized Subgrade: Lime treatment for base course (road mix) - Item 260, Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, 2014 Edition.

Cement Stabilized Subgrade: Cement treatment for base course (road mix) - Item 275, Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, 2014 Edition.

Flexible Base: Crushed Stone Flexible Base – Item 247, Type A, Grades 1 or 2, Texas Department of Transportation Standard Specifications for Construction of Maintenance of Highways, Streets, and Bridges, 2014 Edition.

4.6 General Pavement Considerations

The design of the pavement drainage and grading should consider the potential for differential ground movement due to future soil swelling of up to 3½ inches. In order to minimize rainwater infiltration through the pavement surface, and thereby minimizing future upward movement of the pavement slabs, all cracks and joints in the pavement should be sealed on a routine basis after construction.

Proper surface drainage in the shoulders is also critical to long term performance of the pavement. Water allowed to pond adjacent to the pavement will result in loss of edge and subgrade support and an increase in post construction heave of the pavement.

5.0 EARTHWORK

5.1 Site Preparation

The subgrade should be firm and able to support the construction equipment without displacement. Soft or yielding subgrade should be corrected and made stable before construction proceeds. The subgrade should be proof rolled to detect soft spots, which if exist, should be reworked to provide a firm and otherwise suitable subgrade. Proof rolling should be performed using a heavy pneumatic tired roller, loaded dump truck, or similar piece of equipment. The proof rolling operations should be observed by the project geotechnical engineer or his/her representative. Prior to fill placement, the subgrade should be scarified to a minimum depth of 6 inches, its moisture content adjusted and recompacted to the moisture and density recommended for fill.

Low plasticity clayey sands are present at the surface in selected areas. During periods of inclement weather these surface soils can become saturated and subject to pumping. This may require undercutting to a firm subgrade and blending saturated soils with more clayey site material or mixing them with Portland cement as described in Section 4.3.2.

5.2 Placement and Compaction

Fill material should be placed in loose lifts not exceeding 8 inches in uncompacted thickness. The uncompacted lift thickness should be reduced to 4 inches for structure backfill zones requiring hand-operated power compactors or small self-propelled compactors. The fill material should be uniform with respect to material type and moisture content. Clods and chunks of material should be broken down and the fill material mixed by disking, blading, or plowing, as necessary, so that a material of uniform moisture and density is obtained for each lift. Water required for sprinkling to bring the fill material to the proper moisture content should be applied evenly through each layer.

The on-site soils are suitable for use in site grading. Imported fill material should be clean soil with a Liquid Limit less than 50 and no rock greater than 4 inches in maximum dimension. The fill materials should be free of vegetation and debris.

The fill material should be compacted to a minimum of 95 percent of the maximum dry density determined by the Standard Proctor test, ASTM D 698. In conjunction with the compacting operation, the fill material should be brought to the proper moisture content. The moisture content for general earth fill should range from 2 percentage points below optimum to 5 percentage points above optimum (-2 to +5). These ranges of moisture contents are given as maximum recommended ranges. For some soils and under some conditions, the contractor may have to maintain a more narrow range of moisture content (within the recommended range) in order to consistently achieve the recommended density.

Field density tests should be taken as each lift of fill material is placed. As a guide, one field density test per lift for each 5,000 square feet of compacted area is recommended. For small areas or critical areas the frequency of testing may need to be increased to one test per 2,500 square feet. A minimum of 2 tests per lift should be required. The earthwork operations should be observed and tested on a continuing basis by an experienced geotechnician working in conjunction with the project geotechnical engineer.

Each lift should be compacted, tested, and approved before another lift is added. The purpose of the field density tests is to provide some indication that uniform and adequate compaction is being obtained. The actual quality of the fill, as compacted, should be the responsibility of the contractor and satisfactory results from the tests should not be considered as a guarantee of the quality of the contractor's filling operations.

If fill is to be placed on existing slopes that are steeper than five horizontal to one vertical, then the fill materials should be benched into the existing slopes in such a manner as to provide a good contact between the two materials and allow relatively horizontal lift placement.

Permanent slopes at the site should be as flat as practical to reduce creep and occurrence of shallow slides. The following slope angles are recommended as maximums. The presented angles refer to the total height of a slope. Site improvement should be maintained away from the top of the slope to reduce the possibility of damage due to creep or shallow slides.

TABLE 5.2-1 – RECOMMENDED PERMANENT SLOPE ANGLES

Height (ft.)	Horizontal to Vertical
0 – 3	1:1
3 – 6	2:1
6 – 9	3:1
> 9	4:1

5.3 Excavation

The side slopes of excavations through the overburden soils should be made in such a manner to provide for their stability during construction. Existing structures, pipelines or other facilities, which are constructed prior to or during the currently proposed construction and which require excavation, should be protected from loss of end bearing or lateral support.

Seasonal water seeps can occur in the more granular soils or where exposed by cuts. Subsoil drains may be required in some areas to intercept this seepage. This can be evaluated after grading has been performed.

Temporary construction slopes and/or permanent embankment slopes should be protected from surface runoff water. Site grading should be designed to allow drainage at planned areas where erosion protection is provided, instead of allowing surface water to flow down unprotected slopes.

Trench safety recommendations are beyond the scope of this report. The contractor must comply with all applicable safety regulations concerning trench safety and excavations including, but not limited to, OSHA regulations.

5.4 Trench Backfill

Trench backfill for pipelines or other utilities should be properly placed and compacted. Overly dense or dry backfill can swell and create a mound along the completed trench line. Loose or wet backfill can settle and form a depression along the completed trench line. Distress to overlying structures, pavements, etc. is likely if heaving or settlement occurs. On-site soil fill material is recommended for trench backfill. Care should be taken not to use free draining granular material, to prevent the backfilled trench from becoming a french drain and piping surface or subsurface water beneath structures, pipelines, or pavements. If a higher class bedding material is required for the pipelines, a lean concrete bedding will limit water intrusion into the trench and will not require compaction after placement. The soil backfill should be placed in approximately 4- to 6-inch loose lifts. The density and moisture content should be as recommended for fill in Section 5.2, Placement and Compaction, of this report. A minimum of one field density test should be taken per lift for each 150 linear feet of trench, with a minimum of 2 tests per lift.

5.5 Soil Corrosion Potential

Specific testing for soil corrosion potential was not included in the scope of this study. However, based upon past experience on other projects in the vicinity, the soils at this site may be corrosive. Standard construction practices for protecting metal pipe and similar facilities in contact with these soils should be used.

5.6 Utilities

Care should be taken that utility cuts are not left open for extended periods, and that the cuts are properly backfilled. Backfilling should be accomplished with properly compacted on-site soils, rather than granular materials.

Trench excavations should be sloped or braced in the interest of safety. Attention is drawn to OSHA Safety and Health Standards (29 CFR 1926/1910), Subpart P, regarding trench excavations greater than 5 feet in depth.

5.7 Erosion and Sediment Control

All disturbed areas should be protected from erosion and sedimentation during construction, and all permanent slopes and other areas subject to erosion or sedimentation should be provided with permanent erosion and sediment control facilities. All applicable ordinances and codes regarding erosion and sediment control should be followed.

6.0 CONSTRUCTION OBSERVATIONS

In any geotechnical investigation, the design recommendations are based on a limited amount of information about the subsurface conditions. In the analysis, the geotechnical engineer must assume the subsurface conditions are similar to the conditions encountered in the boring. However, quite often during construction anomalies in the subsurface conditions are revealed. Should such anomalies be discovered Oaktree Assets, LLC should immediately notify CMJ Engineering, Inc. before proceeding further with construction to allow CMJ Engineering, Inc. to reconsider its recommendations as necessary. It is also recommended that Oaktree Assets, LLC retain CMJ Engineering, Inc. to observe earthwork and foundation installation and perform materials evaluation during the construction phase of the project. This enables the geotechnical engineer to stay abreast of the project and to be readily available to evaluate unanticipated conditions, to conduct additional tests if required and, when necessary, to recommend alternative solutions to unanticipated conditions. Until these construction phase services are performed by the project geotechnical engineer, the recommendations contained in this report on such items as final foundation bearing elevations, proper soil moisture condition, and other such subsurface related recommendations shall only be considered as preliminary, and not final, recommendations.

It is proposed that construction phase observation and materials testing commence by the project geotechnical engineer at the outset of the project. Experience has shown that the most suitable method for procuring these services is for the owner or the owner's design engineers to contract directly with the project geotechnical engineer. This results in a clear, direct line of communication between the owner and the owner's design engineers and the geotechnical engineer.

7.0 REPORT CLOSURE

The boring log shown in this report contains information related to the types of soil encountered at specific locations and times and show lines delineating the interface between these materials. The log also contains our field representative's interpretation of conditions that are believed to exist in those depth intervals between the actual samples taken. Therefore, this boring log contains both factual and interpretive information. Laboratory soil classification tests were also performed on samples from selected depths in the boring. The results of these tests, along with visual-manual procedures were used to generally classify each stratum. Therefore, it should be understood that the classification data on the log of boring represent visual estimates of classifications for those portions of each stratum on which the full range of laboratory soil classification tests were not performed. It is not implied that this log is representative of subsurface conditions at other locations and times.

With regard to ground-water conditions, this report presents data on ground water levels as they were observed during the course of the field work. In particular, water level readings have been made in the boring at the times and under conditions stated in the text of the report and on the boring log. It should be noted that fluctuations in the level of the ground-water table can occur with passage of time due to variations in rainfall, temperature and other factors. Also, this report does not include quantitative information on rates of flow of ground water into excavations, on pumping capacities necessary to dewater the excavations, or on methods of dewatering excavations. Unanticipated soil conditions at a construction site are commonly encountered and cannot be fully predicted by mere soil samples, test borings or test pits. Such unexpected conditions frequently require that additional expenditures be made by the owner to attain a properly designed and constructed project. Therefore, provision for some contingency fund is recommended to accommodate such potential extra cost.

The analyses, conclusions and recommendations contained in this report are based on site conditions as they existed at the time of our field investigation and further on the assumption that the exploratory boring is representative of the subsurface conditions throughout the site; that is, the subsurface conditions everywhere are not significantly different from those disclosed by the boring at the time it was completed. If, during construction, different subsurface conditions from those encountered in our boring are observed, or appear to be present in excavations, we must be advised promptly so that we can review these conditions and reconsider our recommendations where necessary. If there is a substantial lapse of time between submission of this report and the start of the work at the site (more than twelve months is considered a substantial lapse of time; however, depending on the circumstances, less than six months may be considered a substantial lapse of time), if conditions have changed due either to natural causes or to construction operations at or adjacent to the site, or if structure locations, structural loads or finish grades are changed, we urge that we be promptly informed and retained to review our report to determine the applicability of the conclusions and recommendations, considering the changed conditions and/or time lapse. In this regard, if (a) construction at the site does not start within twelve months of the date of this report and (b) CMJ Engineering, Inc. is not present at the site when construction starts to confirm that conditions have not changed since the date of this report, the information in this report cannot be relied upon or used for any purpose.

Further, it is urged that CMJ Engineering, Inc. be retained to review those portions of the plans and specifications for this particular project that pertain to earthwork and foundations as a means to determine whether the plans and specifications are consistent with the recommendations contained in this report. In addition, we are available to observe construction, particularly the compaction of structural fill, or backfill and the construction of foundations as recommended in the report, and such other field observations as might be necessary.

The scope of our services did not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, ground water or air, on or below or around the site.

This report has been prepared for use in developing an overall design concept. Paragraphs, statements, test results, boring logs, diagrams, etc. should not be taken out of context, nor utilized without a knowledge and awareness of their intent within the overall concept of this report. The reproduction of this report, or any part thereof, supplied to persons other than the owner, should indicate that this study was made for design purposes only and that verification of the subsurface conditions for purposes of determining difficulty of excavation, trafficability, etc. are responsibilities of the contractor.

This report has been prepared for the exclusive use of Oaktree Assets, LLC and their consultants for specific application to design of this project only, and not for additions or modifications to the project. The only warranty made by us in connection with the services provided is that we have used that degree of care and skill ordinarily exercised under similar conditions by reputable members of our profession practicing in the same or similar locality. No other warranty, expressed or implied, is made or intended.

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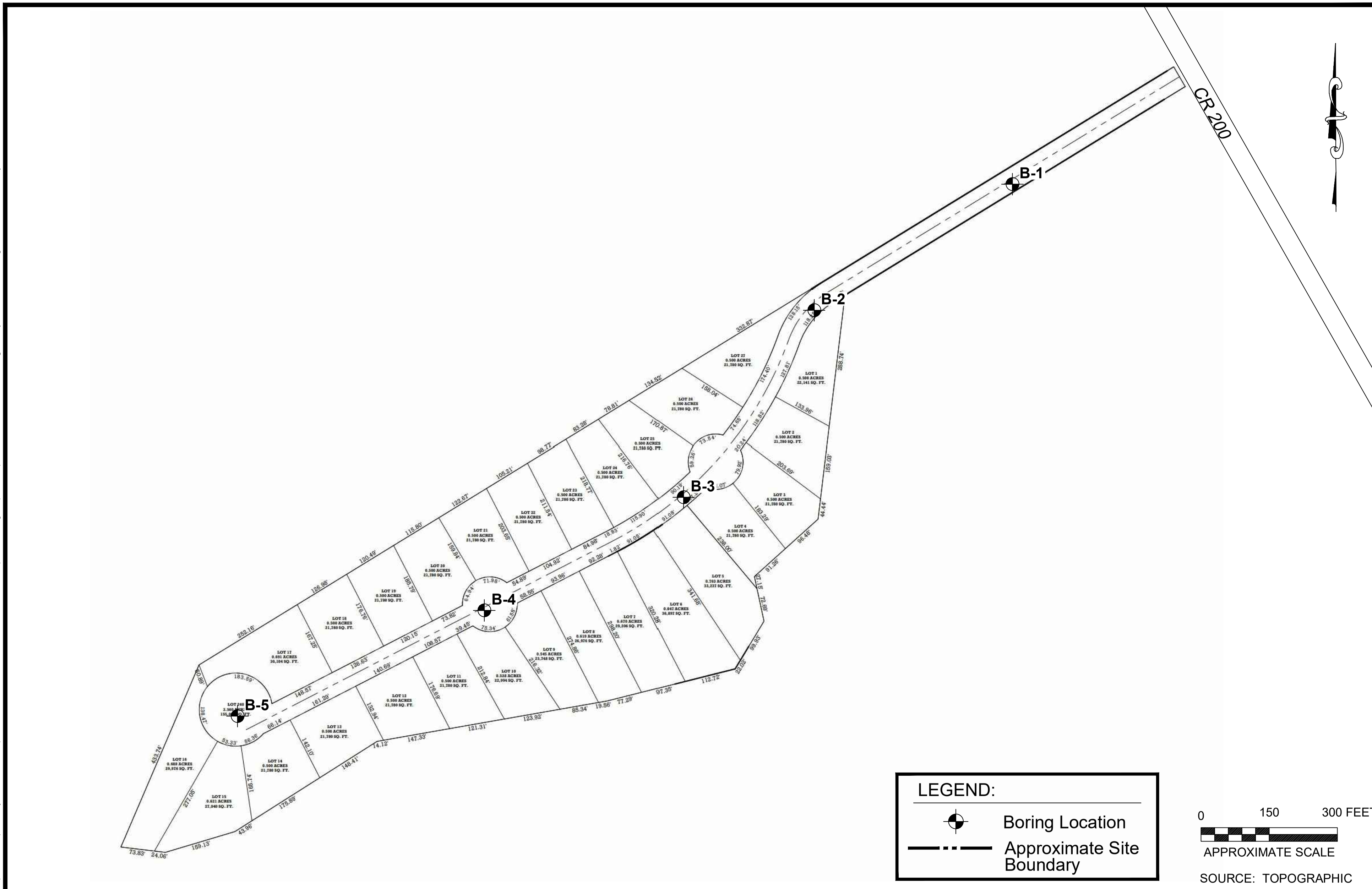


PLAN OF BORINGS

PROPOSED RESIDENTIAL ROADWAYS
GLEN ROSE, TEXAS

CMJ ENGINEERING, INC.

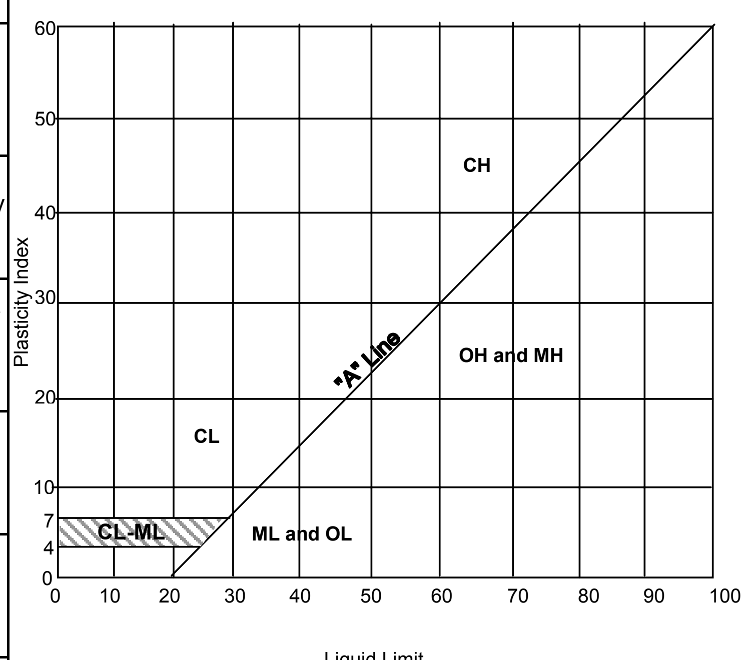
CMJ PROJECT NO. 2982-22-01

PLATE A.1

Date: 04/27/22

C:\Users\CherylDriscoll\OneDrive – TLP Solutions\drawings\CMJ\2982-22-01.dwg Layout: boring Current Layer: -NO PLOT

Major Divisions			Grp. Sym.	Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (more than half of the material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent......GW, GP, SW, SP More than 12 percent......GM, GC, SM, SC 5 to 12 percent......*Borderline* cases requiring dual symbols	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures		Liquid and Plastic limits below "A" line or P.I. greater than 4	Liquid and plastic limits plotting in hatched zone between 4 and 7 are borderline cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Liquid and Plastic limits above "A" line with P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6: $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands; gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures		Liquid and Plastic limits below "A" line or P.I. less than 4	Liquid and plastic limits plotting between 4 and 7 are borderline cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Liquid and Plastic limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, and lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity, organic silts			
	Highly Organic soils		Pt	Peat and other highly organic soils			



Plasticity Chart

UNIFIED SOIL CLASSIFICATION SYSTEM **PLATE A.2**

SOIL OR ROCK TYPES

GRAVEL	LEAN CLAY	LIMESTONE
SAND	SANDY	SHALE
SILT	SILTY	SANDSTONE
HIGHLY PLASTIC CLAY	CLAYEY	CONGLOMERATE

Shelby Tube	Auger	Split Spoon	Rock Core	Cone Pen	No Recovery

TERMS DESCRIBING CONSISTENCY, CONDITION, AND STRUCTURE OF SOIL

Fine Grained Soils (More than 50% Passing No. 200 Sieve)

Descriptive Item	Penetrometer Reading, (tsf)
Soft	0.0 to 1.0
Firm	1.0 to 1.5
Stiff	1.5 to 3.0
Very Stiff	3.0 to 4.5
Hard	4.5+

Coarse Grained Soils (More than 50% Retained on No. 200 Sieve)

Penetration Resistance (blows/foot)	Descriptive Item	Relative Density
0 to 4	Very Loose	0 to 20%
4 to 10	Loose	20 to 40%
10 to 30	Medium Dense	40 to 70%
30 to 50	Dense	70 to 90%
Over 50	Very Dense	90 to 100%

Soil Structure

Calcareous	Contains appreciable deposits of calcium carbonate; generally nodular
Slickensided	Having inclined planes of weakness that are slick and glossy in appearance
Laminated	Composed of thin layers of varying color or texture
Fissured	Containing cracks, sometimes filled with fine sand or silt
Interbedded	Composed of alternate layers of different soil types, usually in approximately equal proportions

TERMS DESCRIBING PHYSICAL PROPERTIES OF ROCK

Hardness and Degree of Cementation

Very Soft or Plastic	Can be remolded in hand; corresponds in consistency up to very stiff in soils
Soft	Can be scratched with fingernail
Moderately Hard	Can be scratched easily with knife; cannot be scratched with fingernail
Hard	Difficult to scratch with knife
Very Hard	Cannot be scratched with knife
Poorly Cemented or Friable	Easily crumbled
Cemented	Bound together by chemically precipitated material; Quartz, calcite, dolomite, siderite, and iron oxide are common cementing materials.

Degree of Weathering

Unweathered	Rock in its natural state before being exposed to atmospheric agents
Slightly Weathered	Noted predominantly by color change with no disintegrated zones
Weathered	Complete color change with zones of slightly decomposed rock
Extremely Weathered	Complete color change with consistency, texture, and general appearance approaching soil

KEY TO CLASSIFICATION AND SYMBOLS **PLATE A.3**

CMJ ENGINEERING INC.

Project No.	Boring No.	Project
2982-22-01	B-1	Residential Roadway - Squaw Valley Subdivision Glen Rose, TX

Location	Water Observations
See Plate A.1	Dry during drilling; dry at completion

Completion Depth	Completion Date
8.0'	5-5-22

Surface Elevation

Type: B-47 w/ CFA

Depth, Ft.	Stratum Description	REC %	RQD %	Blows/Ft. or Pen Reading, T.S.F.	Passing No 200 Sieve, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index	Moisture Content, %	Unit Dry Wt. Lbs./Cu. Ft.	Unconfined Compression Pounds/Sq. Ft.
	CLAYEY SAND/SANDY CLAY, reddish brown, w/ ironstone nodules			4.5+	48	31	21	10	19	98	
	SILTY CLAY, brown and tan, w/ calcareous nodules and ironstone nodules, hard			4.5+					19		
5				4.5+					20		
				4.5+					18		

LOG OF BORING 2982-22-01.GPJ CMJ.GDT 6/8/22

Project No. 2982-22-01	Boring No. B-2	Project Residential Roadway - Squaw Valley Subdivision, Glen Rose, TX
Location: See Plate A.1		Water Observations: Dry during drilling; dry at completion
Completion Depth: 8.0'	Completion Date: 5-5-22	

CMJ ENGINEERING INC.

Surface Elevation:

Type: B-47 w/ CFA

Stratum Description

Depth, Ft.	Stratum Description	REC %	RQD %	Blows/Ft. or Pen Reading, T.S.F.	Passing No 200 Sieve, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index	Moisture Content, %	Unit Dry Wt. Lbs./Cu. Ft.	Unconfined Compression Pounds/Sq. Ft.
	SANDY CLAY, reddish brown, w/ calcareous nodules and ironstone nodules, stiff			1.75					11		
	SILTY CLAY, brown and tan, w/ calcareous nodules and ironstone nodules, very stiff to hard			4.5+		45	15	30	14	102	
5				4.5+					16		
	- grades tan and gray below 8'			3.5					18		

Project No. 2982-22-01	Boring No. B-3	Project: Residential Roadway - Squaw Valley Subdivision, Glen Rose, TX
Location: See Plate A.1		Water Observations: Dry during drilling; dry at completion
Completion Depth: 8.0'	Completion Date: 5-5-22	
Surface Elevation:	Type: B-47 w/ CFA	

CMJ ENGINEERING INC.

Depth, Ft.	Stratum Description	REC %	RQD %	Blows/Ft. or Pen Reading, T.S.F.	Passing No 200 Sieve, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index	Moisture Content, %	Unit Dry Wt. Lbs./Cu. Ft.	Unconfined Compression Pounds/Sq. Ft.
	CLAY, dark brown and brown, w/ calcareous nodules, hard - stiff above 2'			2.75	72	52	17	35	19		
				4.5+					18		
5				4.5+					16		
				4.5+					16		

Project No.	Boring No.	Project	CMJ ENGINEERING INC.
2982-22-01	B-4	Residential Roadway - Squaw Valley Subdivision Glen Rose, TX	

Location	Water Observations
See Plate A.1	Dry during drilling; dry at completion

Completion Depth	Completion Date
8.0'	5-5-22

Surface Elevation:

Type: B-47 w/ CFA

Depth, Ft.	Symbol	Samples	Stratum Description	REC %	RQD %	Blows/Ft. or Pen Reading, T.S.F.	Passing No 200 Sieve, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index	Moisture Content, %	Unit Dry Wt. Lbs./Cu. Ft.	Unconfined Compression Pounds/Sq. Ft.
			CLAY, dark brown and brown, w/ calcareous nodules, hard			4.5+					17	101	
						4.5+		56	20	36	16		
5						4.5+					15		
						4.5+					16		

LOG OF BORING NO. **B-4**

Project No.	Boring No.	Project	
2982-22-01	B-5	Residential Roadway - Squaw Valley Subdivision Glen Rose, TX	CMJ ENGINEERING INC.

Location	Water Observations
See Plate A.1	Dry during drilling; dry at completion

Completion Depth	Completion Date	Surface Elevation	Type
8.0'	5-5-22		B-47 w/ CFA

Stratum Description

Depth, Ft.	Stratum Description	REC %	RQD %	Blows/Ft. or Pen Reading, T.S.F.	Passing No 200 Sieve, %	Liquid Limit, %	Plastic Limit, %	Plasticity Index	Moisture Content, %	Unit Dry Wt. Lbs./Cu. Ft.	Unconfined Compression Pounds/Sq. Ft.
	CLAY, dark brown and brown, w/ calcareous nodules, hard			4.5+	84	51	17	34	14	106	
				4.5+					15		
5				4.5+					15		
				4.5+					17		

LIME SERIES TEST RESULTS

Project: Proposed Residential Roadway
Squaw Valley Subdivision
Glen Rose, Texas

Project No.: 2982-22-01

Boring No.: B-3	Depth: 0' to 2'
Material: Clay	
Percent Lime	pH
0	7.67
2	12.04
4	12.44
6	12.44
8	12.45
10	12.46