818 S. FLORES ST. ◊ SAN ANTONIO, TEXAS 78204 ◊ www.saha.org

Procurement Department

ADDENDUM # 2

To: File 1611-909-23-4577
RFP for: New Affordable Home Construction Services

Please note the following changes:

The closing date and time are hereby changed to:

February 22, 2017 at 2:00 p.m.

The following additional information is hereby incorporated into the RFP Attachments:

See the attached historical soils reports.

Please note that a new soil test has been completed and will be issued possibly the later in the week of January 23-27, 2017.

By: Charles R Bode
Charles Bode Asst. Director of Procurement

Date: January 20, 2017

A-029

Report No. 70-148
March 11, 1971

Noonan & Krocker & Rogers
Assiciates Architects and Engineers
P.O. Box 12348
San Antonio, Texas 78212

Attention: Mr. Robert A. Krocker, P.E.

Evaluation of
Lime Slurry Pressure Injection Stabilization
Menchaca Homes
San Antonio, Texas

Gentlemen:

Submitted here is a report of our evaluation of the Lime Slurry Pressure Injection technique of stabilizing insitu soils at Menchaca Homes in San Antonio, Texas. This study was authorized by Mr. Krocker's letter dated December 31, 1970.

Presented in this report are our conclusions and recommendations for the further investigation of the stabilization process at the site. A discussion of the field and laboratory programs is also presented.

We have appreciated the opportunity to be of service to you on this project. If we can be of additional assistance during the development of this study please call on us.

Very truly yours,

RABA & ASSOCIATES
CONSULTING ENGINEERS, INC.

Carl F. Raba, Jr., Ph.D., P.E.

CFR/bj
Copies submitted: (5)

RABA
& ASSOCIATES
CONSULTING
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(512) 344-6257
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SAN ANTONIO, TEXAS
78216

TABLE OF CONTENTS

ILLUSTRATIONS

Introduction

Submitted here is the report on our investigation of soil and foundation conditions existing at the Menchaca Homes site in San Antonio, Texas. The facilities consist of two story apartment units bounded by N.W. 26th, Poplar, Stanley and Cima Streets. The structures are founded on shallow drilled and underreamed footings and soil supported grade beams and slabs.

The broad objectives of the investigation were to evaluate soil conditions at the site and to determine if techniques were available to minimize the seasonal movements experienced by the structures since they were constructed. The study included the drilling of sample borings to determine subsurface conditions together with a number of laboratory tests to evaluate the physical and engineering properties of the foundation soils. The results of the investigative work performed together with our analysis of the data with respect to foundation design and construction are included herein.

Soil Borings

Soil conditions at the site were investigated by nine borings drilled to nominal depths of 41.5-ft using established-accepted engineering procedures that are described in detail in the Appendix of this report. The borings were drilled using a truck mounted rotary drilling rig at the locations shown on the Plan of Borings, Plate 1. The logs of the borings were developed by our engineer based on his examination and classification of the samples. Representative portions of each soil sample were sealed in containers and transported to our laboratory for testing. Descriptions of the materials encountered in the borings are given on boring logs presented on Plates 2 thru 10. A key to classification terms and symbols used on the logs appears on Plate 11.

Laboratory Tests

In the laboratory, each sample obtained in the borings was inspected and classified by a soil technician. As part of this classification procedure, the natural water contents of ninety five specimens were determined. To determine the plasticity characteristics of the soil strata encountered and to help evaluate the relative volume change potential of the foundation soils, thirty eight liquid and plastic limit tests were performed on samples obtained from the borings. The results of all tests are presented in graphical form on the appropriate boring log. The standardized test procedures followed in the laboratory are discussed in the Appendix.

Estimates of the shear strengths of all other cohesive soil specimens were obtained with a calibrated hand penetrometer. These estimated shear strengths are shown on the boring logs as small circles containing an "x".

General Site Conditions

Topography The site is presently landscaped around the apartments but the surface run off and drainage characteristics are not adequate throughout the area. It is our understanding that the architect is developing a comprehensive drainage plan for the entire site that will preclude the accumulation of water around the apartments.

Soil Stratigraphy The soils underlying the site can be divided into two generalized strata that possess similar engineering characteristics.

Stratum I consists of very highly plastic clays throughout the total depth of all the boreholes except Borings 8 and 9. A liquid limit of 67 and a plasticity index of 50 are average values for the soils encountered. All of the clays possessed

highly jointed structures that will permit deep penetrations of surface water.

Borings 8 and 9 terminated in Stratum II that consists of blue gray clay shale that possesses the same general plasticity characteristics as the overlying clay. The basal stratum possessed good structure and was hard in consistency.

Groundwater Groundwater was not encountered at the time of our investigation and is only anticipated at significant depths below the site. Occasional perched water may stand in the jointed clays after periods of heavy rainfall.

Design Analyses

The foundation soils are highly plastic and moisture deficient throughout their entire depth and will heave as their natural moisture content is increased. Ignoring accidental sources such as broken water lines or sewers, three possible sources of moisture are listed below in their order of significance.

(A) The vertical penetration of surface water down through open joints and fissures in the shallow soils around the structure, followed by lateral diffusional flow into the soil beneath the structure;

(B) lateral penetration of rainwater beneath the structure through open joints and fissures in the shallow soils; and

(C) upward diffusional flow of moisture in the vapor phase from deep perched water that may occur in the jointed structure of the clays.

Methods to Minimize Movements

General A new technique to minimize swell potential consists of insitu chemical stabilization using a lime-slurry pressure injection process. This process utilizes a hydraulic system to push tubes 7-ft into the ground through which lime-slurry containing a surfactant is pumped under high pressures. The soils are preswelled

and partially stabilized simultaneously throughout the entire depth of penetration. The effect of various percentages of lime content on the plasticity indices of the shallow soils is illustrated on Plate 12. A composite sample of the shallow soils from each boring was mixed with various percentages of Hydrated Lime and the Atterberg Indices were determined. Each data point represents an average of two tests conducted on a mixed sample soaked 24 hours. Test results indicate that the addition of about 3% lime reduces the Plastic Index approximately 50%.

Soil - Slurry Interaction

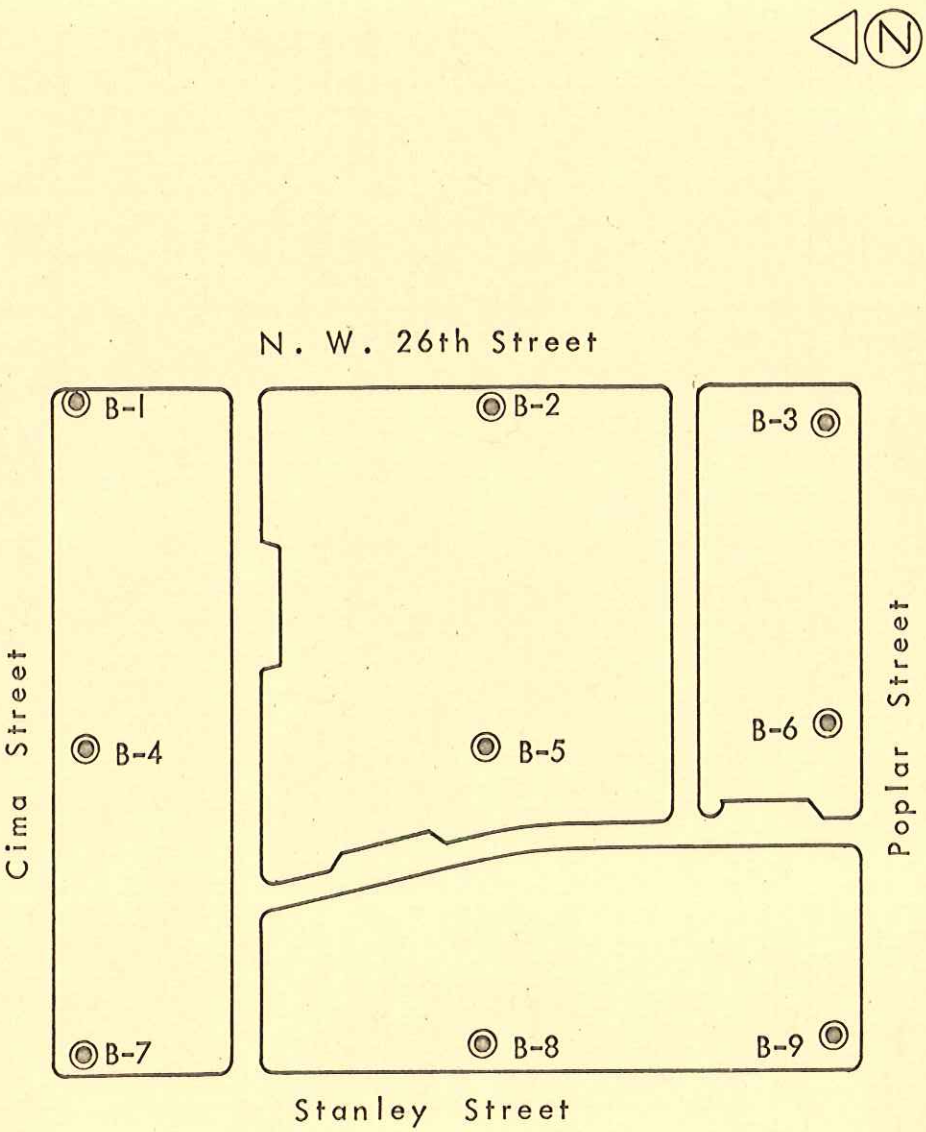
The lime slurry in injected into the ground at a pump pressure of about 50 to 200 psi. The slurry will initially flow through open joints and fissures and as the pressure is increased, progressively smaller discontinuities will be forced open allowing the slurry to enter. The water in the slurry will be sucked into the capillaries of the moisture deficient soils on both sides of the discontinuities, preswelling them. The surfactant is used to decrease the surface tension of the water, which results in an apparent increase in the permeability of the soil. The lime will also decrease the plasticity of the surrounding clays through the physio-chemical phenomenon of cation exchange. After the treatment is completed, all the joints and fissures in the soil mass will be filled with the lime slurry thereby preventing the vertical or lateral flow of rainwater. These thin vertical and horizontal sheets and layers of lime will also greatly reduce the diffusional flow of moisture within the soil mass.

Conclusions and Recommendations

The stratigraphy and structure of the soils encountered indicate that lime slurry pressure injection stabilization should minimize the seasonal movements experienced by the structures a minimum of fifty percent. We recommend that Phase Two of the

investigation be implemented and that swell tests be conducted in the laboratory to more definitively measure the reduction in swell potential of the treated soils.

ILLUSTRATIONS



PLAN OF BORINGS
MENCHACA HOMES
Scale: 1" = 200'

PLATE 1

LOG OF BORING NO. 1

MENCHACA HOMES
SAN ANTONIO, TEXAS

RABA & ASSOCIATES CONSULTING ENGINEERS INC.

TYPE: 3" Shelby Tube LOCATION: See Plate 1

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	ELEVATION, FT
			Very Stiff Dark Gray Clay, jointed			
5			Very Stiff Light Tan Silty Clay with calcareous modules			
10			Very Stiff Tan and Yellow Clay with gray streaks, slightly silty - jointed structure			
15						
20						
25						
30			Very Stiff Dark Tan Clay, slightly silty with yellow streaks and gypsum seams - jointed structure		84	
35						
40						

COMPLETION DEPTH: 41.5'
DATE: 1-25-71

PLATE 2

LOG OF BORING NO. 2

MENCHACA HOMES
SAN ANTONIO, TEXAS

RABA & ASSOCIATES CONSULTING ENGINEERS INC.

TYPE: 3" Shelby Tube LOCATION: See Plate 1

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	ELEVATION, FT
			Very Stiff Dark Gray Clay, jointed			
5			Very Stiff Light Tan Silty Clay with calcareous modules			
10						
15			Very Stiff Tan and Yellow Clay with gray streaks, slightly silty - jointed structure			
20						
25						
30						
35						
40						

COMPLETION DEPTH: 41.5'
DATE: 1-27-71

PLATE 3

LOG OF BORING NO. 3

MENCHACA HOMES
SAN ANTONIO, TEXAS

RABA & ASSOCIATES CONSULTING ENGINEERS INC.

TYPE: 3" Shelby Tube LOCATION: See Plate 1

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	ELEVATION, FT
			Very Stiff Dark Gray Clay, jointed			
5			Very Stiff Tan and Yellow Clay with gray streaks, slightly silty - jointed structure			
10						
15						
20						
25			Very Stiff Dark Tan Clay, slightly silty with yellow streaks and gypsum seams - jointed structure			
30						
35						
40						

COMPLETION DEPTH: 41.5'
DATE: 1-25-71

PLATE 4

LOG OF BORING NO. 4
MENCHACA HOMES
SAN ANTONIO, TEXAS

RABA & ASSOCIATES CONSULTING ENGINEERS INC.

TYPE: 3" Shelby Tube LOCATION: See Plate 1

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	ELEVATION, FT
			Very Stiff Dark Gray Clay, jointed			
5			Very Stiff Light Tan Silty Clay with calcareous modules			
			Very Stiff Tan and Yellow Clay with gray streaks, slightly silty - jointed structure			
10						
15						
20			Very Stiff Dark Tan Clay, slightly silty with yellow streaks and gypsum seams - jointed structure			
25						
30						
35						
40						

COMPLETION DEPTH: 41.5'
DATE: 2-4-71

PLATE 5

LOG OF BORING NO. 5

MENCHACA HOMES
SAN ANTONIO, TEXAS

RABA & ASSOCIATES CONSULTING ENGINEERS INC.

TYPE: 3" Shelby Tube LOCATION: See Plate 1

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	ELEVATION, FT
			Very Stiff Dark Gray Clay, jointed			
5			Very Stiff Light Tan Silty Clay with calcareous modules			
10			Very Stiff Tan and Yellow Clay with gray streaks, slightly silty - jointed structure			
15						
20						
25						
30			Very Stiff Dark Tan Clay, slightly silty with yellow streaks and gypsum seams - jointed structure			
35						
40						

COMPLETION DEPTH: 41.5'
DATE: 1-25-71

PLATE 6

LOG OF BORING NO. 6
MENCHACA HOMES
SAN ANTONIO, TEXAS

RABA & ASSOCIATES CONSULTING ENGINEERS INC.

TYPE: 3" Shelby Tube LOCATION: See Plate 1

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	ELEVATION, FT
			Very Stiff Dark Gray Clay, jointed			
5			Very Stiff Light Tan Silty Clay with calcareous modules			
10			Very Stiff Tan and Yellow Clay with gray streaks, slightly silty - jointed structure			
15						
20						
25						
30						
35						
40			Very Stiff Dark Tan Clay, slightly silty with yellow streaks and gypsum seams - jointed structure			

COMPLETION DEPTH: 41.5'
DATE: 1-25-71

PLATE 7

LOG OF BORING NO. 7

MENCHACA HOMES
SAN ANTONIO, TEXAS

RABA & ASSOCIATES CONSULTING ENGINEERS INC.

TYPE: 3" Shelby Tube LOCATION: See Plate 1

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	ELEVATION, FT
			Very Stiff Dark Gray Clay, jointed			
5			Very Stiff Dark Gray and Tan Clay			
			Very Stiff Light Tan Silty Clay with calcareous modules			
10			Very Stiff Tan and Yellow Clay with gray streaks, slightly silty - jointed structure			
15						
20			Very Stiff Dark Tan Clay, slightly silty with yellow streaks and gypsum seams - jointed structure			
25						
30						
35						
40						

COMPLETION DEPTH: 41.5'
DATE: 1-25-71

PLATE 8

LOG OF BORING NO. 8

MENCHACA HOMES
SAN ANTONIO, TEXAS

RABA & ASSOCIATES CONSULTING ENGINEERS INC.

TYPE: 3" Shelby Tube LOCATION: See Plate 1

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	UNIT DRY WT LB/CU FT
			Very Stiff Dark Gray Clay, jointed	
5			Very Stiff Dark Gray and Tan Clay	
			Very Stiff Light Tan Silty Clay with calcareous modules	
10				
			Very Stiff Tan and Yellow Clay with gray streaks, slightly silty - jointed structure	
15				
20				
			Very Stiff Dark Tan Clay, slightly silty with yellow streaks and gypsum seams - jointed structure	
25				
30				
35				
40			Hard Blue Gray Clay Shale	

COHESION, TON/SQ FT
0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT
10 20 30 40 50 60 70

ELEVATION, FT

COMPLETION DEPTH: 41.5'
DATE: 2-3-71

PLATE 9

LOG OF BORING NO. 9
MENCHACA HOMES
SAN ANTONIO, TEXAS

RABA & ASSOCIATES CONSULTING ENGINEERS INC.

TYPE: 3" Shelby Tube LOCATION: See Plate 1

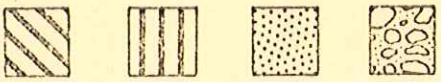
DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT, % — LIQUID LIMIT (10 20 30 40 50 60 70)	ELEVATION, FT
5			Very Stiff Dark Gray Clay, jointed			
10			Very Stiff Light Tan Silty Clay with calcareous modules			
15			Very Stiff Tan and Yellow Clay with gray streaks, slightly silty - jointed structure			
20						
25						
30			Very Stiff Dark Tan Clay, slightly silty with yellow streaks and gypsum seams - jointed structure			
35						
40			Hard Blue Gray Clay Shale			

COMPLETION DEPTH: 41.5'
DATE: 1-26-71

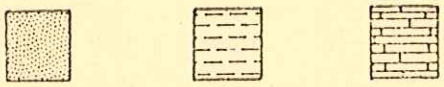
PLATE 10

SYMBOLS AND TERMS USED ON BORING LOGS

SOIL OR ROCK TYPES
(shown in symbols column)



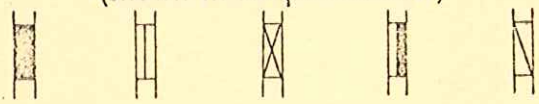
Clay Silt Sand Gravel



Sandstone Shale Limestone

Predominate Soil Types Shown Heavy

SAMPLER TYPES
(shown in sample column)



Shelby Tube | Rock Core | Split Spoon | Auger | No Recovery

STRENGTH TEST RESULTS

⊗ - Estimated Strength
○ - Unconfined Compression

TRIAXIAL COMPRESSION
(Single-Stage Tests)

△ - Unconsolidated-undrained
□ - Consolidated-undrained

(Multiple-Stage Tests)

c - Apparent Cohesion
ϕ - Apparent Angle of Internal Friction

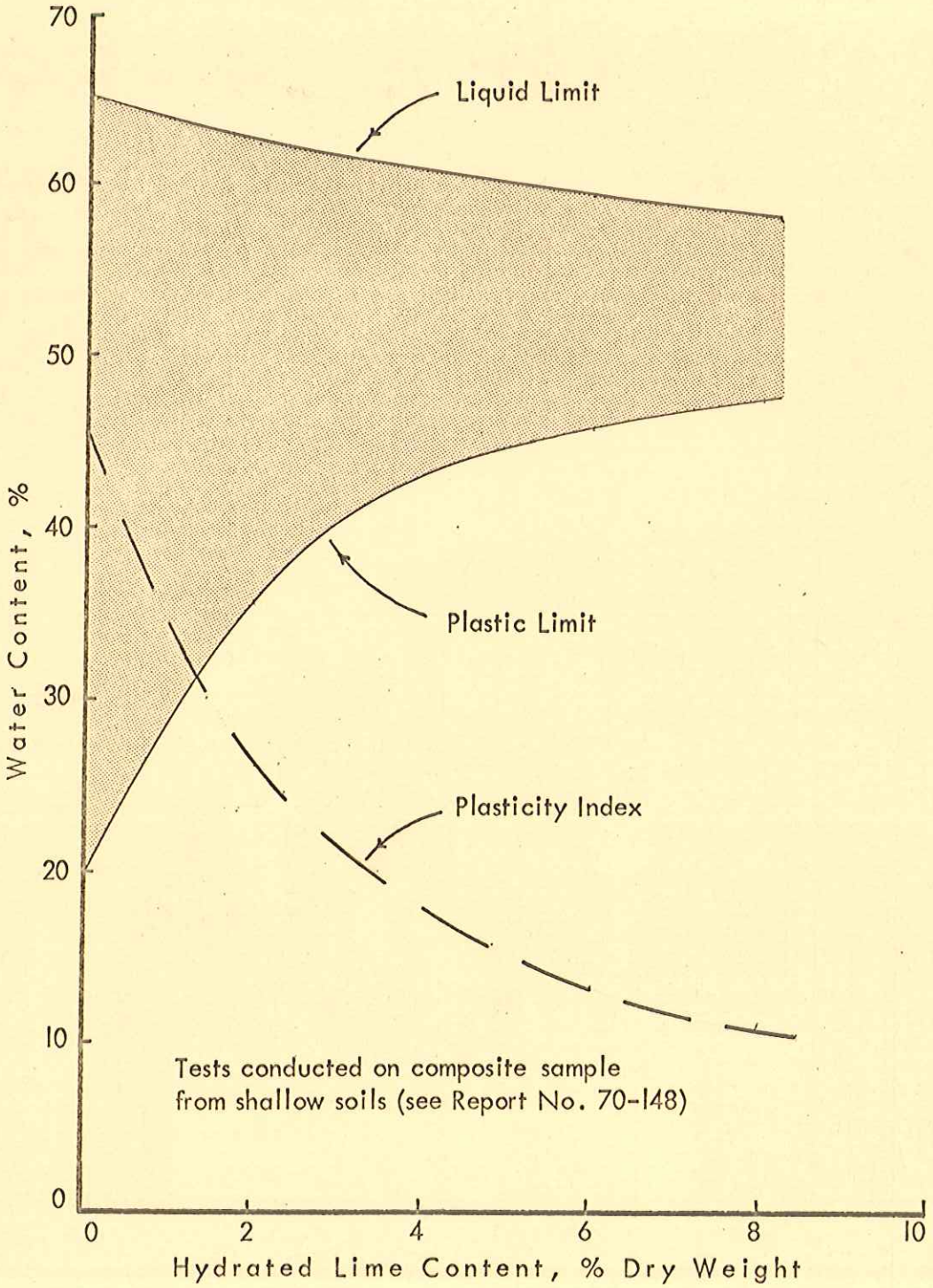
NOTE:
Values symbolized on boring logs represent shear strengths unless otherwise noted.

TERMS DESCRIBING CONSISTENCY, CONDITION OR TEXTURE

Terms used in this report to describe soils with regard to their consistency or condition are in general accordance with the discussion presented in Article 45 of SOIL MECHANICS IN ENGINEERING PRACTICE, Terzaghi and Peck, John Wiley & Sons, Inc., August, 1960, using the most reliable information available from the field and laboratory investigations. Terms used for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in Technical Memorandum No. 3-357, Waterways Experiment Station, March 1953.

TERMS CHARACTERIZING SOIL STRUCTURE

Slickensided - having inclined planes of weakness that are slick and glossy in appearance.
Fissured - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated - composed of thin layers of varying color and texture.
Interbedded - composed of alternate layers of different soil types.
Calcareous - containing appreciable quantities of calcium carbonate.
Well graded - having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Poorly graded - predominantly of one grain size, or having a range of sizes with some intermediate size missing.



PLASTICITY INDICES vs LIME CONTENT

PLATE 12

Engineers, Geologists, Chemists, Water Planners, Hygienists and Environmental Scientists

Raba-Kistner Consultants, Inc.

12821 W. Golden Lane
P.O. Box 690287, San Antonio, TX 78269-0287
(210) 699-9090 FAX (210) 699-6426

Project No. ASA92-168-00
March 25, 1993

Mr. Earl G. Cutler, P.E.
Cutler-Gallaway Services, Inc.
12029 Starcrest
San Antonio, Texas 78247

Re: Geotechnical Engineering Study
Menchaca Homes, Project No. Tex 6-11
San Antonio, Texas

Dear Mr. Cutler:

Submitted here is a report of soil conditions at the site of the existing Menchaca Homes housing project located in west San Antonio, Texas. This study consisted of assessing the existing soil conditions at the site and developing information to aid in the preparation of a written engineering report addressing long-term solutions, priorities, recommendations, and related cost estimates for remediation of the multi-family residential units existing at the site.

This engineering report has been prepared for the use of Cutler-Gallaway Services, Inc., for purposes stated above in accordance with accepted Geotechnical Engineering practices. This report may not contain sufficient information for purposes of other parties or other uses. Authorization for this study was received by our firm on December 14, 1992.

LIMITATIONS

The analyses and recommendations submitted in this report are based on: (a) the data obtained from eight soil borings drilled at this site, and (b) the available information obtained from our previous experience at the site.

This report may not reflect the exact variations of soil conditions across the site. The nature and extent of variations across the site may not become evident until construction commences. If variations then appear evident, it may be necessary to re-evaluate our recommendations after performing on-site observations and tests to establish the engineering significance of the variations.

The scope of our geotechnical engineering study does not include an environmental assessment of the air, soil or water conditions either on or adjacent to the site. No environmental opinions were prepared for or presented in this report.

SOIL BORINGS AND LABORATORY TESTS

Soil conditions at the site were evaluated by eight sample borings drilled at the locations shown on the Plan of Borings, Plate 1. The boring locations were selected by the client and were located in the field by representatives of Raba-Kistner Consultants, Inc., with the aid of the San Antonio Housing Authority. These borings were drilled in accordance with ASTM D 420 procedures to a maximum depth of 20 ft using a rotary drilling rig. As a part of our sampling procedure, the following samples were collected in accordance with ASTM D 1586 and ASTM D 1587 procedures:

Type of Sample	Number Collected
Split-Spoon (with Standard Penetration Test)	4
Undisturbed Shelby Tube	53

In the laboratory each sample was inspected and classified by a Geotechnical Engineer. The geotechnical engineering properties of the strata were evaluated by the following tests:

Type of Test	Number Conducted
Natural Moisture Content	52
Atterberg Limits	9
Ph	12
Swell	4

The results of all laboratory tests are presented in graphical or numerical form on the boring logs illustrated on Plates 2 through 9. A key to classification terms and symbols used on the logs is presented on Plate 10. The results of the field and laboratory tests are also presented in numerical form on Plate 11. The results of the swell tests are presented on Plates 12 through 15.

Standard penetration tests results are noted as "blows per ft" on the boring logs and Plate 11. Where hard or dense materials were encountered, the tests were terminated at 50 blows even if one foot of penetration had not been achieved. These data are conservatively reported as 50 blows per ft in this report.

Samples will be retained in our laboratory for 30 days after submittal of this report. Other arrangements may be provided at the request of the client.

GENERAL SUBSURFACE CONDITIONS

Soil Stratigraphy The soils encountered at this site may be grouped into two generalized strata with similar physical and engineering properties. The lines designating the interface between soil strata on the boring logs represent approximate boundaries. Transitions between strata may be gradual.

Stratum I consists of stiff to hard, dark gray to gray clays with grass, roots and a trace calcareous material. Some tan sand and gravel were encountered in Boring B-2, and gravel was encountered in Boring B-3. This stratum extends to depths ranging from 4.5 to 6.5 feet below the existing ground surface. Moisture content determinations reveal natural moisture contents ranging from 17 to 31 percent. This stratum consists of high plasticity clays with plasticity indices ranging from 39 to 49. Two swell tests (ASTM D 4546, Method B) were conducted to evaluate the swell characteristics of the soils at the time of our study. Swell pressures of 0.32 and 1.83 tsf and percent swell of 0.71 and 4.12 percent at surcharge pressures of 125 psf and 375 psf, respectively, were obtained from our testing. Laboratory Ph tests were conducted on selected soil samples to help detect the presence of lime. The measured Ph ranged from 7.7 to 8.3. Pocket penetrometer tests performed on recovered undisturbed samples indicate estimated undrained cohesions ranging from 0.63 to 2.25 tsf.

Stratum II consists of very stiff to hard, tan and gray clays with some ferrous staining and trace calcareous material. A gravel layer approximately 1 to 1-1/2 feet thick was encountered in Borings B-2, B-3, and B-4 at depths from 5 to 9.6 feet below the existing ground surface. Caliche was encountered with the clay soils from 5.2 to 9 feet in Boring B-7. Moisture content determinations reveal natural moisture contents ranging from 19 to 32 percent. This stratum consists of high plasticity clays with plasticity indices ranging from 37 to 50. Two swell tests (ASTM D 4546, Method B) were conducted to evaluate the swell characteristics of soils at the time of our study. Swell pressures of 0.57 and 1 tsf and percent swell of 0.75 and 1.49 percent at surcharge pressures of 750 psf and 1,000 psf, respectively, were obtained from our testing. Laboratory pH tests were conducted on selected soil samples to help detect the presence of lime. The measured pH ranged from 7.7 to 8.4. Pocket penetrometer tests performed on recovered undisturbed samples indicate estimated undrained cohesions ranging from 1.0 to 2.25 tsf.

Pertinent engineering data from the field and laboratory studies regarding the four strata at this site are summarized in the following table, including bottom depth range, liquid limit (LL), plasticity index (PI), swell pressure (tsf), and pH.

Stratum	Bottom Depth Range (ft)	LL	PI	Swell Pressure (tsf)	pH
I	4.5 - 6.5	61 - 73	39 - 49	0.325 - 1.83	7.7 - 8.3
II	20+	57 - 73	37 - 50	0.57 - 1	7.7 - 8.4

Groundwater Groundwater was not observed at the time of our subsurface exploration; however, some water may be present within the gravel layer and the fractures and fissures in the clay soils encountered. Fluctuations in groundwater levels occur due to variation in rainfall and surface water run-off. The construction process itself may also cause variations in the groundwater level.

REVIEW OF AVAILABLE DOCUMENTATION

Drawings

The Client has made drawings, entitled "Project Tex. 6-11, Program Reservation No. Tex. 6-A, Housing Authority, City of San Antonio," Drawing Nos. M1 through M5, E1 and E2, and U1 through U12, available for our review. These drawings were reviewed for information regarding the subsurface conditions at the site and the type of foundation and floor systems used to support the existing structures. These drawings did not contain information regarding the subsurface conditions at the site or the type of foundation and floor systems.

Geotechnical Information

We have also reviewed the available information from our project files (Project Nos. 71-072 and 71-101) for the geotechnical engineering and inspection services provided in 1971. Review of the boring logs for the borings drilled for those services reveals similar stratigraphy and similar engineering properties as those encountered during this study.

CONCLUSIONS

Based on our previous experience at the site, lime slurry pressure injection (LSPI) was performed at the site in 1971. The LSPI was reportedly performed within three feet of the perimeter of the buildings and to a minimum depth of seven feet below the existing ground surface. The intent of the LSPI was to mitigate problems being experienced at that time due to expansive soil movements.

Based on the Soil Survey of Bexar County, dated June, 1966, by the United States Department of Agriculture Soil Conservation Service, the general range of pH values for untreated surficial soils in this area range from about 7.9 to about 8.4. Our laboratory testing indicates pH values in this range for the soils encountered within the zone of the LSPI previously performed at the site. In addition, the measured plasticity indices of the soils recovered during this study are very similar to those measured in our previous study conducted prior to LSPI. Therefore, we conclude that the LSPI previously performed at the site is not currently having an effect on the soils underlying the site.

We also understand that during a field investigation conducted by the Client, it was discovered that the structures at the site were founded on drilled pier and grade beam foundation systems with soil-supported floor slabs. In addition, the client also reports that grade beams have been lifted off the piers by as much as four inches in some places and that there is some evidence that the piers have also been lifted. Therefore, we have concluded that the underlying clay soils have swelled and raised the piers, grade beams, and floor slabs causing the distress observed

at the site.

RECOMMENDATIONS

We have provided the following repair alternatives and recommendations for your consideration. These alternatives are generally listed in order of decreasing cost and movement reduction potential. We understand that the final selection of a repair alternative will be based on effectiveness and the cost of implementation.

Drilled Pier and Grade Beams

The only way to ensure that no additional movement is experienced by the structures is to structurally isolate the grade beams and floor slabs from the underlying expansive soils. To provide isolation between the existing grade beams and the underlying soils, it will be necessary to replace the existing drilled piers with drilled-and-underreamed piers and establish a void beneath the grade beams to separate them from the underlying soils. We recommend that the existing piers be cut-off to a depth of at least 12 in. below finished grade for ease of construction of the new drilled-and-underreamed piers and to avoid possible future uplift forces acting on these piers from being applied to the structure.

Based on our analyses and experience with similar soil conditions, the new piers should extend to a depth of at least 25 ft below the existing ground surface. The pier diameter should be at least 18 in. to facilitate cleaning the pier excavation, placing reinforcing steel, and inspection. The void beneath grade beams should be a minimum of 12 in.
To provide isolation between the floor slab and the underlying soils, it may be necessary to drill additional piers and construct grade beams (as indicated in the previous paragraph) within each building to structurally support the floor slab and establish a minimum 12 in. void below the floor slab by excavating the supporting soils. This procedure may not be economically feasible for the structures at the site.

If the structures cannot be separated from the underlying soils, alternative measures may also be considered to reduce future distress due to expansion of the underlying soils. These alternatives consist of chemical stabilization beneath each building or the construction of moisture barriers around each building. These alternatives are not anticipated to be as expensive as separating the building from the underlying soils; however, there may be some risk of future distress associated with these alternatives.

Chemical Stabilization

Chemical stabilization using proprietary chemicals have been used successfully in the San Antonio area. Tests conducted by Raba-Kistner Consultants, Inc., (R-KCI) on samples obtained from project sites after chemical treatment have indicated significant reductions in swell of the injected clays.

Since the chemical injection spacing and quantities can be varied to achieve different swell reduction results, no specific recommendations can be provided. These factors affect not only the swell reduction but also the cost of the stabilization. We understand that this method of

stabilization is being considered as part of a foundation repair alternative, and we have provided representatives of Hayward-Baker, Inc., with soil samples for evaluation.

Subsequent discussions with representatives of Hayward-Baker, Inc., have revealed that chemical stabilization is a feasible swell reduction alternative for the soil conditions encountered at the site. During these discussions, the depth of stabilization required was estimated to be on the order of 8 to 10 ft. We understand that Hayward-Baker, Inc., is providing you with a brief report of their evaluation and a cost estimate for chemical stabilization. We recommend that before chemical stabilization is implemented at the site the Owners arrange a meeting with personnel from R-KCI, Hayward-Baker, Inc., and Cutler-Gallaway Services, Inc., to discuss this alternative further.

Moisture Barriers

Moisture barriers can be installed around the perimeter of each building to reduce moisture fluctuations in the foundation soils. The moisture barrier should consist of both horizontal and vertical components. Moisture barriers may be constructed using polyethylene, polyvinyl chloride (PVC), or polypropylene geomembranes, asphalt, concrete, and/or semihardening slurries (for the vertical component), however, the residential application may make geomembranes more aesthetically desirable.

To minimize the lateral extent of the horizontal barrier component, the vertical membrane should be constructed as close to the existing structure as practical. The horizontal barrier should be positively attached to the existing grade beams to avoid leaking at the foundations. Vertical membranes should extend to a minimum depth of ten feet below the existing ground surface, and deeper if the budget allows.

We also recommend that a void be established beneath the existing grade beams separating them from the underlying soils. Based on our analyses and our experience with similar soil conditions, the void should be a minimum of 12 in. It will also be very important to establish positive surface drainage away from each structure to maximize the effectiveness of any remedial measure constructed at the site.

Additional Recommendations

Regardless of the final repair alternative selected, we recommend that positive surface drainage be established at each building to prevent surface water runoff from ponding directly adjacent to the buildings. In addition, all downspouts for roof drainage should extend at least 5 ft from the edge of the building to prevent introducing water from rainfall directly adjacent to the building foundation.

We also recommend pressure testing of all water carrying utilities including water, wastewater, and stormwater lines at or directly adjacent to the building. Any leaks encountered should be repaired.

* * * * * * * * * * * * * * * * * * *

The following illustrations are attached and complete this report:

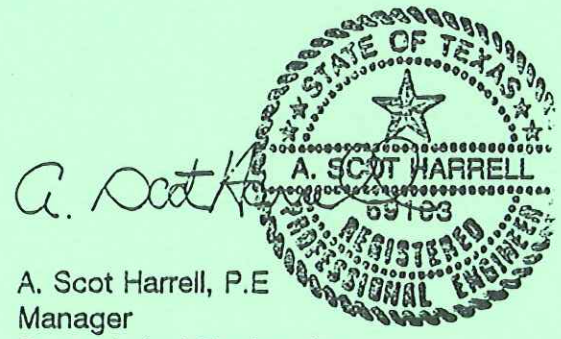
Plate 1	Plan of Borings
Plates 2 through 9	Logs of Borings
Plate 10	Key to Terms and Symbols
Plates 11 through 14	Swell Test Results
Plate 15	Results of Soil Sample Analyses

We appreciate the opportunity to be of service to you on this project. If we may be of additional assistance on the materials testing-quality control program during construction, please call.

Very truly yours,

RABA-KISTNER CONSULTANTS, INC.

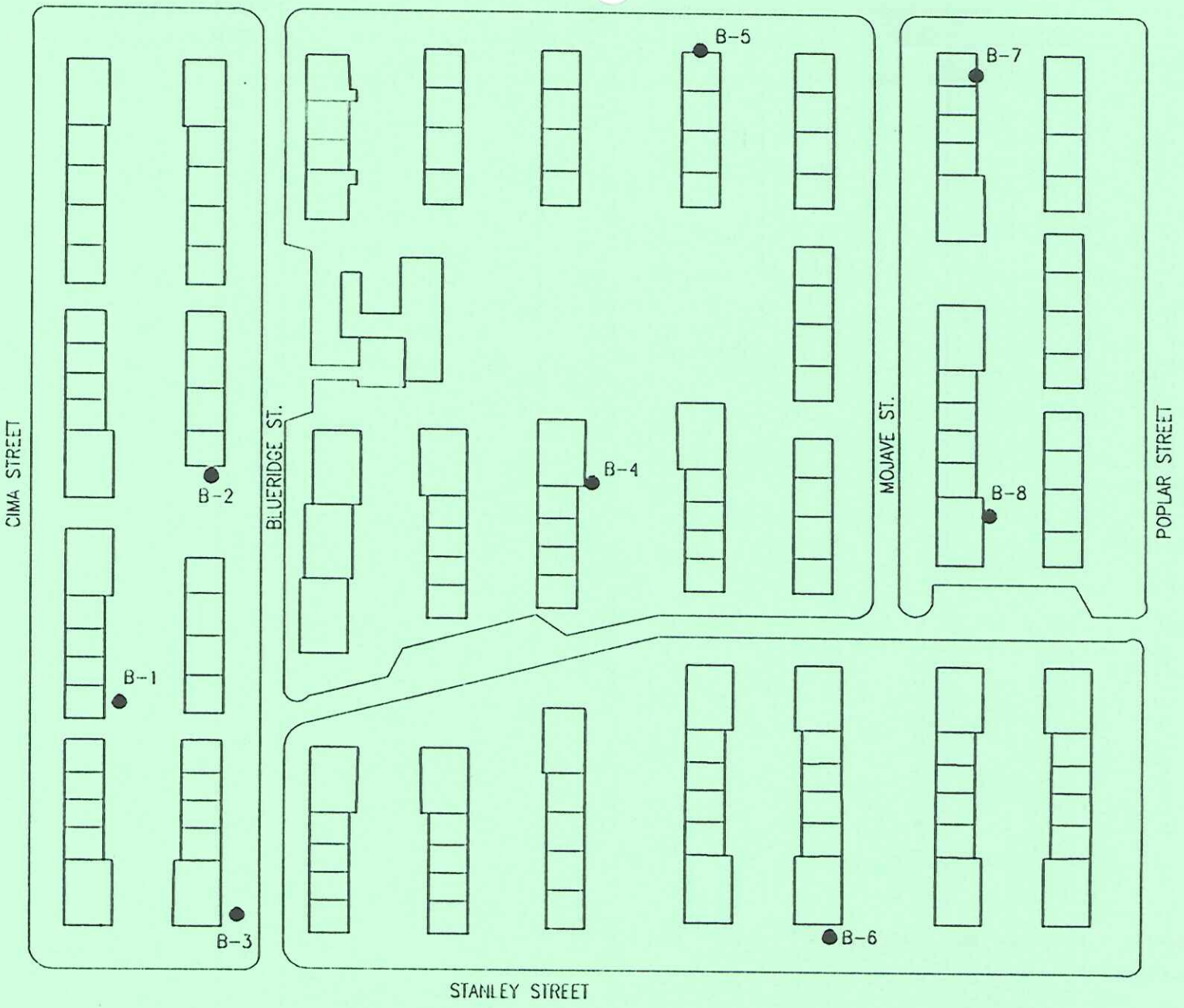
Richard E. Webb, P.E.
Geotechnical Project Manager



A. Scot Harrell, P.E
Manager
Geotechnical Engineering

REW/ASH/mbp
Copies submitted: Above (3)

ILLUSTRATIONS



PLAN OF BORINGS
MENCHACA HOMES - SAN ANTONIO, TEXAS

PROJECT NO.: ASA92-168-00

Raba-Kistner Consultants Inc

LOG OF BORING NO. B-1

MENCHACA HOMES
SAN ANTONIO, TEXAS

Raba-Kistner
Consultants, Inc.

DRILLING METHOD: Hollow Stem Auger

LOCATION: See Plate 1

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	COHESION, TON/SQ FT (⊗ ⊖) 0.3 0.6 0.9 1.2 1.5 1.8 2.1 / PLASTIC LIMIT + WATER CONTENT ● LIQUID LIMIT + / 10 20 30 40 50 60 70	%-200
			SURFACE ELEVATION:				
0			CLAY, Dark Gray to Gray with organic material and a trace of calcareous material		97		
5							
10			CLAY, Tan to Gray with some ferrous staining			>>⊖	
15						>>⊖	
20						>>⊖	
25							
30							
35							
40							
45							
50							

DEPTH DRILLED:	20.0'	DEPTH TO WATER:	Dry	PROJ. No.	ASA92-168-00
DATE DRILLED:	2/8/93	DATE MEASURED:	2/8/93	PLATE	2

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT.

LOG OF BORING NO. B-4

MENCHACA HOMES
SAN ANTONIO, TEXAS

Raba-Kistner
Consultants, Inc.

DRILLING METHOD: Hollow Stem Auger

LOCATION: See Plate 1

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	COHESION, TON/SQ FT (⊗ ⊖) 0.3 0.6 0.9 1.2 1.5 1.8 2.1 / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT 10 20 30 40 50 60 70	%-200
			SURFACE ELEVATION:				
0			CLAY, Dark Gray to Gray with organic material, roots, and grass		91		
5							
			CLAY, Tan to Gray				
10			- with gravel and calcareous material from 9.5' to 10.2'	12			
15							
20							
25							
30							
35							
40							
45							
50							

DEPTH DRILLED:	20.0'	DEPTH TO WATER:	Dry	PROJ. No.	ASA92-168-00
DATE DRILLED:	2/8/93	DATE MEASURED:	2/8/93	PLATE	5

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT.

LOG OF BORING NO. B-6

MENCHACA HOMES
SAN ANTONIO, TEXAS

Raba-Kistner
Consultants, Inc.

DRILLING METHOD: Hollow Stem Auger

LOCATION: See Plate 1

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	COHESION, TON/SQ FT (0.3 0.6 0.9 1.2 1.5 1.8 2.1) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	%-200
			SURFACE ELEVATION:				
0			CLAY, Dark Gray to Gray with organic material and some gravel		93		
5			CLAY, Tan to Gray with calcareous material				
10							
15							
20							
25							
30							
35							
40							
45							
50							

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT.

DEPTH DRILLED:	20.0'	DEPTH TO WATER:	Dry	PROJ. No.	ASA92-168-00
DATE DRILLED:	2/8/93	DATE MEASURED:	2/8/93	PLATE	7

LOG OF BORING NO. B-7

MENCHACA HOMES
SAN ANTONIO, TEXAS

Raba-Kistner
Consultants, Inc.

DRILLING METHOD: Hollow Stem Auger

LOCATION: See Plate 1

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	COHESION, TON/SQ FT (0.3 0.6 0.9 1.2 1.5 1.8 2.1) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	%-200
			SURFACE ELEVATION:				
0			CLAY, Dark Gray with organic material				
5			CLAY, Tan to Gray - with gravel to 6.5' - with caliche to 9'	15	96		
10							
15							
20							
25							
30							
35							
40							
45							
50							

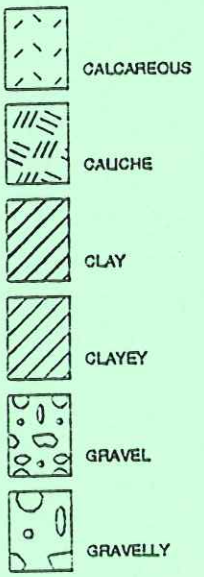
DEPTH DRILLED:	20.0'	DEPTH TO WATER:	Dry	PROJ. No.	ASA92-168-00
DATE DRILLED:	2/8/93	DATE MEASURED:	2/8/93	PLATE	8

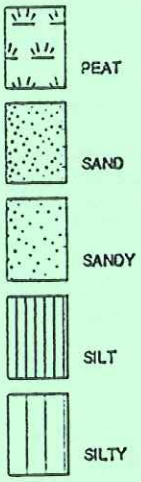
NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT.

KEY TO TERMS AND SYMBOLS

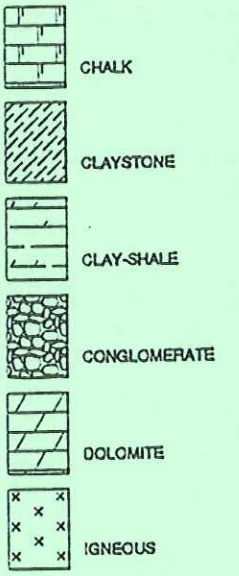
MATERIAL TYPES

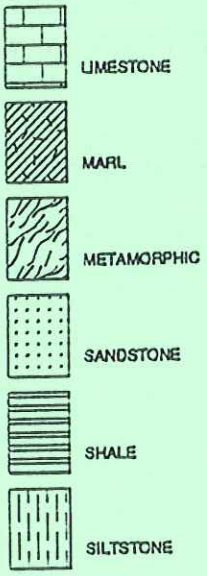
SOIL TERMS



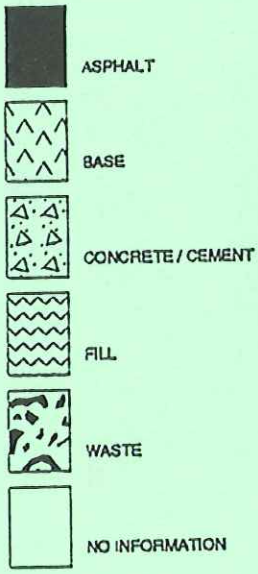


ROCK TERMS

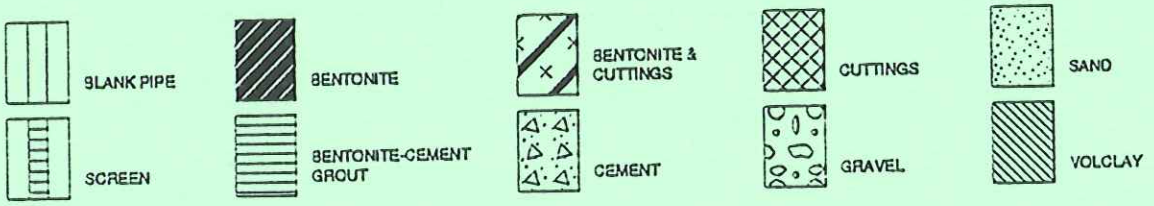




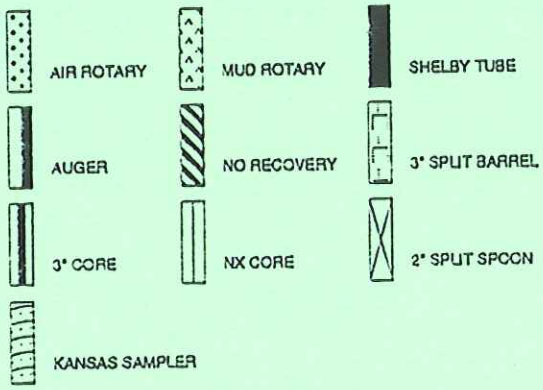
OTHER



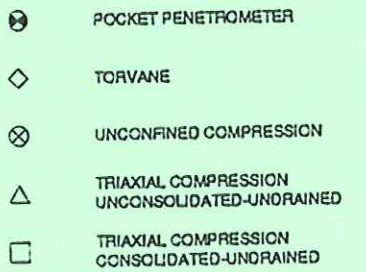
WELL CONSTRUCTION AND PLUGGING MATERIALS



SAMPLE TYPES



STRENGTH TEST RESULTS



NOTE: VALUES SYMBOLIZED ON BORING LOGS REPRESENT SHEAR STRENGTHS UNLESS OTHERWISE NOTED

PROJECT NO. ASA92-168-00

RABA-KISTNER CONSULTANTS, INC.

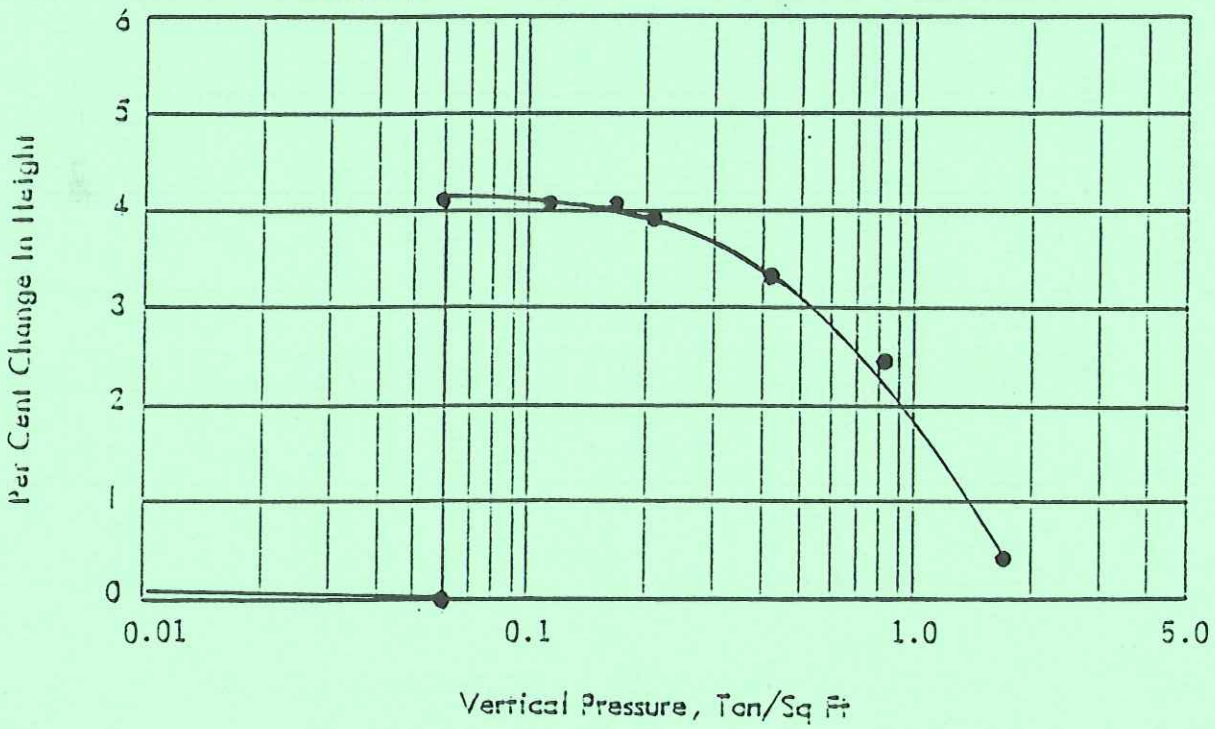
PLATE 10

3/7/92

Boring: B-1 Depth: 0 - 1.5'

Material: CLAY, Dark Gray with organic material and a trace of calcareous material

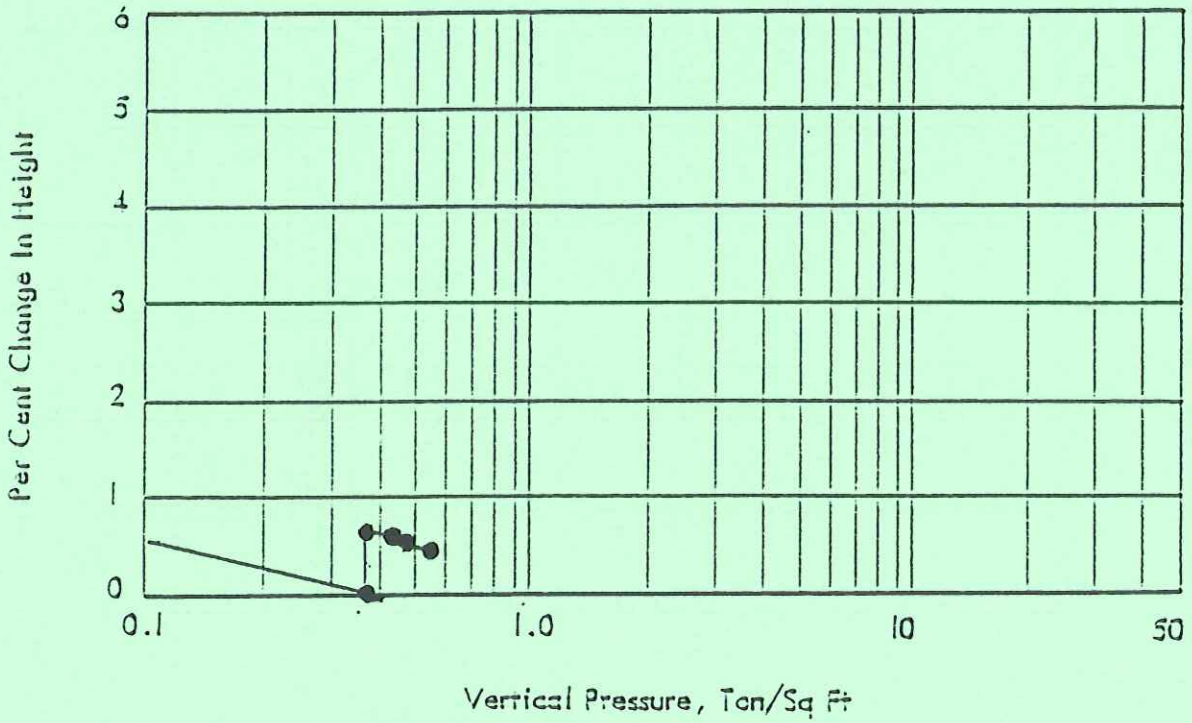
Unit Dry Weight: 97.0 lb/cu ft
Water Content: 23.7 %
Liquid Limit: ---
Plastic Limit: ---



SWELL TEST RESULTS

Boring: B-4 Depth: 5 - 6.5'
Material: CLAY, Dark Gray and Tan

Unit Dry Weight: 91.0lb/cu ft
Water Content: 30.2%
Liquid Limit: ---
Plastic Limit: ---

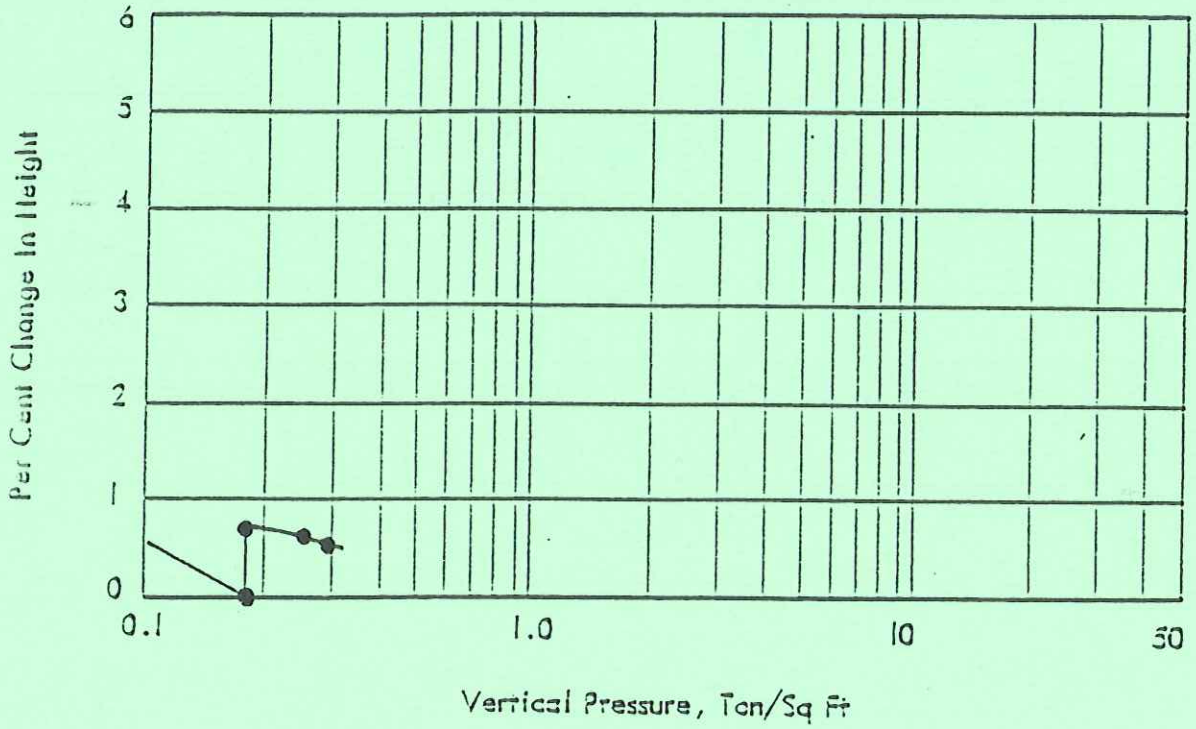


SWELL TEST RESULTS

Proj. No. ASA92-168-00

Boring: B-6 Depth: 2.5 - 4'
Material: CLAY, Gray with some gravel

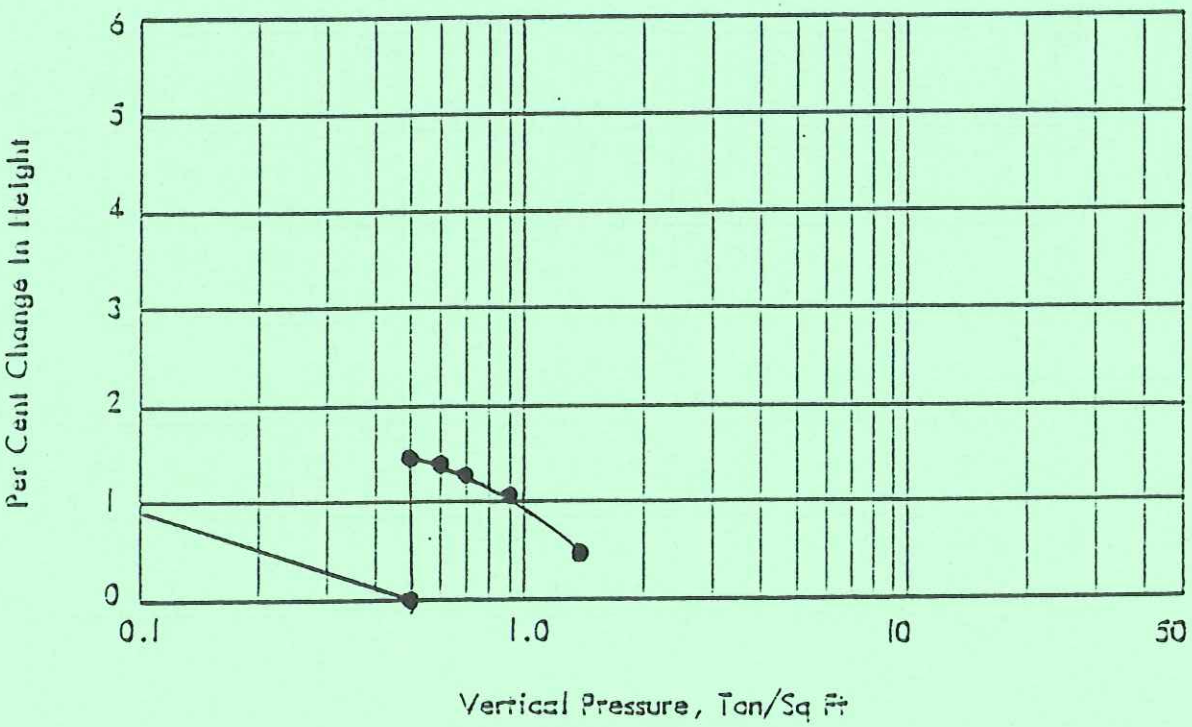
Unit Dry Weight: 93.1 lb/cu ft
Water Content: 27.1 %
Liquid Limit: ---
Plastic Limit: ---



SWELL TEST RESULTS

Boring: B-7 Depth: 7.5 - 9'
Material: CLAY, Tan with a trace of calcareous material

Unit Dry Weight: 96.1lb/cu ft
Water Content: 26.0%
Liquid Limit: ---
Plastic Limit: ---



SWELL TEST RESULTS

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: MENCHACA HOMES
PROJECT LOCATION: SAN ANTONIO, TEXAS

FILE NAME: MENCHACA.WQ1

BORING NO.	SAMPLE DEPTH (FT)	BLOWS PER FT	POCKET PENETROMETER	UNIT DRY WEIGHT (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS
B-1	0.00 to 1.50		4.0	97	23.7				
	2.50 to 4.00		3.5		25.7				
	5.00 to 6.50		2.5		30.1				
	7.50 to 9.00		4.5+		21.2				
	10.00 to 11.50		3.5		22.1				
	15.00 to 16.50		4.5+		24.6				
	18.50 to 20.00		4.5+		24.0	64	23	42	CH
B-2	0.00 to 1.50		1.5		30.7				
	2.50 to 4.00		2.5		29.3				
	5.00 to 6.50		4.0		26.0	68	21	47	CH
	7.50 to 9.00		4.5+		19.1				
	10.00 to 11.50	17			22.4				
	15.00 to 16.50				22.6				
	18.50 to 20.00		4.5+		24.1				
B-3	0.00 to 1.50		4.5+		17.1	73	24	49	CH
	2.50 to 4.00		4.5+		21.2				
	5.00 to 6.50		4.5+						
	7.50 to 9.00		4.5+		19.1				
	10.00 to 11.50		3.5		20.7				
	15.00 to 16.50		4.5+		26.7				
	18.50 to 20.00		4.5+		27.0				
B-4	0.00 to 1.50		2.5		30.4				
	2.50 to 4.00		2.5		31.4	61	22	39	CH
	5.00 to 6.50		2.0	91	30.2				
	7.50 to 9.00		3.0		27.6	57	20	37	CH
	10.00 to 11.50	12			24.6				
	15.00 to 16.50		4.2		24.9				
	18.50 to 20.00		4.2		24.3				
B-5	0.00 to 1.50		4.5+		21.7				
	2.50 to 4.00		4.0		23.2				
	5.00 to 6.50	17			22.6				
	7.50 to 9.00		4.0		22.3				
	10.00 to 11.50		4.2		23.7	73	23	50	CH
	15.00 to 16.50		4.5+						
	18.50 to 20.00		4.5+						
B-6	0.00 to 1.50		2.5		23.4				
	2.50 to 4.00		2.5	93	27.1				
	5.00 to 6.50		4.0		25.7				
	7.50 to 9.00		4.0		23.8				
	10.00 to 11.50		4.5+		23.8				
	15.00 to 16.50		4.5+		22.4	63	21	43	CH
	18.50 to 20.00		4.5+		22.6				

(CONT.)

RESULTS OF SOIL SAMPLE ANALYSES (CONTINUED)

PROJECT NAME: MENCHACA HOMES
PROJECT LOCATION: SAN ANTONIO, TEXAS

FILE NAME: MENCHACA.WQ1

BORING NO.	SAMPLE DEPTH (FT)	BLOWS PER FT	POCKET PENETROMETER	UNIT DRY WEIGHT (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS
B-7	0.00 to 1.50		2.0		31.4				
	2.50 to 4.00		2.5		28.6				
	5.00 to 5.20		2.0		27.1				
	5.20 to 6.70	15			20.3	67	18	49	CH
	7.50 to 9.00		3.0	98	28.0				
	10.00 to 11.50		3.0		25.8				
	15.00 to 16.50		4.5+		18.6				
	18.50 to 20.00		4.5+		20.5				
B-8	0.00 to 1.50		1.4		27.0				
	2.50 to 4.00		2.2		30.0				
	5.00 to 6.50		2.0		29.2				
	7.50 to 9.00		2.0		31.6	58	20	38	CH
	10.00 to 11.50		3.0		30.7				
	15.00 to 16.50		3.2		22.9				
	18.50 to 20.00		4.5+		22.5				