GEOTECHNICAL EXPLORATION
BASELINE ROAD BASIN
SOUTH PHOENIX/LAVEEN DRAINAGE IMPROVEMENT PROJECT, FCD #94-14
PHOENIX, ARIZONA

FOR

HDR ENGINEERING, INC.

TEC 95019RPT.A01

MAY 6, 1997

TERRANE ENGINEERING CORPORATION

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TERRANE ENGINEERING CORPORATION

TERRANE ENGINEERING CORPORATION
1920 East Third Street, #8
Tempe, Arizona 85281
602.894.1207 TEL • 602.894.2667 FAX

May 6, 1997

Mr. Steve Miller
HDR Engineering, Inc.
2141 E. Highland Ave., Ste. 250
Phoenix, AZ 85016

Re: Geotechnical Exploration
Baseline Road Basin
South Phoenix/Laveen Drainage Improvement Project, FCD #94-14
Phoenix, Arizona
TEC 95019RPT.A01

Dear Mr. Miller:

Terrane Engineering Corporation *(TEC)* is pleased to provide this report for the referenced project. Our services were performed in general accordance with *TEC* Proposal 97028PR.FC, dated February 21, 1997.

The attached report summarizes project and site data, describes the services we performed, and presents our recommendations regarding ancillary foundations, lateral earth pressures, excavations, slopes, corrosivity, and use of excavated soils. The report appendices present supporting information such as figures, boring logs, and laboratory data.

We have enjoyed providing this service for you. If you have any questions concerning this report, or if we may be of additional service, please contact us.

Sincerely,

TERRANE ENGINEERING CORPORATION

Frank Costello

Registered Professional Engineer (Civil)
CERTIFICATE NO.
19397
FRANK
COSTELLO
Date Signed 5/6/97
ARIZONA, U.S.A.

Frank Costello, P.E.

Copies to: Addressee (4)

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GEOTECHNICAL EXPLORATION
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FOR
HDR ENGINEERING, INC.

TEC 95019RPT.A01
MAY 6, 1997

1. INTRODUCTION

This report presents the results of our geotechnical exploration for the proposed retention basin at the southeast corner of 27th Avenue and Baseline Road in Phoenix, Arizona. This geotechnical exploration was performed by *TEC* to provide information and recommendations regarding:

- Site soil and groundwater conditions,
- Engineering and index characteristics of site soils,
- Ancillary foundations, lateral earth pressures, corrosivity, slopes, and
- Use of excavated soils.

2. PROJECT DESCRIPTION

The proposed project will consist of an approximately 40-acre, 10-foot-deep, retention basin that will be a part of the South Phoenix Drainage Improvement Project. The basin will detain storm water runoff received from the planned Baseline Road and 27th Avenue Drains through portland cement concrete piping. In order to facilitate landscaping, 5 to 1 sideslopes (horizontal to vertical) are planned for the basin perimeters. The approximate boundaries are illustrated on the Site Plan in the Appendix.

3. SCOPE OF SERVICES

Three categories of services were required for this geotechnical investigation: (1) field, (2) laboratory, and (3) engineering. These services were performed by *TEC* and its subcontractors in general accordance with current standards of practice for engineering and testing.

3.1 Field

The field exploration consisted of site reconnaissance by a field engineer and drilling and sampling with an auger drill rig. *TEC* drilled five borings to a depth of 16½ feet at the locations shown on the Site Plan. The field engineer logged the borings and obtained ring, split-spoon, and bulk samples for laboratory analysis. The borings were backfilled with auger cuttings after drilling. Prior to exploration, a temporary right-of-entry easement agreement was obtained from the property owner by the Maricopa Flood Control District.

3.2 Laboratory

A laboratory testing program was developed by the geotechnical engineer to obtain the data needed to formulate ancillary foundation, lateral earth pressure, slope, corrosivity, and use of excavated soils recommendations. The laboratory testing program consisted of moisture content, dry density, gradation, plasticity, collapse potential, expansion index, chloride content, sulfate content, pH, resistivity, and direct shear tests.

3.3 Engineering

The field and laboratory data were evaluated by the geotechnical engineer to formulate recommendations for lateral earth pressures, slopes, corrosivity, and use of excavated soils.

4. SITE CHARACTERIZATION

Information regarding surface features, subsurface soil and groundwater conditions, and laboratory test results is presented in this section. This information was gathered by *TEC* for geotechnical engineering purposes only. This site characterization does not and was not intended to address the existence or likelihood of contamination on or around the site. Specialized methods and procedures, which were not part of this scope of services, are required for an adequate environmental site assessment.

4.1 Surface

Currently, the site is agricultural land. Irrigation ditches run along the west and south sides of site. There is approximately 3 feet of relief, and drainage is to the north. During exploration the site was fallow.

4.2 Subsurface

As shown in the Boring Logs in the Appendix, low plasticity to medium plasticity, alluvial soils were encountered to the full depth of exploration in each of boring. Silty clayey sands (SC-SM) were encountered to depths of 3 to 8 feet. Underlying soils were clayey sands (SC) to the full depth of exploration. Light calcite cementation was encountered below a depth of 5 feet. The

cementation increased to moderate and heavy below depths of 9 to 12 feet. Groundwater was not encountered.

4.3 Laboratory

Index tests indicated the native soils are silty clayey sands (SC-SM) and clayey sands (SC). Laboratory tests on relatively undisturbed samples indicated in situ dry densities range from 93 to 110 pcf and moisture contents range from 6.8 to 11.0 percent.

A collapse potential test on a sample from a depth between 2 and 3 feet indicated that near-surface silty clayey sand, site soils have moderate settlement potential; 2.4 percent consolidation occurred under a surcharge of 1,500 pounds per square foot (psf). When immersed in water, the sample exhibited high collapse potential by settling an additional 5.7 percent. Total consolidation under a 3,000 psf surcharge was 11.3 percent.

A collapse potential test on a sample from a depth between 7 and 8 feet indicated that underlying clayey sand, site soils have low to moderate settlement potential; 1.8 percent consolidation occurred under a surcharge of 1,500 pounds per square foot (psf). When immersed in water, the sample exhibited low collapse potential by settling an additional 0.5 percent. Total consolidation under a 3,000 psf surcharge was 3.7 percent.

An expansion index test indicated that the near-surface silty clayey sand (0 to 3 feet deep) soils have very low expansive potential; after immersion under a 144 psf surcharge no expansion was observed. An expansion index test indicated that the underlying clayey sand soils (5 to 10 feet deep) have low expansive potential; after immersion, the expansion index was 11.

From direct shear tests, the friction angle ranged from 30 to 35 degrees, and the cohesion ranged from 0.05 to 0.6 kips per square foot (ksf)

Laboratory tests conducted on samples from various depths indicated that site soils had low chloride contents ranging from 0.009 to 0.085 percent and low sulfate contents ranging from 0.0065 to 0.022 percent. The pH of site soils ranged from 8.3 to 8.7, and the resistivity ranged from 1191 to 2565 ohm-cm.

5. LIMITATIONS

The recommendations presented herein are based on our understanding of the project as presented in the Project Description and the assumption that the subsurface conditions encountered in the borings adequately represent conditions near and between the borings.

Because project criteria regarding grading, number and type of structures, foundation loads, etc. can change and because subsurface conditions near and between the borings are not always similar to those encountered in the borings, the geotechnical engineer must be contacted for review and possible revision of the recommendations presented herein when related project criteria are altered during design or construction or when subsurface conditions substantially different from those described in the boring logs are encountered during construction.

6. RECOMMENDATIONS

This section presents recommendations regarding lateral earth pressures, slopes, corrosivity, use of excavated soils, and construction observation and testing. All construction should be in accordance with the project specifications and governmental standards, which may include City of Phoenix, Maricopa Association of Governments (MAG), and Maricopa County Flood Control District Standards. Currently, no large foundation supported structures are planned for the project. Should project elements change, design plans and specifications regarding earth-supported elements such as foundations and retaining walls should be reviewed by the geotechnical engineer.

6.1 Ancillary Foundations

Foundation recommendations for lightly loaded structures such as retaining walls and headwalls will depend on final footing elevations. Laboratory results indicate that the upper 5 feet of site soils are susceptible to collapse at elevated moisture contents. Therefore, for preliminary purposes, overexcavation and recompaction of native soils should be anticipated for foundations bearing in the upper 5 feet of existing soils. For foundations bearing on the cemented soils encountered below a depth of 5 feet in the borings, specialized treatment of native soils is not anticipated. In both cases, the geotechnical engineer should be contacted for final recommendations based on final design. An allowable bearing capacity of 1,500 pounds per square foot is recommended for preliminary design.

6.2 Lateral Earth Pressures

Preliminary guidelines for lateral earth pressures are provided; however, because of variable soil conditions, functions, and grades, the geotechnical engineer should be consulted for review of features where lateral earth pressures are a significant component. For initial design in unsaturated relatively flat areas, lateral earth pressures may be calculated using the following equivalent fluid pressures: active (30 psf/ft) and passive (300 psf/ft). A coefficient of friction of 0.4 between footings and bearing soils may be used to resist lateral foundation loads. If passive earth pressures are used in conjunction with base friction to resist lateral loads, reduce the coefficient of friction to 0.3.

6.3 Corrosivity

Chloride and sulfate contents of site soils were low. Chloride contents were less that 0.02 percent which is below the 0.06 percent maximum allowed by the 1994 Uniform Building Code (UBC) for prestressed concrete, and well below the UBC maximum chloride content of 0.15 percent for reinforced concrete. Sulfate contents were less than 0.023 percent. According to the UBC, a sulfate content of 0.10 percent or less is considered to have a negligible effect on portland cement concrete.

The pH of site soils ranged from 8.3 to 8.7 which is slightly basic. Resistivity ranged from 1191 to 2565 ohm-cm. According to the Arizona Department of Transportation (ADOT) Materials Preliminary Engineering and Design Manual, resistivities ranging from 500 to 1,999 ohm-cm require that buried metals be constructed with bituminous coating or of aluminum alloy. For resistivities greater than 2,000 ohm-cm, galvanized coated steel is acceptable. Neither the pH nor the resistivity is expected to affect the planned portland cement concrete features or pipe.

6.4 Basin Slopes

Results of laboratory tests indicate that friction angles of site soils range from 30 to 35 degrees and cohesion ranges from 0.05 to 0.6 ksf. The planned sideslopes of 5 to 1 (horizontal to vertical) will have a factor of safety in excess of 3, which is considered acceptable.

6.5 Excavation

Generally, conventional equipment is expected to be suitable for the upper 5 feet of excavation in the retention basin. For deeper excavations, where moderately to heavily cemented soils are encountered, the need for heavier equipment should be anticipated. According to Occupational Safety and Health Administration (OSHA) Excavation Guidelines, the site soils are classified as Type C. The maximum allowable slope for temporary excavations of less that 20 feet deep in Type C Soils is 1½ to 1 (horizontal to vertical). In all cases, OSHA standards must be followed.

6.6 Off-Site Use of Excavated Soils

Site soils are generally medium plasticity, clayey sands and silty clayey sands with low expansive potential. The soils are corrosive to uncoated metals and not corrosive to portland cement concrete. The engineering properties of the soils are considered fair to good for use as road fill, poor for use as sand, and moderate for use as embankments, dikes, or levees. When site soils are removed, exported, and recompacted, shrinkage on the order of 20 percent for the shallower silty clayey sand (SC-SM) soils and 15 percent for the deeper clayey sand soils (SC) should be anticipated.

6.7 Construction Observation and Testing

The recommendations presented in this report rely on adequate observation and testing by a

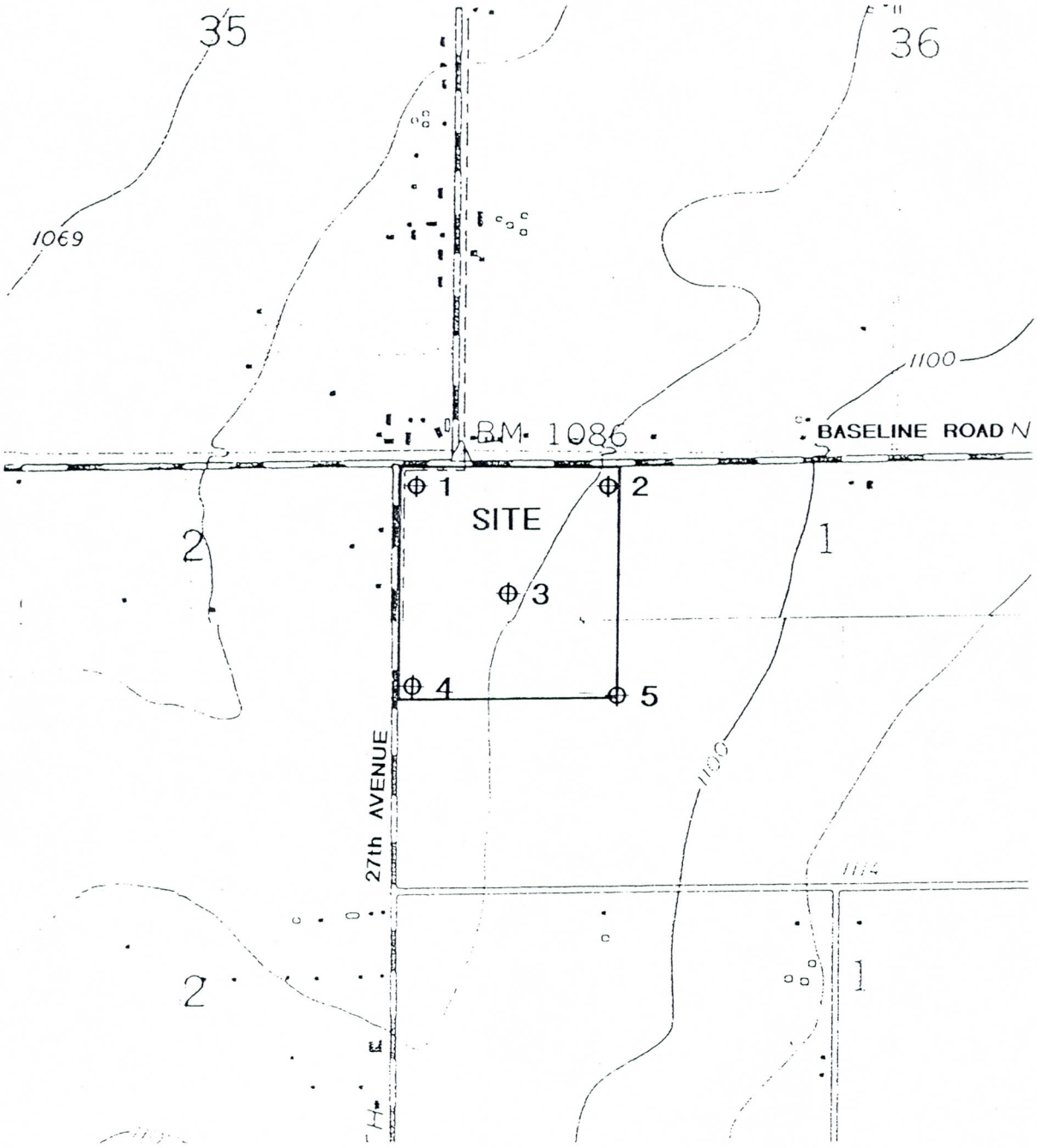
professional engineer or his qualified representative in accordance with the project specifications. At a minimum, the testing program should include:

- Observation and review of all foundation excavations and cut slopes to evaluate whether actual conditions are consistent with those encountered during exploration.

- Observation and testing of placement and compaction of all fill and backfill materials to evaluate compliance with specifications.

- Field and laboratory testing of portland cement concrete to evaluate compliance with specifications regarding slump, temperature, and strength.

APPENDIX



⊕ BORING

SITE PLAN

SCALE : 1 : 12,000	APPROVED BY : F. COSTELLO	DRAWN BY : A. CHEE
DATE : 5/5/97		REVISED :

BASELINE ROAD BASIN

REF : U.S.G.S.	DRAWING NUMBER : 95019A - 1

GLOSSARY OF TERMS

ALLOWABLE BEARING CAPACITY: The allowable pressure at the base of the footing in excess of that at the same level due to the surrounding surcharge.

ASTM: American Society for Testing and Materials.

BACKFILL: Material replaced in a confined space usually a man-made excavation.

BASE COURSE: A layer of specified material, usually granular, of planned thickness constructed on the subgrade for the purpose of serving one or more functions such as distributing load, providing drainage, minimizing frost action, etc.

BENCH: A horizontal surface in a sloped deposit.

CALICHE: A desert soil formed by the near surface crystallization of calcite and/or other soluble minerals by upward-moving solutions.

COLLAPSE POTENTIAL: Ability of a soil to undergo significant decrease in volume upon an increase in moisture content.

COMPRESSIBILITY: The property of a soil or rock pertaining to its susceptibility to decrease in volume when subjected to load.

DIFFERENTIAL SETTLEMENT: The difference in downward movement between two adjacent foundation elements.

ENGINEERED FILL: Specified material placed and compacted under full time observation of the geotechnical engineer or his qualified representative in accordance with project specifications.

EQUIVALENT FLUID PRESSURE: Horizontal pressure of soil, or soil and water, in combination which increases linearly with depth and are equivalent to those that would be produced by a fluid of a selected unit weight.

EXISTING GRADE: Elevation of ground surface at time of exploration.

EXPANSION POTENTIAL: The ability of a soil to increase its volume upon contact with water.

FILL: Material placed by man to raise the surface of the land.

FINISHED GRADE: The final grade of ground surface or floor slab.

HEAVE: Upward movement of ground or structural element.

MAG: Maricopa Association of Governments.

MAXIMUM DRY DENSITY: The maximum dry density obtainable in the laboratory for a given compactive effort.

MOISTURE CONTENT: The ratio of the mass of water contained in the pore spaces of soil or rock material, to the solid mass of particles in that material, expressed as a percentage.

OPTIMUM MOISTURE CONTENT: The moisture content at which a soil can be compacted to a maximum dry unit weight by a given compactive effort.

PLASTICITY: The property of a soil that allows it to be deformed beyond the point of recovery without cracking or appreciable volume change.

ROCK: Natural solid mineral matter occurring in large masses or fragments.

SCARIFY: To mechanically loosen or break the existing soil structure.

SETTLEMENT: Downward movement of ground or structural element.

SOIL: Sediments or other unconsolidated accumulations of solid particles produced by the physical and chemical disintegration of rocks, and which may or may not contain organic matter.

STRIP: Remove from present location.

SUBBASE: A layer used in pavement or slab-on-grade system between the subgrade and base coarse, or between the subgrade and portland cement concrete pavement.

SUBGRADE: The soil prepared and compacted to support a structure or a pavement system.

TERRANE: 1. A geologic formation or group of formations. 2. The area of surface over which a particular rock or group of rocks is prevalent. 3. An area or region considered in relation to its fitness or suitability for some specific purpose.

BORING LOG NOTES

These notes and boring logs are intended for use with this geotechnical report for the purposes described therein. The logs indicate our interpretation of subsurface conditions at the described locations on the date noted. Subsurface conditions may vary, and groundwater levels may change because of seasonal or other factors. Accordingly, the boring logs should not be made a part of the construction plans or be used to define construction conditions.

The borings were positioned by measuring from and visually referencing existing site features. The approximate positions are shown on the Site Plan.

"Boring Size/Type" refers to the diameter and type of boring. "HSA" denotes hollow-stem auger, and "SSA" denotes solid stem auger.

"Sample Type" refers to the sampling method and equipment used during exploration where:

- N indicates a 2.00-inch-inside-diameter, split-spoon sampler driven by a 140-pound hammer dropped 30 inches,
- R indicates a 2.42-inch-inside-diameter ring sampler driven by a 140-pound hammer dropped 30 inches, and
- G indicates a grab sample from auger cuttings.

"Blows/Foot" refers to the number of blows required to drive the sampler one foot or a specified distance. Refusal is 50 blows per foot for R samples and 100 blows per foot, 50 blows for six inches, or 25 blows without advancing for N samples.

"Dry Density" refers to unit weight of the soil in pounds per cubic foot as determined in the laboratory. "NR" indicates that no sample was recovered, and "*" indicates that the sample was too disturbed for density testing.

"Moisture Content" refers to the moisture content of the soil in percent by weight as determined in the laboratory.

"Description and Classification" refer to the materials encountered in the boring. Generally, the descriptions and classifications are based on visual examination in the field. Further examination and testing were performed on selected samples in the laboratory. The terms and symbols used in the boring logs are in general accordance with the Unified Soil Classification System and the American Society for Testing and Materials.

Log of Boring 1

Project: Baseline Road Basin
Location: Phoenix, AZ
***TEC* Job No:** 95019
Date: March 20, 1997

Drill Rig: CME 75
Boring Size/Type: 7"/HSA
Elevation: Not determined
Logged by: G. Seligmiller

Drilled by: Geomechanics SW
Groundwater: Not encountered
Other:

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
					Silty Clayey Sand (SC-SM); brown
	R	29	102	10.9	
					Clayey Sand (SC); brown
5	N	31			light cementation
	R	34	110	11.0	
10	N	39			moderate cementation, caliche nodules
	R	50-8"	110	9.6	
15	N	47			
					Stopped at 16½ feet
20					
25					
30					
35					
40					

Log of Boring 2

Project: Baseline Road Basin
Location: Phoenix, AZ
***TEC* Job No:** 95019
Date: March 20, 1997

Drill Rig: CME 75
Boring Size/Type: 7"/HSA
Elevation: Not determined
Logged by: G. Seligmiller

Drilled by: Geomechanics SW
Groundwater: Not encountered
Other:

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
					Silty Clayey Sand (SC-SM); brown
	N	31			
5	R	20	94	8.3	light cementation
	N	16			
10	R	30	105	10.8	Clayey Sand (SC); brown, moderate cementation, caliche nodules
					light cementation
	N	69			moderate to heavy cementation
15	N	44			heavy cementation
					Stopped at 16½ feet
20					
25					
30					
35					
40					

Log of Boring 3

Project: Baseline Road Basin
Location: Phoenix, AZ
***TEC* Job No:** 95019
Date: March 20, 1997

Drill Rig: CME 75
Boring Size/Type: 7"/HSA
Elevation: Not determined
Logged by: G. Seligmiller

Drilled by: Geomechanics SW
Groundwater: Not encountered
Other:

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
					Silty Clayey Sand (SC-SM); brown
	R	28	93	8.7	
5					
	N	25			Clayey Sand (SC); light brown, light cementation
	R	2	98	6.8	
10					
	N	41			
					moderate to heavy cementation
	R	50-10"			
15					
	N	25			with gravel, light cementation
					Stopped at 16½ feet
20					
25					
30					
35					
40					

Log of Boring 4

Project: Baseline Road Basin
Location: Phoenix, AZ
***TEC* Job No:** 95019
Date: March 20, 1997

Drill Rig: CME 75
Boring Size/Type: 7"/HSA
Elevation: Not determined
Logged by: G. Seligmiller

Drilled by: Geomechanics SW
Groundwater: Not encountered
Other:

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
					Silty Clayey Sand (SC-SM); brown
	R	15	104	7.3	
5					
	N	19			Clayey Sand (SC); brown, light cementation
	R	16	96	15.2	less cementation
10					moderate cementation, caliche nodules
	N	40			
	R	50-10"	108	13.4	with gravel, brown, light cementation
15					
	N	31			
					Stopped at 16½ feet
20					
25					
30					
35					
40					

Log of Boring 5

Project: Baseline Road Basin
Location: Phoenix, AZ
***TEC* Job No:** 95019
Date: March 20, 1997

Drill Rig: CME 75
Boring Size/Type: 7"/HSA
Elevation: Not determined
Logged by: G. Seligmiller

Drilled by: Geomechanics SW
Groundwater: Not encountered
Other:

Depth (feet)	Sample Type	Blows/ Foot	Dry Density (pcf)	Water Content (%)	Description and Classification
					Silty Clayey Sand (SC-SM); brown
	N	21			
5					
	R	50-11"	98	7.9	Clayey Sand (SC); brown, light to moderate cementation
	N	12			
10					
	R	18	104	8.2	
					light brown, moderate cementation
	N	34			
15					
	N	38			
					Stopped at 16½ feet
20					
25					
30					
35					
40					

SUMMARY OF PHYSICAL PROPERTY LABORATORY TESTS - *TEC* 95019RPT.A01

BORING NO.	DEPTH (ft)	USCS SOIL TYPE	PARTICLE SIZE ANALYSIS - ASTM D422 (percent passing by weight)						ATTERBERG LIMITS (ASTM D4318)			R-VALUE (ASTM D2844)	CHLORIDE CONTENT (%)	SULFATE CONTENT (%)	pH	RESISTIVITY (ohm-cm)	NOTES
			¾"	#4	#16	#40	#100	#200	LL	PL	PI						
1	3-6	SC	100	88	71	59	47	36	37	23	14				8.5	1191	
1	5-6½	SC											0.019	0.015			1
	10-11½	SC	100	85	64	49	37	28	36	21	15						
2	0-3	SC-SM	100	96	84	71	56	42	24	20	4				8.3	1390	
2	2½-4	SC-SM											0.013	0.017			1
	12½-14	SC	100	85	58	43	31	23	42	23	19						
3	5-6½	SC											0.009	0.0065			1
	8-12	SC	100	86	66	54	52	32	45	24	21				8.7	2565	
4	5-10	SC	100	92	77	65	55	46	39	22	17				8.6	2223	
	10-11½	SC											0.0085	0.016			1
	15-16½	SC	100	79	48	34	22	15	44	27	17						
5	7½-9	SC	100	91	68	54	41	31	36	21	15						
	12½-16½	SC													8.6	1390	1
	15-16½	SC											0.012	0.022			1

(1) Visual classification.

SUMMARY OF SOIL PROPERTIES LABORATORY TESTS - *TEC* 95019RPT.A01

BORING NO.	DEPTH (ft)	USCS SOIL TYPE	INITIAL CONDITIONS		COMPRESSION/EXPANSION				SHEAR STRENGTH		PERMEABILITY (cm/s)	EXPANSION INDEX ASTM D4829	NOTES
			DRY DENSITY (pcf)	WATER CONTENT (%)	SURCHARGE (ksf)	ΔH (%)	VOID RATIO (%)	MAX. SWELL PRES. (ksf)	ϕ (deg)	c (ksf)			
1	2-3	SC-SM	109	3.0					35	0.05			1
	7-8	SC	110	11.0	1.5	-1.8							
					1.5	-2.3							1
					3.0	-3.7							
2	0-3	SC-SM	112	7.1								0	1, 2
4	2-3	SC-SM	101	7.3	1.5	-2.4							
					1.5	-8.1							1
					3.0	-11.3							
4	5-10	SC	114	10.4								11	1, 3
5	10-11	SC	102	9.0					30	0.6			1

1) Sample immersed in water.
2) Calculated at 39 percent saturation.
3) Calculated at 58 percent saturation.

RESULTS OF DIRECT SHEAR TESTS

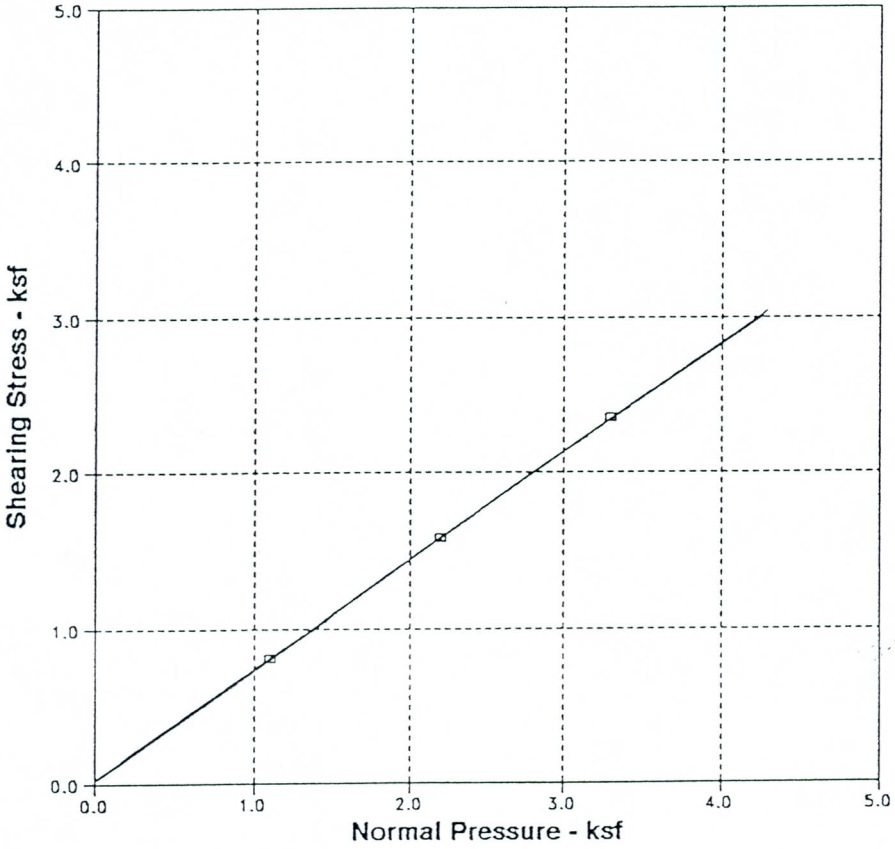
Project: Terrane Engineering Corp. **Date:** 08-Apr-97

Source: A1 @ 2-3'
Type: Driven Ring; 109 pcf Dry Density; 3% Field Moisture
Material: Not Classified
Sampled By: TEC

TESTED: ASTM D3080; Samples soaked.

RESULTS:

Friction Angle (phi) = 35 deg. Cohesion (c) = 0.05 ksf



Project No. 61370

RESULTS OF DIRECT SHEAR TESTS

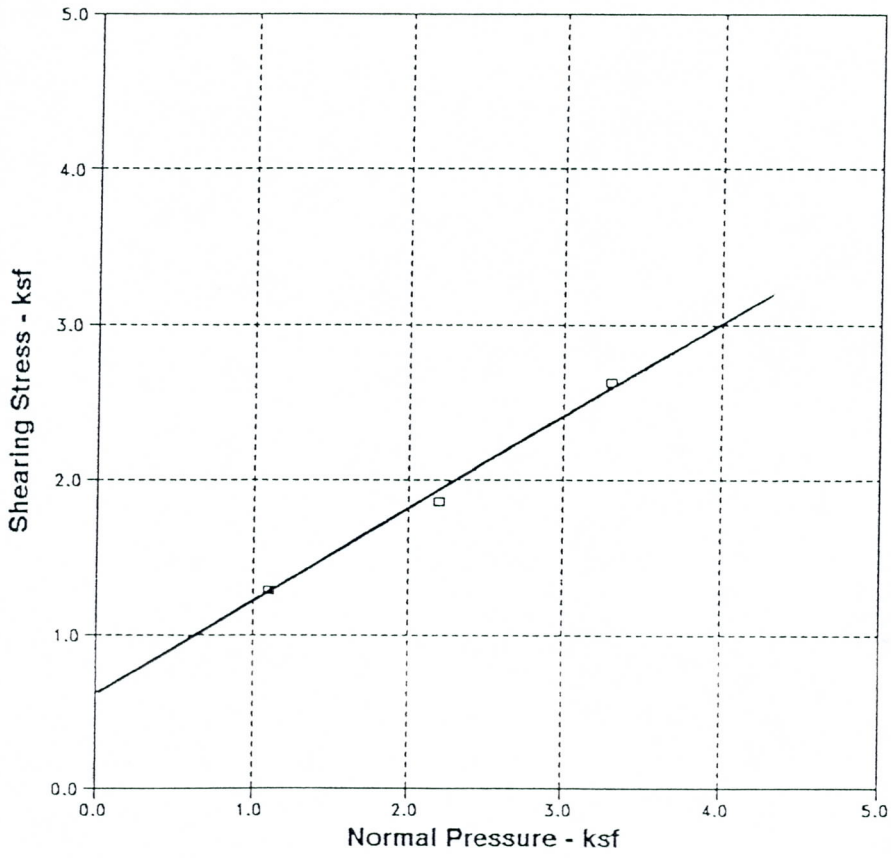
Project: Terrane Engineering Corp. **Date:** 08-Apr-97

Source: A5 @ 10-11'
Type: Driven Ring; 102 pcf Dry Density; 9% Field Moisture
Material: Not Classified
Sampled By: TEC

TESTED: ASTM D3080; Samples soaked.

RESULTS:

Friction Angle (phi) = 30 deg. Cohesion (c) = 0.6 ksf



Project No. 61370