CMT ENGINEERING LABORATORIES

Engineering
Geology
Environmental (ESA I & II)
Organic Chemistry
Materials Testing
Special Inspections

GEOGRID INSTALLATION REPORT

HIGLEY AND ELLIOT

South-Bound Lanes of Higley Road, North of Elliot Road
Gilbert, Arizona

Prepared For:

Tensar International Corporation
975 East Riggs Road, Suite 256
Chandler, Arizona 85249

Registered Professional Engineer (Civil)
CERTIFICATE NO. 22719
DAVID PRESTON HAYES
Date Signed 09-03-19
ARIZONA U.S.A.
Expires 3/31/21

CMT Project No. 1403
September 3, 2019

CMT ENGINEERING LABORATORIES

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1.0 INTRODUCTION

1.1 Scope of Assessment

CMT Engineering Laboratories (CMT) was contracted by Tensar International Corporation to act as an independent, third party assessor of the installation of the Tensar Triaxle Geogrid for a Town of Gilbert project. Also included in the scope of work were property tests of the in-situ soil subgrade along with a discussion of the results of the Automated Plate Load Testing (APLT) performed after installation of the grid, aggregate base, and paving.

The Town of Gilbert project encompassed the Elliot Road-Higley Road intersection, as well as the southbound lanes of Higley Road north and south of the intersection. In correspondence dated March 29, 2018, to the Geotechnical Engineer, Tensar International Corporation provided a Value Engineering Design proposal using TriAx geogrid to enhance the section. As part of the proposal, field validation using field and laboratory testing of the subgrade materials by an independent, certified 3rd party, laboratory was proposed. Specifically, proposed tasks included:

- Sample the subgrade and perform laboratory testing, including Grain Size Distribution, Atterberg Limits, Maximum Density and Optimum Moisture using Standard Proctor procedures, California Bearing Ratio, and R-value.
- Sample and test the aggregate base course for material classification by Grain Size Distribution and Atterberg Limits.
- Observe the scarification and re-compaction of the subgrade, placement of the first layer of geogrid, placement and compaction of the aggregate base, placement of the second layer of geogrid, placement and compaction of the asphaltic concrete.
- Observation of the APLT testing.

Note that field testing of all components was performed by the Contractor's quality control laboratory.

The following documents were reviewed as background research for this assessment:

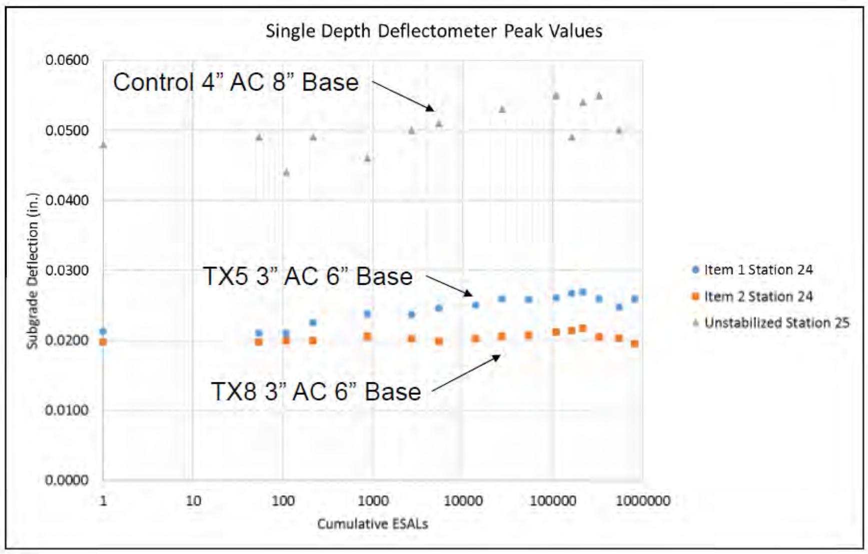
- Geotechnical Report entitled "Geotechnical Engineering Report, Higley Road Improvements, Elliot Road to the North Side of Higley Trail Crossing, Gilbert, Arizona" prepared by RAMM dated December 6, 2017, RAMM Project Number G24380.
- ARA report validating the Tensar SP4 design output.
- Applicable portions of the Project Plans and Specifications.

1.2 General Benefits of Using Geogrid as Layer Stabilization

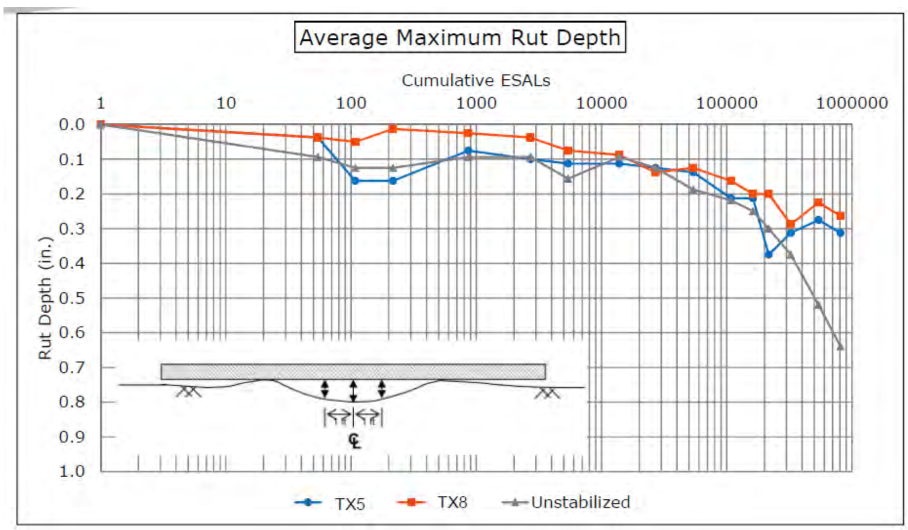
One of more comprehensive studies that evaluated geogrid stabilized flexible pavements was conducted by the US Army Corps of Engineers, Engineer Research and Development Center in Vicksburg, MS and the results published in a report entitled ***"Full-Scale Accelerated Testing of Multi-axial Geogrid Stabilized Flexible Pavements"*** dated June, 2017. The work was performed for Tensar Corporation and consisted of evaluating two (2) pavement sections. One was stabilized with Tensar's TX5, and the other stabilized with TX8. Both are multi-axial geogrids.

The purpose of that study was to provide performance data to compare the effectiveness of using Tensar's multi-axial geogrid to stabilize the section of an unstabilized flexible pavement section. The results of the study are summarized as follows:

- Measured deflections in the stabilized sections were approximately one-half of those observed in the un-stabilized section.



- Both geogrid stabilized pavement sections improved the rutting resistance when compared to the un-stabilized test section.



This study is just one example of similar studies performed at many other locations. The sum of the information was used as a basis for its proposed use on the Higley/Elliot Road project. Section 2.2 of this report details the TX8 application procedures used by the contractor for the Higley Road project in Gilbert, Arizona. A summary of CMT's observations are presented in Section 3.0.

2.0 CONSTRUCTION OF PROJECT PAVEMENT SECTION

2.1 Pavement Section Components

The original pavement section for the project consisted of:

Asphaltic Concrete = 5 inches
Aggregate Base = 15 inches
The design Subgrade Modulus was 12,999 psi
The design Structural Number was 3.90 and that would support 5,371,000 ESALs over 20 years.

The value-engineered pavement section, using one layer of Tensar TX8 inserted between the subgrade and aggregate base was:

Asphaltic Concrete = 5 inches
Aggregate Base = 10 inches
The design Subgrade Modulus was 12,999 psi
The new Structural Number was 4.04 and that would support 6,641,000 ESALS over 20 years.

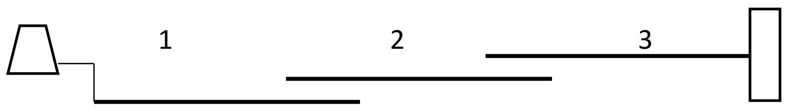
2.2 Subgrade Properties and Installation of Geogrid

The southbound lane of Higley Road north of the Elliot Road intersection was excavated to the proposed top of subgrade in late September, 2018. MR Tanner was the prime contractor with third party inspection and testing provided through the City of Gilbert. The site experienced significant amounts of rain for the next few weeks, resulting in a subgrade that was near to or over optimum, and thus difficult to run equipment over without severe rutting.

The subgrade eventually dried out to the point where compaction could be obtained and the contractor began placing the grid and the aggregate base. The contractor stockpiled some aggregate base at the north end of the site. The TX-8 Geogrid was delivered on site in rolls as shown in Photo No. 1.

Photo No. 1 - Rolls of Geogrid

It took three (3) rolls placed longitudinally with a 2-foot overlap to span the width of the road from gutter line on the outside edge to the median as shown in Photo No. 2. The order of roll out was from the outside edge to the median. The transverse areas were overlapped 1-foot. Both the longitudinal and transverse overlapping rolls were placed, in relation to the previous roll, as shown in the sketch below, with each successive roll on top of the previous roll.



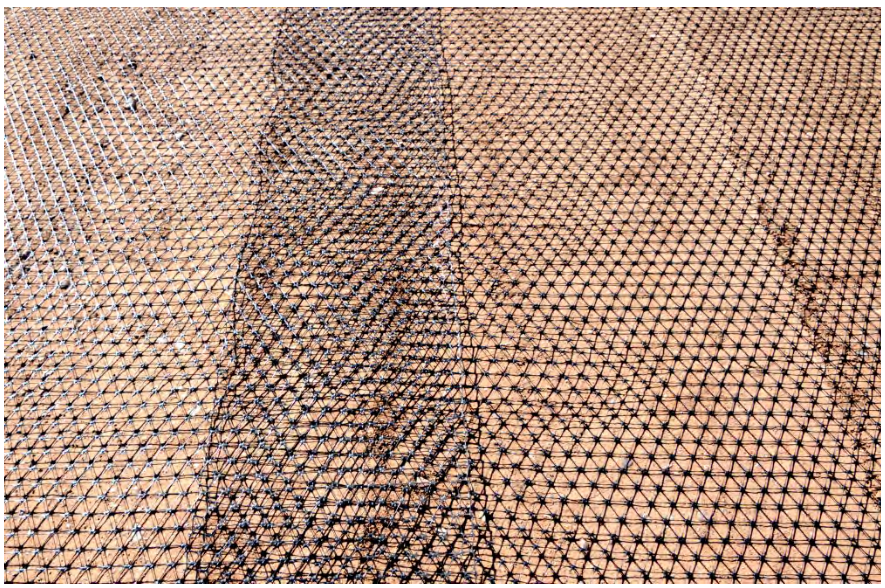


Photo No. 2 - Grid in Place with Longitudinal Overlap

The contractor tacked down the inside edge adjacent to the median in order to maintain stability during placement of all three rolls. It was not necessary to tack down the outer roll. In addition, small amounts of AB were placed randomly on each roll after placement to maintain vertical stability. Some longitudinal cutting of the grid using a utility knife was required to fit the roll placed adjacent to the median. It should be noted that two men manually unrolled the grid. A backhoe was not used in this case to hold each roll while it was unwound. A “chop” saw was not used because the heat generated might melt the grid.

Construction progressed from north to south. The subgrade continued to be unstable, even after the rains had diminished. This condition was more noticeable in the lane adjacent to the curb and gutter. It was decided to add another layer of TX8 geogrid at the midpoint of the aggregate base layer, 5 inches above the layer placed at the interface of the aggregate base and subgrade.

Subsequent testing by CMT Laboratories revealed subgrade strengths less than design values obtained from other areas of the site. Table No. 1 on the following page presents a comparison of results. CBR and R-value testing were performed on combined samples using ASTM procedures D1883 and D2844 respectively. Test reports are presented in Appendix A.

TABLE 1 – SUBGRADE TEST RESULTS

PARAMETER	DESIGN VALUE	DURING CONSTRUCTION
CBR (Subgrade Modulus)		3.6% 4,606 PSI
R-Value (Subgrade Modulus)	-- 12,299 PSI	8 2,850 PSI
Classification		CL (lean clay)
Atterberg Limits		PI=22, Fines=51%
Standard Proctor		Max Density=111.3 pcf Optimum Moist=14.9%

The acceptance values for conformance with Town of Gilbert Specifications were determined by the contractor's quality control laboratory and the Town's consultant inspection staff.

It was observed that it was difficult for the contractor to obtain the required 100% compaction level on the final lift of aggregate base course. A combination of scarification and revising the rolling pattern and moisture content resulted in an acceptable compaction level.

2.3 Project APLT Testing

A complete report of the APLT testing and results for this project has been published by Tensar International Corporation, as TriAx RD Project Summary, No. 12102016 Higley, Gilbert, AZ – APLT. In summary, the Automated Plate Load Tests (APLT) were performed for Tensar by Ingios Geotechnics in accordance with static and repetitive/cyclic plate load test procedures in ASTM D1196/ASTM D1195 and AASHTO T222/T221 specifications. These tests were performed after the placement and compaction of the aggregate base course. Their purpose was to determine resilient modulus values for the composite section, aggregate base, and subgrade, and to compare them with required values, thus validating performance. The other type of APLT performed on the aggregate base course was a long-term test to measure the anticipated performance of the aggregate base section over 20 plus years.

CMT witnessed the initial setup and APLT testing. The results indicated that the AB layer coefficient increased from the value of 0.12 to 0.29, higher than other stabilization methods that range from 0.17 to 0.23. The results also indicated that measured subgrade modulus increased significantly because the addition of the TriAx Geogrid reduced the stress felt by the subgrade.

Photographs of the APLT testing rig and the output from the on-board test panel are presented in Appendix B of this report.

3.0 SUMMARY

This assessment was performed on an actual project and revealed typical issues that face contractors, engineers, and owners in constructing new pavements or reconstruction existing sections. The issues that CMT observed were:

- Weather,
- Change in subgrade properties,
- Schedule,
- Past experience with geogrid installation,
- Proper equipment on site,
- Addition of another layer of geogrid,
- Traffic control.

The contractor's superintendent and grader operator had experience in placing geogrid. A crew was organized, led by the superintendent, to roll out the geogrid, including overlapping and alignment with the gutter and median. After placement of several rolls, the less experienced crew was able to continue with minimum supervision. Thus, neither special equipment nor specific technical expertise were required to place the geogrid properly.

The change in procedure, adding another layer of geogrid, partway through the project, was accomplished with no effect on the schedule. The amount of rain presented the biggest challenge to the schedule. The SpectraPave4 Pro Pavement Optimization Design and Cost Analysis program, available from Tensar, was utilized to easily and quickly provide revised recommendations. Mix design revisions and lengthy retesting were not required. Only additional grid was needed and that was readily available.

The contractor was able to divert traffic so that the entire south-bound lane west of the median was undisturbed during construction.

The use of the APLT to confirm the pavement and subgrade qualities after construction was an effective way to confirm potential performance of the actual constructed pavement. It provided a high confidence level in the final product.

We appreciate the opportunity to be of service to you on this project. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (602) 241-1097.

Sincerely,
CMT Engineering Laboratories

Registered Professional Engineer (Civil)
CERTIFICATE NO. 22719
DAVID PRESTON HAYES
Date Signed 09-03-19
ARIZONA U.S.A.
Expires 3/31/21

David P. Hayes, P.E.
AZ Business Development Manager

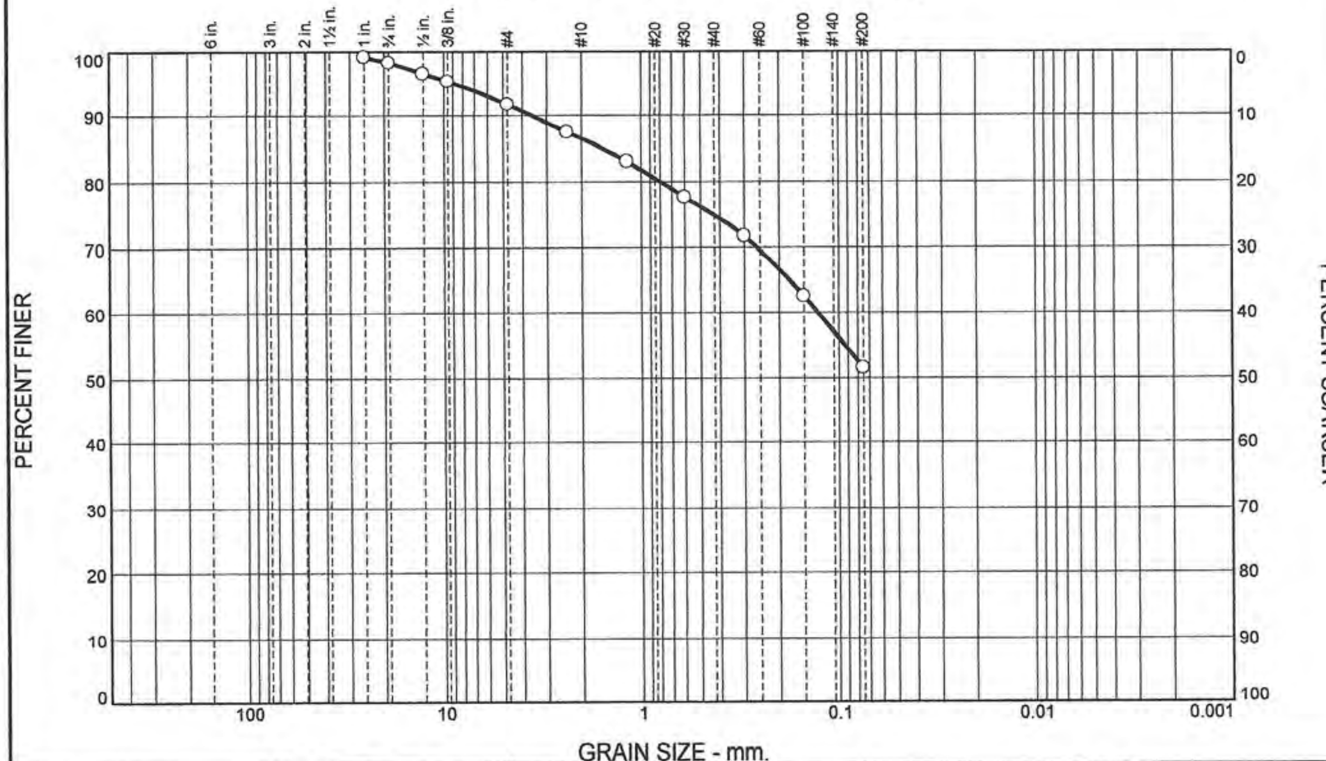
Reviewed by:

Hank Belliston, M.S., P.E.
Arizona Engineering Manager

APPENDIX A

CMT LABORATORY TEST RESULTS
SUBGRADE

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
		6.5	5.3	11.6	23.3	51.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1"	99.1		
3/4"	98.2		
1/2"	96.5		
3/8"	95.3		
#4	91.7		
#8	87.4		
#16	83.0		
#30	77.6		
#50	71.6		
#100	62.5		
#200	51.5		

* (no specification provided)

Material Description

Subgrade (two buckets)

Atterberg Limits

PL= 18 LL= 40 PI= 22

Classification

USCS= CL AASHTO= A-6(8)

Remarks

Source of Sample: Higley and Elliot Subgrade
Sample Number: 1

Date: Oct 30, 2018

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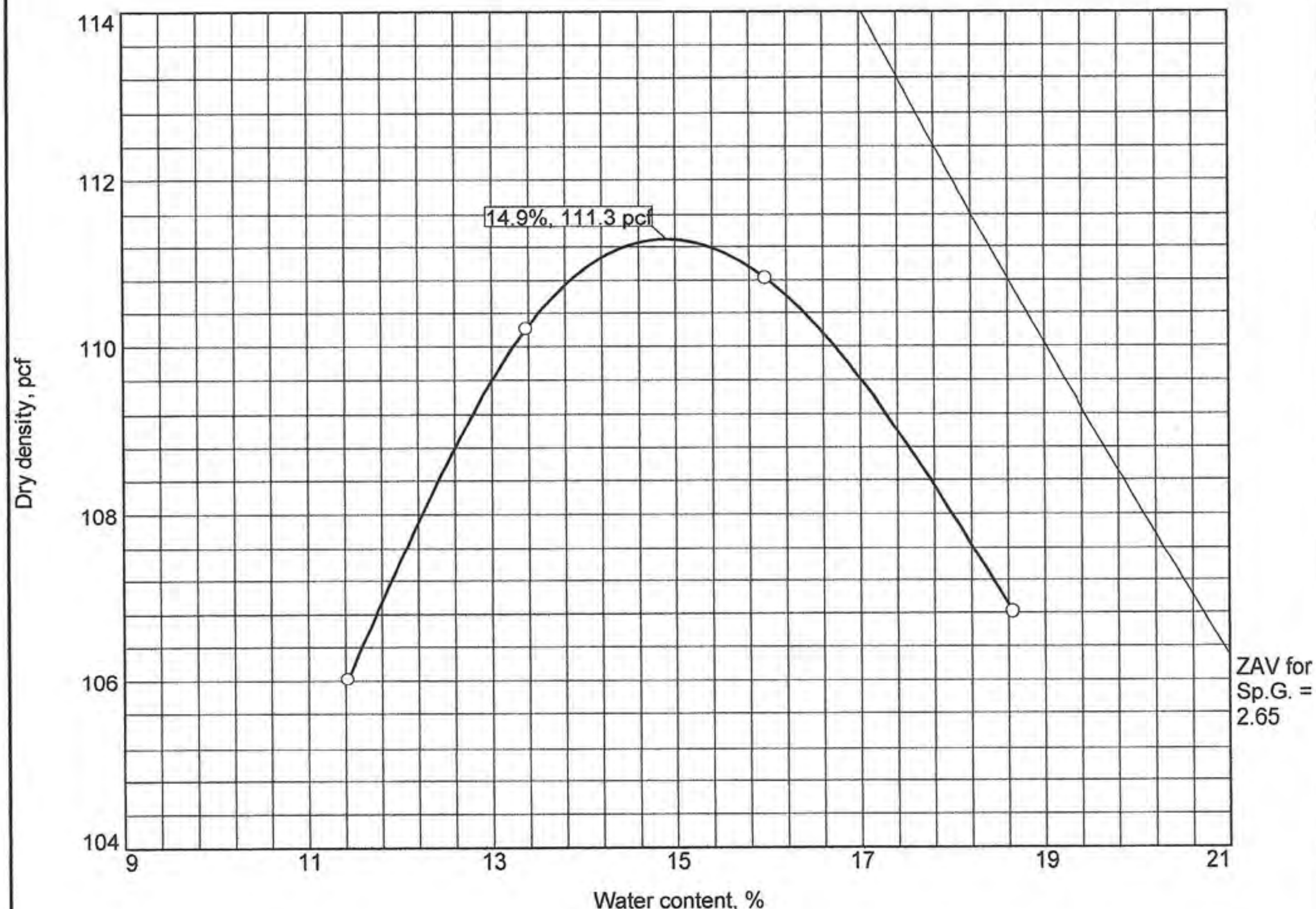
Client: Tensar
Project: Higley and Elliot Pavement Reconstruction
Project No: 1381 **Figure**

Tested By: NS

COMPACTION TEST REPORT



Test specification: ASTM D 698-12 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	CL	A-6(8)		2.650	40	22	8.3	51.5

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 111.3 pcf Optimum moisture = 14.9 %	Subgrade (two buckets)

Project No. 1381 **Client:** Tensar

Project: Higley and Elliot Pavement Reconstruction

○**Source of Sample:** Higley and Elliot Subgrade **Sample Number:** 1

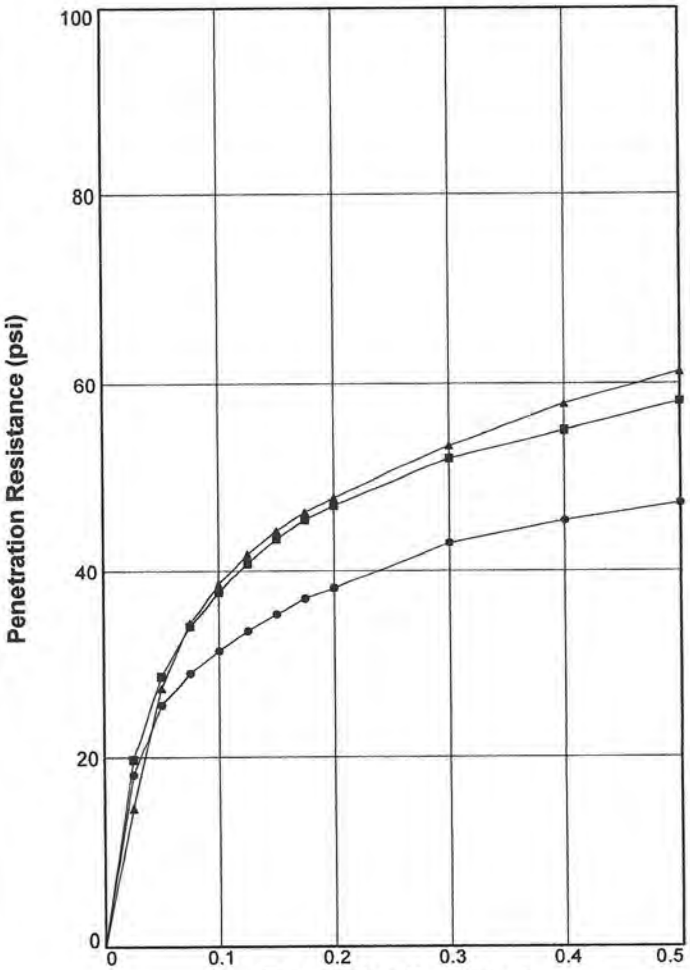
Remarks:

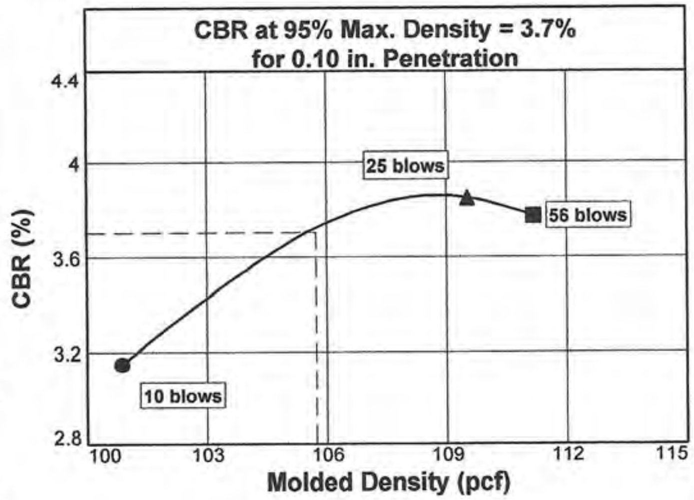
CMT ENGINEERING LABORATORIES

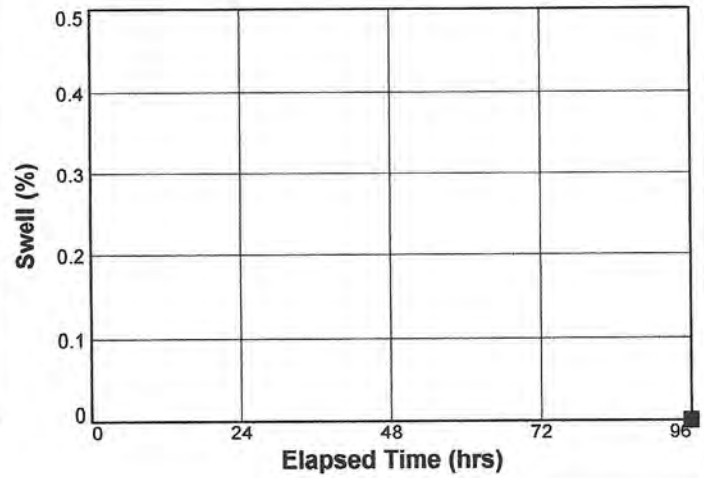
Figure

Tested By: NS

BEARING RATIO TEST REPORT
ASTM D 1883-99







	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ○	100.9	90.7	17.6	100.9	90.6	17.6	3.1	2.5	0.000	10	0
2 △	109.5	98.4	16.7	109.5	98.4	18.4	3.9	3.2	0.000	10	0
3 □	111.2	99.9	15.7	111.2	99.9	17.5	3.8	3.1	0.000	10	0

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Subgrade (two buckets)	CL	111.3	14.9	40	22

Project No: 1381

Project: Higley and Elliot Pavement Reconstruction

Source of Sample: Higley and Elliot Subgrade

Sample Number: 1

Date: Oct 30, 2018

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Test Description/Remarks:

Figure ______

R VALUE REPORT

Report Number: 65171234.0002
Service Date: 10/04/18
Report Date: 10/04/18
Task:

Terracon
4685 S Ash Ave, Ste H-4
Tempe, AZ 85282-6767
480-897-8200

Client

CMT Engineering Laboratories
Attn: Meichel Coates
2921 North 30th Ave.
Phoenix, AZ 85017

Project

CMT Engineering Laboratories Materials Testing
Terracon Tempe Lab
Tempe, AZ

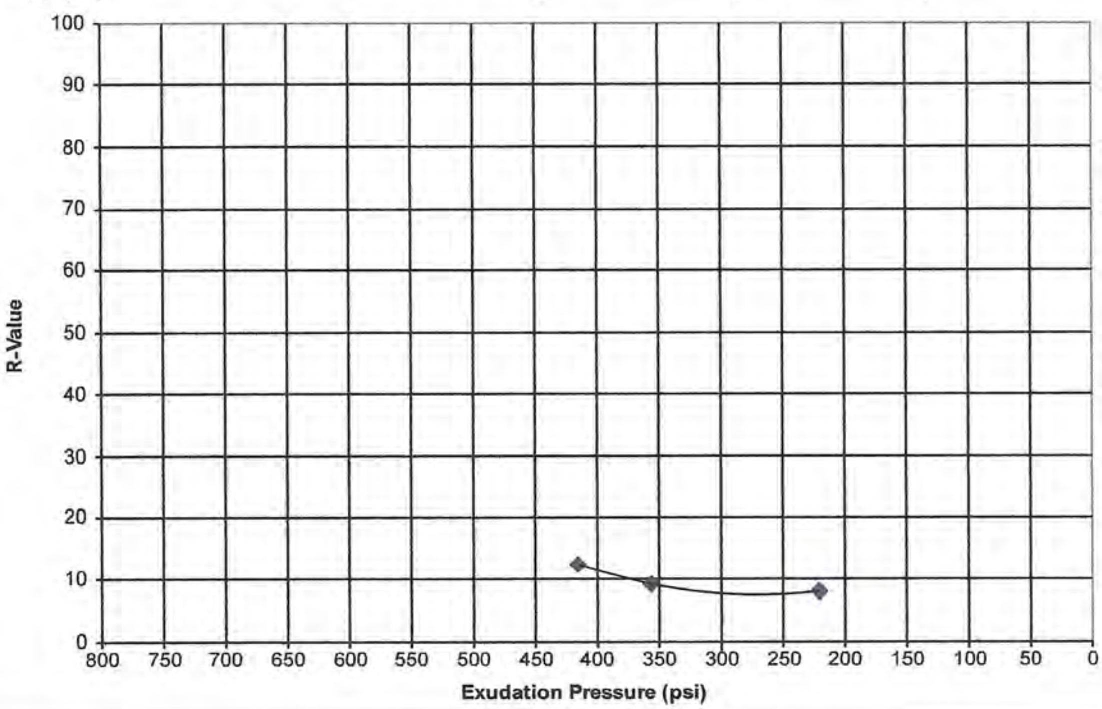
Project No. 65171234

Material Description: Silty Clay w/Sand
Sample Location: CMT Project #1381 - Sample by Client
Lab Number: ###

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (ASTM D2844)

SPECIMEN I. D.	A	B	C
Moisture Content	20.1%	17.5%	16.2%
Compaction Pressure (psi)	*	*	75
Specimen Height (inches)	2.55	2.52	2.49
Dry Density (pcf)	109.9	112.7	115.7
Horiz. Pres. @ 1000lbs (psi)	65.0	60.0	57.0
Horiz. Pres. @ 2000lbs (psi)	140.0	138.0	132.0
Displacement	4.07	3.91	3.68
Expansion Pressure (psi)	0.0	0.0	0.0
Exudation Pressure (psi)	221	356	416
R Value	8	9	13

R-Value: 8



Services:
Terracon Rep:
Reported To:
Contractor:

Report Distribution

(1) CMT Engineering Laboratories,

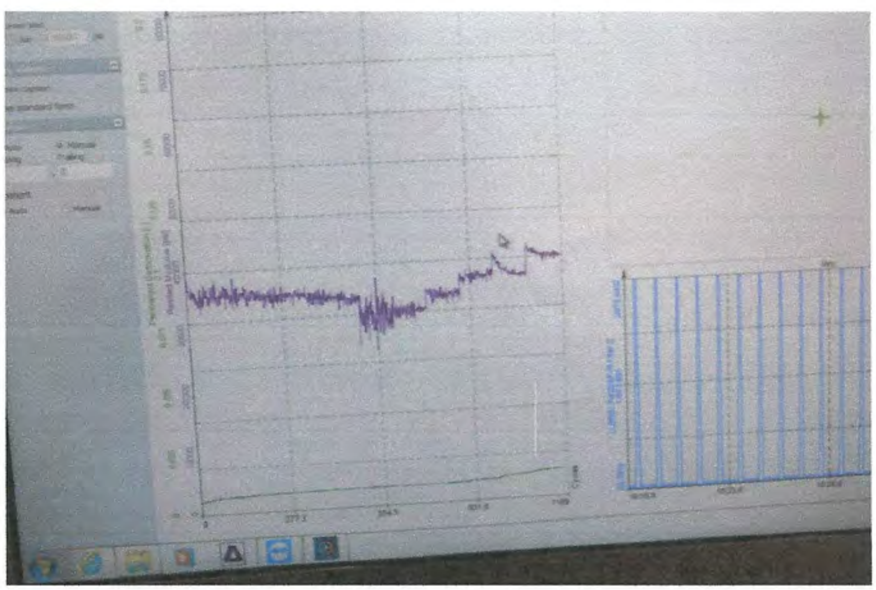
Reviewed By: Cliff Metz
Clifford, Metz
Laboratory Manager

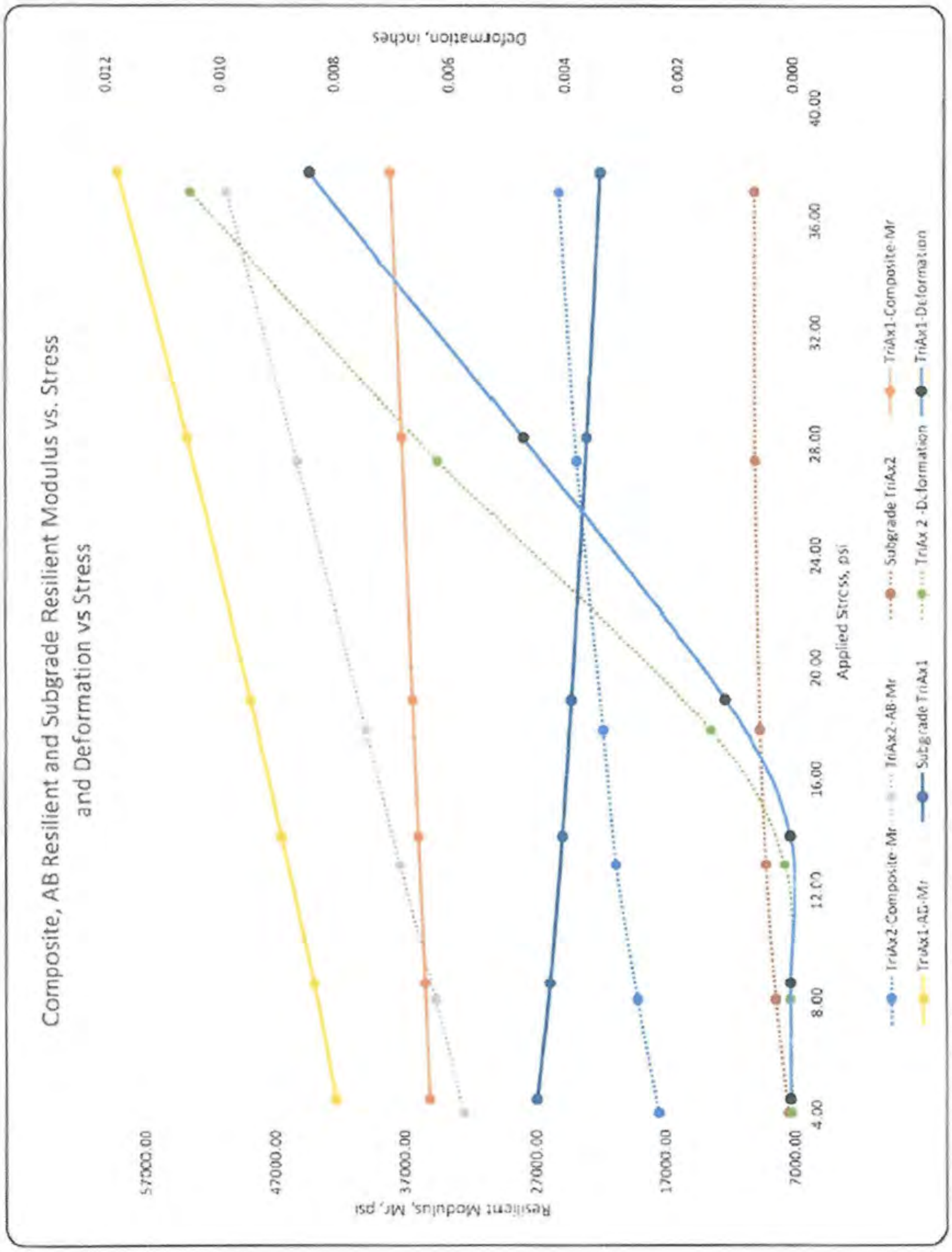
The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

APPENDIX B

APLT GRAPICAL PRESENTATION
DEFORMATION VS STRESS

2.3 Project APLT Testing and Results





AB AND SUBGRADE, RESILIENT MODULUS VS. STRESS

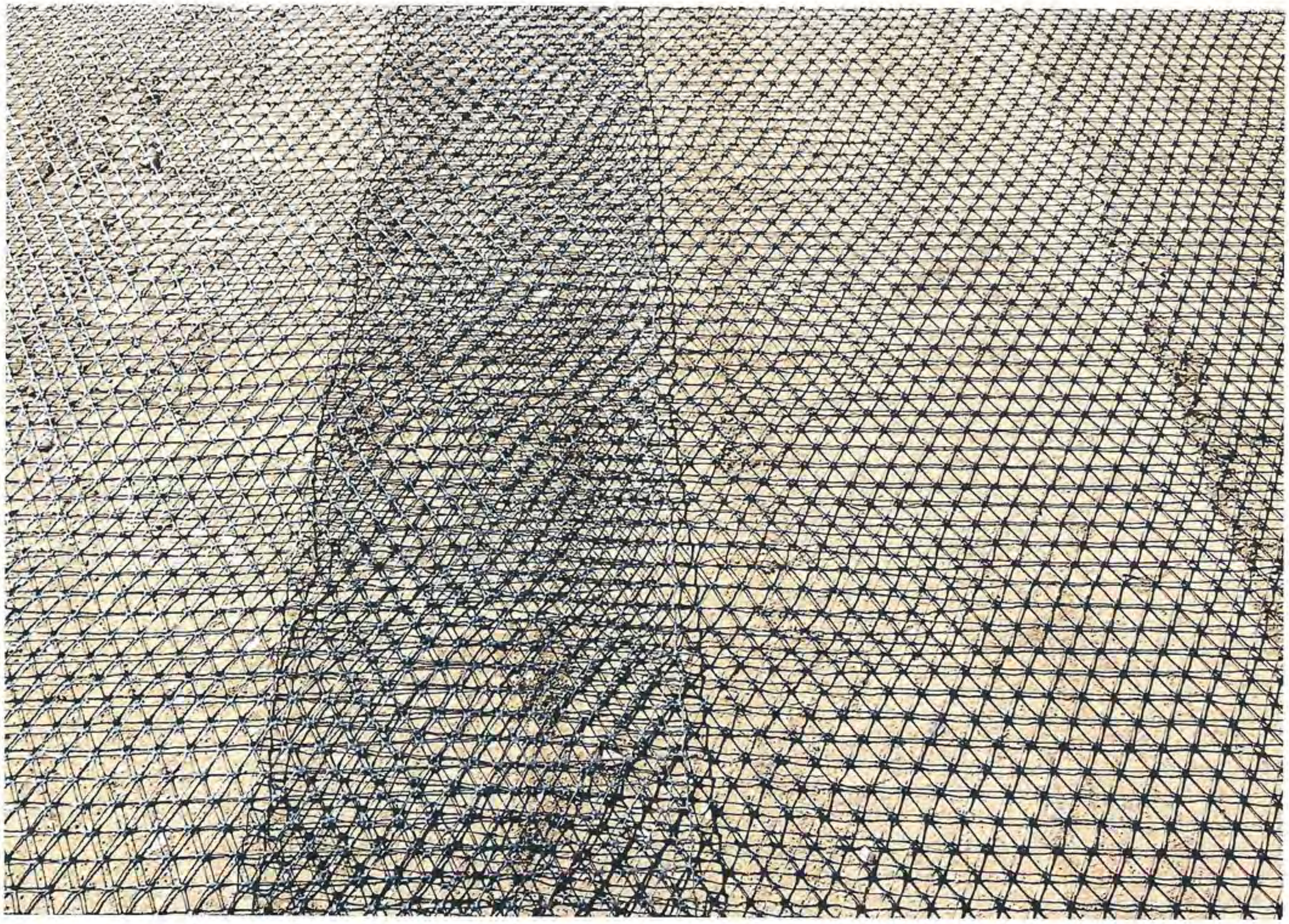
AND

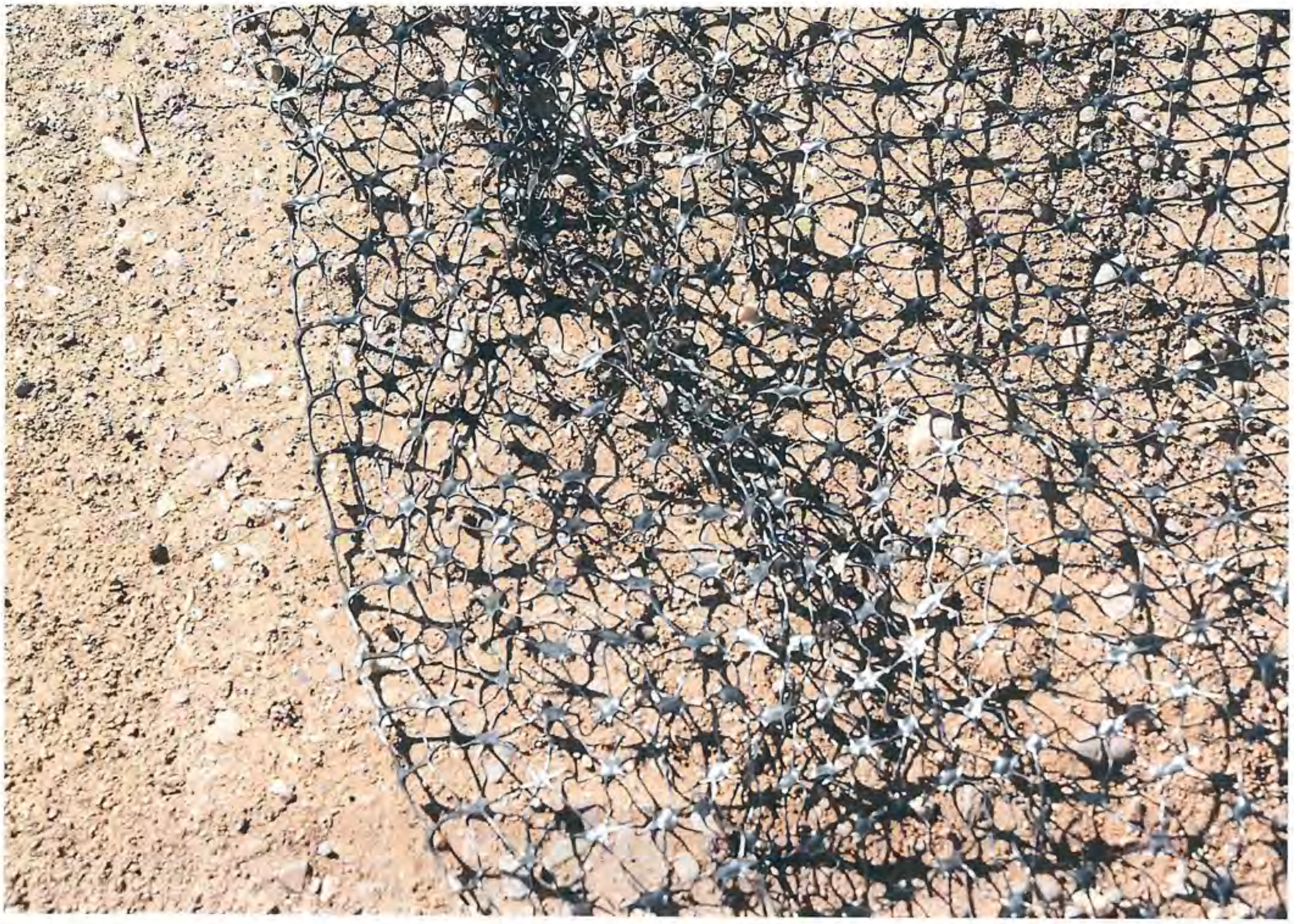
DEFORMATION VS. STRESS

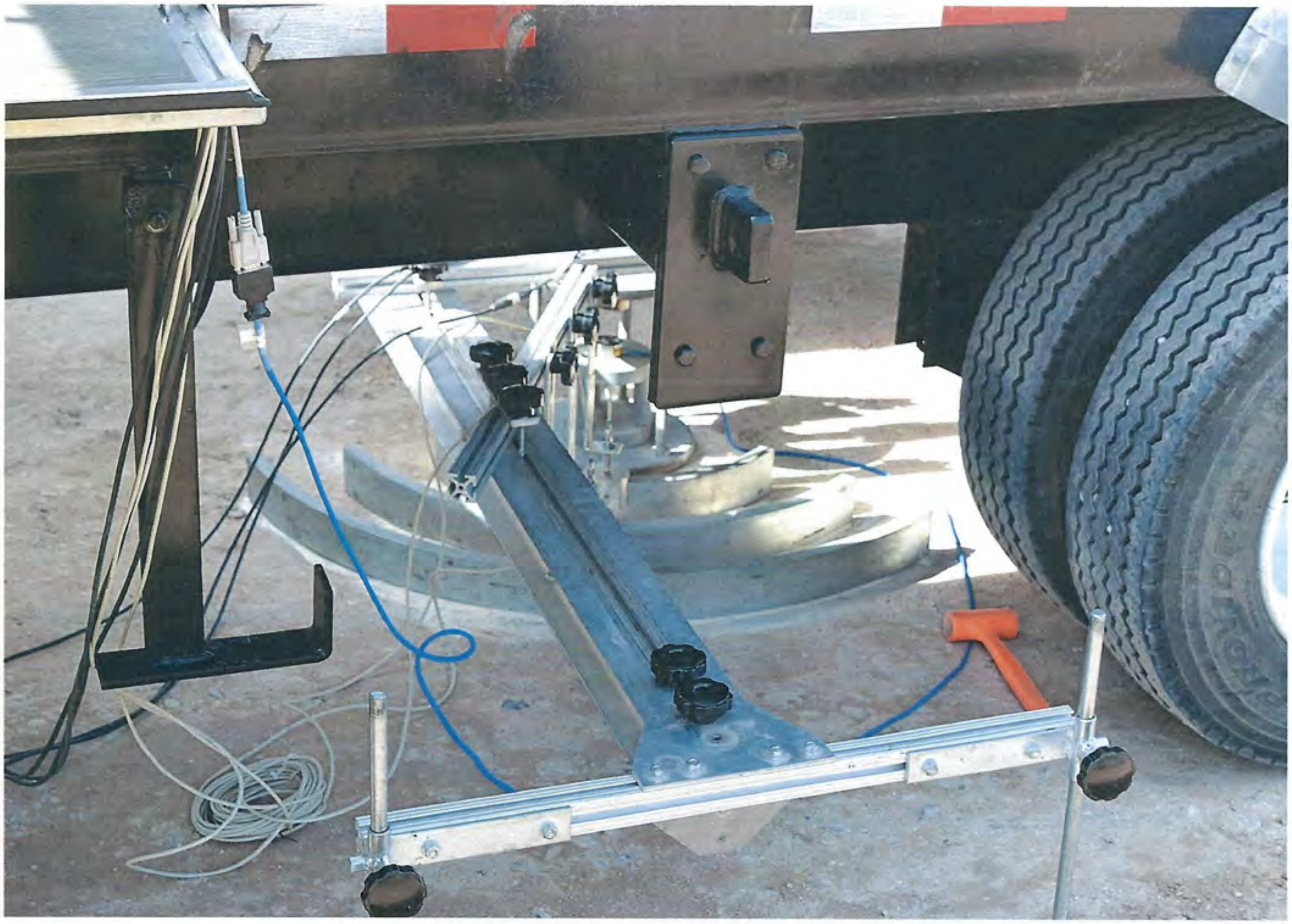
APPENDIX C

GENERAL SITE PHOTOGRAPHS

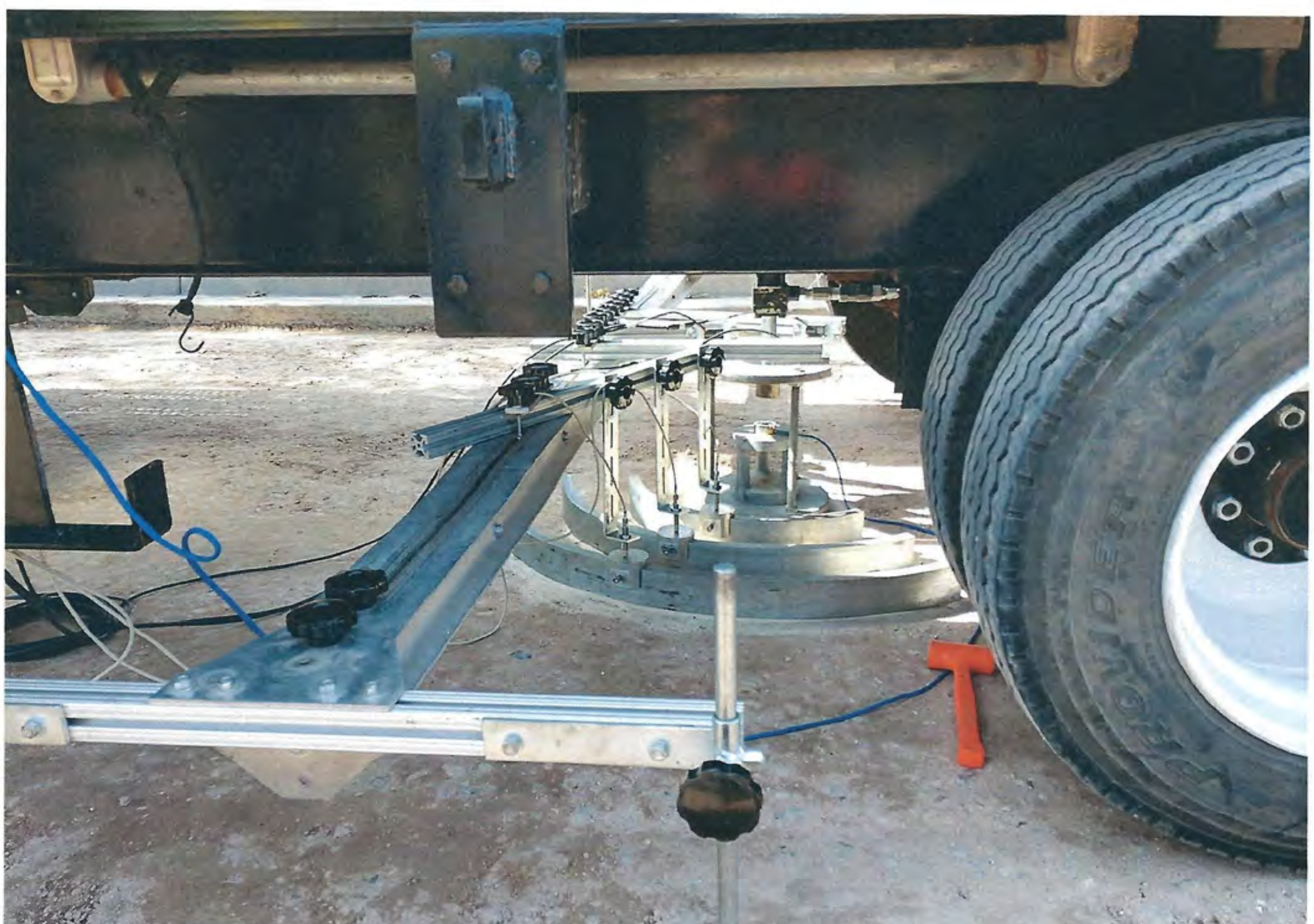

HIGLEY GROVES
at Morrison Ranch








ingios

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GEOTECHNICS
US DOT 2570835
Ford