Geotechnical Engineering Report

In-Place Soil Survey
Interstate 35 over Waterloo Road Interchange
Oklahoma and Logan Counties, Oklahoma
Job Piece No. 29843(04)
Engineering Contract No. EC-1500N

December 6, 2018
Terracon Project No. 03185251

Prepared for:
Garver
Tulsa, Oklahoma

Prepared by:
Terracon Consultants, Inc.
Oklahoma City, Oklahoma

December 6, 2018

Terracon

Garver
6450 South Lewis, Suite 300
Tulsa, Oklahoma 74136

Attn: Ms. Jenny Sallee
P: [918] 858 4166
E: jesallee@garverusa.com

Re: Geotechnical Engineering Report
In-Place Soil Survey
Interstate 35 over Waterloo Road Interchange
Oklahoma and Logan Counties, Oklahoma
Job Piece No. 29843(04)
Engineering Contract No. EC-1500N
Terracon Project No. 03185251

Dear Ms. Sallee:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. The scope of our services was outlined in the Geotechnical Scope of Work Revision 2 (Terracon Proposal No. P03165261) dated August 16, 2016.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.
Cert. Of Auth. #CA-4531 exp. 6/30/19

Kristi Deason

for Diana Vargas-Suaza, E.I.
Consultant

LICENSED PROFESSIONAL ENGINEER
NORMAN TAN
12/6/18
23083
OKLAHOMA

Norman Tan, P.E.
Oklahoma No. 23083

DCVS\NT\kd\n:\projects\2018\03185251\project documents\dec2018

Copies to: Addressee (1 via email)

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INTERSTATE 35 OVER
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1.0 INTRODUCTION

The in-place soil survey services performed for the pavement tie-ins of I-35 mainline, Waterloo Road, Sooner Road, Boucher Drive, Industrial Boulevard and Air Depot Boulevard in Oklahoma and Logan Counties, Oklahoma have been completed. The results of the borings and diagrams showing their approximate locations are included in this report. This report discusses the data collection methods and presents the data collected.

2.0 PROJECT INFORMATION

The project is located near the Interstate 35 and Waterloo Road interchange in Oklahoma and Logan Counties, Oklahoma. The roadway project will include the reconstruction of approximately 1.3 miles of I-35 on its existing alignment, widening of Waterloo Road between Sooner Road and Air Depot Boulevard to accommodate a three-to-five lane roadway, the reconstruction of approximately 0.3 miles of Sooner Road, the reconstruction of approximately 500 feet of Boucher Drive, the reconstruction of Industrial Boulevard on a new alignment and the reconstruction of approximately 0.1 miles of North Air Depot Boulevard along the existing alignment.

3.0 DATA COLLECTION AND FINDINGS

3.1 Pavement Cores

Twelve pavement cores were collected for this project at locations as shown on Exhibits A-1 to A-7 - Boring Location Plans of Appendix A. Cores were cut with a diamond bit rotary core drill.

An engineer examined the pavement cores in the laboratory to evaluate the thickness of each pavement layer. The cores were observed for the presence of voids, separation, fabrics, the

lack of fines, weathering of the pavement and stripping of asphaltic materials. These observations are recorded on the core logs included in Exhibits A-8 to A-19 in Appendix A.

3.2 Subgrade Borings

After coring the pavement as previously noted, disturbed subgrade samples of the pavement subgrade soils were collected using a hand auger. The borings were augured to depths of approximately 36 inches below the bottom of the pavement. Classification tests were performed on selected representative subgrade soils from the core locations. The subsurface profiles are shown on the In-Place Soil Survey Table in Exhibit A-20. The soil samples collected from the borings were sealed and returned to the laboratory for testing.

Three representative bulk samples were obtained in the field. The bulk samples were tested for Atterberg Limits and sieve analysis. The bulk samples were also tested for standard Proctor moisture-density and resilient modulus. The Atterberg Limits and sieve analysis test results for the bulk samples and the standard Proctor moisture-density and resilient modulus test results for the selected two bulk samples are included in Appendices A and B. A brief description of the USCS classification system is included in Appendix C.

COMPOSITE SAMPLES					
Sample Designation	**Source Material**	**Maximum Unit Weight & Optimum Moisture AASHTO T-99**	**Percent Finer than No.200 Sieve**	**Atterberg Limits (LL/PI)**	**AASHTO Classification**
Bulk C-5	C-5 (14 1/8” – 50 1/8”)	117/11.4	24.8	NP/NP	A-2-4(0)
Bulk C-6	C-6 (11" – 60“)	116.9/13.5	62.3	33/20	A-6(9)
Bulk C-7	C-7 (13 3/8” – 49 3/8”)	120.2/11.6	74.8	27/13	A-6(7)

Subgrade soils encountered in the borings generally consist of various shades of red and brown, soil type A-2-4, A-4 and A-6 extending to the boring termination depths of approximately 36 inches below the pavement.

After collecting the pavement subgrade soils, the core locations in the drive lanes were backfilled with similar materials.

4.0 GENERAL COMMENTS

The results presented in this report are based upon the data obtained from the pavement cores and borings performed at the indicated locations and from any other information discussed in this report. This report does not reflect any variations which may occur between cores or borings or across the site. The nature and extent of such variations may not become evident until construction. If variations appear, it will be necessary to reevaluate the recommendations of this report.

The scope of services for this project does not include either specifically or by implication any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed, and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied are intended or made. In the event that any changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon Consultants, Inc. reviews the changes, and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION

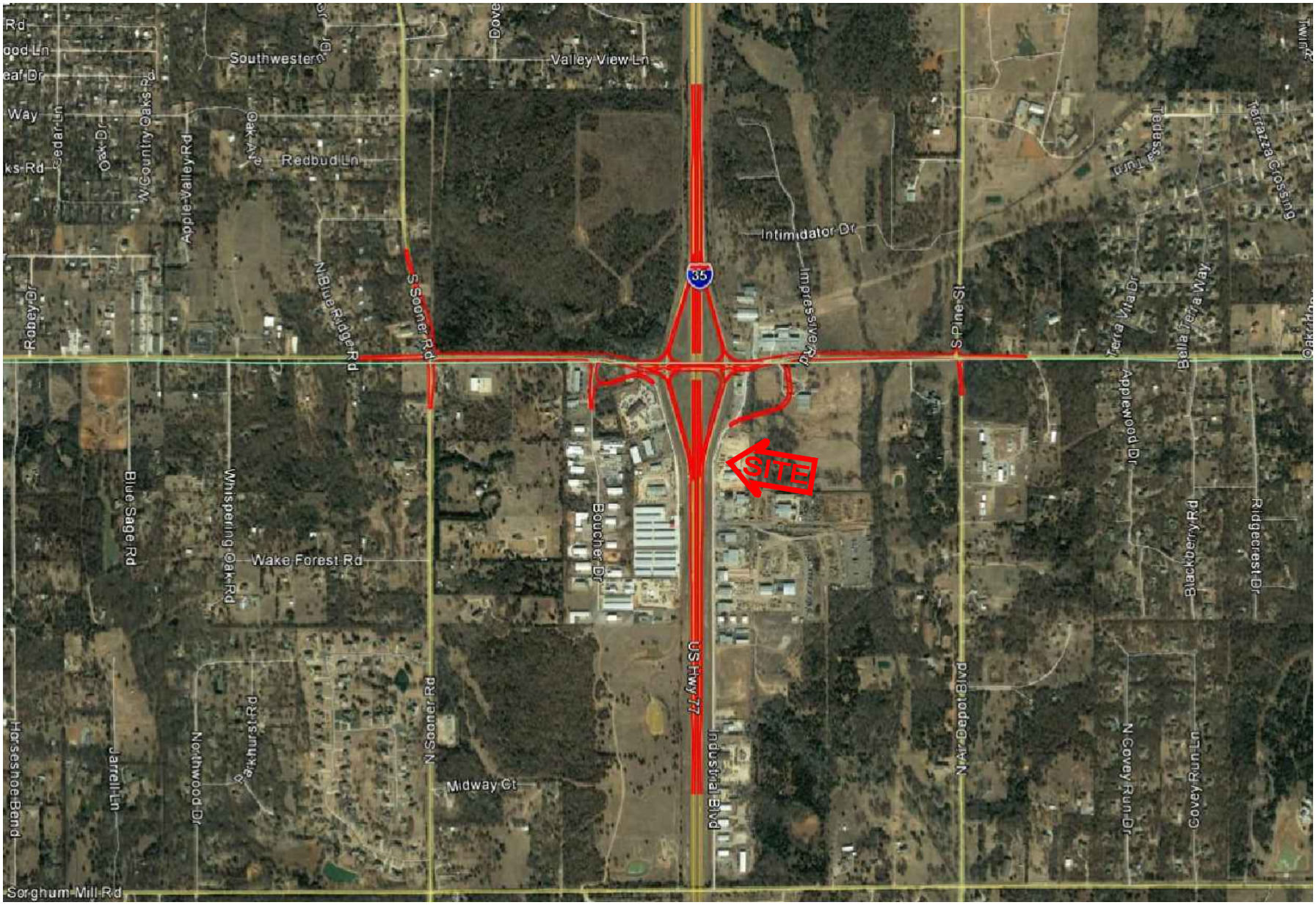


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

Project Mngr: DCVS	Project No. 03185251
Drawn By: CAN	Scale: NTS
Checked By: DCVS	File No. 03185251 (A1-A7)
Approved By: NKT	Date: DEC 2018

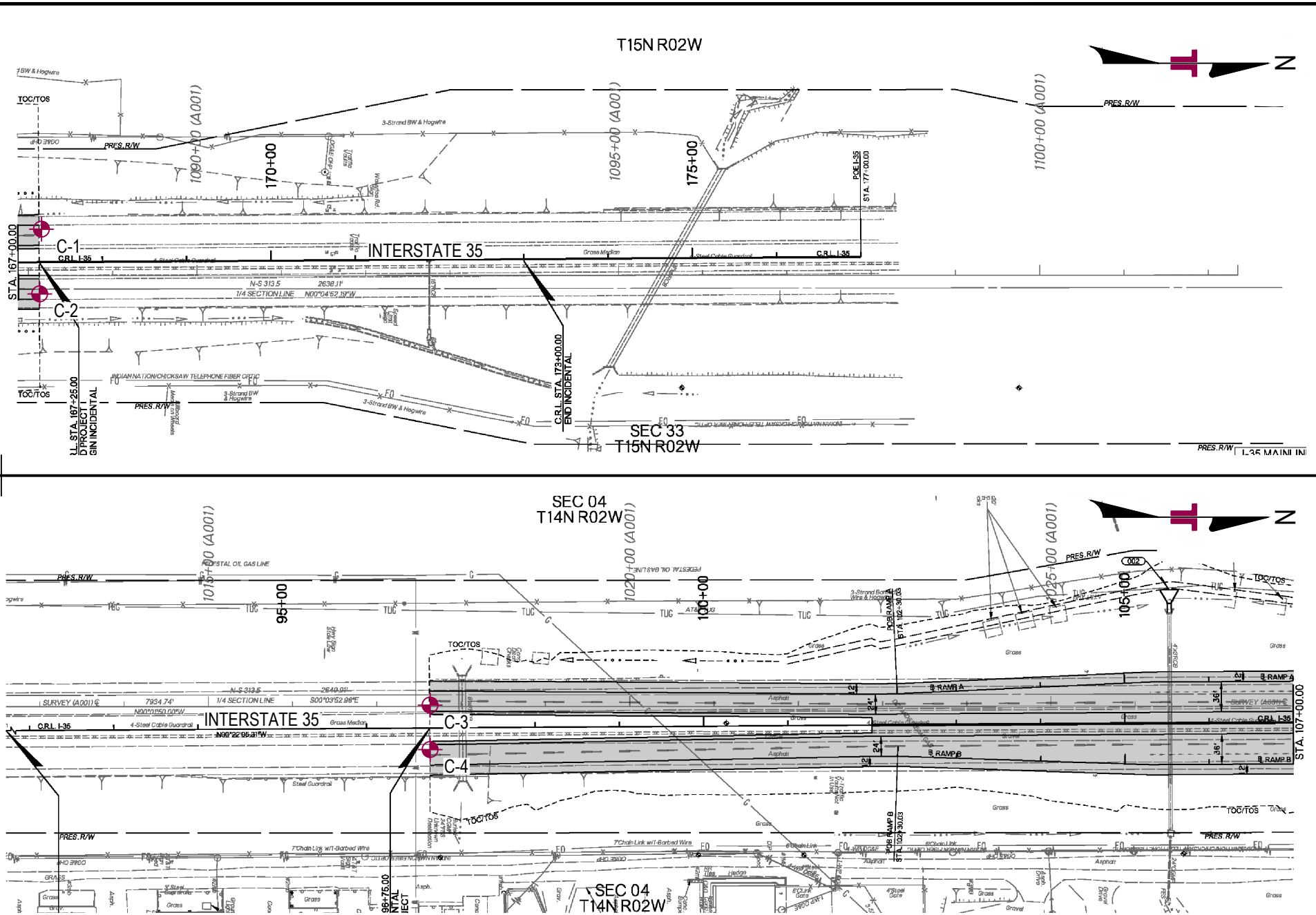
Terracon
Consulting Engineers and Scientists
4701 N STILES AVE OKLAHOMA CITY, OKLAHOMA 73105
PH. (405) 525-0453 FAX. (405) 557-0549

SITE LOCATION PLAN

IN-PLACE SOIL SURVEY
INTERSTATE 35 AND WATERLOO ROAD INTERCHANGE
LOGAN AND OKLAHOMA COUNTIES, OKLAHOMA

EXHIBIT

A1



LEGEND

BORING LOCATION

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES.

Project Mngr:	DCVS
Drawn By:	CAN
Checked By:	DCVS
Approved By:	NKT

Project No.	03185251
Scale:	NTS
File No.	03175251 (A1-A7)
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BORING LOCATION PLAN

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INTERSTATE 35 AND WATERLOO ROAD INTERCHANGE
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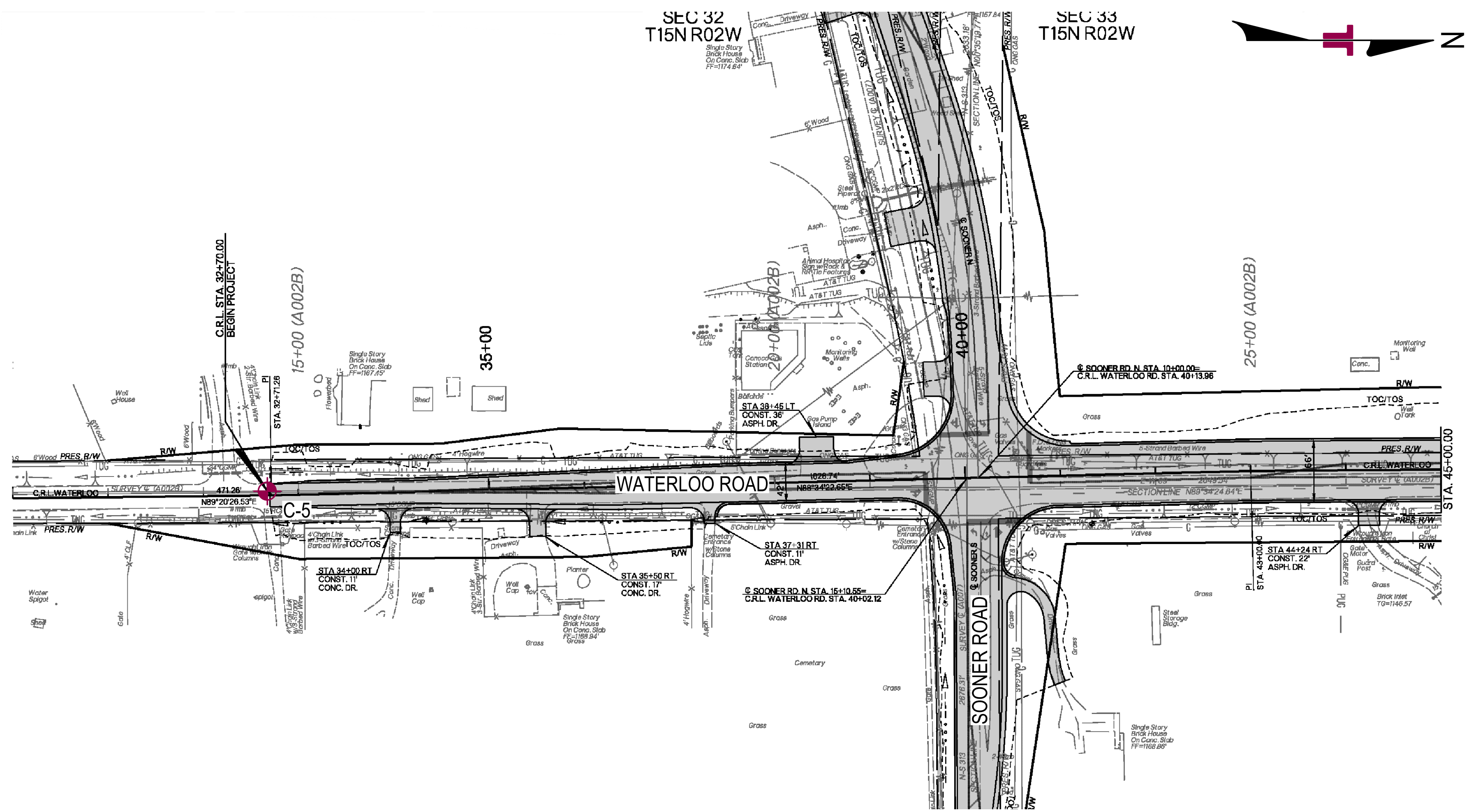
EXHIBIT

A2



LEGEND

BORING LOCATION

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Checked By:	DCVS	File No.	03175251 (A1-A7)
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BORING LOCATION PLAN

IN-PLACE SOIL SURVEY
INTERSTATE 35 AND WATERLOO ROAD INTERCHANGE
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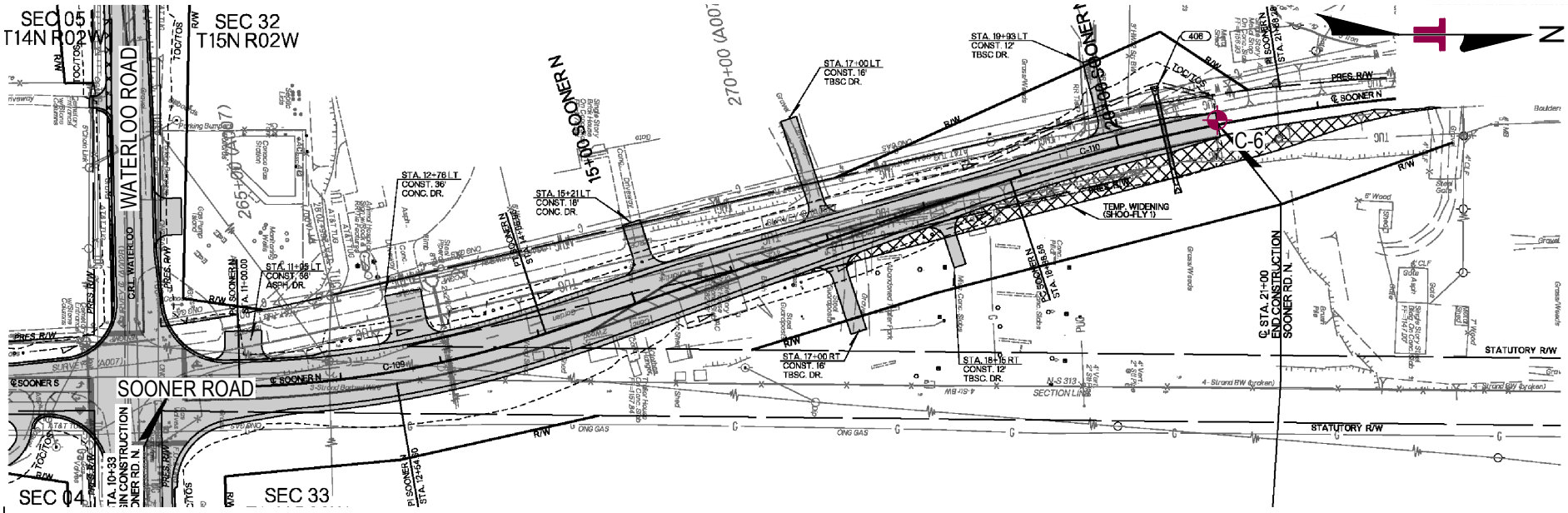
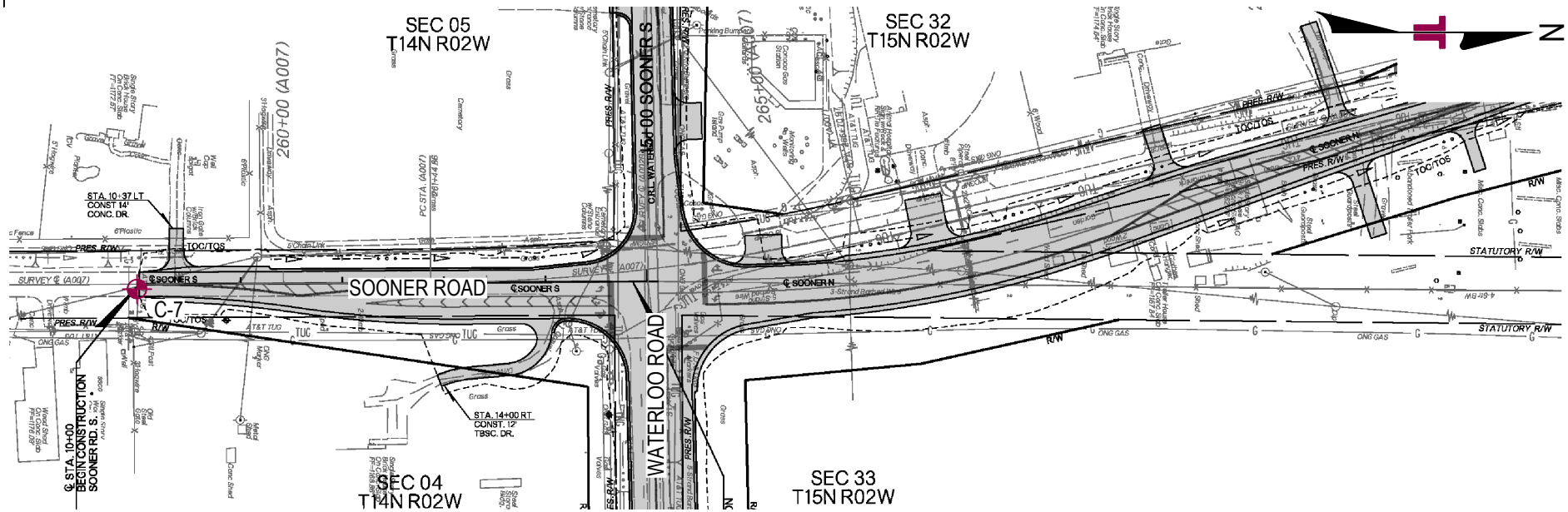
EXHIBIT

A3





LEGEND

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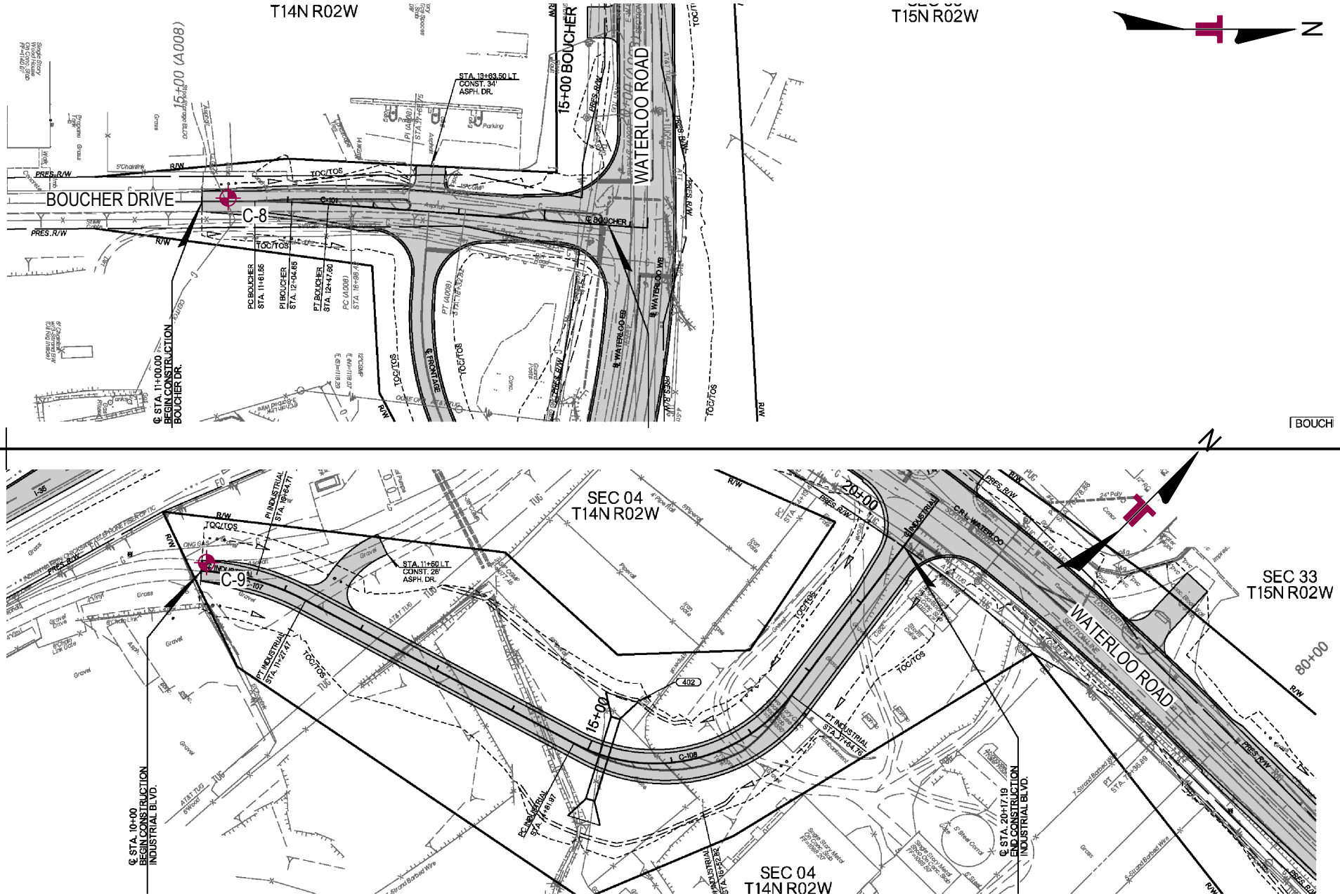
BORING LOCATION PLAN

IN-PLACE SOIL SURVEY
INTERSTATE 35 AND WATERLOO ROAD INTERCHANGE
LOGAN AND OKLAHOMA COUNTIES, OKLAHOMA

EXHIBIT

A4



LEGEND

BORING LOCATION

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BORING LOCATION PLAN

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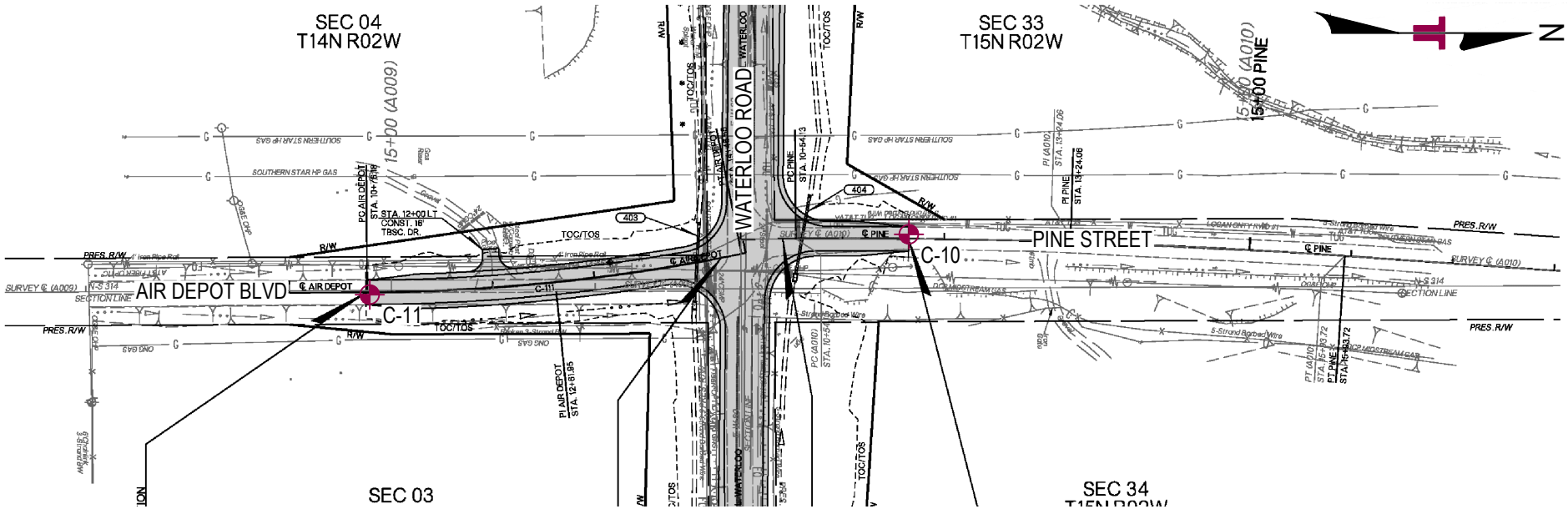
EXHIBIT

A5



LEGEND

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IN-PLACE SOIL SURVEY
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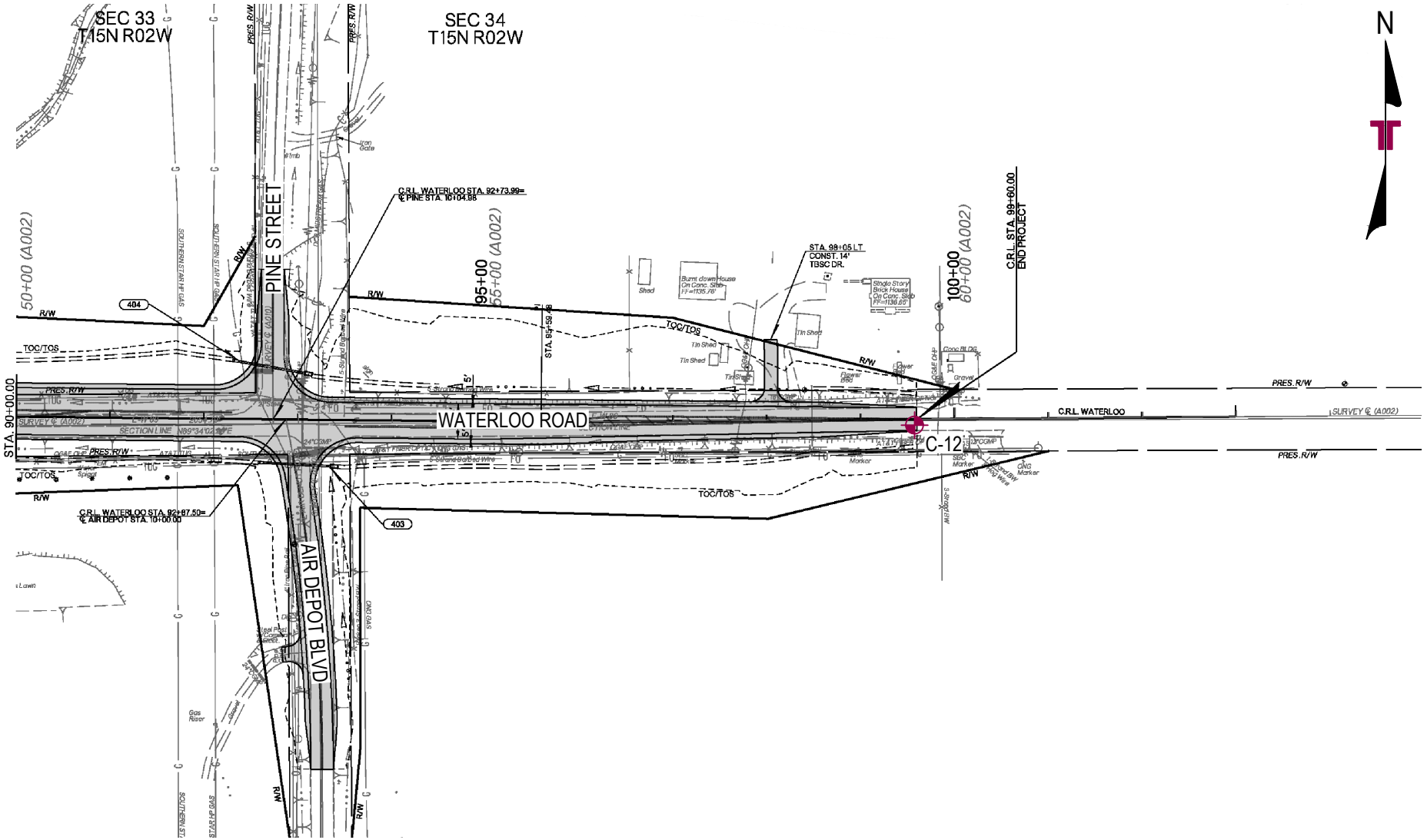
LOGAN AND OKLAHOMA COUNTIES, OKLAHOMA

EXHIBIT

A6



LEGEND

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Drawn By:	CAN
Checked By:	DCVS
Approved By:	NKT

Project No.	03185251
Scale:	NTS
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BORING LOCATION PLAN

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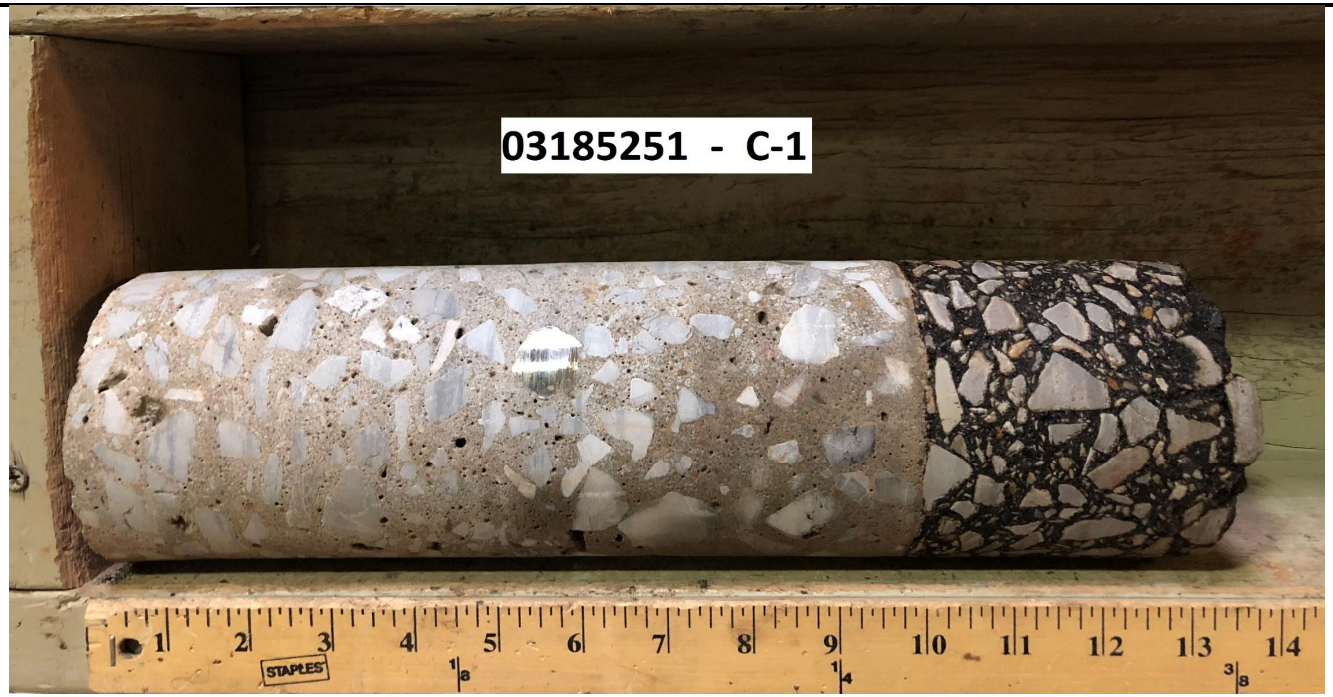
LOGAN AND OKLAHOMA COUNTIES, OKLAHOMA

EXHIBIT

A7

TOP



Terracon

CORE LOG

CORE NUMBER	C-1
DATE CORED	10/23/2018
LOCATION	Interstate 35
	Logan County, Oklahoma
STATION	167+28
LANE DIRECTION	Southbound
OFFSET	39 ft LT

CORE LAYER DATA (FROM TOP TO BOTTOM):

Sample No	Layer Type	Layer Thickness (in.)	Layer Characteristics
1	Portland Cement Concrete	9 7/8	
	Asphaltic Concrete	3 5/8	
	Total Core Thickness	**13 1/2**	

CORE DATA

Surface Material Type: ☐ A.C. ☑ P.C.C. ☐ Continuously Reinforced Concrete

Stripping or Separation in Asphalt: ☐ Stripping ☐ Separation ☑ N/A

Honeycomb or "D" Cracking in PCC: ☐ Honeycomb ☐ "D" Cracking ☑ N/A

Stabilized Subgrade Beneath Pavement or Sub-base? ☐ Yes ☑ No ☐ Unknown

Bottom of Boring at 36 inches below bottom of pavement

Water Level Observations

None W.D. None A.B.

TOP

Terracon

CORE LOG

CORE NUMBER	C-2
DATE CORED	10/23/2018
LOCATION	Interstate 35
	Logan County, Oklahoma
STATION	167+26
LANE DIRECTION	Northbound
OFFSET	38 ft RT

CORE LAYER DATA (FROM TOP TO BOTTOM):

Sample No	Layer Type	Layer Thickness (in.)	Layer Characteristics
1	Portland Cement Concrete	9 5/8	
	Asphaltic Concrete	3	
	Total Core Thickness	**12 5/8**	

CORE DATA

Surface Material Type: ☐ A.C. ☑ P.C.C. ☐ Continuously Reinforced Concrete

Stripping or Separation in Asphalt: ☐ Stripping ☐ Separation ☑ N/A

Honeycomb or "D" Cracking in PCC: ☐ Honeycomb ☐ "D" Cracking ☑ N/A

Stabilized Subgrade Beneath Pavement or Sub-base? ☐ Yes ☑ No ☐ Unknown

Bottom of Boring at 36 inches below bottom of pavement

Water Level Observations

None W.D. None A.B.

TOP

Terracon

CORE LOG

CORE NUMBER	C-3
DATE CORED	10/23/2018
LOCATION	Interstate 35
	Oklahoma County, Oklahoma
STATION	96+75
LANE DIRECTION	Southbound
OFFSET	27 ft LT

CORE LAYER DATA (FROM TOP TO BOTTOM):

Sample No	Layer Type	Layer Thickness (in.)	Layer Characteristics
1	Asphaltic Concrete	5 1/4	Separation at 5 1/4
	Asphaltic Concrete	3/4	Reinforcing fabric at 6 inches
	Asphaltic Concrete	1 1/4	
	Portland Cement Concrete	8	
	Total Core Thickness	**15 1/4**	

CORE DATA

Surface Material Type: ☑ A.C. ☐ P.C.C. ☐ Continuously Reinforced Concrete

Stripping or Separation in Asphalt: ☐ Stripping ☑ Separation ☐ N/A

Honeycomb or "D" Cracking in PCC: ☐ Honeycomb ☐ "D" Cracking ☑ N/A

Stabilized Subgrade Beneath Pavement or Sub-base? ☐ Yes ☑ No ☐ Unknown

Bottom of Boring at 36 inches below bottom of pavement

Water Level Observations

None W.D. None A.B.

TOP

Terracon

CORE LOG

CORE NUMBER	C-4
DATE CORED	10/23/2018
LOCATION	Interstate 35
	Oklahoma County, Oklahoma
STATION	96+75
LANE DIRECTION	Northbound
OFFSET	26 ft RT

CORE LAYER DATA (FROM TOP TO BOTTOM):

Sample No	Layer Type	Layer Thickness (in.)	Layer Characteristics
1	Asphaltic Concrete	1 7/8	
	Asphaltic Concrete	2 7/8	
	Asphaltic Concrete	2 1/4	Reinforcing fabric at 7 inches
	Asphaltic Concrete	1 1/4	Separation at 8 1/4
	Portland Cement Concrete	8 3/8	
	Total Core Thickness	**16 5/8**	

CORE DATA

Surface Material Type: ☑ A.C. ☐ P.C.C. ☐ Continuously Reinforced Concrete

Stripping or Separation in Asphalt: ☐ Stripping ☑ Separation ☐ N/A

Honeycomb or "D" Cracking in PCC: ☐ Honeycomb ☐ "D" Cracking ☑ N/A

Stabilized Subgrade Beneath Pavement or Sub-base? ☐ Yes ☑ No ☐ Unknown

Bottom of Boring at 36 inches below bottom of pavement

Water Level Observations

None W.D. None A.B.

TOP

Terracon

CORE LOG

CORE NUMBER	C-5
DATE CORED	10/22/2018
LOCATION	Waterloo Road
	Logan County, Oklahoma
STATION	32+68
LANE DIRECTION	Westbound
OFFSET	4 ft LT

CORE LAYER DATA (FROM TOP TO BOTTOM):

Sample No	Layer Type	Layer Thickness (in.)	Layer Characteristics
1	Asphaltic Concrete	1 3/4	
	Asphaltic Concrete	1 1/2	Separation at 3 1/4
	Asphaltic Concrete	2 3/8	
	Asphaltic Concrete	1 1/2	
	Aggregate Base	7	
	Total Core Thickness	**14 1/8**	

CORE DATA

Surface Material Type: ☑ A.C. ☐ P.C.C. ☐ Continuously Reinforced Concrete

Stripping or Separation in Asphalt: ☑ Stripping ☑ Separation ☐ N/A

Honeycomb or "D" Cracking in PCC: ☐ Honeycomb ☐ "D" Cracking ☑ N/A

Stabilized Subgrade Beneath Pavement or Sub-base? ☐ Yes ☑ No ☐ Unknown

Bottom of Boring at 36 inches below bottom of pavement

Water Level Observations

None W.D. None A.B.

TOP

Terracon

CORE LOG

CORE NUMBER	C-6
DATE CORED	10/22/2018
LOCATION	Sooner Road
	Logan County, Oklahoma
STATION	21+00
LANE DIRECTION	Southbound
OFFSET	6 ft LT

CORE LAYER DATA (FROM TOP TO BOTTOM):

Sample No	Layer Type	Layer Thickness (in.)	Layer Characteristics
1	Asphaltic Concrete	2 1/2	
	Asphaltic Concrete	2	Reinforcing fabric at 4 1/2 inches
	Asphaltic Concrete	3/4	
	Portland Cement Concrete	5 3/4	
	Total Core Thickness	**11**	

CORE DATA

Surface Material Type: ☑ A.C. ☐ P.C.C. ☐ Continuously Reinforced Concrete

Stripping or Separation in Asphalt: ☐ Stripping ☐ Separation ☑ N/A

Honeycomb or "D" Cracking in PCC: ☐ Honeycomb ☐ "D" Cracking ☑ N/A

Stabilized Subgrade Beneath Pavement or Sub-base? ☐ Yes ☑ No ☐ Unknown

Bottom of Boring at 36 inches below bottom of pavement

Water Level Observations

None W.D. None A.B.

TOP

Terracon

CORE LOG

CORE NUMBER	C-7
DATE CORED	10/22/2018
LOCATION	Sooner Road
	Oklahoma County, Oklahoma
STATION	9+97
LANE DIRECTION	Northbound
OFFSET	5 ft RT

CORE LAYER DATA (FROM TOP TO BOTTOM):

Sample No	Layer Type	Layer Thickness (in.)	Layer Characteristics
1	Asphaltic Concrete	2	
	Asphaltic Concrete	1 1/2	Separation at 3 1/2
	Asphaltic Concrete	1 3/8	Separation at 4 7/8
	Brick	3	Separation at 7 3/4
	Portland Cement Concrete	5 1/2	
	Total Core Thickness	**13 3/8**	

CORE DATA

Surface Material Type: ☑ A.C. ☐ P.C.C. ☐ Continuously Reinforced Concrete

Stripping or Separation in Asphalt: ☐ Stripping ☑ Separation ☐ N/A

Honeycomb or "D" Cracking in PCC: ☐ Honeycomb ☐ "D" Cracking ☑ N/A

Stabilized Subgrade Beneath Pavement or Sub-base? ☐ Yes ☑ No ☐ Unknown

Bottom of Boring at 36 inches below bottom of pavement

Water Level Observations

None W.D. None A.B.

TOP

Terracon

CORE LOG

CORE NUMBER	C-8
DATE CORED	10/23/2018
LOCATION	Boucher Drive
	Oklahoma County, Oklahoma
STATION	11+30
LANE DIRECTION	Southbound
OFFSET	4 ft LT

CORE LAYER DATA (FROM TOP TO BOTTOM):

Sample No	Layer Type	Layer Thickness (in.)	Layer Characteristics
1	Asphaltic Concrete	3 1/2	
	Asphaltic Concrete	2 1/2	
	Total Core Thickness	**6**	

CORE DATA

Surface Material Type: ☑ A.C. ☐ P.C.C. ☐ Continuously Reinforced Concrete

Stripping or Separation in Asphalt: ☑ Stripping ☐ Separation ☑ N/A

Honeycomb or "D" Cracking in PCC: ☐ Honeycomb ☐ "D" Cracking ☑ N/A

Stabilized Subgrade Beneath Pavement or Sub-base? ☐ Yes ☑ No ☐ Unknown

Bottom of Boring at 36 inches below bottom of pavement

Water Level Observations

None W.D. None A.B.

TOP

Terracon

CORE LOG

CORE NUMBER	C-9
DATE CORED	10/22/2018
LOCATION	Industrial Boulevard
	Oklahoma County, Oklahoma
STATION	10+05
LANE DIRECTION	Southbound
OFFSET	10 ft LT

CORE LAYER DATA (FROM TOP TO BOTTOM):

Sample No	Layer Type	Layer Thickness (in.)	Layer Characteristics
1	Asphaltic Concrete	1 1/2	
	Sand Asphalt	1 7/8	
	Total Core Thickness	**3 3/8**	

CORE DATA

Surface Material Type: ☑ A.C. ☐ P.C.C. ☐ Continuously Reinforced Concrete

Stripping or Separation in Asphalt: ☐ Stripping ☐ Separation ☑ N/A

Honeycomb or "D" Cracking in PCC: ☐ Honeycomb ☐ "D" Cracking ☑ N/A

Stabilized Subgrade Beneath Pavement or Sub-base? ☐ Yes ☑ No ☐ Unknown

Bottom of Boring at 36 inches below bottom of pavement

Water Level Observations

None W.D. None A.B.

TOP

Terracon

CORE LOG

CORE NUMBER	C-10
DATE CORED	10/24/2018
LOCATION	Pine Street
	Logan County, Oklahoma
STATION	11+65
LANE DIRECTION	Southbound
OFFSET	8 ft LT

CORE LAYER DATA (FROM TOP TO BOTTOM):

Sample No	Layer Type	Layer Thickness (in.)	Layer Characteristics
1	Asphaltic Concrete	3 1/8	
	Total Core Thickness	**3 1/8**	

CORE DATA

Surface Material Type: ☑ A.C. ☐ P.C.C. ☐ Continuously Reinforced Concrete

Stripping or Separation in Asphalt: ☐ Stripping ☐ Separation ☑ N/A

Honeycomb or "D" Cracking in PCC: ☐ Honeycomb ☐ "D" Cracking ☑ N/A

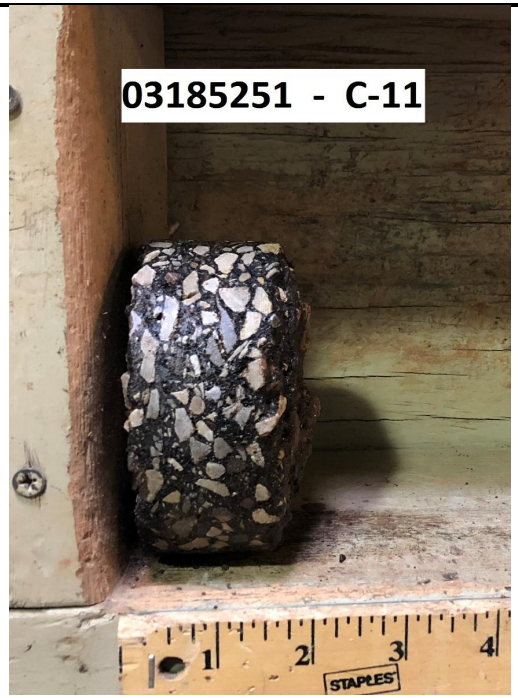
Stabilized Subgrade Beneath Pavement or Sub-base? ☐ Yes ☑ No ☐ Unknown

Bottom of Boring at 36 inches below bottom of pavement

Water Level Observations

None W.D. None A.B.

TOP



Terracon

CORE LOG

CORE NUMBER	C-11
DATE CORED	10/24/2018
LOCATION	Air Depot Boulevard
	Oklahoma County, Oklahoma
STATION	10+78
LANE DIRECTION	Northbound
OFFSET	8 ft RT

CORE LAYER DATA (FROM TOP TO BOTTOM):

Sample No	Layer Type	Layer Thickness (in.)	Layer Characteristics
1	Asphaltic Concrete	1 3/4	
	Total Core Thickness	**1 3/4**	

CORE DATA

Surface Material Type: ☑ A.C. ☐ P.C.C. ☐ Continuously Reinforced Concrete

Stripping or Separation in Asphalt: ☐ Stripping ☐ Separation ☑ N/A

Honeycomb or "D" Cracking in PCC: ☐ Honeycomb ☐ "D" Cracking ☑ N/A

Stabilized Subgrade Beneath Pavement or Sub-base? ☐ Yes ☑ No ☐ Unknown

Bottom of Boring at 36 inches below bottom of pavement

Water Level Observations

None W.D. None A.B.

TOP

Terracon

CORE LOG

CORE NUMBER	C-12
DATE CORED	10/24/2018
LOCATION	Waterloo Road
	Logan County, Oklahoma
STATION	99+58
LANE DIRECTION	Eastbound
OFFSET	6 ft RT

CORE LAYER DATA (FROM TOP TO BOTTOM):

Sample No	Layer Type	Layer Thickness (in.)	Layer Characteristics
1	Asphaltic Concrete	1 7/8	
	Asphaltic Concrete	2 1/8	
	Asphaltic Concrete	1 1/4	
	Asphaltic Concrete	1 3/4	
	Asphaltic Concrete	1 1/2	Not pictured
	Total Core Thickness	**8 1/2**	

CORE DATA

Surface Material Type: ☑ A.C. ☐ P.C.C. ☐ Continuously Reinforced Concrete

Stripping or Separation in Asphalt: ☐ Stripping ☐ Separation ☑ N/A

Honeycomb or "D" Cracking in PCC: ☐ Honeycomb ☐ "D" Cracking ☑ N/A

Stabilized Subgrade Beneath Pavement or Sub-base? ☐ Yes ☑ No ☐ Unknown

Bottom of Boring at 36 inches below bottom of pavement

Water Level Observations

None W.D. None A.B.

Surveyed By: Terracon Consultants, Inc. **In-Place Soil Survey** **Terracon Project No.: 03185251**

Client: Garver, Tulsa, Oklahoma **Project: I-35 and Waterloo Road Interchange**

Date Surveyed: 10/22, 10/23 & 10/24 **EC-1500N** **Job Piece No. 29843(04)**

Location: Oklahoma and Logan Counties, Oklahoma

Field No.	Direction	Description	Depth (in)	L.L.	P.I.	Percent Passing						AASHTO	OSI	M.C. (%)
						3 in.	3/4 in.	#4	#10	#40	#200			
C-1; S-1	Southbound Station 167+28	Portland Cement Concrete	0 - 9 7/8											
		Asphaltic Concrete	9 7/8 - 13 1/2											
C-1; S-2	Offset: 39 Ft. LT	Similar as C-2; S-2, red (2.5YR 4/6)	13 1/2 - 43 1/2											12
C-1; S-3	I-35 Oustide Lane	Lean clay (CL), red (2.5YR 4/6)	43 1/2 - 49 1/2	36	21	100	100	99	97	95	90.8	A-6 (18)	16.0	12
C-2; S-1	Northbound Station 167+26	Portland Cement Concrete	0 - 9 5/8											
		Asphaltic Concrete	9 5/8 - 12 5/8											
C-2; S-2	Offset: 38 Ft. RT	Clayey sand (SC), red (10R 4/6)	12 5/8 - 42 1/2	22	9	100	96	88	85	79	33.3	A-2-4(0)	2.0	11
C-2; S-3	I-35 Outside Lane	Similar as C-1; S-3, red (10R 5/8)	42 1/2 - 48 1/2											10
C-3; S-1	Southbound Station 96+75	Asphaltic Concrete	0 - 7 1/4											
		Portland Cement Concrete	7 1/4 - 15 1/4											
C-3; S-2	Offset: 27 Ft. LT	Similar as C-2, S-2, weak red (7.5R 4/4)	15 1/4 - 45											13
C-3; S-3	I-35 Inside Lane	Sandy lean clay (CL), weak red (10R 4/4)	45 - 51 1/4	29	14	100	100	100	99	99	50.3	A-6 (4)	8.0	13
C-4; S-1	Northbound Station 96+75	Asphaltic Concrete	0 - 8 1/4											
		Portland Cement Concrete	8 1/4 - 16 5/8											
C-4; S-2	Offset: 26 Ft. RT	Similar as C-4, S-3, weak red (10R 4/4)	16 5/8 - 45											16
C-4; S-3	I-35 Inside Lane	Clayey sand (SC), weak red (10R 4/4) & red (7.5R 5/6)	45 - 52 5/8	20	8	100	100	96	94	92	50.0	A-4 (1)	4.0	13
C-5; S-1	Westbound Station 32+68	Asphaltic Concrete	0 - 7 1/8											
		Aggregate base, brown (7.5YR 4/2) & gray (GLEY 1 5/N)	7 1/8 - 14 1/8											4
C-5; S-2	Offset: 4 Ft. LT	Silty sand (SM), weak red (10R 5/4)	14 1/8 - 44	NP	NP	100	100	100	100	98	26.4	A-2-4 (0)	0.0	5
C-5; S-3	Waterloo Road	Similar as C-5; S-2, light red (10R 6/8)	44 - 50 1/8											5
Bulk C-5		**Silty sand (SM), light red (10R 6/8) & weak red (10R 5/4)**	14 1/8 - 50 1/8	NP	NP	100	100	91	86	75	24.8	A-2-4 (0)	0.0	
C-6; S-1	Southbound Station 21+00	Asphaltic Concrete	0 - 5 1/4											
		Portland Cement Concrete	5 1/4 - 11											
C-6; S-2	Offset: 6 Ft. LT	Lean clay with sand (CL), reddish brown (5YR 4/4)	11 - 40 1/2											9
C-6; S-3	Sooner Road	Sandy lean clay (CL), red (10R 4/6)	40 1/2 - 47	45	30	100	100	99	99	97	57.7	A-7-6 (14)	21.0	13
Bulk C-6		**Sandy lean clay (CL), red (10R 4/6) & reddish-brown (5YR 4/6)**	11 - 60	33	20	100	100	100	96	90	62.3	A-6 (9)	13.0	
C-7; S-1	Northbound Station 9+97	Asphaltic Concrete	0 - 4 7/8											
		Brick	4 7/8 - 7 7/8											
		Portland Cement Concrete	7 7/8 - 13 3/8											
C-7; S-2	Offset: 5 Ft. RT	Sandy lean clay (CL), red (10R 5/6)	13 3/8 - 43	32	19	100	100	99	96	90	81.5	A-6 (9)	14.0	13
C-7; S-3	Sooner Road	Similar as C-1; S-3, red (10R 5/6)	43 - 49 3/8											13
Bulk C-7		**Lean clay with sand (CL), red (10R 5/6)**	13 3/8 - 49 3/8	27	13	100	100	100	98	95	74.8	A-6 (7)	11.0	
C-8; S-1	Southbound Station 11+30	Asphaltic Concrete	0 - 6											
C-8; S-2	Offset: 4 Ft. LT	Similar as C-8; S-3, dark reddish brown (2.5YR 3/4)	6 - 42											13
C-8; S-3	Boucher Drive	Clayey sand (SC), reddish-brown (2.5YR 4/4)	42 - 48	20	9	100	100	100	100	100	35.7	A-4 (0)	2.0	14

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Exhibit A-20

Surveyed By: Terracon Consultants, Inc. **In-Place Soil Survey** **Terracon Project No.: 03185251**

Client: Garver, Tulsa, Oklahoma **Project: I-35 and Waterloo Road Interchange**

Date Surveyed: 10/22, 10/23 & 10/24 **EC-1500N** **Job Piece No. 29843(04)**

Location: Oklahoma and Logan Counties, Oklahoma

Field No.	Direction	Description	Depth (in)	L.L.	P.I.	Percent Passing						AASHTO	OSI	M.C. (%)
						3 in.	3/4 in.	#4	#10	#40	#200			
C-9; S-1	Southbound Station 10+05	Asphaltic Concrete	0 - 1 1/2											
		Sand asphalt	1 1/2 - 3 3/8											
C-9; S-2	Offset: 10 Ft. LT	Silty sand (SM), weak red (7.5R 4/4)	3 3/8 - 33 1/2	NP	NP	100	100	100	100	100	17.2	A-2-4 (0)	0.0	7
C-9; S-3	Industrial Blvd.	Similar as C-8; S-3, dusky red (5R 3/4)	33 1/2 - 39 3/8											12
C-10; S-1	Southbound Station 11+65	Asphaltic Concrete	0 - 3 1/8											
C-10; S-2	Offset:8 Ft. LT	Similar as C-10; S-3, weak red (10R 5/4)	3 1/8 - 33											2
C-10; S-3	Pine Street	Silty clayey sand with gravel (SC-SM), weak red (10R 4/4)	33 - 39 1/8	20	7	100	92	79	72	69	26.2	A-2-4 (0)	1.0	5
C-11; S-1	Northbound Station 10+78	Asphaltic Concrete	0 - 1 3/4											
C-11; S-2	Offset: 8 Ft. RT	Silty sand (SM), red (2.5YR 4/6)	1 3/4 - 32	NP	NP	100	100	100	99	98	18.0	A-2-4 (0)	0.0	7
C-11; S-3	N Air Depot Blvd.	Similar as C-11; S-2	32 - 37 3/4											7
C-12; S-1	Eastbound Station 99+58	Asphaltic Concrete	0 - 8 1/2											
C-12; S-2	Offset: 6 Ft. RT	Silty sand (SM), red (10R 5/8) & dark brown (7.5YR 3/3)	8 1/2 - 38 1/2	NP	NP	100	100	92	88	83	13.9	A-2-4 (0)	0.0	7
C-12; S-3	Waterloo Road	Similar as C-12; S-2, dusky red (10R 3/2)	38 1/2 - 44 1/2											7

APPENDIX B

LABORATORY TESTING

Laboratory Compaction Characteristics of Soil

Terracon
4701 North Stiles Ave.
Oklahoma City, OK 73105
(405) 525 0453

Client Name: Garver
Project Name: In-Place Soil Survey
Location: I-35 over Waterloo Road Interchange
Oklahoma and Logan Counties

Source Material: Bulk C-5 (14 1/8" - 50 1/8")
Sample Description: Silty sand (SM), red (10R 6/8)
& weak red (10R 5/4)
Material Designation: Lab 652 Sample date: 10/22/18
Test Method: Method A
Test Procedure: AASHTO T-99
Sample Preparation: Dry
Rammer: X Mechanical ____ Manual

Project No.: 03185251 Date: 11/02/18

TEST RESULTS
Maximum Dry Unit Wt.: 117.0 pcf
Optimum Water Content: 11.4 %

Liquid Limit: NP Plastic Limit: NP
Plasticity Index: NP
% passing # 200 sieve: 24.8
AASHTO Class. A-2-4(0) USCS: SM
Reviewed by: DCVS

Zero air voids for specific gravity of 2.60

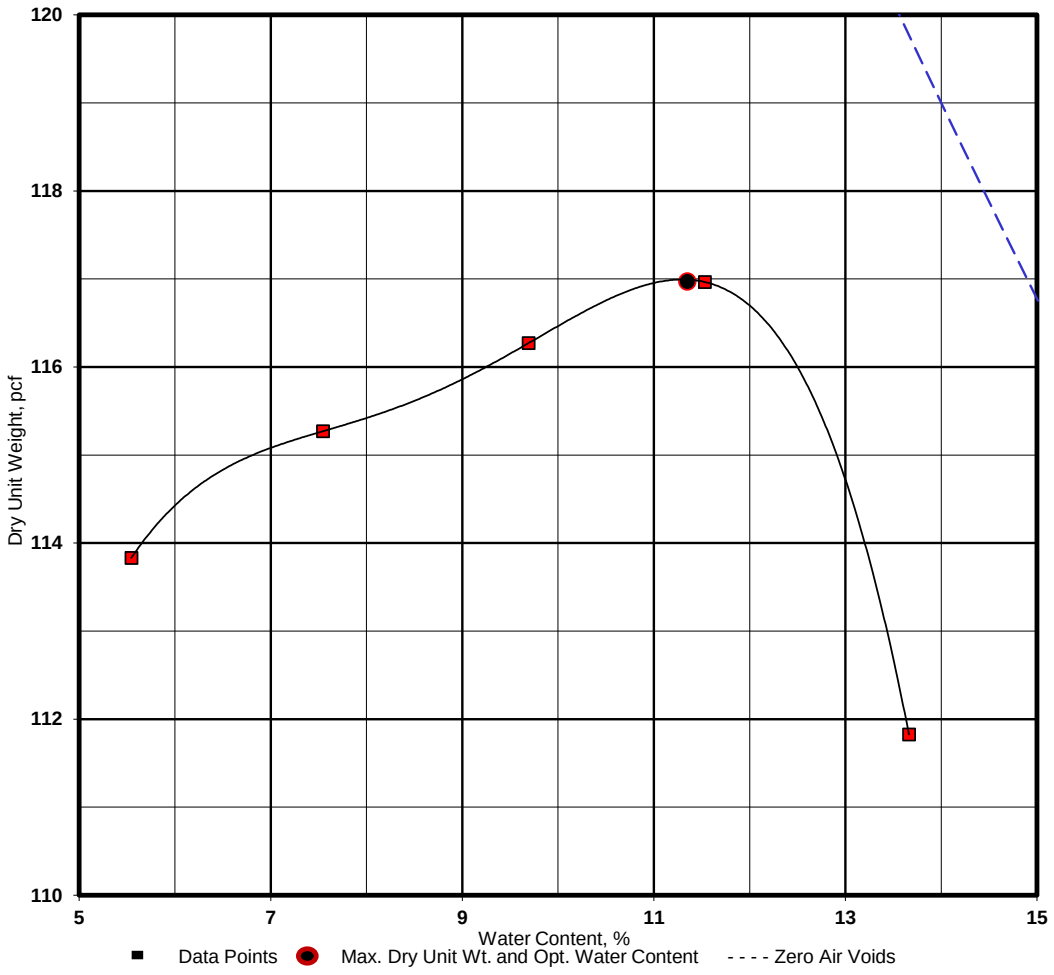


Exhibit B-1

Laboratory Compaction Characteristics of Soil

Terracon
4701 North Stiles Ave.
Oklahoma City, OK 73105
(405) 525 0453

Client Name: Garver
Project Name: In-Place Soil Survey
Location: I-35 over Waterloo Road Interchange
Oklahoma and Logan Counties

Source Material: Bulk C-6 (11"- 60")
Sample Description: Sandy lean clay (CL), red (10R 4/6) & reddish-brown (5YR 4/4)
Material Designation: Lab 653 Sample date: 10/22/18
Test Method: Method A
Test Procedure: AASHTO T-99
Sample Preparation: Dry
Rammer: X Mechanical ___ Manual

Project No.: 03185251 Date: 11/02/18

TEST RESULTS
Maximum Dry Unit Wt.: 116.9 pcf
Optimum Water Content: 13.5 %

Liquid Limit: 33 Plastic Limit: 13
Plasticity Index: 20
% passing # 200 sieve: 62.3
AASHTO Class. A-6(9) USCS: CL
Reviewed by: DCVS

Zero air voids for specific gravity of 2.70

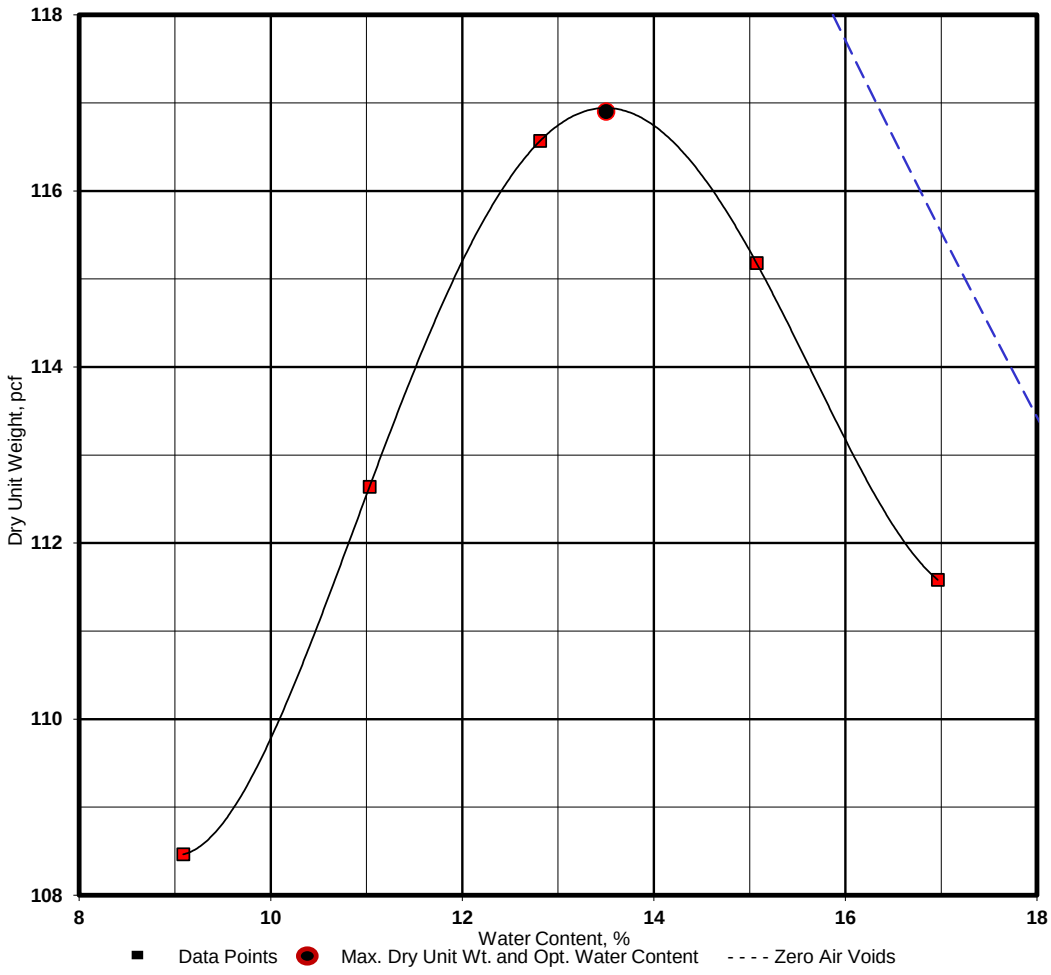


Exhibit B-2

Laboratory Compaction Characteristics of Soil

Terracon
4701 North Stiles Ave.
Oklahoma City, OK 73105
(405) 525 0453

Client Name: Garver
Project Name: In-Place Soil Survey
Location: I-35 over Waterloo Road Interchange
Oklahoma and Logan Counties

Source Material: Bulk C-7 (13 3/8" - 49 3/8")
Sample Description: Lean clay with sand (CL), red (10YR 5/6)

Material Designation: Lab 654 Sample date: 10/22/18
Test Method: Method A
Test Procedure: AASHTO T-99
Sample Preparation: Dry
Rammer: X Mechanical ___ Manual

Project No.: 3185251 Date: 11/02/18

TEST RESULTS
Maximum Dry Unit Wt.: 120.2 pcf
Optimum Water Content: 11.6 %

Liquid Limit: 27 Plastic Limit: 14
Plasticity Index: 13
% passing # 200 sieve: 74.8
AASHTO Class. A-6(7) USCS: CL
Reviewed by: DCVS

Zero air voids for specific gravity of 2.70

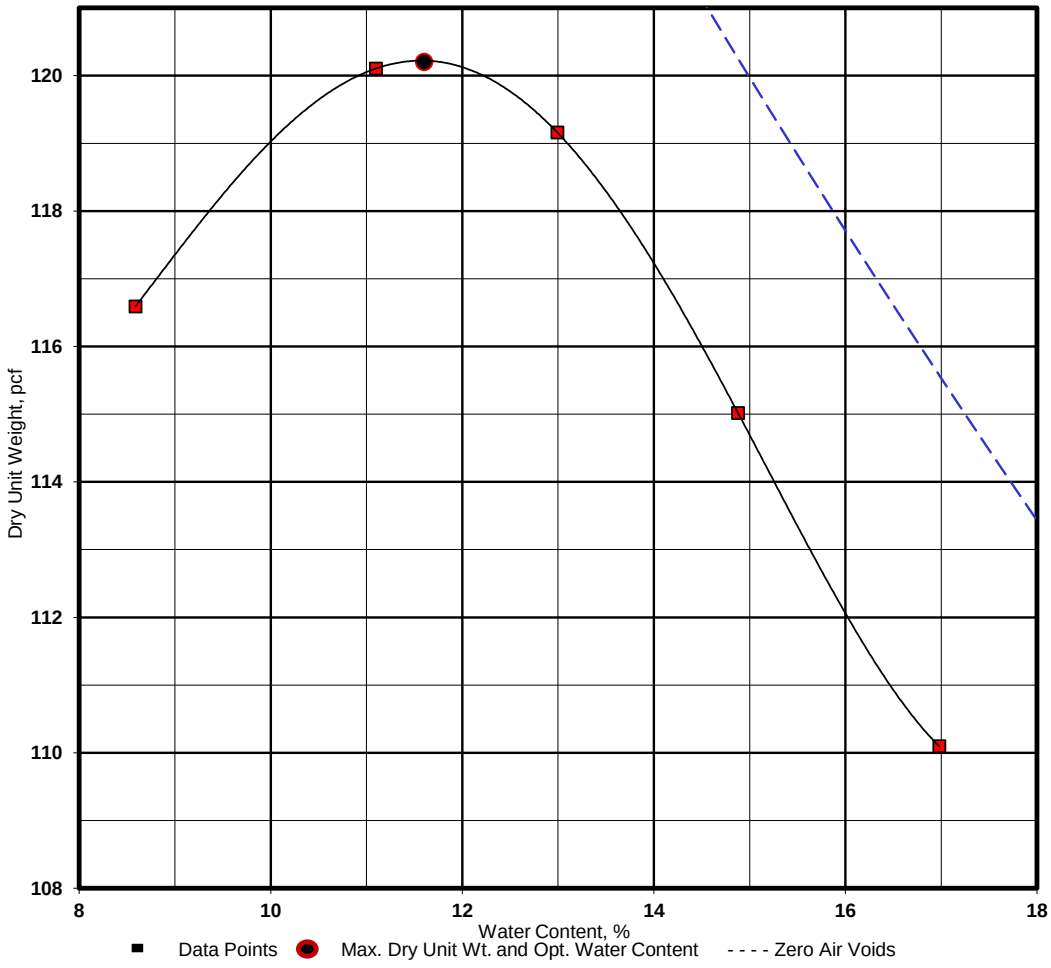


Exhibit B-3

Terracon

Resilient Modulus Testing - AASHTO T 307-99 English Units

Report Date: 6-Dec-18
Lab No.: 03185251 Lab 652 RM 44 omc
Project No.: 03185251

Soil Map Unit:	Bulk C-5 OMC
Soil Symbol:	A-2-4 / SM
Depth (in.)	14 1/8-50 1/8
Compaction Method	Static
Max. Dry Density (pcf)	117.0
Opt. Moisture Content (%)	11.4
Inside Mold Diameter (in)	3.94

Weight of Wet Soil (lb)	6.87
Initial Sample Diameter (in)	3.94
Initial Sample Height (in)	7.87
Initial Sample Area (in^2)	12.17
Sample Volume (in^3)	95.86
Compacted Moisture Content(%)	11.4
Wet Density (pcf)	123.8
Dry Density (pcf)	111.1

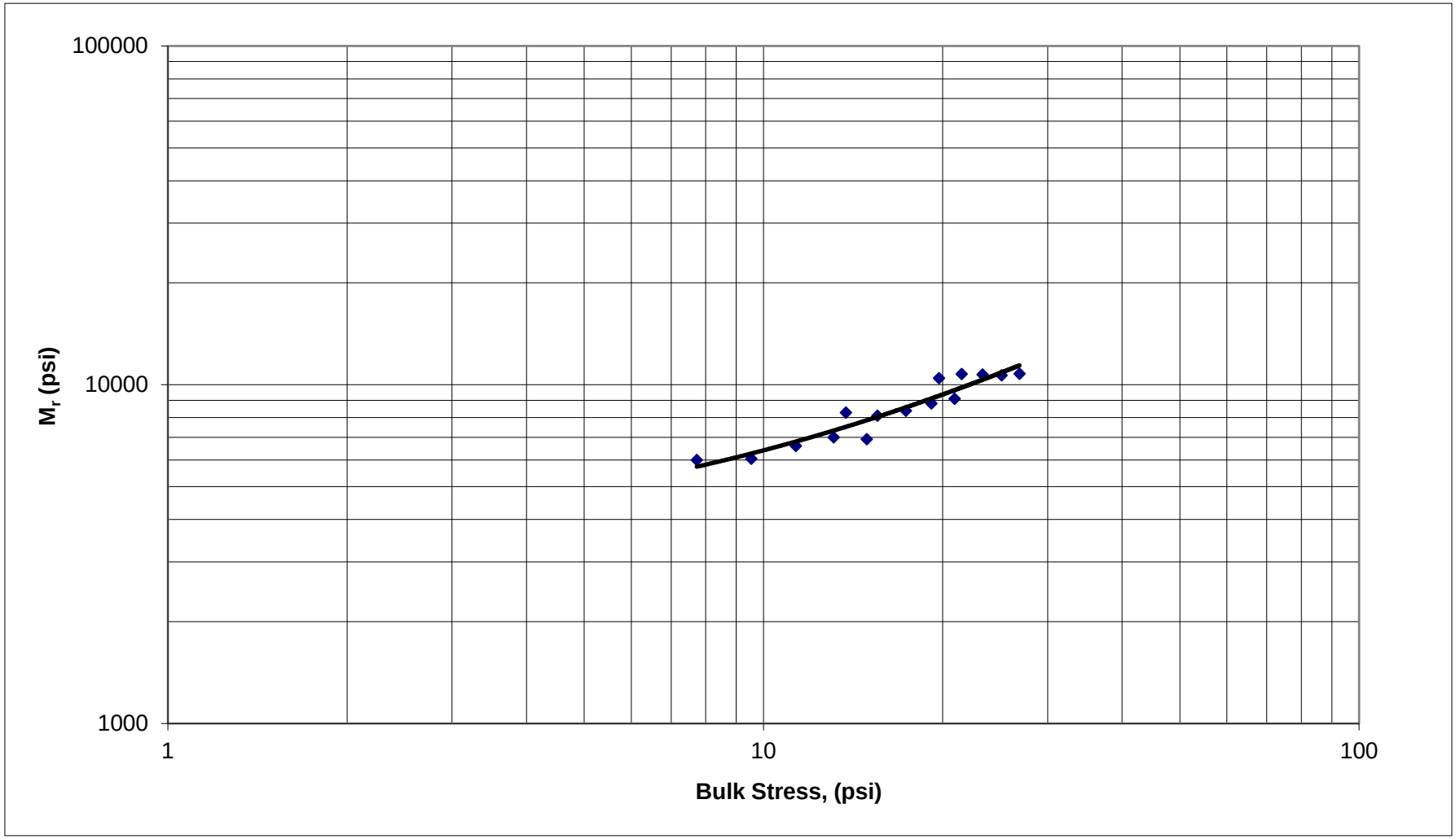
Test Date: November 15, 2018

Final Sample Height (in)	7.8
Final Sample Wet Weight (lb)	6.85
Final Moisture Content (%)	11.3
Accumulated Strain (%)	0.51
Percent Passing No. 10	86
Percent Passing No. 200	24.8
Liquid Limit	NP
Plasticity Index	NP

Chamber Confining Pressure (S_3) psi	Nominal Maximum Axial Stress (S_{cyclic}) psi	Actual Applied Max. Axial Load (P_{max}) lb	Actual Applied Cyclic Load (P_{cyclic}) lb	Actual Applied Contact Load ($P_{contact}$) lb	Actual Applied Max. Axial Stress (S_{max}) psi	Actual Applied Cyclic Stress (S_{cyclic}) psi	Actual Applied Contact Stress ($S_{contact}$) psi	Recov. Def. LVDT #1 Reading (H_1) in	Recov. Def. LVDT #2 Reading (H_2) in	Average Recov. Def. LVDT 1 and 2 (H_{avg}) in	Resilient Strain (ϵ_r) in/in	Resilient Modulus (M_r) psi
6.00	2.00	23.3	20.8	2.5	1.92	1.71	0.208	0.0014	0.0012	0.0013	0.000163	10,458
6.00	4.00	47.4	42.6	4.8	3.90	3.50	0.394	0.0027	0.0024	0.0026	0.000325	10,764
6.00	6.00	72.0	64.6	7.4	5.92	5.31	0.607	0.0041	0.0037	0.0039	0.000495	10,728
6.00	8.00	96.9	86.6	10.3	7.96	7.11	0.848	0.0056	0.0049	0.0053	0.000667	10,656
6.00	10.00	121.3	108.4	12.9	9.96	8.90	1.063	0.0069	0.0061	0.0065	0.000826	10,771
4.01	2.00	24.3	20.9	3.4	2.00	1.72	0.280	0.0017	0.0016	0.0016	0.000207	8,277
4.01	4.00	48.6	42.8	5.9	3.99	3.51	0.482	0.0036	0.0032	0.0034	0.000434	8,104
4.01	6.00	73.0	64.7	8.4	6.00	5.31	0.686	0.0053	0.0047	0.0050	0.000634	8,373
4.01	8.00	97.4	86.5	10.9	8.00	7.11	0.891	0.0067	0.0060	0.0064	0.000807	8,806
4.01	10.00	121.7	108.3	13.4	9.99	8.90	1.097	0.0082	0.0073	0.0077	0.000979	9,089
2.00	2.00	23.9	20.9	3.0	1.96	1.72	0.244	0.0023	0.0022	0.0023	0.000287	5,996
2.00	4.00	48.3	43.0	5.3	3.97	3.53	0.439	0.0048	0.0044	0.0046	0.000584	6,044
2.00	6.00	72.8	64.8	8.0	5.98	5.33	0.657	0.0067	0.0060	0.0064	0.000808	6,591
2.00	8.00	97.1	86.6	10.5	7.97	7.11	0.865	0.0084	0.0076	0.0080	0.001016	6,996
2.00	10.00	121.5	108.4	13.1	9.98	8.90	1.078	0.0107	0.0096	0.0102	0.001290	6,902

Terracon

Date Reported: 12/6/2018 Bulk C-5 OMC
Terracon Lab No. 03185251 Lab 652 RM 44 omc
Project No. 03185251



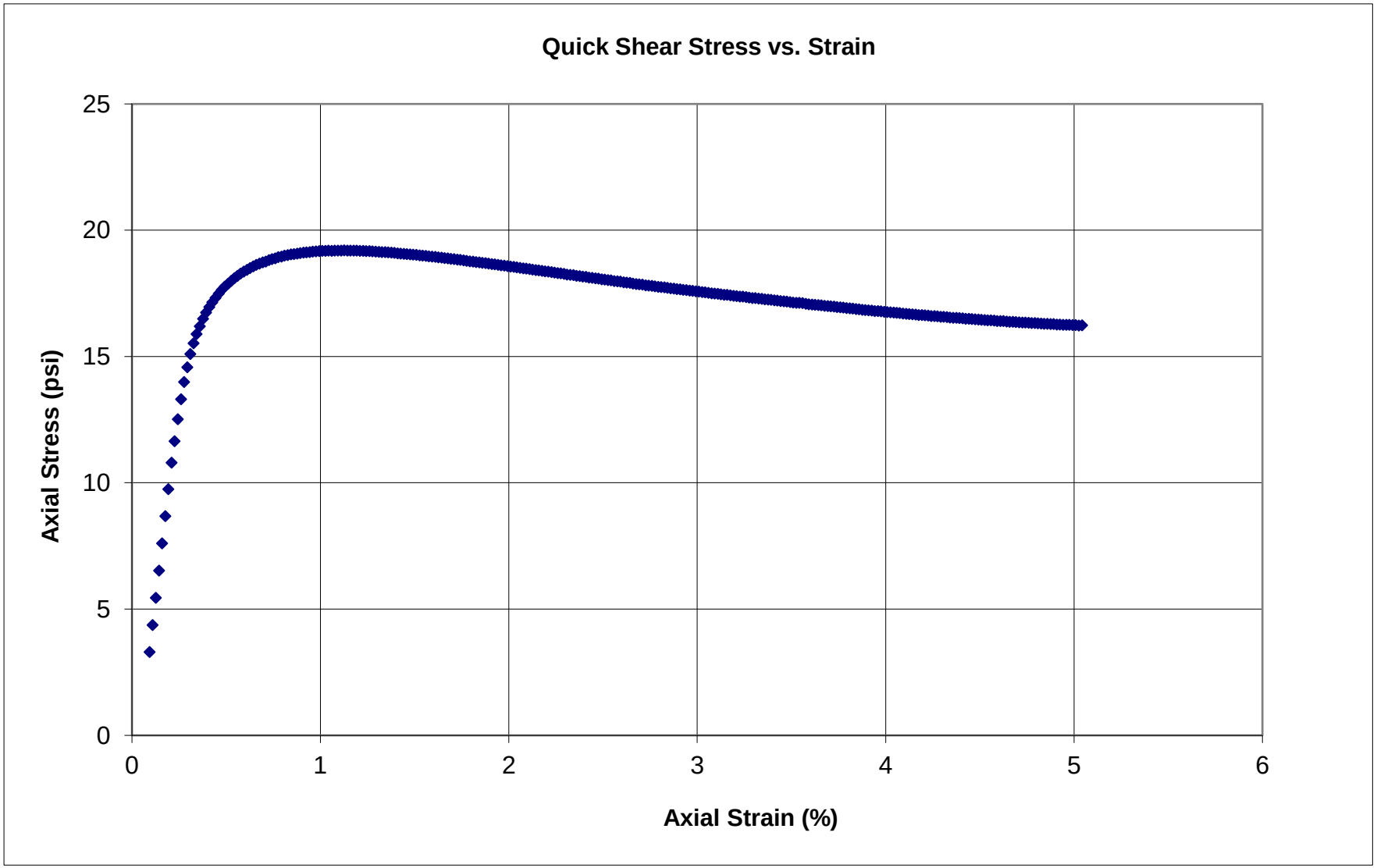
Mr = K1 x Θ^{k2}

[$\Theta = S_{cyclic} + 3\ (S3)$]

S3 (psi)	K1	K2	R^2
6	8704.6	0.065	0.43
4	4185.5	0.250	0.78
2	3463.6	0.262	0.88
All	1744.9	0.562	0.89

Terracon

Date Reported: 12/6/2018 Bulk C-5 OMC
Terracon Lab No. 03185251 Lab 652 RM 44 omc
Project No. 03185251



Terracon

Resilient Modulus Testing - AASHTO T 307-99 English Units

Report Date: 6-Dec-18
Lab No.: 03185251 Lab 652 RM 44 omc+2
Project No.: 03185251

Soil Map Unit: Bulk C-5 OMC+2%
Soil Symbol: A-2-4 / SM
Depth (in.) 14 1/8 -50 1/8
Compaction Method Static
Max. Dry Density (pcf) 117.0
Opt. Moisture Content (%) 11.4
Inside Mold Diameter (in) 3.94

Weight of Wet Soil (lb)	6.99
Initial Sample Diameter (in)	3.94
Initial Sample Height (in)	7.87
Initial Sample Area (in^2)	12.17
Sample Volume (in^3)	95.86
Compacted Moisture Content(%)	13.0
Wet Density (pcf)	126.0
Dry Density (pcf)	111.5

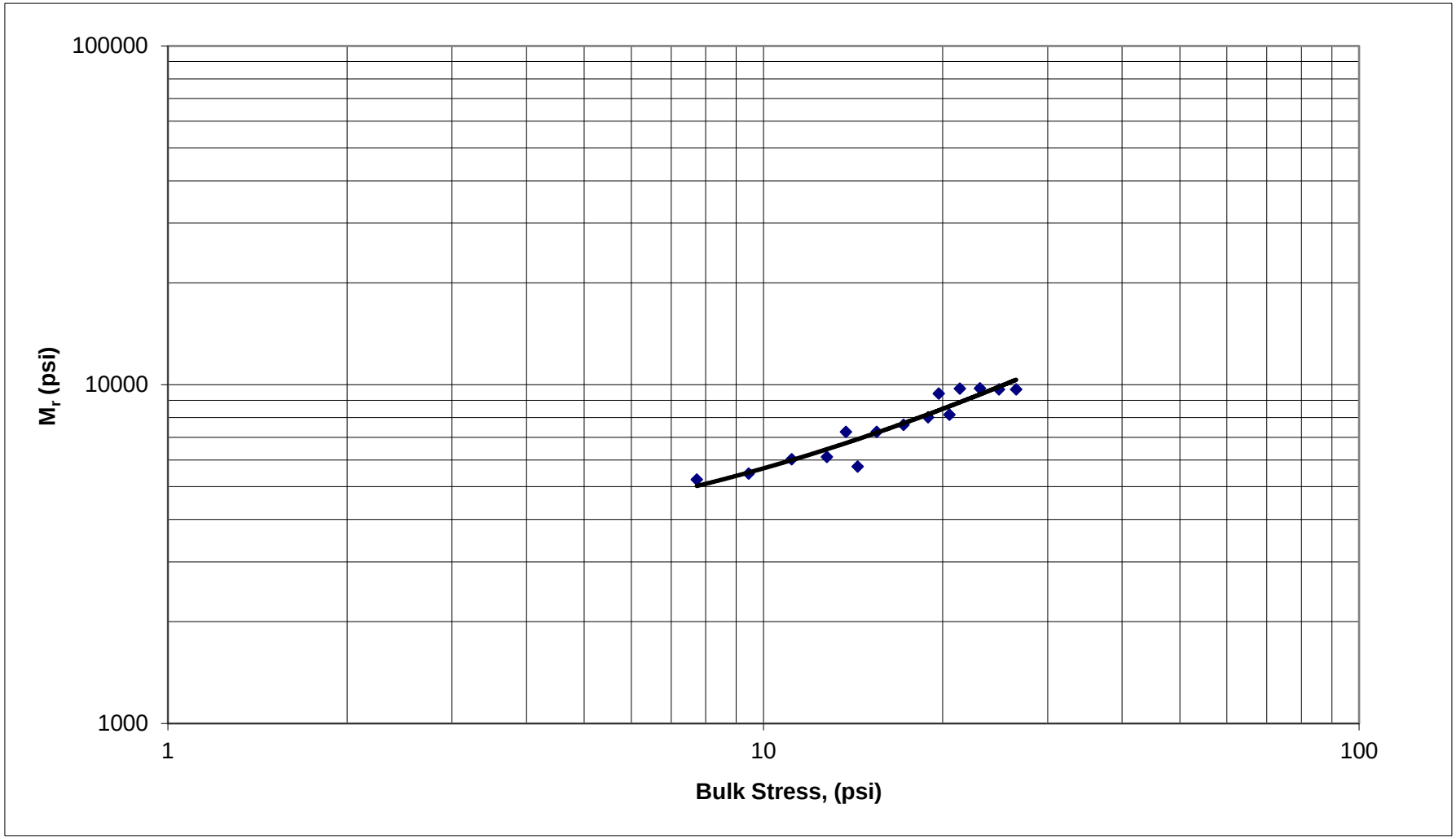
Test Date: November 15, 2018

Final Sample Height (in)	7.8
Final Sample Wet Weight (lb)	6.98
Final Moisture Content (%)	13.0
Accumulated Strain (%)	1.25
Percent Passing No. 10	86
Percent Passing No. 200	24.8
Liquid Limit	NP
Plasticity Index	NP

Chamber Confining Pressure (S_3) psi	Nominal Maximum Axial Stress (S_{cyclic}) psi	Actual Applied Max. Axial Load (P_{max}) lb	Actual Applied Cyclic Load (P_{cyclic}) lb	Actual Applied Contact Load ($P_{contact}$) lb	Actual Applied Max. Axial Stress (S_{max}) psi	Actual Applied Cyclic Stress (S_{cyclic}) psi	Actual Applied Contact Stress ($S_{contact}$) psi	Recov. Def. LVDT #1 Reading (H_1) in	Recov. Def. LVDT #2 Reading (H_2) in	Average Recov. Def. LVDT 1 and 2 (H_{avg}) in	Resilient Strain (ϵ_r) in/in	Resilient Modulus (M_r) psi
6.00	2.00	23.3	20.6	2.7	1.91	1.69	0.224	0.0014	0.0014	0.0014	0.000179	9,421
6.00	4.00	46.0	41.0	5.0	3.78	3.37	0.413	0.0028	0.0026	0.0027	0.000345	9,745
6.00	6.00	69.6	62.0	7.5	5.71	5.09	0.619	0.0042	0.0040	0.0041	0.000522	9,755
6.00	8.00	93.3	83.2	10.1	7.66	6.84	0.828	0.0056	0.0055	0.0056	0.000705	9,692
6.00	10.00	116.8	104.1	12.7	9.60	8.55	1.043	0.0069	0.0070	0.0069	0.000882	9,693
4.01	2.00	24.3	21.1	3.2	1.99	1.74	0.259	0.0018	0.0019	0.0019	0.000239	7,258
4.01	4.00	47.8	42.2	5.6	3.92	3.46	0.462	0.0037	0.0038	0.0038	0.000477	7,254
4.01	6.00	70.9	62.8	8.1	5.83	5.16	0.666	0.0053	0.0054	0.0053	0.000678	7,614
4.01	8.00	94.1	83.6	10.5	7.73	6.87	0.859	0.0066	0.0069	0.0067	0.000857	8,017
4.01	10.00	116.8	103.5	13.2	9.59	8.50	1.088	0.0081	0.0083	0.0082	0.001043	8,153
2.01	2.00	23.7	20.9	2.8	1.94	1.71	0.232	0.0025	0.0027	0.0026	0.000326	5,249
2.00	4.00	47.2	41.8	5.3	3.87	3.43	0.438	0.0048	0.0050	0.0049	0.000628	5,469
2.00	6.00	70.3	62.6	7.7	5.78	5.14	0.632	0.0066	0.0068	0.0067	0.000853	6,029
2.00	8.00	92.7	82.4	10.3	7.61	6.76	0.847	0.0086	0.0088	0.0087	0.001105	6,119
2.00	10.00	115.1	102.0	13.1	9.45	8.38	1.074	0.0113	0.0117	0.0115	0.001462	5,730

Terracon

Date Reported: 12/6/2018 Bulk C-5 OMC+2%
Terracon Lab No. 03185251 Lab 652 RM 44 omc+2
Project No. 03185251



$Mr = K1 \times \Theta^{k2}$

$[\Theta = S_{cyclic} + 3\ (S3)]$

S3 (psi)	K1	K2	R^2
6	7714.2	0.072	0.35
4	3011.4	0.329	0.91
2	3543.4	0.200	0.58
All	1447.3	0.591	0.88

Terracon

Date Reported: 12/6/2018 Bulk C-5 OMC+2%
Terracon Lab No. 03185251 Lab 652 RM 44 omc+2
Project No. 03185251

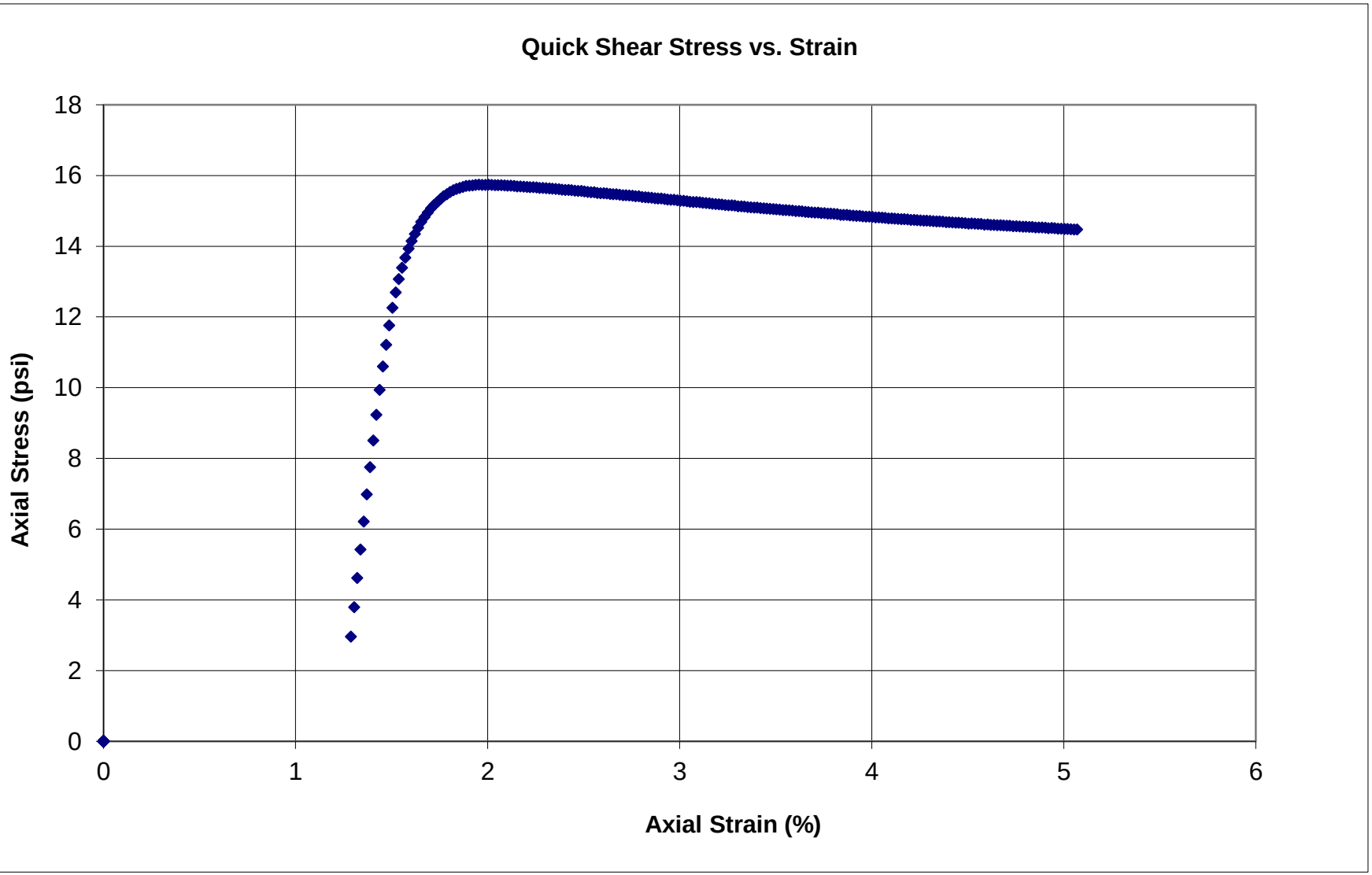


Exhibit B-5

Terracon

Resilient Modulus Testing - AASHTO T 307-99 English Units

Report Date: 6-Dec-18
Lab No.: 03185251 Lab 653 RM 45 omc
Project No.: 03185251

Soil Map Unit:	Bulk C-6 OMC
Soil Symbol:	A-6(9) / CL
Depth (in.)	11 - 60
Compaction Method	Static
Max. Dry Density (pcf)	116.9
Opt. Moisture Content (%)	13.5
Inside Mold Diameter (in)	3.94

Weight of Wet Soil (lb)	6.99
Initial Sample Diameter (in)	3.94
Initial Sample Height (in)	7.87
Initial Sample Area (in^2)	12.17
Sample Volume (in^3)	95.86
Compacted Moisture Content(%)	13.7
Wet Density (pcf)	125.9
Dry Density (pcf)	110.7

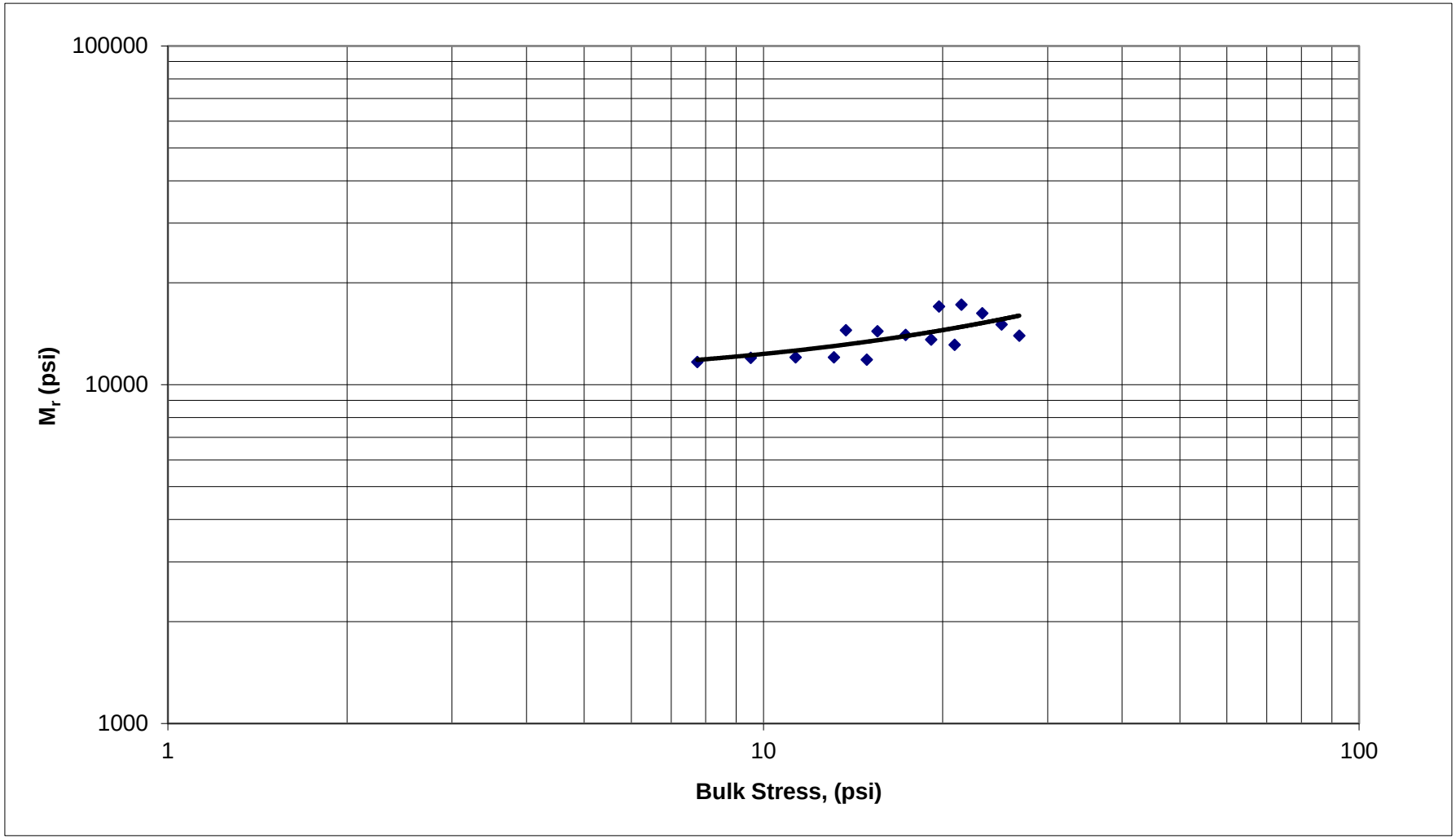
Test Date: November 15, 2018

Final Sample Height (in)	7.9
Final Sample Wet Weight (lb)	6.98
Final Moisture Content (%)	13.4
Accumulated Strain (%)	0.04
Percent Passing No. 10	96
Percent Passing No. 200	62.3
Liquid Limit	33
Plasticity Index	20

Chamber Confining Pressure (S_3) psi	Nominal Maximum Axial Stress (S_{cyclic}) psi	Actual Applied Max. Axial Load (P_{max}) lb	Actual Applied Cyclic Load (P_{cyclic}) lb	Actual Applied Contact Load ($P_{contact}$) lb	Actual Applied Max. Axial Stress (S_{max}) psi	Actual Applied Cyclic Stress (S_{cyclic}) psi	Actual Applied Contact Stress ($S_{contact}$) psi	Recov. Def. LVDT #1 Reading (H_1) in	Recov. Def. LVDT #2 Reading (H_2) in	Average Recov. Def. LVDT 1 and 2 (H_{avg}) in	Resilient Strain (ϵ_r) in/in	Resilient Modulus (M_r) psi
6.00	2.00	23.3	20.7	2.7	1.92	1.70	0.219	0.0008	0.0008	0.0008	0.000100	17,026
6.00	4.00	47.4	42.4	5.0	3.90	3.49	0.410	0.0016	0.0016	0.0016	0.000202	17,235
6.00	6.00	71.8	64.3	7.6	5.90	5.28	0.621	0.0026	0.0025	0.0026	0.000325	16,253
6.00	8.00	96.3	86.4	9.9	7.91	7.10	0.810	0.0037	0.0037	0.0037	0.000471	15,071
6.00	10.00	120.4	108.0	12.4	9.89	8.87	1.020	0.0050	0.0050	0.0050	0.000636	13,955
4.01	2.00	24.0	21.0	3.1	1.98	1.72	0.253	0.0010	0.0009	0.0009	0.000119	14,478
4.01	4.00	48.4	42.9	5.5	3.97	3.52	0.450	0.0020	0.0019	0.0019	0.000245	14,388
4.01	6.00	72.6	64.6	8.0	5.96	5.30	0.660	0.0030	0.0029	0.0030	0.000378	14,037
4.01	8.00	96.9	86.5	10.4	7.96	7.11	0.853	0.0041	0.0041	0.0041	0.000522	13,603
4.01	10.00	121.3	108.4	12.9	9.96	8.91	1.056	0.0054	0.0053	0.0053	0.000678	13,127
2.00	2.00	23.8	21.1	2.7	1.95	1.73	0.219	0.0012	0.0011	0.0012	0.000149	11,668
2.00	4.00	48.0	42.7	5.3	3.94	3.51	0.436	0.0023	0.0023	0.0023	0.000292	12,004
2.00	6.00	72.4	64.7	7.7	5.95	5.31	0.633	0.0035	0.0034	0.0035	0.000441	12,055
2.00	8.00	96.8	86.7	10.1	7.95	7.12	0.830	0.0047	0.0046	0.0047	0.000591	12,042
2.00	10.00	120.9	108.4	12.5	9.93	8.90	1.029	0.0059	0.0059	0.0059	0.000751	11,857

Terracon

Date Reported: 12/6/2018 Bulk C-6 OMC
Terracon Lab No. 03185251 Lab 653 RM 45 omc
Project No. 03185251



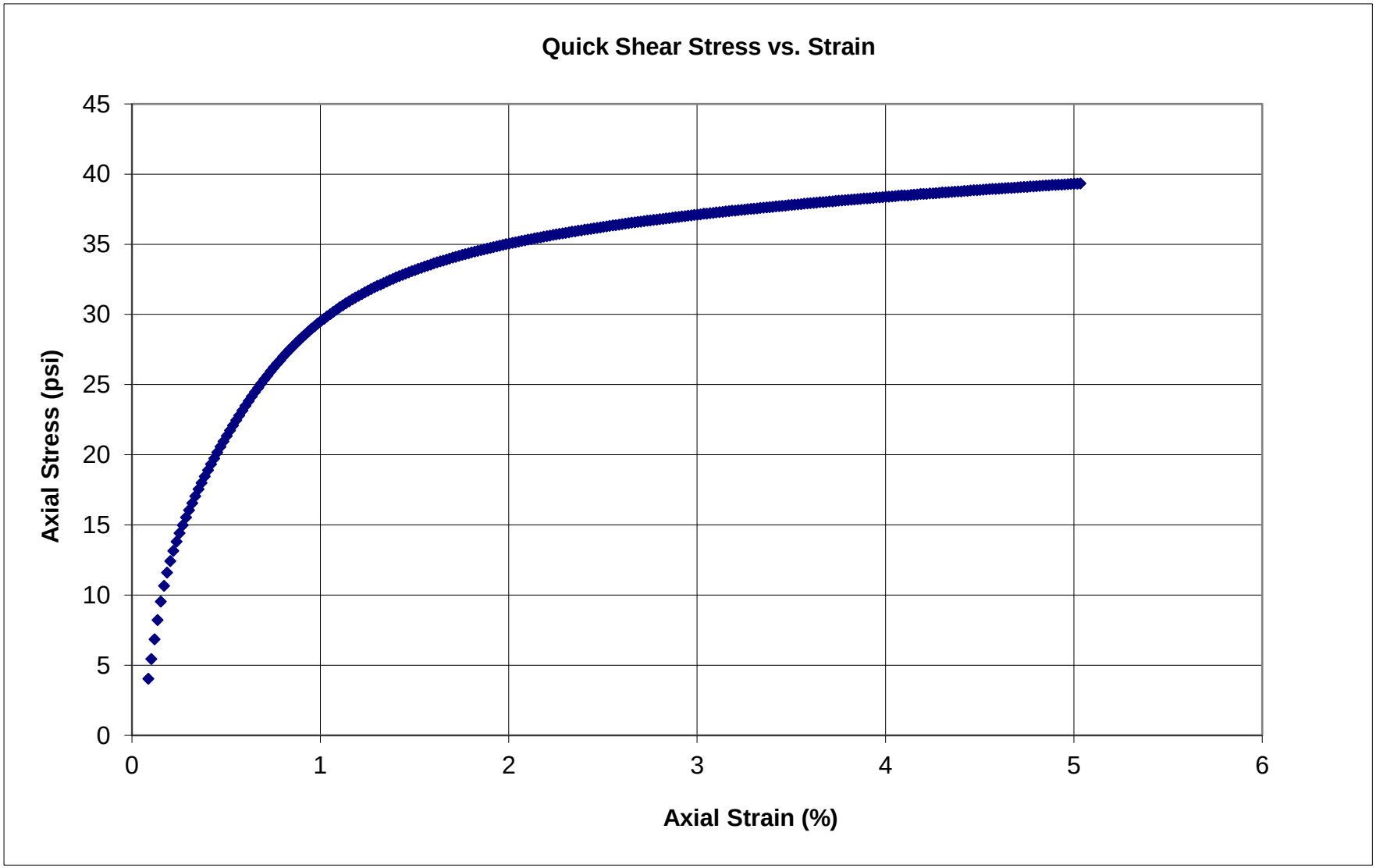
Mr = K1 x Θ^{k2}

[$\Theta = S_{cyclic} + 3\ (S3)$]

S3 (psi)	K1	K2	R^2
6	131595.8	-0.673	0.87
4	27233.9	-0.236	0.92
2	11201.5	0.026	0.24
All	6720.1	0.258	0.50

Terracon

Date Reported: 12/62018 Bulk C-6 OMC
Terracon Lab No. 03185251 Lab 653 RM 45 omc
Project No. 03185251



Terracon

Resilient Modulus Testing - AASHTO T 307-99 English Units

Report Date: 6-Dec-18
Lab No.: 03185251 Lab 653 RM 45 omc+3.5
Project No.: 03185251

Soil Map Unit:	Bulk C-6 OMC+
Soil Symbol:	A-6(9) / CL
Depth (in.)	11 - 60
Compaction Method	Static
Max. Dry Density (pcf)	116.9
Opt. Moisture Content (%)	13.5
Inside Mold Diameter (in)	3.94

Weight of Wet Soil (lb)	7.21
Initial Sample Diameter (in)	3.94
Initial Sample Height (in)	7.87
Initial Sample Area (in^2)	12.17
Sample Volume (in^3)	95.86
Compacted Moisture Content(%)	16.8
Wet Density (pcf)	129.9
Dry Density (pcf)	111.2

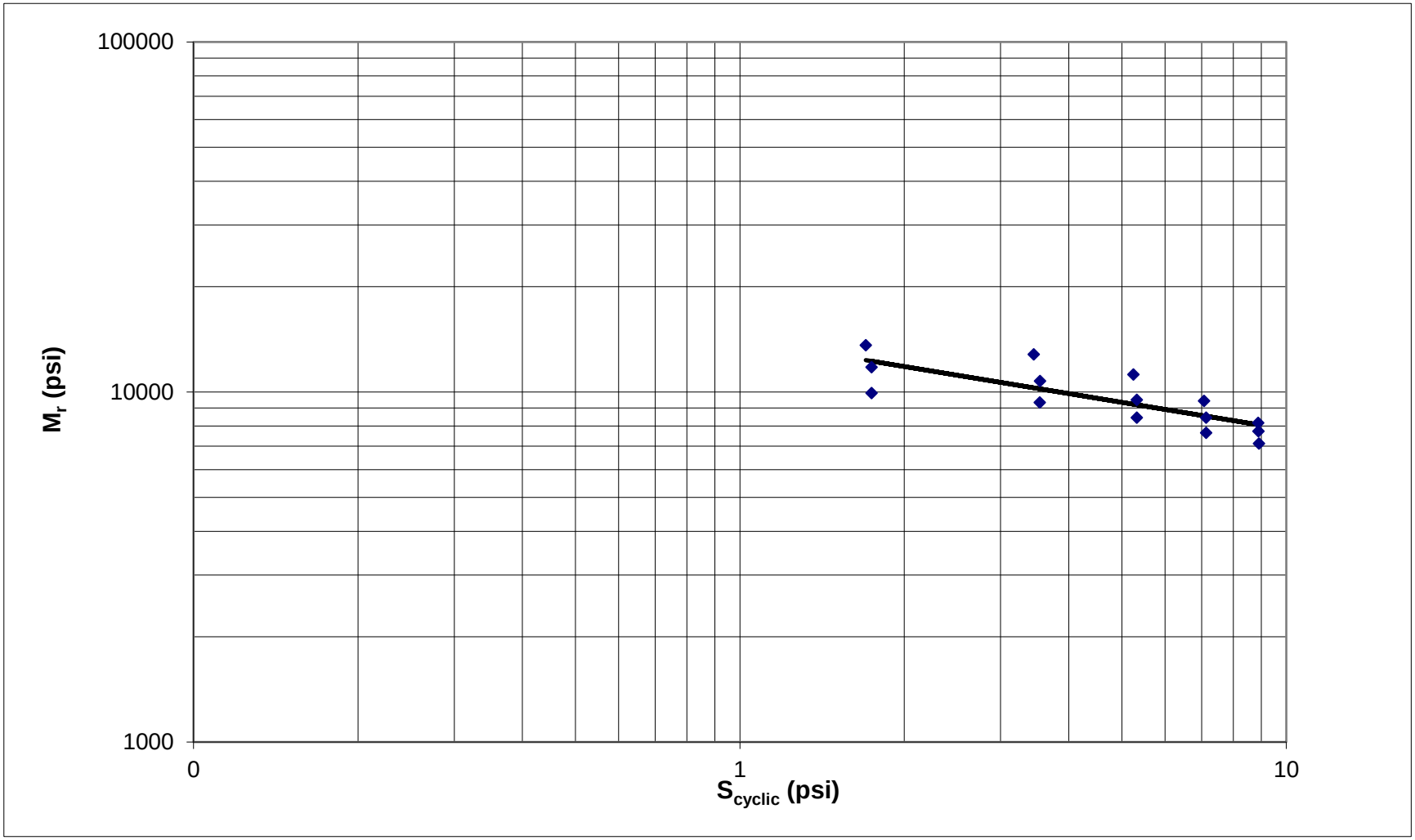
Test Date: November 15, 2018

Final Sample Height (in)	7.9
Final Sample Wet Weight (lb)	7.20
Final Moisture Content (%)	16.8
Accumulated Strain (%)	0.14
Percent Passing No. 10	96
Percent Passing No. 200	62.3
Liquid Limit	33
Plasticity Index	20

Chamber Confining Pressure (S_3) psi	Nominal Maximum Axial Stress (S_{cyclic}) psi	Actual Applied Max. Axial Load (P_{max}) lb	Actual Applied Cyclic Load (P_{cyclic}) lb	Actual Applied Contact Load ($P_{contact}$) lb	Actual Applied Max. Axial Stress (S_{max}) psi	Actual Applied Cyclic Stress (S_{cyclic}) psi	Actual Applied Contact Stress ($S_{contact}$) psi	Recov. Def. LVDT #1 Reading (H_1) in	Recov. Def. LVDT #2 Reading (H_2) in	Average Recov. Def. LVDT 1 and 2 (H_{avg}) in	Resilient Strain (ϵ_r) in/in	Resilient Modulus (M_r) psi
6.00	2.00	23.5	20.7	2.8	1.93	1.70	0.233	0.0010	0.0010	0.0010	0.000125	13,608
6.00	4.00	47.3	42.0	5.3	3.88	3.45	0.432	0.0021	0.0021	0.0021	0.000270	12,807
6.00	6.00	71.8	64.0	7.8	5.89	5.25	0.641	0.0036	0.0037	0.0037	0.000468	11,221
6.00	8.00	96.5	86.1	10.3	7.92	7.07	0.849	0.0058	0.0060	0.0059	0.000750	9,437
6.00	10.00	121.0	108.2	12.9	9.94	8.88	1.058	0.0084	0.0088	0.0086	0.001088	8,166
4.01	2.00	24.6	21.2	3.4	2.02	1.74	0.276	0.0011	0.0012	0.0012	0.000148	11,774
4.01	4.00	48.9	43.1	5.8	4.02	3.54	0.474	0.0025	0.0027	0.0026	0.000330	10,746
4.01	6.00	73.1	64.9	8.3	6.00	5.33	0.678	0.0043	0.0045	0.0044	0.000560	9,503
4.01	8.00	97.5	86.9	10.6	8.01	7.14	0.873	0.0065	0.0068	0.0067	0.000845	8,442
4.01	10.00	121.5	108.2	13.3	9.98	8.89	1.092	0.0089	0.0093	0.0091	0.001151	7,721
2.00	2.00	24.2	21.2	3.0	1.99	1.74	0.248	0.0013	0.0015	0.0014	0.000175	9,925
2.00	4.00	48.5	43.1	5.4	3.98	3.54	0.446	0.0028	0.0031	0.0030	0.000379	9,338
2.00	6.00	72.7	64.9	7.8	5.97	5.33	0.645	0.0048	0.0051	0.0050	0.000631	8,450
2.00	8.00	97.2	86.9	10.3	7.98	7.13	0.846	0.0071	0.0076	0.0073	0.000933	7,648
2.00	10.00	121.4	108.5	12.9	9.97	8.91	1.060	0.0096	0.0101	0.0098	0.001251	7,124

Terracon

Date Reported: 12/6/2018 Bulk C-6 OMC+
Terracon Lab No. 03185251 Lab 653 RM 45 omc+3.5
Project No. 03185251

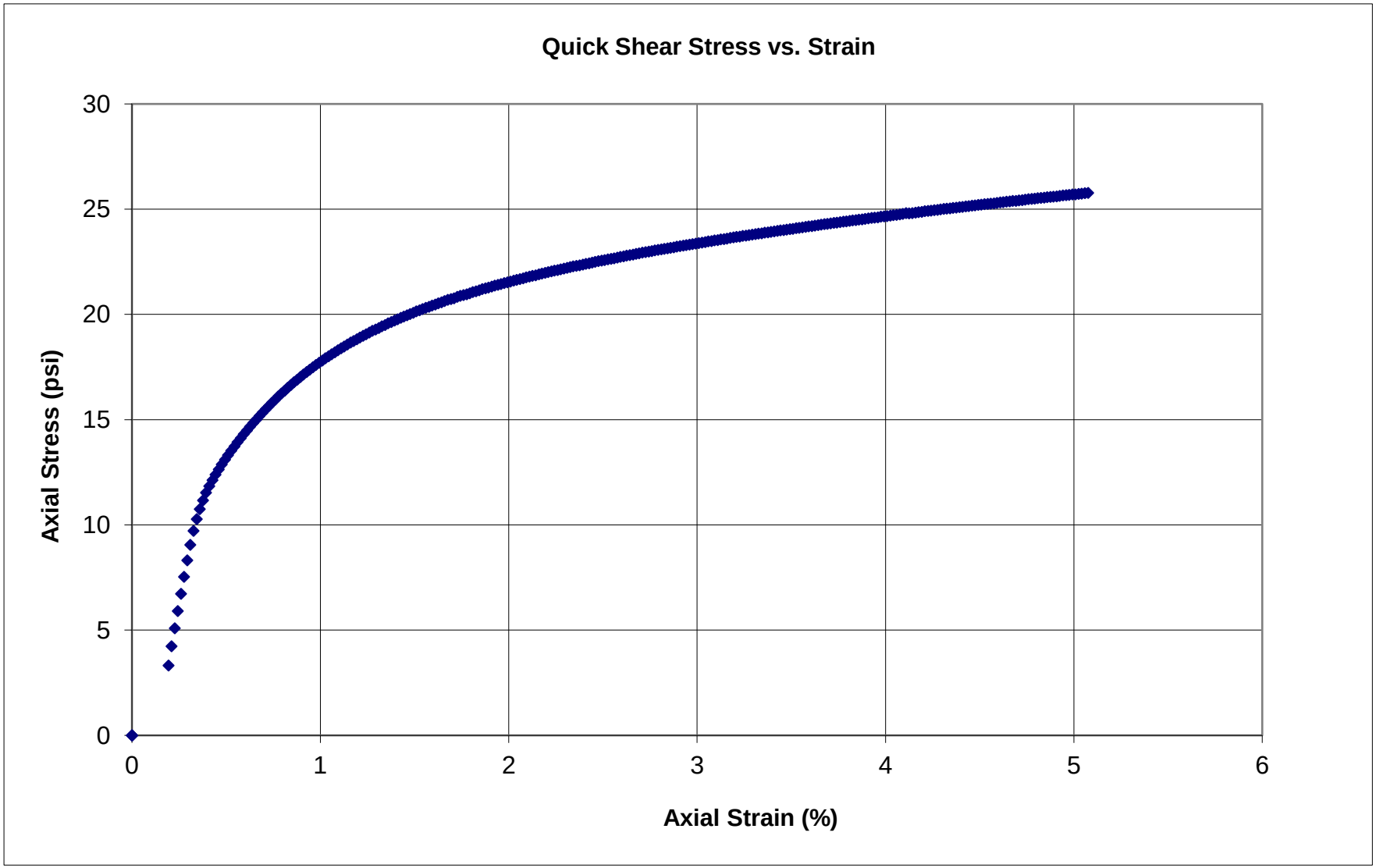


$Mr = K1 \times S_{cylic}^{k2}$

S3 (psi)	K1	K2	R^2
6	17143.6	-0.302	0.86
4	14139.1	-0.258	0.94
2	11517.1	-0.204	0.92
All	14132.4	-0.257	0.62

Terracon

Date Reported: 12/6/2018 Bulk C-6 OMC+
Terracon Lab No. 03185251 Lab 653 RM 45 omc+3.5
Project No. 03185251



Terracon

Resilient Modulus Testing - AASHTO T 307-99 English Units

Report Date: 6-Dec-18
Lab No.: 03185251 Lab 654 RM 46 omc
Project No.: 03185251

Soil Map Unit:	Bulk C-7 OMC
Soil Symbol:	A-6(7)/ CL
Depth (in.)	13 3/8-49 3/8
Compaction Method	Static
Max. Dry Density (pcf)	120.2
Opt. Moisture Content (%)	11.6
Inside Mold Diameter (in)	3.94

Weight of Wet Soil (lb)	7.07
Initial Sample Diameter (in)	3.94
Initial Sample Height (in)	7.87
Initial Sample Area (in^2)	12.17
Sample Volume (in^3)	95.86
Compacted Moisture Content(%)	12.0
Wet Density (pcf)	127.3
Dry Density (pcf)	113.7

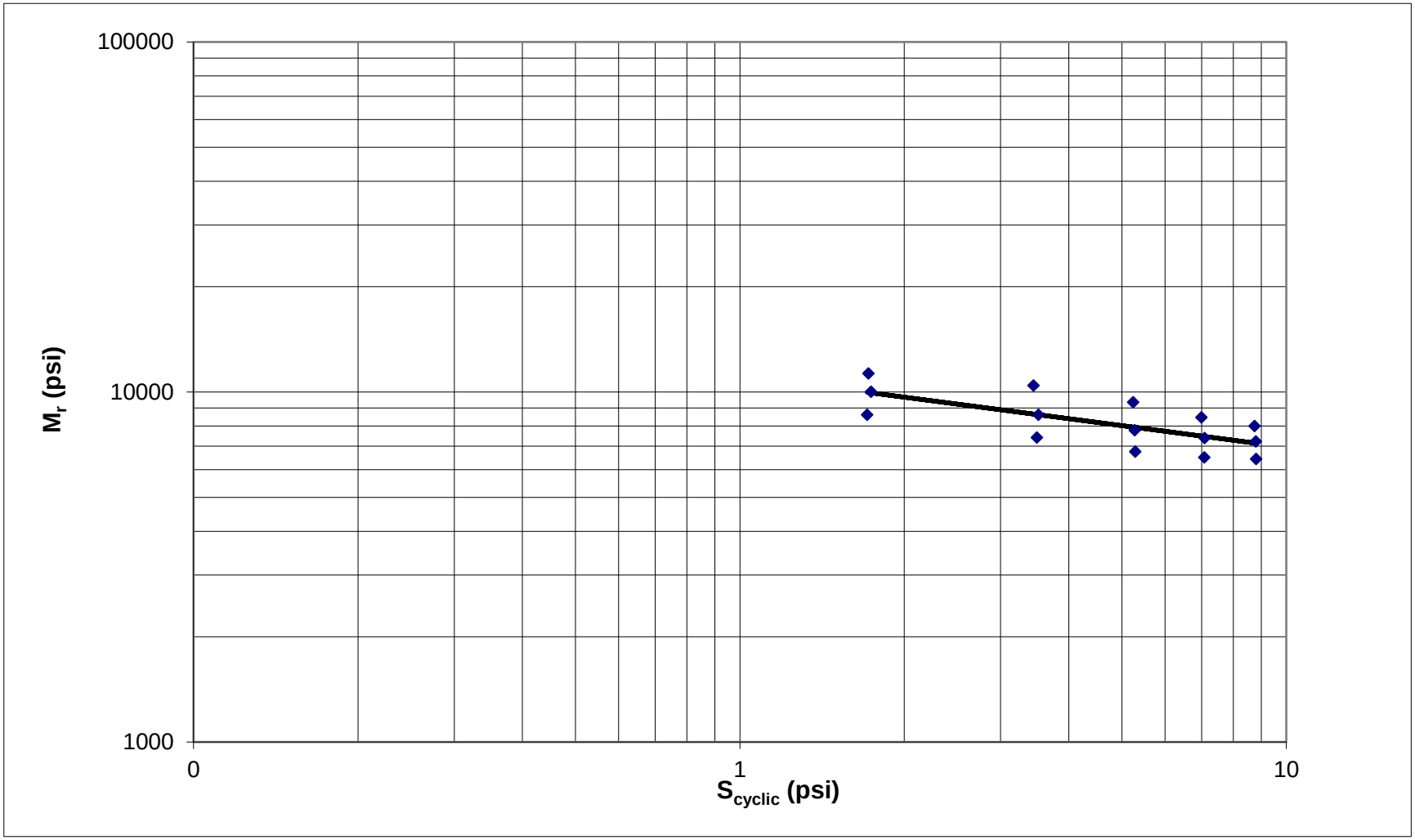
Test Date: November 15, 2018

Final Sample Height (in)	7.9
Final Sample Wet Weight (lb)	7.06
Final Moisture Content (%)	11.7
Accumulated Strain (%)	0.13
Percent Passing No. 10	98
Percent Passing No. 200	74.8
Liquid Limit	27
Plasticity Index	13

Chamber Confining Pressure (S_3) psi	Nominal Maximum Axial Stress (S_{cyclic}) psi	Actual Applied Max. Axial Load (P_{max}) lb	Actual Applied Cyclic Load (P_{cyclic}) lb	Actual Applied Contact Load ($P_{contact}$) lb	Actual Applied Max. Axial Stress (S_{max}) psi	Actual Applied Cyclic Stress (S_{cyclic}) psi	Actual Applied Contact Stress ($S_{contact}$) psi	Recov. Def. LVDT #1 Reading (H_1) in	Recov. Def. LVDT #2 Reading (H_2) in	Average Recov. Def. LVDT 1 and 2 (H_{avg}) in	Resilient Strain (ϵ_r) in/in	Resilient Modulus (M_r) psi
6.00	2.00	23.3	20.9	2.4	1.92	1.72	0.197	0.0012	0.0012	0.0012	0.000152	11,296
6.00	4.00	46.8	42.0	4.8	3.84	3.45	0.392	0.0026	0.0026	0.0026	0.000330	10,432
6.00	6.00	71.2	63.9	7.3	5.85	5.25	0.601	0.0044	0.0044	0.0044	0.000561	9,356
6.00	8.00	95.3	85.2	10.1	7.82	7.00	0.827	0.0066	0.0065	0.0065	0.000827	8,461
6.00	10.00	119.0	106.5	12.5	9.77	8.75	1.027	0.0086	0.0086	0.0086	0.001093	8,002
4.01	2.00	23.9	21.2	2.8	1.97	1.74	0.227	0.0014	0.0014	0.0014	0.000174	10,014
4.01	4.00	48.1	42.8	5.3	3.95	3.52	0.436	0.0033	0.0032	0.0032	0.000409	8,611
4.01	6.00	72.3	64.3	8.0	5.94	5.28	0.655	0.0054	0.0053	0.0053	0.000679	7,776
4.01	8.00	96.5	86.3	10.2	7.92	7.09	0.836	0.0076	0.0075	0.0075	0.000959	7,393
4.01	10.00	119.8	107.1	12.7	9.84	8.80	1.043	0.0096	0.0095	0.0096	0.001217	7,227
2.00	2.00	23.4	20.8	2.6	1.92	1.71	0.214	0.0016	0.0015	0.0016	0.000198	8,610
2.00	4.00	47.7	42.5	5.1	3.92	3.49	0.421	0.0038	0.0037	0.0037	0.000471	7,416
2.00	6.00	72.4	64.4	8.0	5.95	5.29	0.655	0.0062	0.0061	0.0062	0.000784	6,750
2.00	8.00	96.7	86.2	10.5	7.95	7.08	0.866	0.0086	0.0085	0.0086	0.001089	6,504
2.00	10.00	120.3	107.2	13.1	9.88	8.81	1.077	0.0108	0.0107	0.0108	0.001369	6,435

Terracon

Date Reported: 12/6//2018 Bulk C-7 OMC
Terracon Lab No. 03185251 Lab 654 RM 46 omc
Project No. 03185251

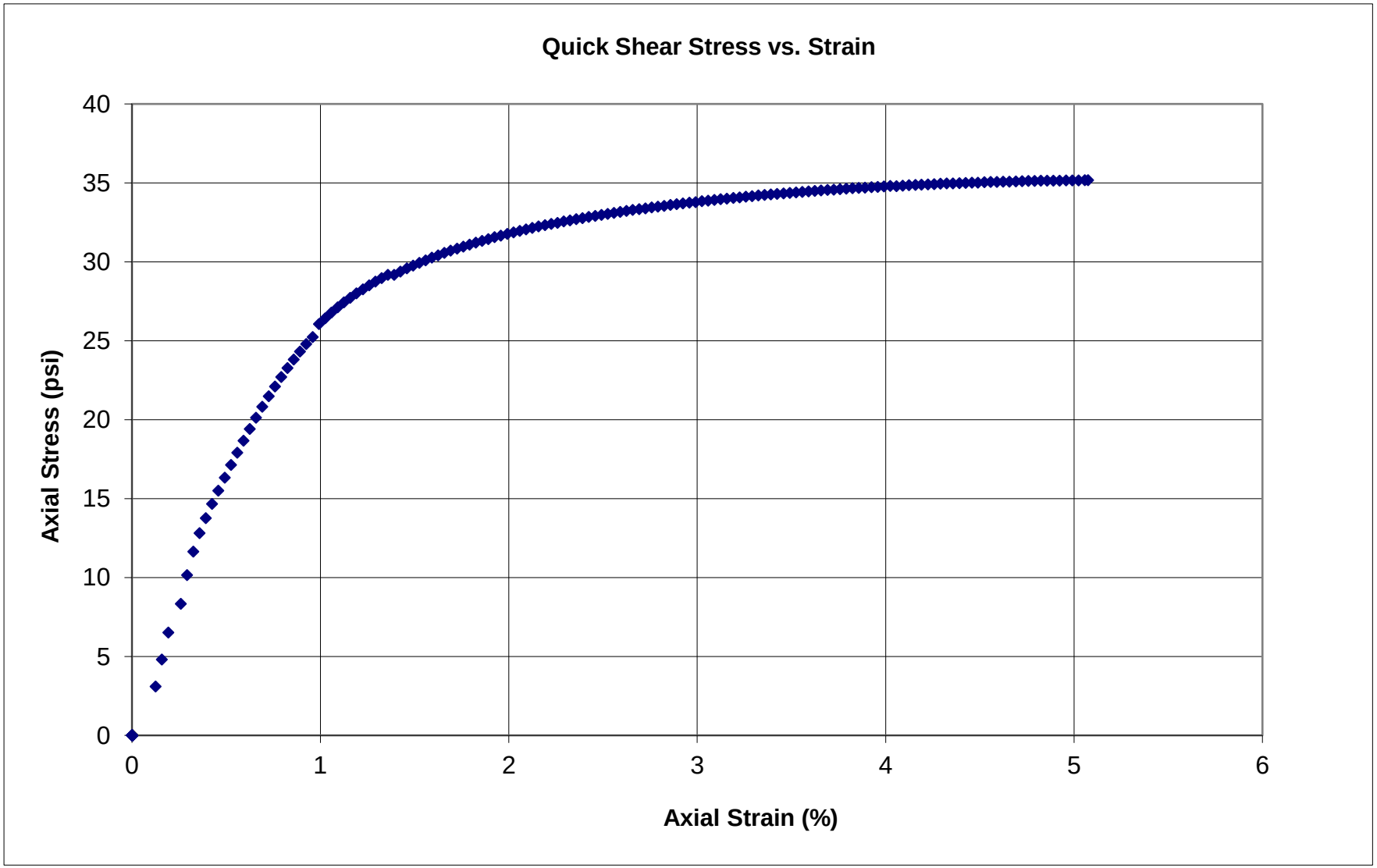


$Mr = K1 \times S_{cylic}^{k2}$

S3 (psi)	K1	K2	R^2
6	13081.5	-0.217	0.95
4	11171.2	-0.208	0.99
2	9402.6	-0.185	0.98
All	11133.0	-0.204	0.50

Terracon

Date Reported: 12/6/2018 Bulk C-7 OMC
Terracon Lab No. 03185251 Lab 654 RM 46 omc
Project No. 03185251



Terracon

Resilient Modulus Testing - AASHTO T 307-99 English Units

Report Date: 6-Dec-18
Lab No.: 03185251 Lab 654 RM 46 omc+2
Project No.: 03185251

Soil Map Unit:	Bulk C-7 OMC+
Soil Symbol:	A-6(7) - CL
Depth (in.)	13 3/8-49 3/8
Compaction Method	Static
Max. Dry Density (pcf)	120.2
Opt. Moisture Content (%)	11.6
Inside Mold Diameter (in)	3.94

Weight of Wet Soil (lb)	7.20
Initial Sample Diameter (in)	3.94
Initial Sample Height (in)	7.87
Initial Sample Area (in^2)	12.17
Sample Volume (in^3)	95.86
Compacted Moisture Content(%)	13.7
Wet Density (pcf)	129.7
Dry Density (pcf)	114.1

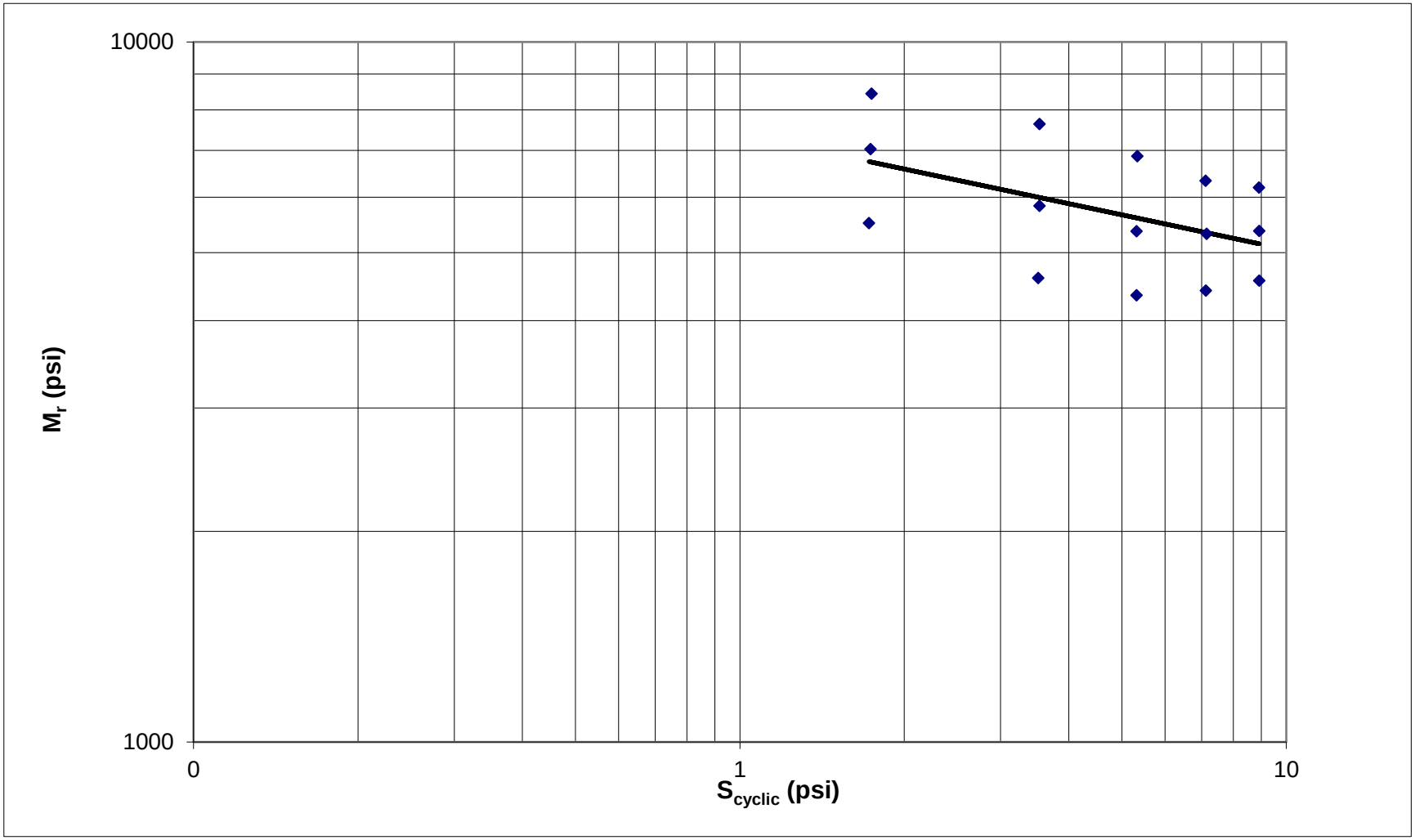
Test Date: November 15, 2018

Final Sample Height (in)	7.8
Final Sample Wet Weight (lb)	7.19
Final Moisture Content (%)	13.7
Accumulated Strain (%)	0.31
Percent Passing No. 10	98
Percent Passing No. 200	74.8
Liquid Limit	27
Plasticity Index	13

Chamber Confining Pressure (S_3) psi	Nominal Maximum Axial Stress (S_{cyclic}) psi	Actual Applied Max. Axial Load (P_{max}) lb	Actual Applied Cyclic Load (P_{cyclic}) lb	Actual Applied Contact Load ($P_{contact}$) lb	Actual Applied Max. Axial Stress (S_{max}) psi	Actual Applied Cyclic Stress (S_{cyclic}) psi	Actual Applied Contact Stress ($S_{contact}$) psi	Recov. Def. LVDT #1 Reading (H_1) in	Recov. Def. LVDT #2 Reading (H_2) in	Average Recov. Def. LVDT 1 and 2 (H_{avg}) in	Resilient Strain (ϵ_r) in/in	Resilient Modulus (M_r) psi
6.00	2.00	23.9	21.2	2.7	1.96	1.74	0.220	0.0016	0.0016	0.0016	0.000207	8,434
6.00	4.00	48.1	43.1	5.1	3.95	3.54	0.415	0.0036	0.0037	0.0036	0.000463	7,634
6.00	6.00	72.6	65.0	7.6	5.96	5.34	0.625	0.0060	0.0062	0.0061	0.000777	6,872
6.00	8.00	97.0	86.6	10.3	7.96	7.12	0.849	0.0086	0.0091	0.0088	0.001123	6,333
6.00	10.00	121.5	108.6	12.9	9.97	8.92	1.058	0.0110	0.0117	0.0113	0.001439	6,196
4.01	2.00	24.3	21.1	3.2	2.00	1.73	0.261	0.0019	0.0020	0.0019	0.000247	7,028
4.01	4.00	48.7	43.0	5.6	4.00	3.54	0.463	0.0045	0.0051	0.0048	0.000606	5,831
4.01	6.00	73.0	64.7	8.2	5.99	5.32	0.676	0.0076	0.0080	0.0078	0.000990	5,369
4.01	8.00	97.7	87.0	10.7	8.02	7.15	0.878	0.0103	0.0109	0.0106	0.001343	5,321
4.01	10.00	121.9	108.7	13.3	10.01	8.93	1.089	0.0127	0.0135	0.0131	0.001662	5,371
2.00	2.00	24.2	21.0	3.3	1.99	1.72	0.269	0.0024	0.0026	0.0025	0.000312	5,512
2.00	4.00	48.4	42.8	5.6	3.98	3.52	0.460	0.0058	0.0062	0.0060	0.000764	4,601
2.00	6.00	72.8	64.8	8.0	5.98	5.32	0.658	0.0093	0.0100	0.0096	0.001224	4,345
2.00	8.00	97.2	86.7	10.5	7.98	7.12	0.858	0.0123	0.0131	0.0127	0.001613	4,416
2.01	10.00	121.5	108.6	12.9	9.98	8.92	1.061	0.0148	0.0160	0.0154	0.001956	4,560

Terracon

Date Reported: 12/6/2018 Bulk C-7 OMC+
Terracon Lab No. 03185251 Lab 654 RM 46 omc+2
Project No. 03185251

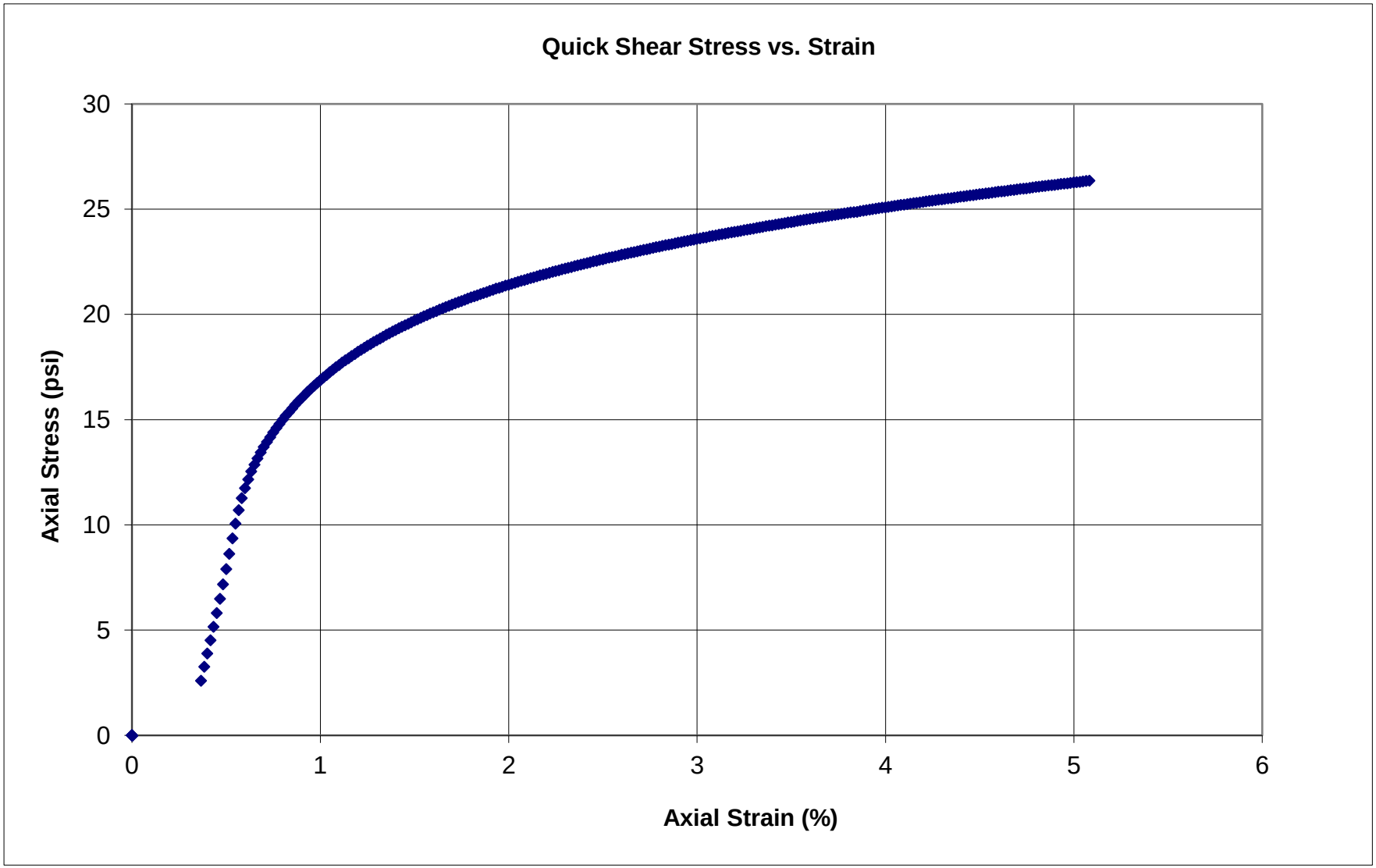


$Mr = K1 \times S_{cylic}^{k2}$

S3 (psi)	K1	K2	R^2
6	9552.7	-0.199	0.98
4	7484.0	-0.172	0.89
2	5642.5	-0.124	0.71
All	7377.4	-0.164	0.23

Terracon

Date Reported: 12/6/2018 Bulk C-7 OMC+
Terracon Lab No. 03185251 Lab 654 RM 46 omc+2
Project No. 03185251

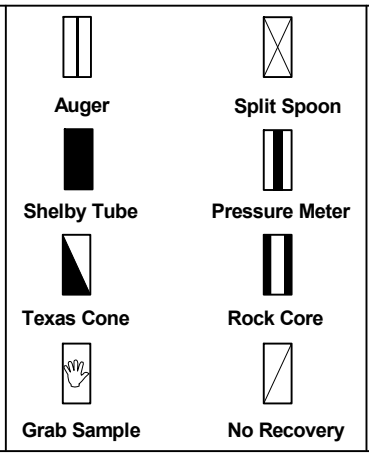


APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING



WATER LEVEL

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer
(TCP)	Texas Cone Penetrometer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength, Qu, psf**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18
Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42
			Hard	> 8,000	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

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UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification	
					Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

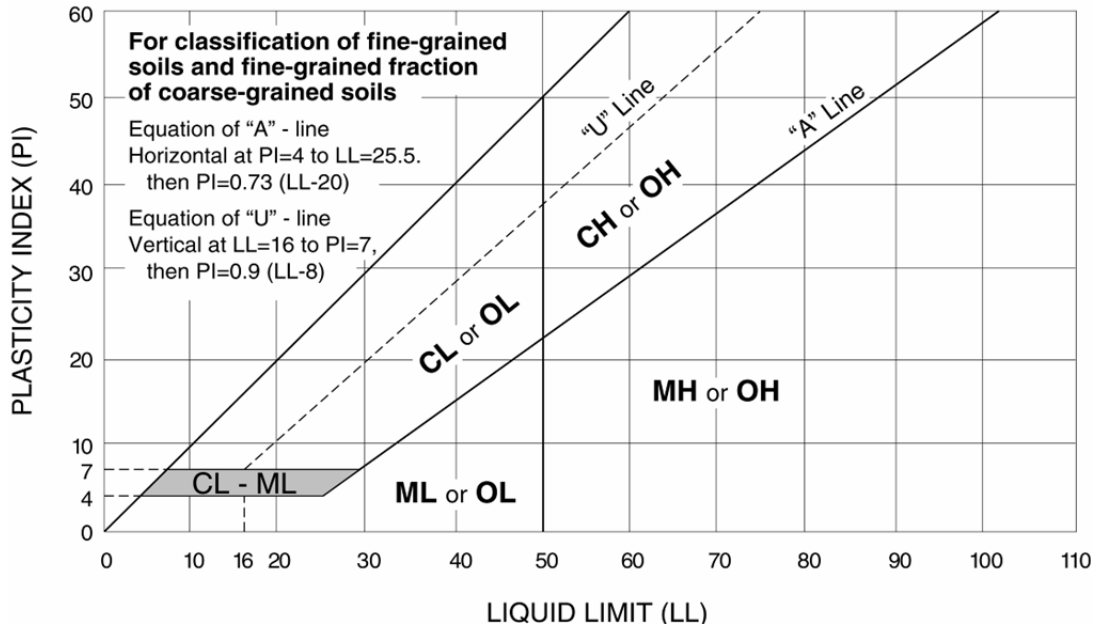
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



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