RED ROCK
CONSULTING

Report of Geotechnical Investigation

OF

I-35 SHOULDER SOILS SURVEY
MCCLAIN COUNTY, OKLAHOMA

35589(04)

Prepared For:

Olsson Associates
11600 Broadway Extension, Suite 300
Oklahoma City, Oklahoma 73114
Attention: Mr. Russell Beaty, PE

Prepared By:

Red Rock Consulting, LLC
PO Box 30591
Edmond, Oklahoma 73003
(405) 562-3328

June 23, 2023
Project No. 22117

RED ROCK
CONSULTING

June 23, 2023

Olsson Associates
11600 Broadway Extension, Suite 300
Oklahoma City, Oklahoma 73114

Attention: Mr. Russell Beaty, PE

Re: Report of Geotechnical Investigation
I-35 Shoulder Soils Survey
35589(04)
McClain County, Oklahoma
Project No. 22117

Dear Mr. Beaty:

I am pleased to submit herewith this report entitled "Geotechnical Investigation, I-35 Shoulder Soils Survey, 35589(04), McClain County, Oklahoma".

In an effort to provide a more environmentally friendly service, this report has been provided electronically.

It has been our pleasure to assist you with this project. Should you have any questions regarding the contents of this report, please contact Red Rock Consulting.

Yours very truly,
RED ROCK CONSULTING, LLC
CA No. 5707 Exp. 06/30/23

Emma Coggin, EI
Project Specialist

Jeremy Basler, PE
Geotechnical Manager
Oklahoma PE No. 20233

REGISTERED PROFESSIONAL ENGINEER
JEREMY BASLER
6-23-2023
20233
OKLAHOMA

REPORT OF GEOTECHNICAL INVESTIGATION

I-35 SHOULDER SOILS SURVEY
MCCLAIN COUNTY, OKLAHOMA

35589(04)

PROJECT NO. 22117

APPENDICES

REPORT OF GEOTECHNICAL INVESTIGATION

I-35 SHOULDER SOILS SURVEY
MCCLAIN COUNTY, OKLAHOMA

35589(04)

PROJECT NO. 22117

INTRODUCTION

General

This report presents the results of the geotechnical investigation performed for the widening of the existing pavement of I-35 in the center median and outside lanes to accommodate adding one lane of traffic in each direction from 1.0 mile south of Ladd Road extending north approximately 4.7 miles in McClain County, Oklahoma.

Proposed Construction

The project includes the widening of the existing pavement of I-35 in the center median and outside lanes to accommodate adding one lane of traffic in each direction from 1.0 mile south of Ladd Road extending north approximately 4.7 miles in McClain County, Oklahoma. The project also includes the potential overlay or reconstruction of the existing pavement of the I-35 mainline.

The purpose of this investigation is to evaluate the subsurface conditions at the site and to provide information pertaining to the geotechnical aspects of the proposed project.

Scope of Work

The scope of this investigation includes the following:

1. Review of previous geotechnical and geological information of sites near this site. This was augmented with data obtained during the field investigation phase of the project.

2. Investigation of the subsurface soils by drilling and sampling a total of 33 boreholes within the planned project area.

3. A laboratory testing program consisting of moisture content, Atterberg limits, full sieve, soluble sulfates, standard proctor and resilient modulus tests on the soils encountered

4. Presentation of laboratory test data

FIELD AND LABORATORY INVESTIGATIONS

Field Exploration

Subsurface exploration was performed from December 12th to 16th, 2022. The borings were located in the field by a representative of Red Rock Consulting by measuring distances from known site reference points as depicted on the plans provided by Olsson Associates. The locations of the borings should be considered accurate only to the degree implied by the methods used to define them.

The subsurface exploration program consisted of drilling and sampling a total of 33 borings under the full-time supervision of an engineer. All of the borings were advanced in the grass median of the existing I-35 mainline. The boring locations are shown on the Boring Location Diagrams, which are included in Appendix A.

The boring locations were drilled to depths of 36 inches beneath the existing ground surface using a HD99 Hydraulic Earth Drill. Representative samples of the borings were obtained from the auger cuttings at depths shown on the Shoulder Soils Survey chart in Appendix B.

Samples were collected and transported back to the lab for further classification and testing. The final Shoulder Soils Survey chart was developed from the draft logs, observations and test results of the samples returned to the laboratory. The stratigraphic contacts indicated are only for the specific dates and locations reported, and therefore, are not necessarily representative of other locations and times. The Shoulder Soils Survey chart, presenting conditions encountered at each location explored, are included in Appendix B.

Laboratory Testing

Representative soil samples were tested to refine the field classifications and evaluate physical properties of the soils which may affect the geotechnical aspects of project design and construction. The laboratory testing program included the following:

- Moisture content (AASHTO T265)
- Liquid limit (AASHTO T89)
- Plastic limit (AASHTO T90)
- Particle size analysis (AASHTO T88)
- Soluble sulfates (OHD L-49)
- Standard Proctor (AASHTO T99)
- Resilient modulus tests (AASHTO T307)

The results of the physical laboratory tests conducted are shown on the Shoulder Soils Survey chart in Appendix B. The laboratory results in entirety are included in Appendix C.

The above laboratory tests were performed in general accordance with applicable AASHTO procedures, or generally accepted practice. It should be noted that reference to AASHTO procedures does not imply that all cross-referenced procedures in AASHTO standards have been used, or that all AASHTO procedures used have been followed exactly. Only those AASHTO procedures and/or portions of procedures, which, in the professional judgment of the geotechnical engineer of record for this report, are applicable, appropriate, and necessary for this particular project, have been used or followed.

SITE DESCRIPTION

Surface Conditions

At the time of the field exploration, the borings were located in the existing I-35 grass median of I-35. I-35 was a four lane divided highway with a grass median for the entire length of the project. The project area was partially developed with a few businesses and a small airport near the SH 74 interchange. Continuing south along I-35 was primarily agricultural fields and a few residences. The town of Goldsby was located towards the northern end of the job.

Traffic was high on I-35 during drilling operations. Large trucks consisted of approximately half of the traffic. Traffic control was required to drill the borings.

For the Boring Location Diagrams, refer to Appendix A.

Site Geology

The geology of the project site was researched using the “Division Three Engineering Classification of Geological Materials”, published by the Oklahoma Department of Transportation (ODOT) and the Geologic Map of the “Hydrologic Atlas 4 of Oklahoma,” Reconnaissance of the Water Resources of the Oklahoma City quadrangle, central Oklahoma,” by Roy H. Bingham and Robert L. Moore, U.S. Geological Survey, 1975.

ODOT PUBLICATION

Division Three of the “Engineering Classification of Geological Materials”, published by the Oklahoma Department of Transportation (ODOT) indicates the project site consists of Terrace deposits (Qts) underlain by the Hennessey Unit (Phy).

Terrace deposits consist of sand, silt, clay, gravel, or mixtures of these. These materials were deposited by streams or wind and may be found adjacent to most streams.

The Hennessey unit consists of red platy to blocky clay shales and mudstone. The mudstones are hard and appear blocky. The red clay shale of the Hennessey unit is characterized by numerous bands or streaks of gray, white, or light green color ranging from a few inches to four feet in thickness. Small spheres of light green color up to 10 inches in diameter are an odd characteristic of the unit.

The total thickness of the unit varies from 400 to 600 feet. The Hennessey unit outcrops in a 5 to 20 mile wide north-south band across Cleveland, McClain, and Garvin Counties in Division three.

Topographically, the unit is near level to gently rolling prairies, but most of the more level outcrops of the unit are cultivated.

USGS MAP

According to the USGS geologic map, the project consists of Terrace deposits (Qt) which are underlain by Purcell Sandstone (Pp).

Terrace deposits consist of lenticular beds of sand, silt, clay, and gravel. Thickness ranges from a few feet to about 100 feet and probably averages about 50 feet along major streams. These deposits are major aquifers along Cimarron, Canadian, and North Canadian Rivers.

Purcell Sandstone consists of red-brown to maroon fine- to coarse-grained sandstone, mudstone conglomerate, and red-brown shale. Thickness, 150 feet.

Subsurface Conditions

Information collected during the field investigation indicates that the subgrade materials consisted of lean clay with various amounts of sand and silt, silty sand with various amounts of gravel, clayey sand with various amounts of gravel, sandy silt and silty, clayey sand. The subgrade materials encountered in the borings consisted of A-2-4, A-4, A-6 and A-7-6 soils. The subgrade materials encountered in the borings appeared to be native to the site except for borings SS-1, SS-5, SS-11, SS-13 and SS-17 where minor amounts of possible fill was encountered.

All of the conditions summarized above can be found on the Shoulder Soils Survey chart in Appendix B. Laboratory results can be found in Appendix C.

Soluble Sulfates

Sulfates are naturally occurring in some soils. If combined with calcium based materials, such as cement, lime, fly ash and cement kiln dust, sulfate rich soils can expand up to 250 percent of the original size when exposed to moisture.

A level of “less than 200 ppm” is the lowest and “greater than 8,000 ppm” is the highest reportable level when using the colorimeter method OHD L-49. Soluble sulfate levels less than 3,000 ppm are considered to be too low to be of concern when considering the

use of calcium based construction materials. Soluble sulfate levels in excess of 8,000 ppm are considered to be high risk.

The maximum soluble sulfate level encountered at the project site was 1,235 ppm. Since the maximum value is less than 3,000 ppm, the use of calcium based construction materials should not cause localized distresses in this project. However, good mix design and construction practices should be followed.

Any material imported to the site during construction for use as a fill material should be tested for soluble sulfates. Soluble sulfate levels are shown on the Shoulder Soils Survey chart in Appendix B and are included in Appendix C.

Groundwater Conditions

Groundwater conditions were monitored in the borings during and immediately after drilling. Groundwater was not encountered in any of the borings at these times.

To obtain more accurate groundwater level information, long-term observations in a well or piezometer that is sealed from the influence of surface water would be needed. Fluctuations in groundwater levels can occur due to seasonal variations in the amount of rainfall, runoff, altered drainage paths, and other factors not evident at the time borings were advanced. Consequently, the contractor should be aware of this possibility while constructing this project.

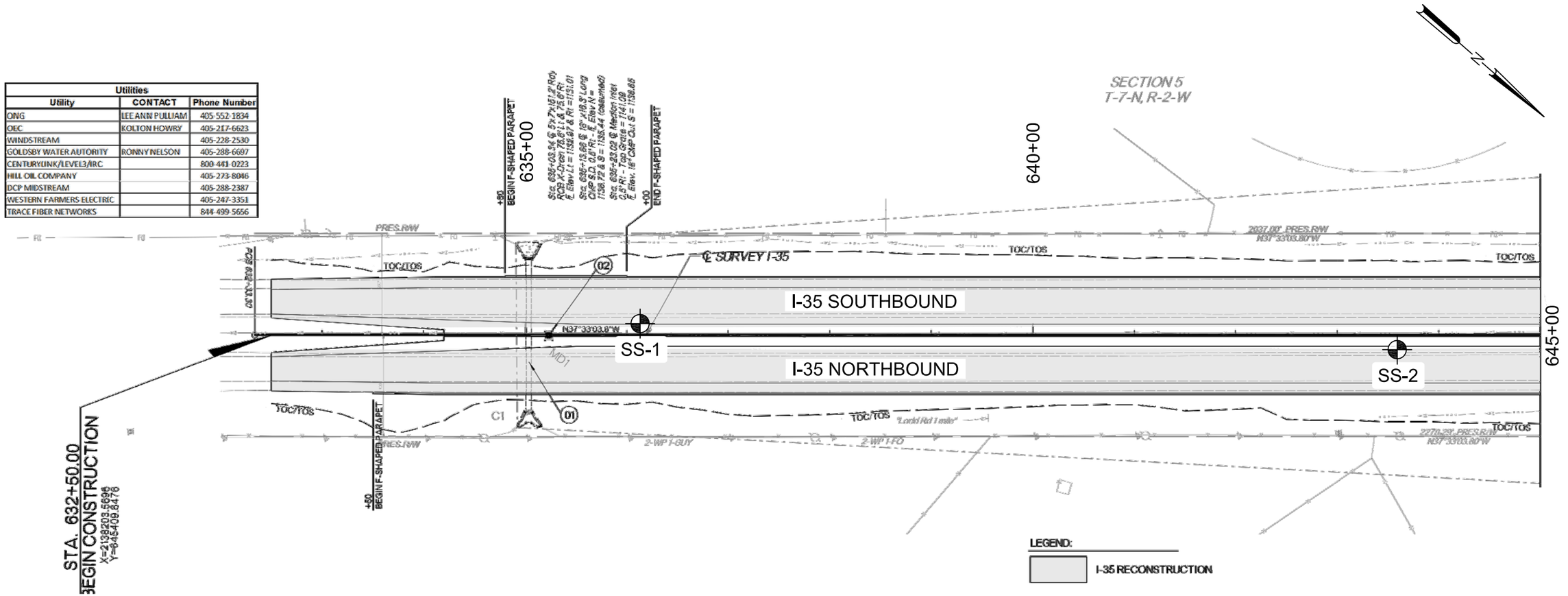
CLOSURE

The data presented in this report are based on the negotiated scope for this project and site conditions as they existed at the time of the field exploration. The conditions encountered in the exploratory borings are assumed to be representative of the subsurface conditions within the study area.

This report was prepared for the exclusive use of Olsson Associates, ODOT and their agents and consultants. It should be made available to prospective contractors for information and factual data only and not as a warranty of subsurface conditions similar to those interpreted from the Shoulder Soils Survey chart or discussions presented herein.

APPENDIX A

Utilities		
Utility	CONTACT	Phone Number
ONG	LEE ANN PULLIAM	405-552-1834
OEC	KOLTON HOWRY	405-217-6623
WINDSTREAM		405-228-2530
GOLDSBY WATER AUTORITY	RONNY NELSON	405-288-6697
CENTURYLINK/LEVEL3/IRC		800-441-0223
HILL OIL COMPANY		405-273-8046
DCP MIDSTREAM		405-288-2387
WESTERN FARMERS ELECTRIC		405-247-3351
TRACE FIBER NETWORKS		844-499-5656



Boring	Station	I-35 CL Survey
SS-1	636+13	11' left
SS-2	643+60	15' right

Stations and offsets estimated from plans provided by Olsson Associates

RED ROCK CONSULTING
PO Box 30591
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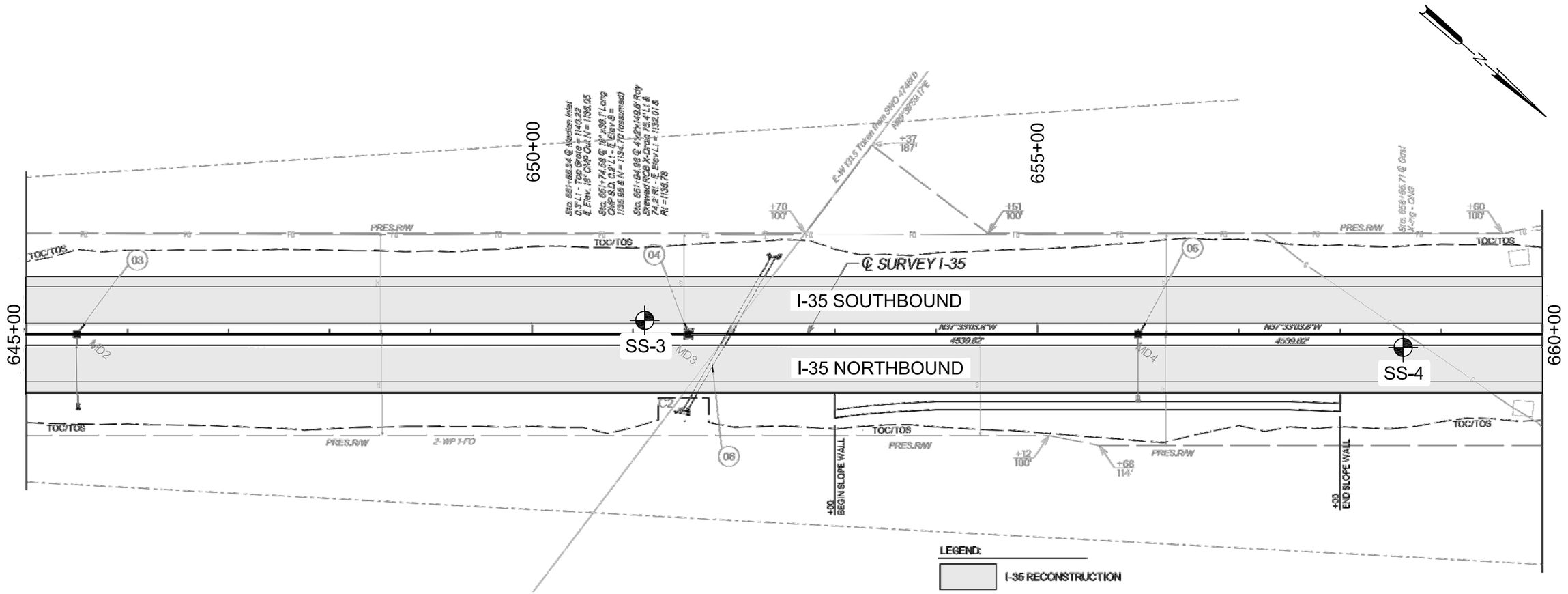
(405) 562-3328

BORING LOCATION DIAGRAM
I-35 SHOULDER SURVEY
MCCLAIN COUNTY, OKLAHOMA
J/P 35589(04)

Project Mngr:	EDC	RRC Project No.	22117
Designed By:	DLW	Scale:	NOT TO SCALE
Checked By:	JWB	Date:	12/14/2022
Approved By:	JWB	Page No:	1/17



Boring	Station	I-35 CL Survey
SS-3	651+12	13' left
SS-4	658+63	14' right

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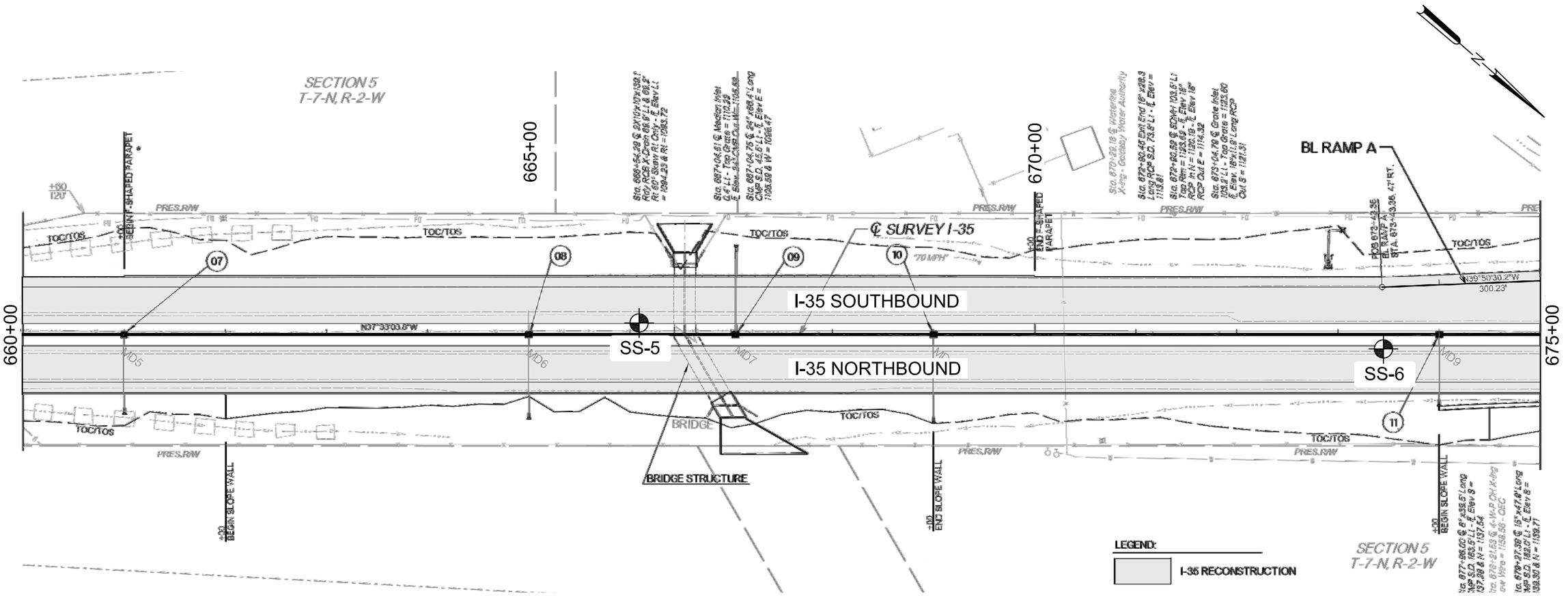

Boring	Station	I-35 CL Survey
SS-5	666+10	13' left
SS-6	673+46	14' right

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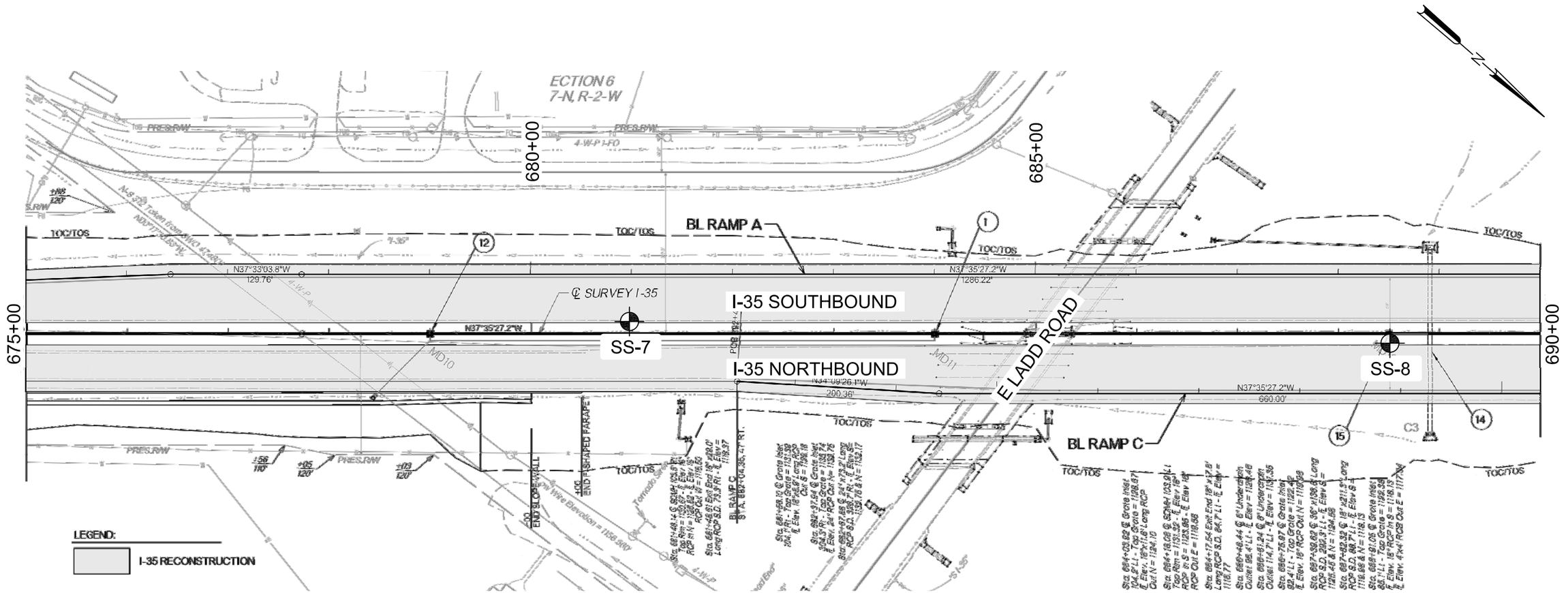

Boring	Station	I-35 CL Survey
SS-7	680+98	13' left
SS-8	688+52	10' right

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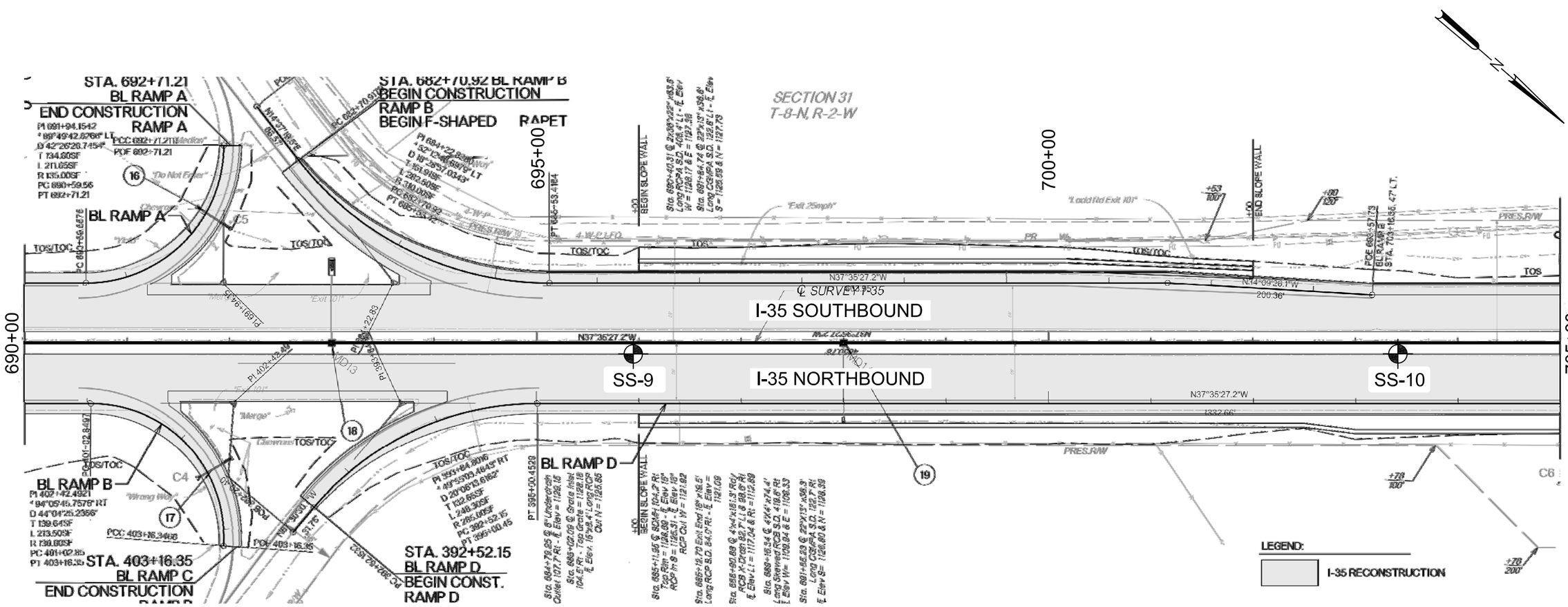

Boring	Station	I-35 CL Survey
SS-9	695+95	11' right
SS-10	703+42	10' right

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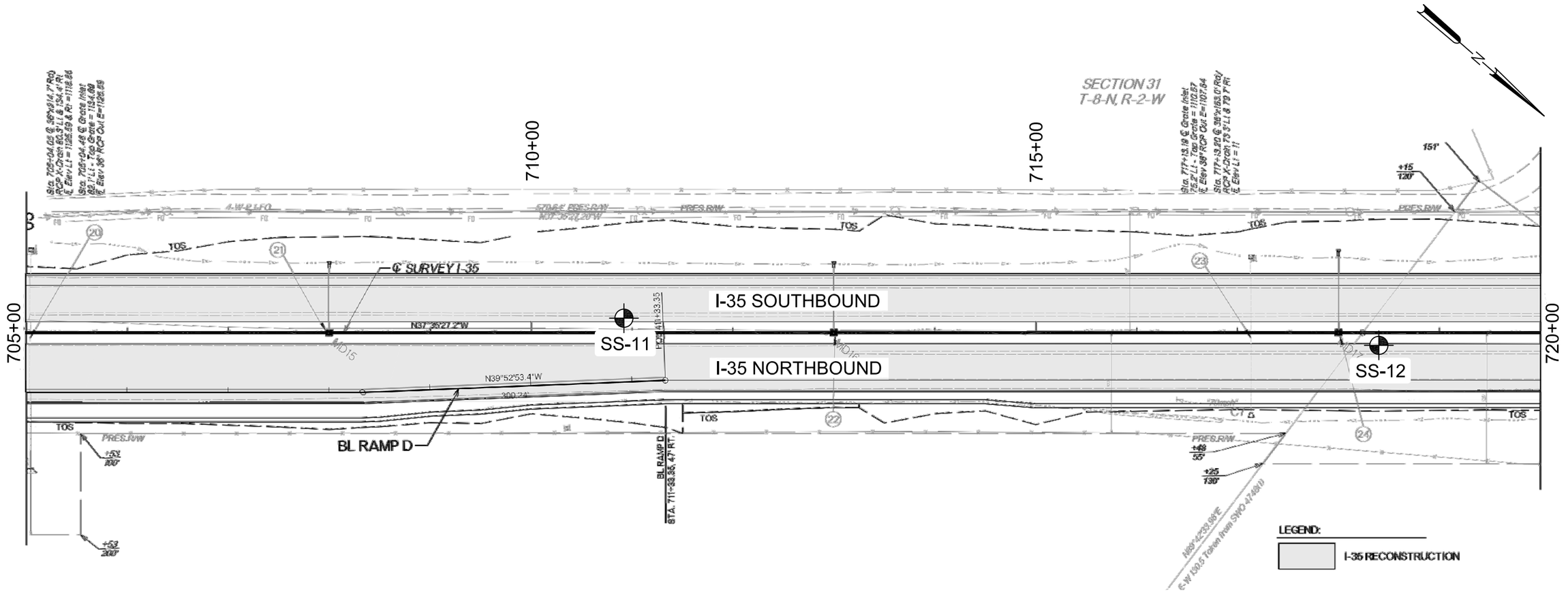

Boring	Station	I-35 CL Survey
SS-11	710+92	14' left
SS-12	718+40	13' right

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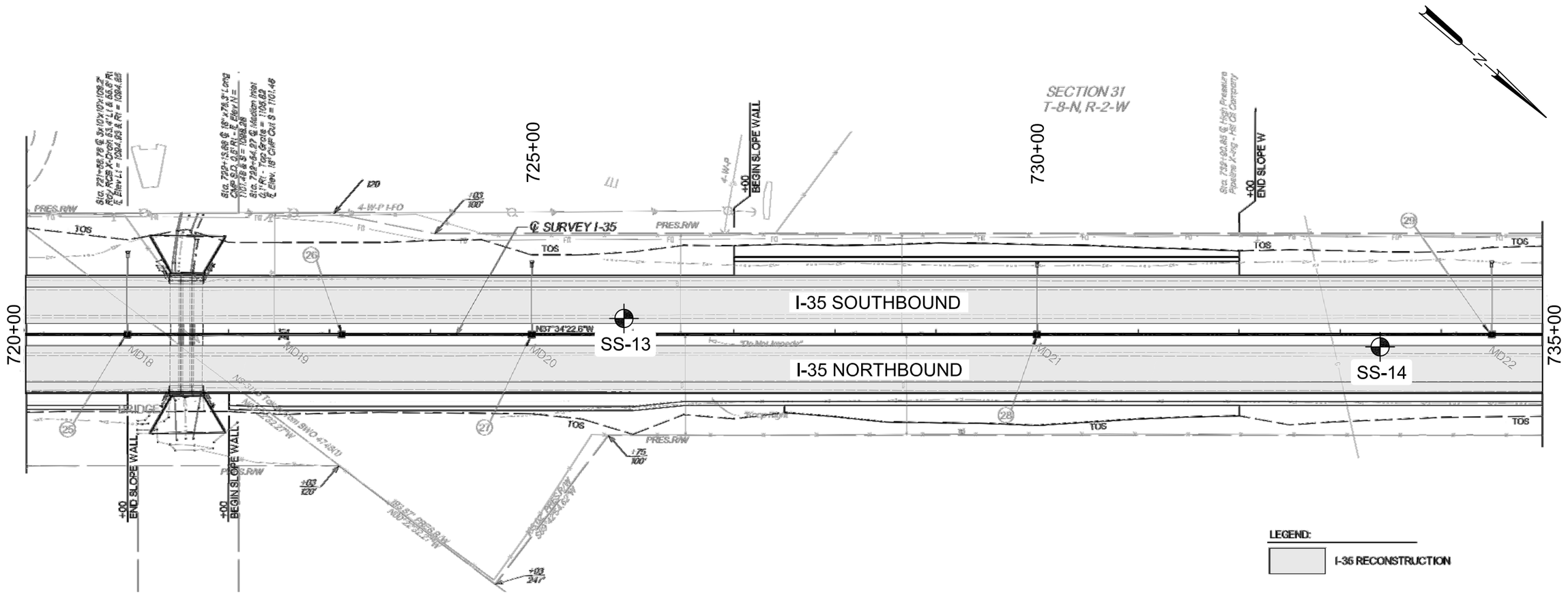

Boring	Station	I-35 CL Survey
SS-13	725+92	15' left
SS-14	733+40	14' right

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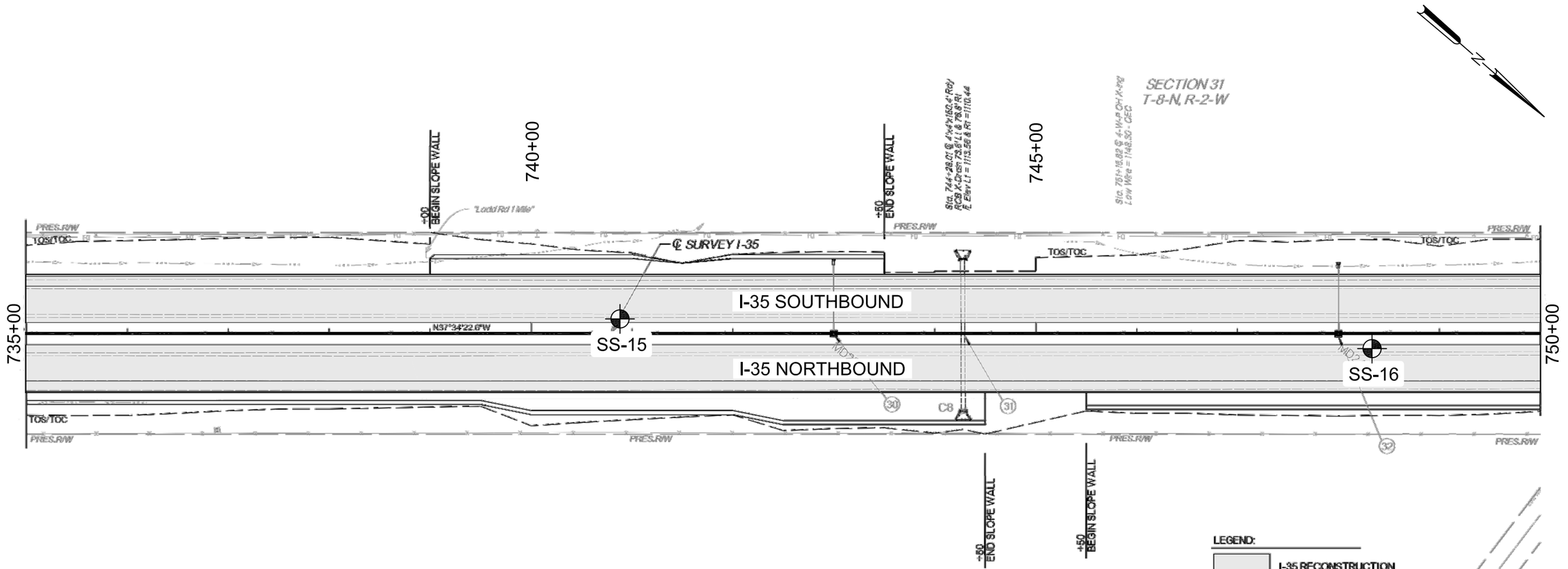

Boring	Station	I-35 CL Survey
SS-15	740+89	14' left
SS-16	748+34	15' right

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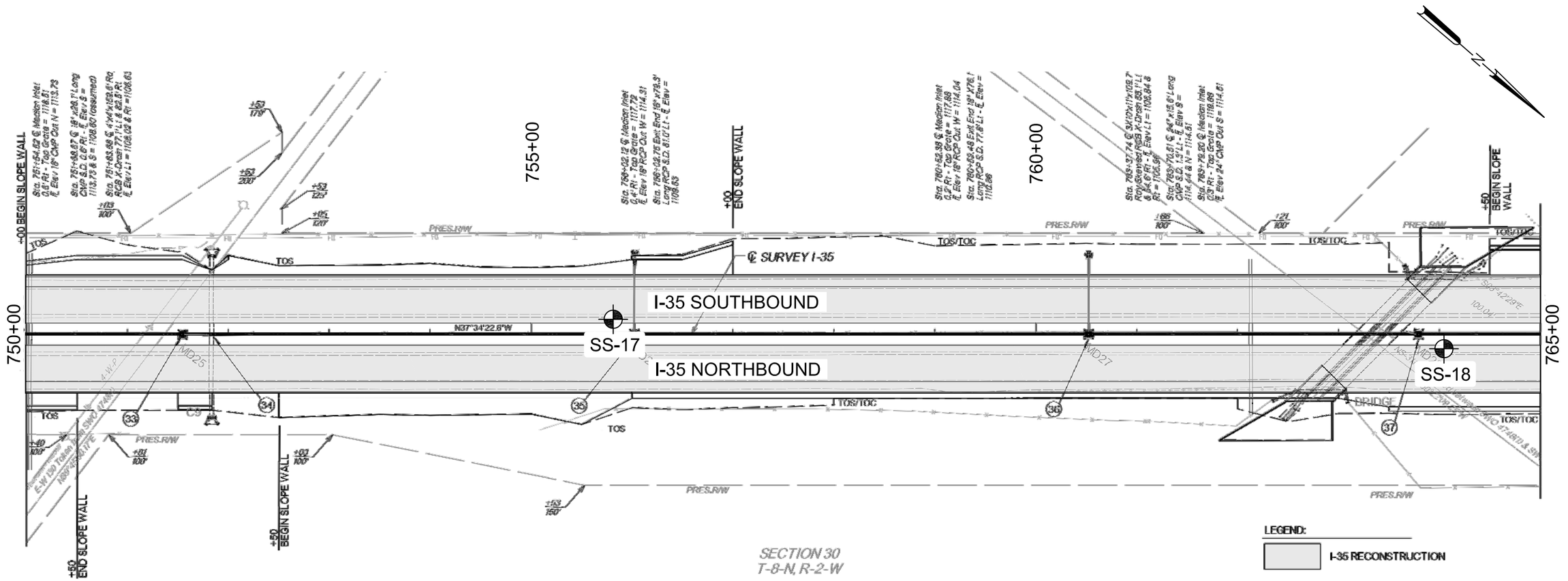

LEGEND:

I-35 RECONSTRUCTION

Boring	Station	I-35 CL Survey
SS-17	755+82	15' left
SS-18	764+05	14' right

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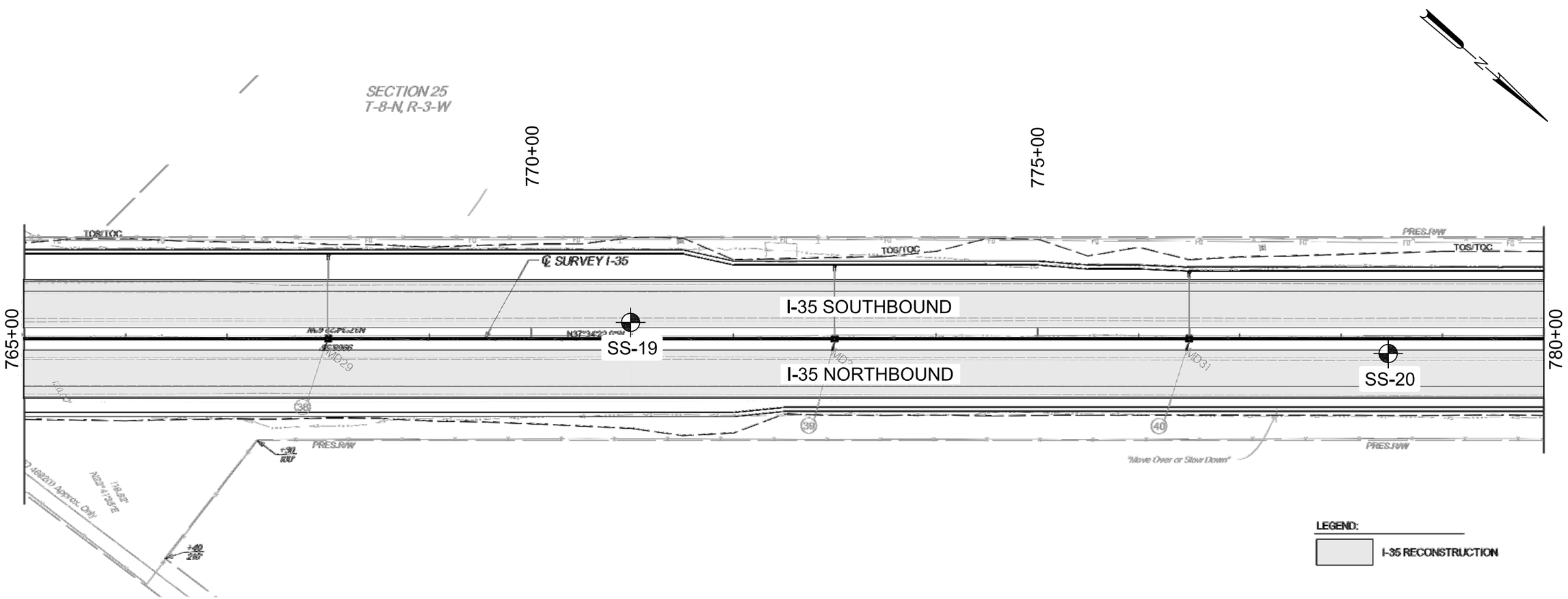

Boring	Station	I-35 CL Survey
SS-19	770+99	15' left
SS-20	778+47	14' right

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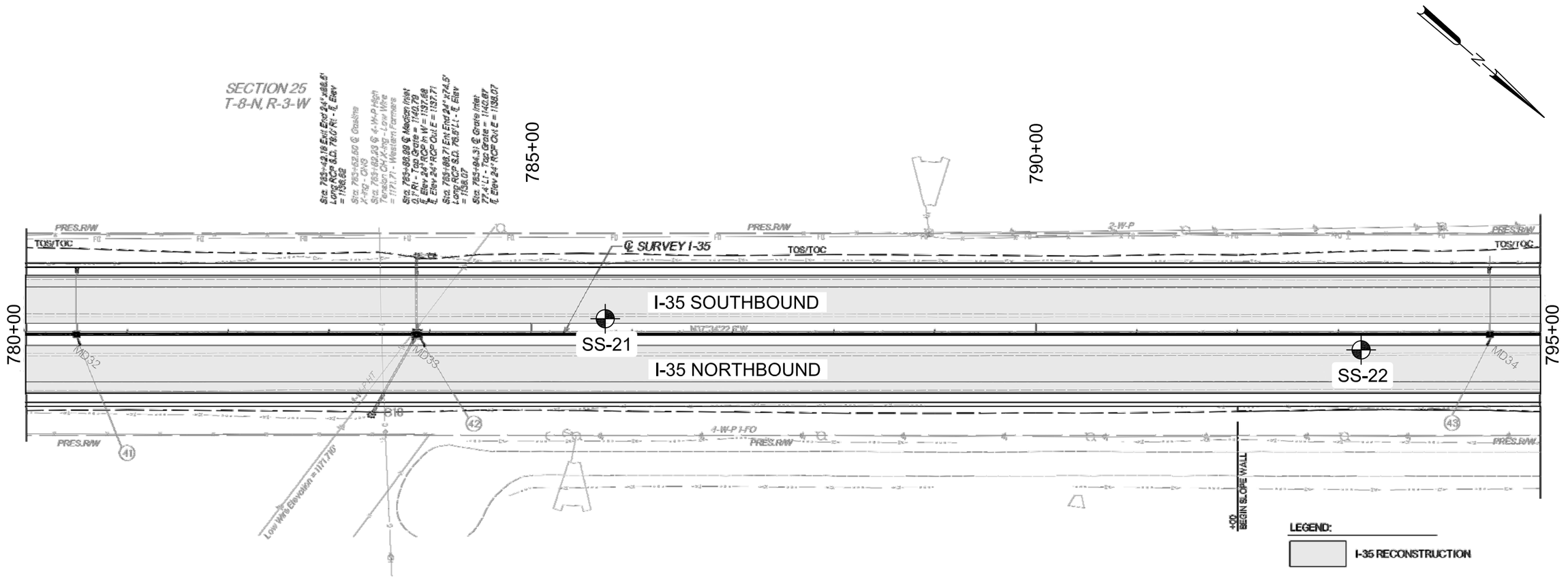

Boring	Station	I-35 CL Survey
SS-21	785+74	15' left
SS-22	793+23	15' right

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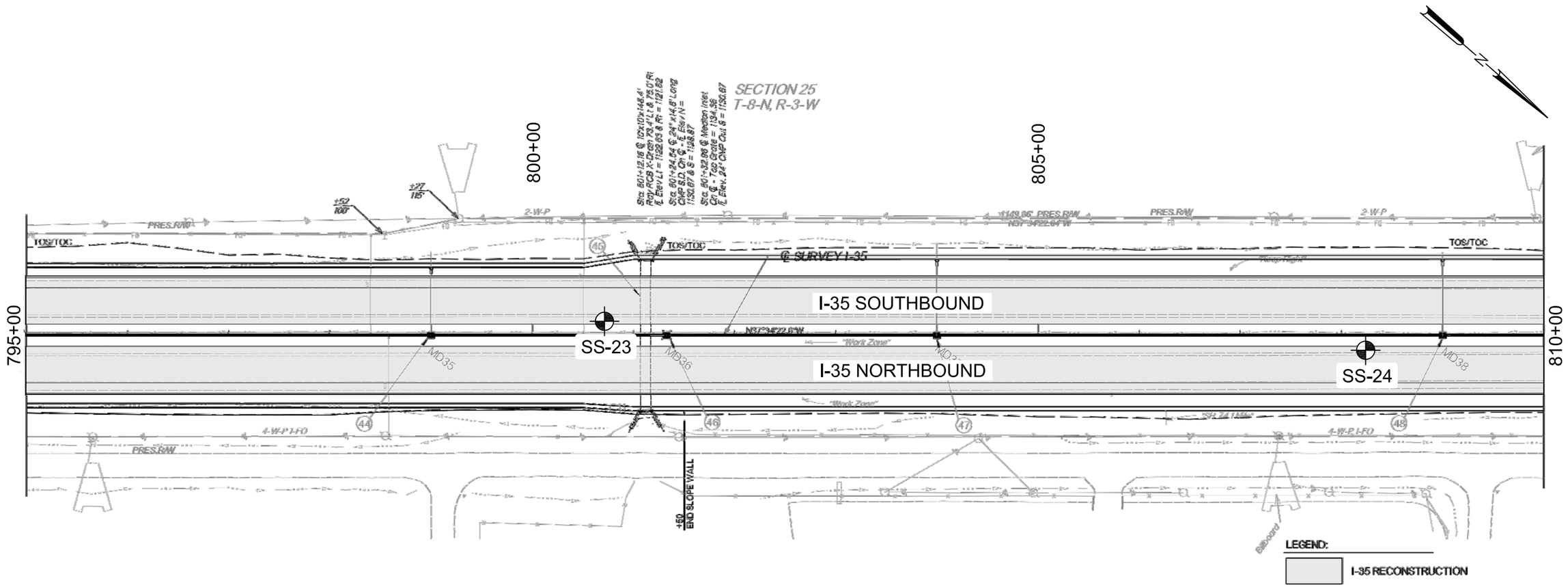

Boring	Station	I-35 CL Survey
SS-23	800+72	15' left
SS-24	808+25	15' right

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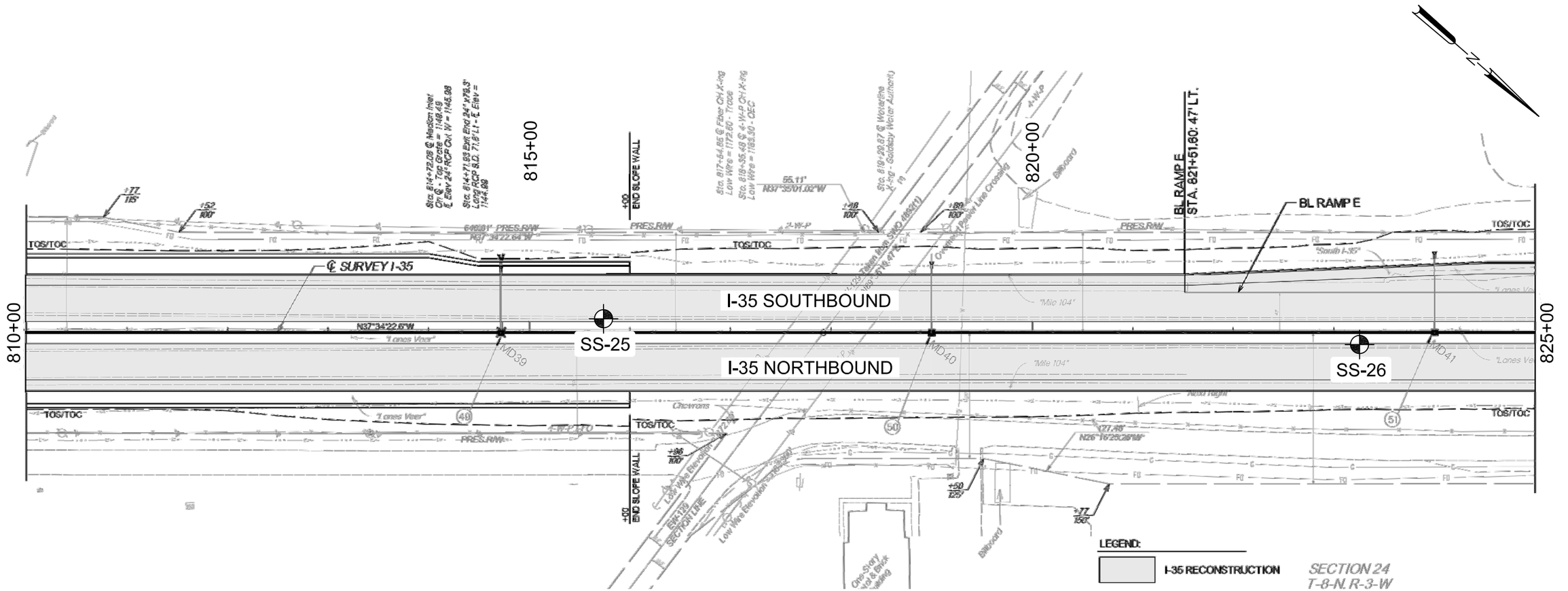

SECTION 24
T-8-N, R-3-W

Boring	Station	I-35 CL Survey
SS-25	815+75	13' left
SS-26	823+26	12' right

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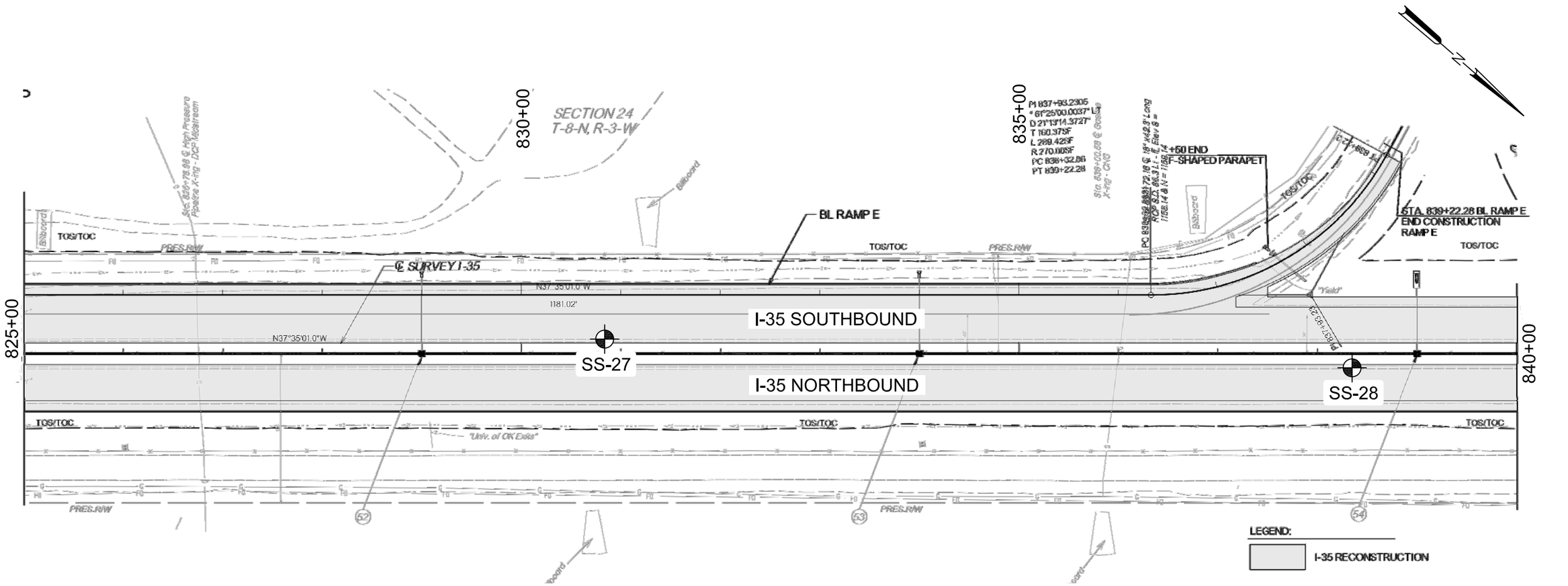

Boring	Station	I-35 CL Survey
SS-27	830+84	14' left
SS-28	838+36	14' right

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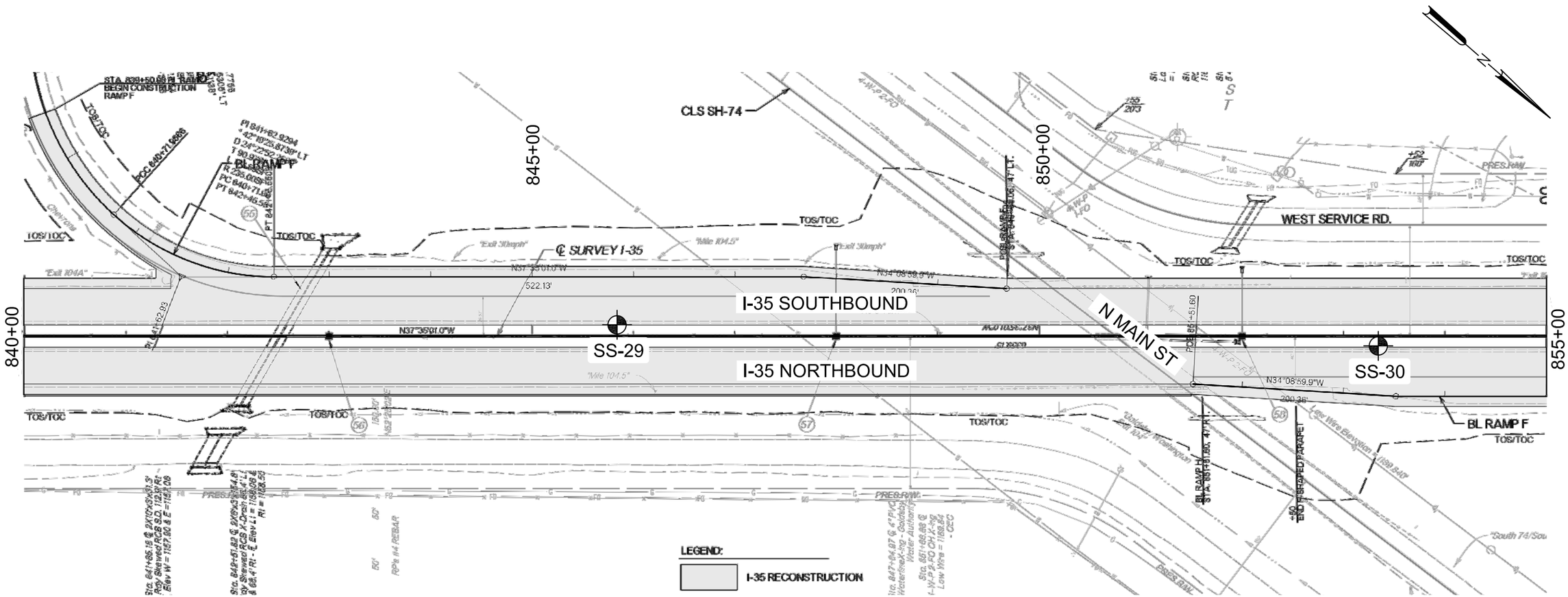

Boring	Station	I-35 CL Survey
SS-29	845+85	11' left
SS-30	853+35	10' right

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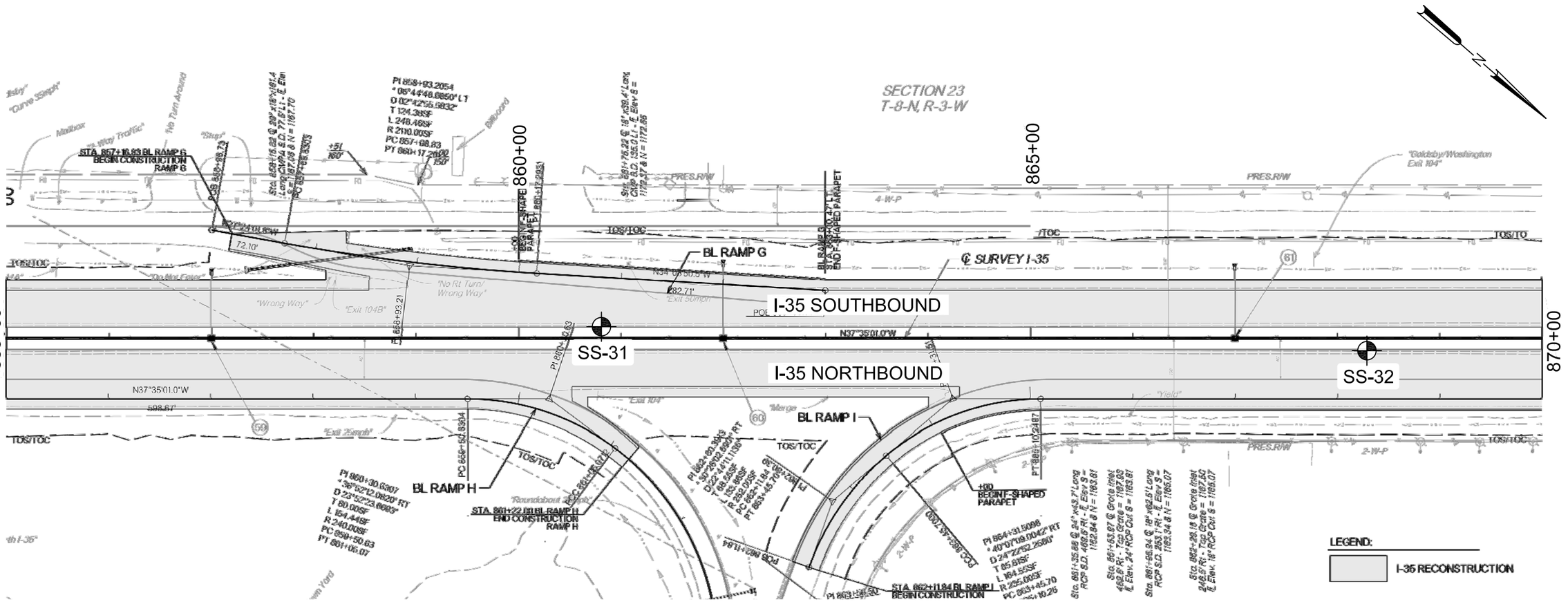

Boring	Station	I-35 CL Survey
SS-31	860+82	11' left
SS-32	868+30	12' right

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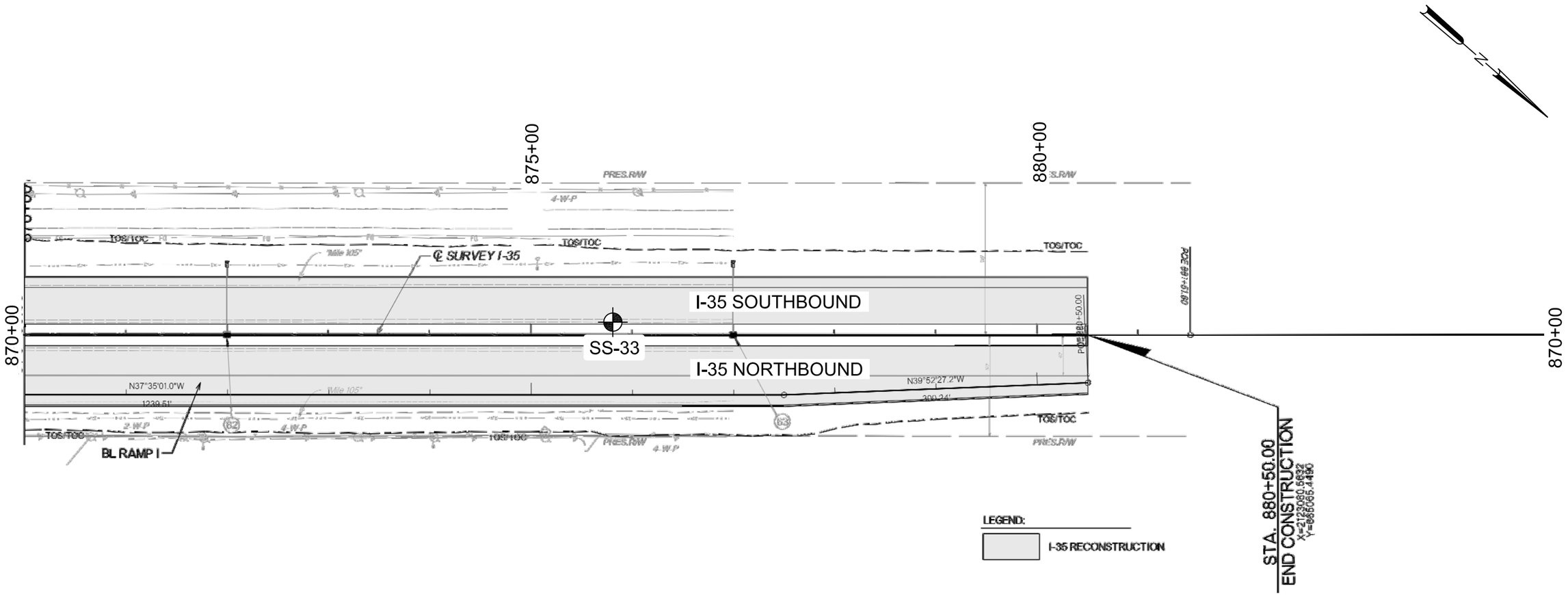
I-35 SHOULDER SURVEY
MCCLAIN COUNTY, OKLAHOMA
J/P 35589(04)

Project Mngr:	EDC	RRC Project No.	22117
Designed By:	DLW	Scale:	NOT TO SCALE
Checked By:	JWB	Date:	12/14/2022
Approved By:	JWB	Page No:	16/17



Boring	Station	I-35 CL Survey
SS-33	875+81	12' left

Stations and offsets estimated from plans provided by Olsson Associates

RED ROCK CONSULTING
PO Box 30591
Edmond, Oklahoma 73003
(405) 562-3328

BORING LOCATION DIAGRAM
I-35 SHOULDER SURVEY
MCCLAIN COUNTY, OKLAHOMA
J/P 35589(04)

Project Mngr:	EDC	RRC Project No.	22117
Designed By:	DLW	Scale:	NOT TO SCALE
Checked By:	JWB	Date:	12/14/2022
Approved By:	JWB	Page No:	17/17

APPENDIX B

Surveyed By: Dawson Wiseman
Date Surveyed: December 12 to 16, 2022

RED ROCK CONSULTING

RRC Project No: 22117
Project No: 35589(04)
Location: McClain County, Oklahoma

Shoulder Soils Survey

Boring	Field No.	Soil Group	Approximate Station (I-35 CL Survey)	Description	Depth (in)	L.L.	P.I.	Percent Passing						OSI	MC %	Soluble Sulfates (ppm)
								3 in	3/4 in	#4	#10	#40	#200			
SS-1	1A		636+13, 11' left	**POSSIBLE FILL, SIMILAR AS 6A,** dark reddish brown	0-6										22	
	1B			**SIMILAR AS 6A,** dark reddish brown	6-30										16	
	1C	A-4(0)		**SILTY SAND (SM),** reddish brown	30-36	NV	NP	100	100	96	92	82	49.7	0	15	<200
SS-2	2A		643+60, 15' right	**SIMILAR AS 8B,** dark brown	0-6										15	
	2B	A-6(9)		**LEAN CLAY with SAND (CL),** reddish brown	6-24	32	16	100	100	98	95	87	70.3	12	14	<200
	2C			**SIMILAR AS 2B,** red	24-36										14	
SS-3	3A		651+12, 13' left	**SIMILAR AS 9B,** dark reddish brown	0-6										22	
	3B	A-6(4)		**SANDY LEAN CLAY (CL),** reddish brown	6-30	29	12	100	100	89	85	76	57.9	8	16	276
	3C			**SIMILAR AS 1C,** reddish brown	30-36										15	
Bulk 1		A-6(5)		**SANDY LEAN CLAY (CL),** reddish brown	6-30	33	14	100	100	93	88	77	55.3	9		
SS-4	4A		658+63, 14' right	**SIMILAR AS 6A,** dark brown	0-6										9	
	4B	A-6(11)		**LEAN CLAY with SAND (CL),** reddish brown	6-36	33	17	100	100	98	95	89	77.3	13	16	<200
SS-5	5A		666+10, 13' left	**POSSIBLE FILL, SIMILAR AS 6A ,** dark reddish brown	0-6										14	
	5B			**SIMILAR AS 6A,** dark reddish brown	6-24										12	
	5C	A-4(0)		**SILTY SAND (SM),** light brown	24-36	NV	NP	100	100	96	92	80	42.4	0	17	<200
Bulk 2		A-4(0)		**SILTY SAND (SM),** light brown	24-36	NV	NP	100	100	92	87	77	37.7	0		
SS-6	6A	A-2-4	673+46, 14' right	**SILTY SAND with GRAVEL (SM),** dark brown	0-6	NV	NP	100	100	83	75	63	34.0	0	12	<200
	6B			**SIMILAR AS 3B,** reddish brown	6-18										15	
				*Auger refusal at 18 inches												
SS-7	7A		680+98, 13' left	**SIMILAR AS 6A,** reddish brown	0-6										14	
	7B	A-6(2)		**CLAYEY SAND (SC),** reddish brown	6-18	27	13	100	100	88	81	70	45.3	6	13	1235
				*Auger refusal at 18 inches												
SS-8	8A		688+52, 10' right	**SIMILAR AS 8B,** dark brown	0-6										15	
	8B	A-4(0)		**CLAYEY SAND with GRAVEL (SC),** reddish brown	6-12	27	10	100	100	77	70	60	38.2	3	13	934
				*Auger refusal at 12 inches												
SS-9	9A		695+95, 11' right	**SIMILAR AS 9B,** brown	0-6										16	
	9B	A-4(0)		**SILTY, CLAYEY SAND (SC-SM),** brown	6-24	25	6	100	100	86	78	67	41.8	3	17	700
				*Auger refusal at 24 inches												
SS-10	10A		703+42, 10' right	**SIMILAR AS 10B,** dark brown	0-6										17	
	10B	A-4(0)		**SILTY, CLAYEY SAND (SC-SM),** brown	6-36	23	7	100	100	91	84	75	45.7	3	14	1171
Bulk 4		A-4(0)		**SILTY, CLAYEY SAND (SC-SM),** brown	6-36	21	4	100	100	94	90	78	46.2	2		

Surveyed By: Dawson Wiseman
Date Surveyed: December 12 to 16, 2022

RED ROCK CONSULTING

RRC Project No: 22117
Project No: 35589(04)
Location: McClain County, Oklahoma

Shoulder Soils Survey

Boring	Field No.	Soil Group	Approximate Station (I-35 CL Survey)	Description	Depth (in)	L.L.	P.I.	Percent Passing						OSI	MC %	Soluble Sulfates (ppm)
								3 in	3/4 in	#4	#10	#40	#200			
SS-11	11A		710+92, 14' left	**POSSIBLE FILL, SIMILAR AS 17A,** dark reddish brown	0-6										18	
	11B			**SIMILAR AS 13B,** reddish brown	6-33										16	
	11C	A-4(0)		**SILTY SAND (SM),** reddish brown	33-36	NV	NP	100	100	99	96	86	44.8	0	14	355
SS-12	12A		718+40, 13' right	**SIMILAR AS 6A,** dark brown	0-6										18	
	12B			**SIMILAR AS 14C,** reddish brown	6-18										17	
	12C	A-6(10)		**LEAN CLAY with SAND (CL),** dark brown	18-36	32	16	100	100	98	94	88	75.5	13	15	<200
SS-13	13A		725+92, 15' left	**POSSIBLE FILL, SIMILAR AS 17A,** reddish brown	0-6										28	
	13B	A-6(11)		**LEAN CLAY with SAND (CL),** reddish brown	6-30	33	19	100	100	96	94	87	70.4	13	17	<200
	13C			**SIMILAR AS 10B,** light brown	30-36										13	
SS-14	14A		733+40, 14' right	**SIMILAR AS 18C,** dark brown	0-6										22	
	14B			**SIMILAR AS 14C,** red	6-24										17	
	14C	A-4(2)		**SANDY LEAN CLAY (CL),** reddish brown	24-36	25	9	100	100	98	93	82	55.5	6	14	<200
SS-15	15A		740+89, 14' left	**SIMILAR AS 16B,** dark brown	0-6										24	
	15B			**SIMILAR AS 14C,** brown	6-24										19	
	15C	A-4(0)		**SILTY SAND (SM),** reddish brown	24-36	NV	NP	100	100	99	96	85	42.9	0	16	<200
SS-16	16A		748+34, 15' right	**SIMILAR AS 16B,** reddish brown	0-6										12	
	16B	A-6(4)		**SANDY LEAN CLAY (CL),** reddish brown	6-24	28	13	100	100	95	88	74	52.9	8	13	<200
	16C			**SIMILAR AS 15C,** reddish brown	24-36										12	
SS-17	17A	A-6(1)	755+82, 15' left	**POSSIBLE FILL, CLAYEY SAND with GRAVEL (SC),** dark brown	0-6	34	11	100	100	77	70	58	40.0	5	18	<200
	17B			**SIMILAR AS 10B,** dark brown	6-30										14	
	17C			**SIMILAR AS 15C,** reddish brown	30-36										14	
SS-18	18A		764+05, 14' right	**SIMILAR AS 17A,** reddish brown	0-6										20	
	18B			**SIMILAR AS 14C,** reddish brown	6-24										13	
	18C	A-4(1)		**SANDY SILTY CLAY (CL-ML),** reddish brown	24-36	23	5	100	100	98	96	90	59.0	5	14	<200
Bulk 3		A-4(0)		**SANDY SILTY CLAY (CL-ML),** reddish brown	24-36	20	5	100	100	93	88	80	62.3	5		
SS-19	19A		770+99, 15' left	**SIMILAR AS 17A,** dark brown	0-6										25	
	19B	A-4(1)		**SANDY SILTY CLAY (CL-ML),** reddish brown	6-36	21	7	100	100	99	97	86	51.0	4	13	<200
SS-20	20A	A-6(6)	778+47, 14' right	**SANDY LEAN CLAY (CL),** dark brown	0-6	32	12	100	100	97	94	85	65.8	10	11	<200
	20B			**SIMILAR AS 21B,** brown	6-24										15	
	20C			**SIMILAR AS 15C,** brown	24-36										12	

Surveyed By: Dawson Wiseman
Date Surveyed: December 12 to 16, 2022

RED ROCK CONSULTING

RRC Project No: 22117
Project No: 35589(04)
Location: McClain County, Oklahoma

Shoulder Soils Survey

Boring	Field No.	Soil Group	Approximate Station (I-35 CL Survey)	Description	Depth (in)	L.L.	P.I.	Percent Passing						OSI	MC %	Soluble Sulfates (ppm)
								3 in	3/4 in	#4	#10	#40	#200			
SS-21	21A		785+74, 15' left	**SIMILAR AS 20A,** reddish brown	0-6										25	
	21B	A-4(2)		**SANDY SILTY CLAY (CL-ML),** reddish brown	6-18	27	7	100	100	86	82	76	56.0	6	14	<200
	21C			**SIMILAR AS 15C,** reddish brown	18-36										15	
SS-22	22A		793+23, 15' right	**SIMILAR AS 24A,** dark brown	0-6										17	
	22B			**SIMILAR AS 21B,** brown	6-24										14	
	22C	A-4(0)		**SANDY SILT (ML),** reddish brown	24-36	NV	NP	100	100	97	95	85	51.4	0	13	<200
SS-23	23A		800+72, 15' left	**SIMILAR AS 20A,** dark brown	0-6										24	
	23B	A-4(2)		**SANDY LEAN CLAY (CL),** reddish brown	6-30	26	8	100	100	91	87	79	58.8	6	13	<200
	23C			**SIMILAR AS 15C,** reddish brown	30-36										13	
SS-24	24A	A-6(7)	808+25, 15' right	**SANDY LEAN CLAY with GRAVEL (CL),** dark brown	0-6	39	17	100	100	83	80	72	57.2	11	19	<200
	24B			**SIMILAR AS 23B,** brown	6-30										16	
	24C			**SIMILAR AS 22C,** reddish brown	30-36										13	
SS-25	25A	A-6(12)	815+75, 13' left	**LEAN CLAY with SAND (CL),** dark brown	0-6	37	18	100	100	100	96	88	73.1	14	24	<200
	25B			**SIMILAR AS 26B,** reddish brown	6-24										17	
	25C			**SIMILAR AS 22C,** reddish brown	24-36										13	
SS-26	26A		823+26, 12' right	**SIMILAR AS 26B,** reddish brown	0-6										17	
	26B	A-6(12)		**LEAN CLAY with SAND (CL),** reddish brown	6-30	34	19	100	100	99	97	90	75.7	14	15	<200
	26C			**SIMILAR AS 29C,** brown	30-36										7	
SS-27	27A		830+84, 14' left	**SIMILAR AS 29C,** dark brown	0-6										14	
	27B			**SIMILAR AS 29C,** dark brown	6-24										10	
	27C	A-2-4		**SILTY SAND with GRAVEL (SM),** light brown	24-36	NV	NP	100	100	81	77	68	30.1	0	11	<200
SS-28	28A		838+36, 14' right	**SIMILAR AS 29C,** dark brown	0-6										27	
	28B	A-4(3)		**SANDY LEAN CLAY (CL),** reddish brown	6-24	24	8	100	100	99	95	88	68.8	7	14	<200
	28C			**SIMILAR AS 29C,** light brown	24-36										12	
SS-29	29A		845+85, 11' left	**SIMILAR AS 20A,** dark brown	0-6										21	
	29B			**SIMILAR AS 21B,** reddish brown	6-30										16	
	29C	A-4(0)		**SILTY SAND with GRAVEL (SM),** reddish brown	30-36	NV	NP	100	100	78	77	72	45.0	0	12	<200
SS-30	30A	A-7-6(16)	853+35, 10' right	**LEAN CLAY with SAND (CL),** reddish brown	0-6	41	22	100	100	97	94	86	76.4	17	20	<200
	30B			**SIMILAR AS 30A,** reddish brown	6-30										16	
	30C			**SIMILAR AS 29C,** brown	30-36										16	

Surveyed By: Dawson Wiseman
Date Surveyed: December 12 to 16, 2022

RED ROCK CONSULTING

RRC Project No: 22117
Project No: 35589(04)
Location: McClain County, Oklahoma

Shoulder Soils Survey

Boring	Field No.	Soil Group	Approximate Station (I-35 CL Survey)	Description	Depth (in)	L.L.	P.I.	Percent Passing						OSI	MC %	Soluble Sulfates (ppm)
								3 in	3/4 in	#4	#10	#40	#200			
SS-31	31A		860+82, 11' left	**SANDY LEAN CLAY (CL),** dark brown	0-6	25	10	100	100	93	90	83	63.3	8	15	393
	31B			**SIMILAR AS 31A,** dark brown	6-18										20	
	31C			**SIMILAR AS 21B,** reddish brown	18-30										16	
	31D			**SIMILAR AS 29C,** reddish brown	30-36										13	
SS-32	32A		868+30, 12' right	**SIMILAR AS 31A,** dark brown	0-6										20	
	32B	A-6(16)		**LEAN CLAY with SAND (CL),** reddish brown	6-30	39	21	100	100	97	95	88	80.1	16	17	<200
	32C			**SIMILAR AS 19B,** reddish brown	30-36										16	
SS-33	33A	A-4(4)	875+81, 12' left	**LEAN CLAY with SAND (CL),** dark brown	0-6	26	8	100	100	100	97	90	77.6	8	19	320
	33B			**SIMILAR AS 26B,** reddish brown	6-30										14	
	33C			**SIMILAR AS 27C,** reddish brown	30-36										17	

APPENDIX C

RED ROCK CONSULTING
PO Box 30591
Edmond, OK 73003
405-562-3328

SUMMARY OF LABORATORY RESULTS

CLIENT Olsson Associates

PROJECT NAME I-35 Shoulder Soils Survey 35589(04)

PROJECT NUMBER 22117

PROJECT LOCATION McClain County, Oklahoma

Borehole	Depth (in)	% Moist.	Liquid Limit	Plastic Limit	Plasticity Index	-3" Sieve	- 3/4" Sieve	-4 Sieve	-10 Sieve	-40 Sieve	-200 Sieve	Sulfates (ppm)
Bulk 01	6-30		33	19	14	100	100	93	88	77	55.3	
Bulk 02	24-36		NV	NP	NP	100	100	92	87	77	37.7	
Bulk 03	24-36		20	15	5	100	100	93	88	80	62.3	
Bulk 04	6-36		21	17	4	100	100	94	90	78	46.2	
SS-01	0-6	21.7										
SS-01	6-30	15.6										
SS-01	30-36	15.4	NV	NP	NP	100	100	96	92	82	49.7	<200
SS-02	0-6	15.4										
SS-02	6-24	14.4	32	16	16	100	100	98	95	87	70.3	<200
SS-02	24-36	13.8										
SS-03	0-6	21.7										
SS-03	6-30	15.5	29	17	12	100	100	89	85	76	57.9	276
SS-03	30-36	14.5										
SS-04	0-6	8.7										
SS-04	6-36	15.6	33	16	17	100	100	98	95	89	77.3	<200
SS-05	0-6	13.7										
SS-05	6-24	12.4										
SS-05	24-36	17.0	NV	NP	NP	100	100	96	92	80	42.4	<200
SS-06	0-6	12.3	NV	NP	NP	100	100	83	75	63	34.0	<200
SS-06	6-18	15.2										
SS-07	0-6	13.5										
SS-07	6-18	13.4	27	14	13	100	100	88	81	70	45.3	1235
SS-08	0-6	14.5										
SS-08	6-12	12.5	27	17	10	100	100	77	70	60	38.2	934
SS-09	0-6	16.2										
SS-09	6-24	16.6	25	19	6	100	100	86	78	67	41.8	700
SS-10	0-6	16.6										
SS-10	6-36	13.5	23	16	7	100	100	91	84	75	45.7	1171
SS-11	0-6	18.4										
SS-11	6-33	15.7										
SS-11	33-36	14.4	NV	NP	NP	100	100	99	96	86	44.8	355
SS-12	0-6	18.2										
SS-12	6-18	16.5										
SS-12	18-36	15.1	32	16	16	100	100	98	94	88	75.5	<200
SS-13	0-6	28.8										
SS-13	6-30	16.5	33	14	19	100	100	96	94	87	70.4	<200
SS-13	30-36	12.9										
SS-14	0-6	22.0										
SS-14	6-24	17.0										
SS-14	24-36	14.2	25	16	9	100	100	98	93	82	55.5	<200
SS-15	0-6	24.4										
SS-15	6-24	18.9										
SS-15	24-36	15.6	NV	NP	NP	100	100	99	96	85	42.9	<200

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SUMMARY OF LABORATORY RESULTS

CLIENT Olsson Associates **PROJECT NAME** I-35 Shoulder Soils Survey 35589(04)

PROJECT NUMBER 22117 **PROJECT LOCATION** McClain County, Oklahoma

Borehole	Depth (in)	% Moist.	Liquid Limit	Plastic Limit	Plasticity Index	-3" Sieve	- 3/4" Sieve	-4 Sieve	-10 Sieve	-40 Sieve	-200 Sieve	Sulfates (ppm)
SS-16	0-6	12.3										
SS-16	6-24	13.0	28	15	13	100	100	95	88	74	52.9	<200
SS-16	24-36	11.6										
SS-17	0-6	18.0	34	23	11	100	100	77	70	58	40.0	<200
SS-17	6-30	14.0										
SS-17	30-36	13.5										
SS-18	0-6	19.7										
SS-18	6-24	13.0										
SS-18	24-36	14.1	23	17	6	100	100	98	96	90	59.0	<200
SS-19	0-6	24.8										
SS-19	6-36	13.2	21	14	7	100	100	99	97	86	51.0	<200
SS-20	0-6	11.1	32	20	12	100	100	97	94	85	65.8	<200
SS-20	6-24	14.9										
SS-20	24-36	11.7										
SS-21	0-6	25.1										
SS-21	6-18	14.2	27	20	7	100	100	86	82	76	56.0	<200
SS-21	18-36	14.7										
SS-22	0-6	16.9										
SS-22	6-24	13.8										
SS-22	24-36	12.8	NV	NP	NP	100	100	97	95	85	51.4	<200
SS-23	0-6	23.8										
SS-23	6-30	13.3	26	18	8	100	100	91	87	79	58.8	<200
SS-23	30-36	12.5										
SS-24	0-6	18.7	39	22	17	100	100	83	80	72	57.2	<200
SS-24	6-30	15.8										
SS-24	30-36	12.6										
SS-25	0-6	23.8	37	19	18	100	100	100	96	88	73.1	<200
SS-25	6-24	16.9										
SS-25	24-36	12.9										
SS-26	0-6	16.7										
SS-26	6-30	14.7	34	15	19	100	100	99	97	90	75.7	<200
SS-26	30-36	6.7										
SS-27	0-6	13.8										
SS-27	6-24	10.1										
SS-27	24-36	10.5	NV	NP	NP	100	100	81	77	68	30.1	<200
SS-28	0-6	27.3										
SS-28	6-24	14.1	24	16	8	100	100	99	95	88	68.8	<200
SS-28	24-36	12.1										
SS-29	0-6	21.2										
SS-29	6-30	15.9										
SS-29	30-36	11.6	NV	NP	NP	100	100	78	77	72	45.0	<200
SS-30	0-6	20.2	41	19	22	100	100	97	94	86	76.4	<200
SS-30	6-30	15.8										

RED ROCK CONSULTING
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SUMMARY OF LABORATORY RESULTS

CLIENT Olsson Associates **PROJECT NAME** I-35 Shoulder Soils Survey 35589(04)

PROJECT NUMBER 22117 **PROJECT LOCATION** McClain County, Oklahoma

Borehole	Depth (in)	% Moist.	Liquid Limit	Plastic Limit	Plasticity Index	-3" Sieve	- 3/4" Sieve	-4 Sieve	-10 Sieve	-40 Sieve	-200 Sieve	Sulfates (ppm)
SS-30	30-36	15.7										
SS-31	0-6	14.9	25	15	10	100	100	93	90	83	63.3	393
SS-31	6-18	20.3										
SS-31	18-30	26.2										
SS-31	30-36	12.9										
SS-32	0-6	19.5										
SS-32	6-30	17.2	39	18	21	100	100	97	95	88	80.1	<200
SS-32	30-36	16.1										
SS-33	0-6	18.9	26	18	8	100	100	100	97	90	77.6	320
SS-33	6-30	13.9										
SS-33	30-36	16.6										

RED ROCK CONSULTING

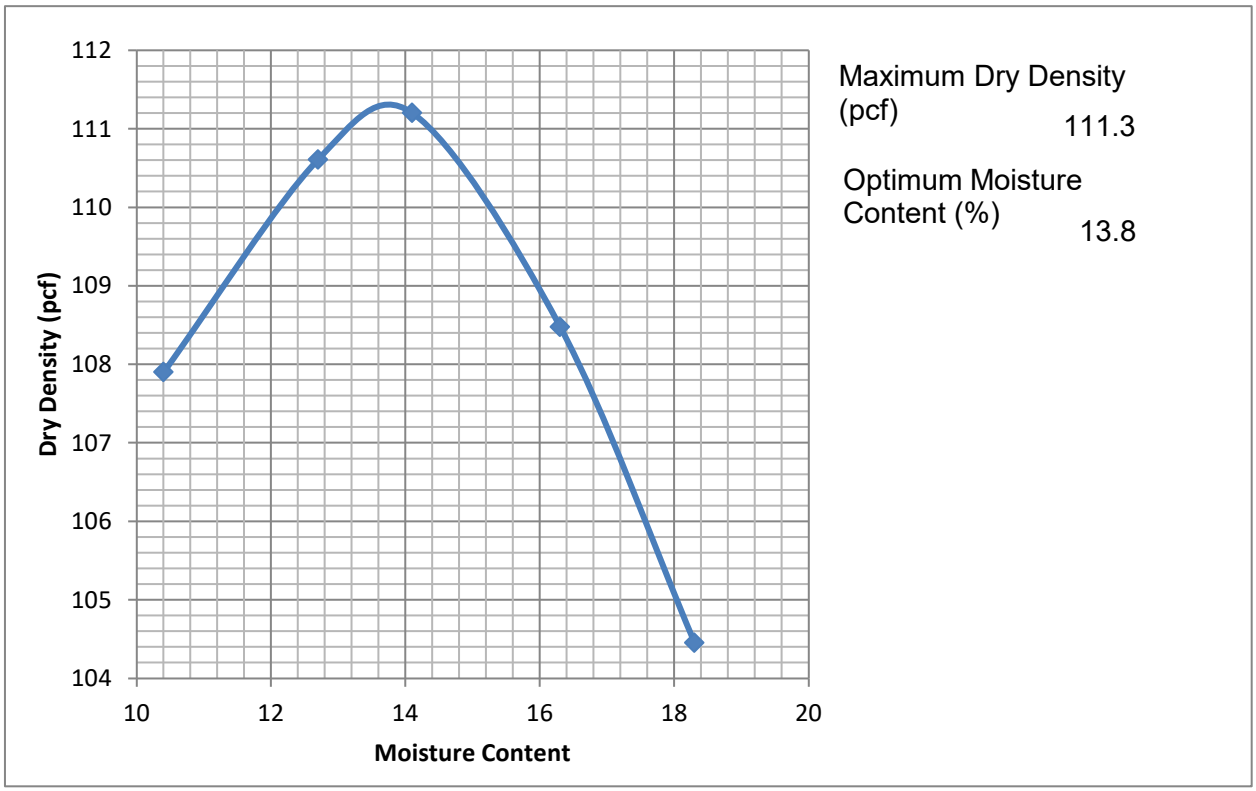
Proctor

Project #: 22117 Project Name: I-35 Shoulder Soils Survey 35589(04)

Tested By: CP Test Date: 6.12.23 Client: Olsson Associates

Weight of Hammer: 5.5 No. of Blows: 25

Bulk 1



Liquid Limit: 33 USCS CL

Plasticity Index: 14 AASHTO A-6(5)

Method: A Soil Classification: Sandy Lean Clay

Resilient Modulus of Subgrade Soils (Recompacted Samples)

1. Project Number I-35 Shoulder Soils Survey 35589(04)
2. County//State Name McClain // Oklahoma
3. Test Date 6/19/2023

4.Sample Number Bulk 1 (Compacted @ OMC)
5. Material Type 2
6. Soil Series n/a
7. Horizon n/a

9. Soil Properties

Optimum Moisture Content, (%)	13.80
Maximum Dry Density, pcf	111.30
95% MDD (pcf)	105.74

8. Specimen Properties

Compaction Water content, wc, %	13.95
Compaction Dry Density, pcf	106.23
Moisture Content After Mr Test, w(%)	13.67
Permanent Deformation (in)	0.065

10. Test Information

Preconditioning-Permanent Strain>5%	No
Testing-Permanent Strain >5%	No
Number of Load Sequences Completed	15
Quick Shear Test	No

Column #	1	2	3	4	5	6	7	8	9	10	11	12	13
Parameter	Chamber Confining Pressure	Nominal Maximum Axial Stress	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT # 1 Reading	Recov. Def. LVDT # 2 Reading	Average Recov. Def. LVDT 1 & 2	Resilient Strain	Resilient Modulus
Designation	S3	Scyclic	Pmax	Pcyclic	Pcontact	Smax	Scyclic	Scontact	H1	H2	Havg	er	Mr
Unit	psi	psi	lbs	lbs	lbs	psi	psi	psi	in	in	in	in/in	psi
Precision	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequence 1	6	2	24.99	22.73	2.26	1.99	1.81	0.18	0.0011	0.0012	0.0011	0.00014	12784
Sequence 2	6	4	50.11	45.22	4.90	3.99	3.60	0.39	0.0022	0.0024	0.0023	0.00029	12303
Sequence 3	6	6	75.36	67.70	7.66	6.00	5.39	0.61	0.0035	0.0039	0.0037	0.00046	11782
Sequence 4	6	8	100.10	90.06	10.05	7.97	7.17	0.80	0.0050	0.0055	0.0053	0.00066	10898
Sequence 5	6	10	124.97	112.91	12.06	9.95	8.99	0.96	0.0068	0.0075	0.0071	0.00089	10102
Sequence 6	4	2	25.12	22.73	2.39	2.00	1.81	0.19	0.0012	0.0013	0.0012	0.00015	11782
Sequence 7	4	4	50.74	45.47	5.28	4.04	3.62	0.42	0.0026	0.0028	0.0027	0.00034	10738
Sequence 8	4	6	75.23	67.95	7.28	5.99	5.41	0.58	0.0039	0.0043	0.0041	0.00051	10537
Sequence 9	4	8	100.35	90.31	10.05	7.99	7.19	0.80	0.0055	0.0060	0.0057	0.00072	10009
Sequence 10	4	10	125.85	113.17	12.69	10.02	9.01	1.01	0.0070	0.0077	0.0074	0.00092	9787
Sequence 11	2	2	24.87	22.73	2.14	1.98	1.81	0.17	0.0012	0.0014	0.0013	0.00016	11201
Sequence 12	2	4	50.49	45.47	5.02	4.02	3.62	0.40	0.0027	0.0029	0.0028	0.00035	10211
Sequence 13	2	6	75.23	67.70	7.54	5.99	5.39	0.60	0.0042	0.0046	0.0044	0.00055	9823
Sequence 14	2	8	100.61	90.43	10.17	8.01	7.20	0.81	0.0058	0.0064	0.0061	0.00076	9444
Sequence 15	2	10	125.35	113.17	12.18	9.98	9.01	0.97	0.0075	0.0083	0.0079	0.00099	9102

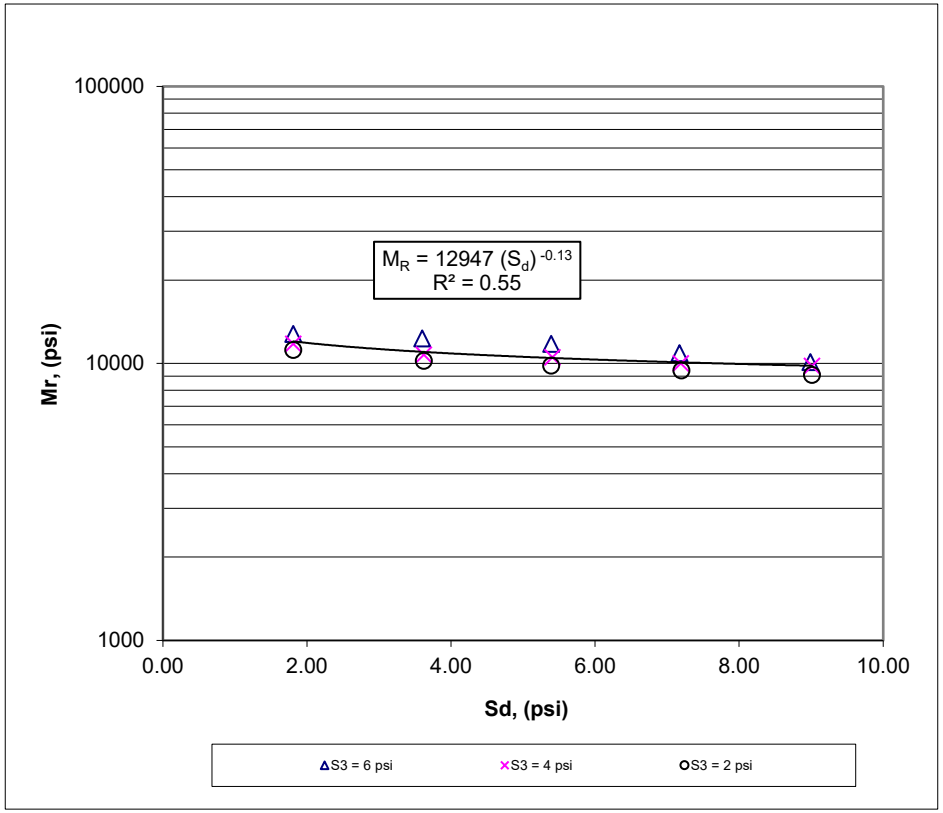
* Reported results are based on the average of the last 5 cycles of each load sequence

Resilient Modulus of Subgrade Soils (Recompacted Samples)

(Plot)

1. Sample Number	Bulk 1 (Compacted @ OMC)
2. Material Type	2
3. Soil Series	n/a
4. Horizon	n/a
5. Test Date	6/19/2023

Column #	1	**2**	3	4	**5**
Parameter	Chamber Confining Pressure	**Desired Applied Cyclic Stress**	Actual Applied Cyclic Stress	Actual Resilient Modulus	**Predicted Resilient Modulus***
Designation	S3	**Scyclic**	Scyclic	Mr	**Mr**
Unit	psi	**psi**	psi	psi	**psi**
Precision	—	**—**	—	—	**—**
Sequence 1	6	**1.80**	1.81	12784	**12021**
Sequence 2	6	**3.60**	3.60	12303	**11014**
Sequence 3	6	**5.40**	5.39	11782	**10464**
Sequence 4	6	**7.20**	7.17	10898	**10091**
Sequence 5	6	**9.00**	8.99	10102	**9811**
Sequence 6	4	**1.80**	1.81	11782	**12021**
Sequence 7	4	**3.60**	3.62	10738	**11014**
Sequence 8	4	**5.40**	5.41	10537	**10464**
Sequence 9	4	**7.20**	7.19	10009	**10091**
Sequence 10	4	**9.00**	9.01	9787	**9811**
Sequence 11	2	**1.80**	1.81	11201	**12021**
Sequence 12	2	**3.60**	3.62	10211	**11014**
Sequence 13	2	**5.40**	5.39	9823	**10464**
Sequence 14	2	**7.20**	7.20	9444	**10091**
Sequence 15	2	**9.00**	9.01	9102	**9811**
*Predicted Mr values at the desired applied cyclic stresses using Model #1					



Model #1; $Mr = K1 \times Sd^{K2}$

S3 (psi)	K1	K2	R^2
6	14297	-0.14	0.86
4	12568	-0.11	0.98
2	12066	-0.13	1.00
All	12947	-0.13	0.55

Resilient Modulus of Subgrade Soils (Recompacted Samples)

1. Project Number I-35 Shoulder Soils Survey 35589(04)
2. County//State Name McClain // Oklahoma
3. Test Date 6/19/2023

4.Sample Number Bulk 1 (Compacted @ Wetter than OMC)
5. Material Type 2
6. Soil Series n/a
7. Horizon n/a

9. Soil Properties

Optimum Moisture Content, (%)	13.80
Maximum Dry Density, pcf	111.30
95% MDD (pcf)	105.74

8. Specimen Properties

Compaction Water content, wc, %	16.87
Compaction Dry Density, pcf	107.23
Moisture Content After Mr Test, w(%)	17.01
Permanent Deformation (in)	0.300

10. Test Information

Preconditioning-Permanent Strain>5%	No
Testing-Permanent Strain >5%	No
Number of Load Sequences Completed	15
Quick Shear Test	No

Column #	1	2	3	4	5	6	7	8	9	10	11	12	13
Parameter	Chamber Confining Pressure	Nominal Maximum Axial Stress	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT # 1 Reading	Recov. Def. LVDT # 2 Reading	Average Recov. Def. LVDT 1 & 2	Resilient Strain	Resilient Modulus
Designation	S3	Scyclic	Pmax	Pcyclic	Pcontact	Smax	Scyclic	Scontact	H1	H2	Havg	er	Mr
Unit	psi	psi	lbs	lbs	lbs	psi	psi	psi	in	in	in	in/in	psi
Precision	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequence 1	6	2	25.12	22.73	2.39	2.00	1.81	0.19	0.0022	0.0020	0.0021	0.00027	6786
Sequence 2	6	4	49.99	45.47	4.52	3.98	3.62	0.36	0.0052	0.0048	0.0050	0.00063	5787
Sequence 3	6	6	74.61	67.70	6.91	5.94	5.39	0.55	0.0085	0.0077	0.0081	0.00101	5320
Sequence 4	6	8	99.98	90.06	9.92	7.96	7.17	0.79	0.0124	0.0110	0.0117	0.00146	4898
Sequence 5	6	10	125.35	113.17	12.18	9.98	9.01	0.97	0.0162	0.0147	0.0154	0.00193	4667
Sequence 6	4	2	24.74	22.61	2.14	1.97	1.80	0.17	0.0023	0.0021	0.0022	0.00027	6554
Sequence 7	4	4	50.37	45.22	5.15	4.01	3.60	0.41	0.0056	0.0050	0.0053	0.00066	5444
Sequence 8	4	6	75.36	67.57	7.79	6.00	5.38	0.62	0.0090	0.0081	0.0086	0.00107	5012
Sequence 9	4	8	100.10	89.93	10.17	7.97	7.16	0.81	0.0128	0.0117	0.0122	0.00153	4676
Sequence 10	4	10	125.10	112.41	12.69	9.96	8.95	1.01	0.0178	0.0162	0.0170	0.00212	4212
Sequence 11	2	2	24.99	22.48	2.51	1.99	1.79	0.20	0.0030	0.0027	0.0029	0.00036	5001
Sequence 12	2	4	49.86	45.22	4.65	3.97	3.60	0.37	0.0066	0.0060	0.0063	0.00079	4556
Sequence 13	2	6	75.11	67.45	7.66	5.98	5.37	0.61	0.0109	0.0100	0.0105	0.00131	4102
Sequence 14	2	8	100.10	90.18	9.92	7.97	7.18	0.79	0.0150	0.0137	0.0143	0.00179	4009
Sequence 15	2	10	125.85	113.17	12.69	10.02	9.01	1.01	0.0189	0.0172	0.0180	0.00225	3998

* Reported results are based on the average of the last 5 cycles of each load sequence

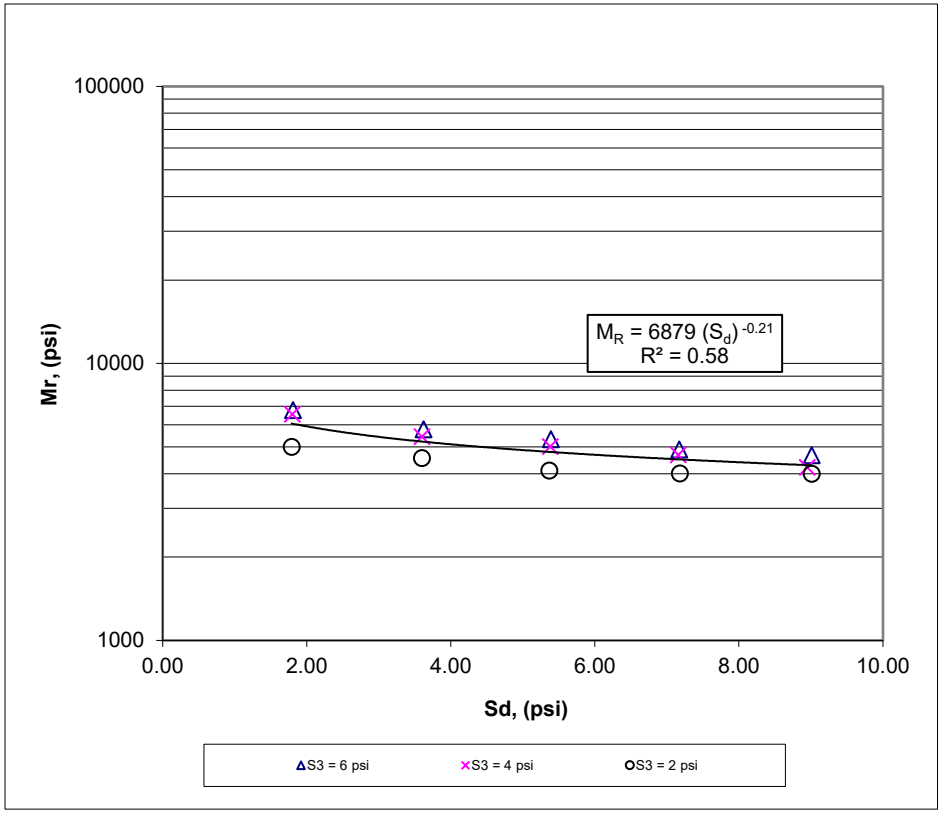
Resilient Modulus of Subgrade Soils (Recompacted Samples)

(Plot)

1. Sample Number	Bulk 1 (Compacted @ Wetter than OMC)
2. Material Type	Type 2
3. Soil Series	n/a
4. Horizon	n/a
5. Test Date	6/19/2023

Column #	1	**2**	3	4	**5**
Parameter	Chamber Confining Pressure	**Desired Applied Cyclic Stress**	Actual Applied Cyclic Stress	Actual Resilient Modulus	**Predicted Resilient Modulus***
Designation	S3	**Scyclic**	Scyclic	Mr	**Mr**
Unit	psi	**psi**	psi	psi	**psi**
Precision	—	**—**	—	—	**—**
Sequence 1	6	**1.80**	1.81	6786	**6063**
Sequence 2	6	**3.60**	3.62	5787	**5224**
Sequence 3	6	**5.40**	5.39	5320	**4788**
Sequence 4	6	**7.20**	7.17	4898	**4501**
Sequence 5	6	**9.00**	9.01	4667	**4290**
Sequence 6	4	**1.80**	1.80	6554	**6063**
Sequence 7	4	**3.60**	3.60	5444	**5224**
Sequence 8	4	**5.40**	5.38	5012	**4788**
Sequence 9	4	**7.20**	7.16	4676	**4501**
Sequence 10	4	**9.00**	8.95	4212	**4290**
Sequence 11	2	**1.80**	1.79	5001	**6063**
Sequence 12	2	**3.60**	3.60	4556	**5224**
Sequence 13	2	**5.40**	5.37	4102	**4788**
Sequence 14	2	**7.20**	7.18	4009	**4501**
Sequence 15	2	**9.00**	9.01	3998	**4290**

*Predicted Mr values at the desired applied cyclic stresses using Model #1



Model #1; Mr = K1 x Sd ^{K2}

S3 (psi)	K1	K2	R^2
6	7816	-0.23	1.00
4	7673	-0.26	0.99
2	5445	-0.15	0.96
All	6879	-0.21	0.58

RED ROCK CONSULTING

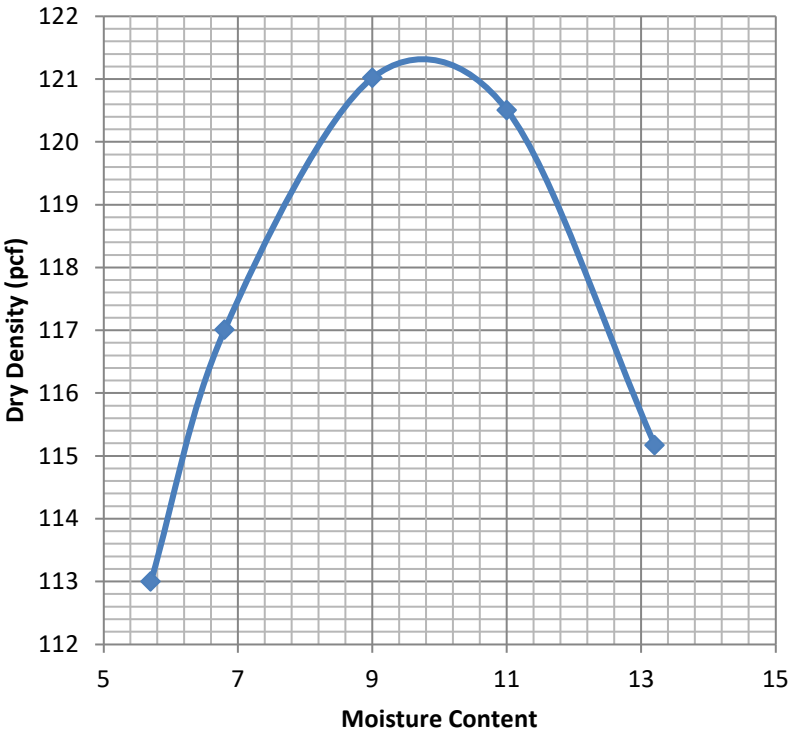
Proctor

Project #: 22117 Project Name: I-35 Shoulder Soils Survey 35589(04)

Tested By: CP Test Date: 6.9.23 Client: Olsson Associates

Weight of Hammer: 5.5 No. of Blows: 25

Bulk 2



Maximum Dry Density (pcf) 121.2

Optimum Moisture Content (%) 9.7

Liquid Limit: NV USCS SM

Plasticity Index: NP AASHTO A-4(0)

Method: A Soil Classification: Silty Sand

Resilient Modulus of Subgrade Soils (Recompacted Samples)

1. Project Number I-35 Shoulder Soils Survey 35589(04)
2. County//State Name McClain // Oklahoma
3. Test Date 6/19/2023

4.Sample Number Bulk 2 (Compacted @ OMC)
5. Material Type 2
6. Soil Series n/a
7. Horizon n/a

9. Soil Properties

Optimum Moisture Content, (%)	9.70
Maximum Dry Density, pcf	121.20
95% MDD (pcf)	115.14

8. Specimen Properties

Compaction Water content, wc, %	9.76
Compaction Dry Density, pcf	116.3
Moisture Content After Mr Test, w(%)	9.61
Permanent Deformation (in)	<1/6

10. Test Information

Preconditioning-Permanent Strain>5%	No
Testing-Permanent Strain >5%	No
Number of Load Sequences Completed	15
Quick Shear Test	No

Column #	1	2	3	4	5	6	7	8	9	10	11	12	13
Parameter	Chamber Confining Pressure	Nominal Maximum Axial Stress	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT # 1 Reading	Recov. Def. LVDT # 2 Reading	Average Recov. Def. LVDT 1 & 2	Resilient Strain	Resilient Modulus
Designation	S3	Scyclic	Pmax	Pcyclic	Pcontact	Smax	Scyclic	Scontact	H1	H2	Havg	er	Mr
Unit	psi	psi	lbs	lbs	lbs	psi	psi	psi	in	in	in	in/in	psi
Precision	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequence 1	6	2	26.00	23.11	2.89	2.07	1.84	0.23	0.0011	0.0012	0.0011	0.00014	12814
Sequence 2	6	4	51.12	45.72	5.40	4.07	3.64	0.43	0.0024	0.0025	0.0024	0.00030	12059
Sequence 3	6	6	76.24	68.08	8.16	6.07	5.42	0.65	0.0036	0.0038	0.0037	0.00047	11606
Sequence 4	6	8	100.73	90.56	10.17	8.02	7.21	0.81	0.0051	0.0054	0.0052	0.00066	10994
Sequence 5	6	10	126.10	113.29	12.81	10.04	9.02	1.02	0.0066	0.0070	0.0068	0.00085	10672
Sequence 6	4	2	25.50	22.98	2.51	2.03	1.83	0.20	0.0013	0.0013	0.0013	0.00016	11253
Sequence 7	4	4	50.37	45.34	5.02	4.01	3.61	0.40	0.0026	0.0028	0.0027	0.00034	10627
Sequence 8	4	6	75.61	67.95	7.66	6.02	5.41	0.61	0.0041	0.0043	0.0042	0.00052	10332
Sequence 9	4	8	100.35	90.43	9.92	7.99	7.20	0.79	0.0055	0.0058	0.0056	0.00070	10232
Sequence 10	4	10	125.47	113.29	12.18	9.99	9.02	0.97	0.0071	0.0075	0.0073	0.00091	9889
Sequence 11	2	2	24.99	22.61	2.39	1.99	1.80	0.19	0.0013	0.0014	0.0013	0.00017	10872
Sequence 12	2	4	50.24	45.34	4.90	4.00	3.61	0.39	0.0028	0.0030	0.0029	0.00036	9913
Sequence 13	2	6	75.11	67.82	7.28	5.98	5.40	0.58	0.0043	0.0045	0.0044	0.00056	9720
Sequence 14	2	8	100.48	90.56	9.92	8.00	7.21	0.79	0.0059	0.0062	0.0061	0.00076	9490
Sequence 15	2	10	126.10	113.42	12.69	10.04	9.03	1.01	0.0076	0.0080	0.0078	0.00097	9288

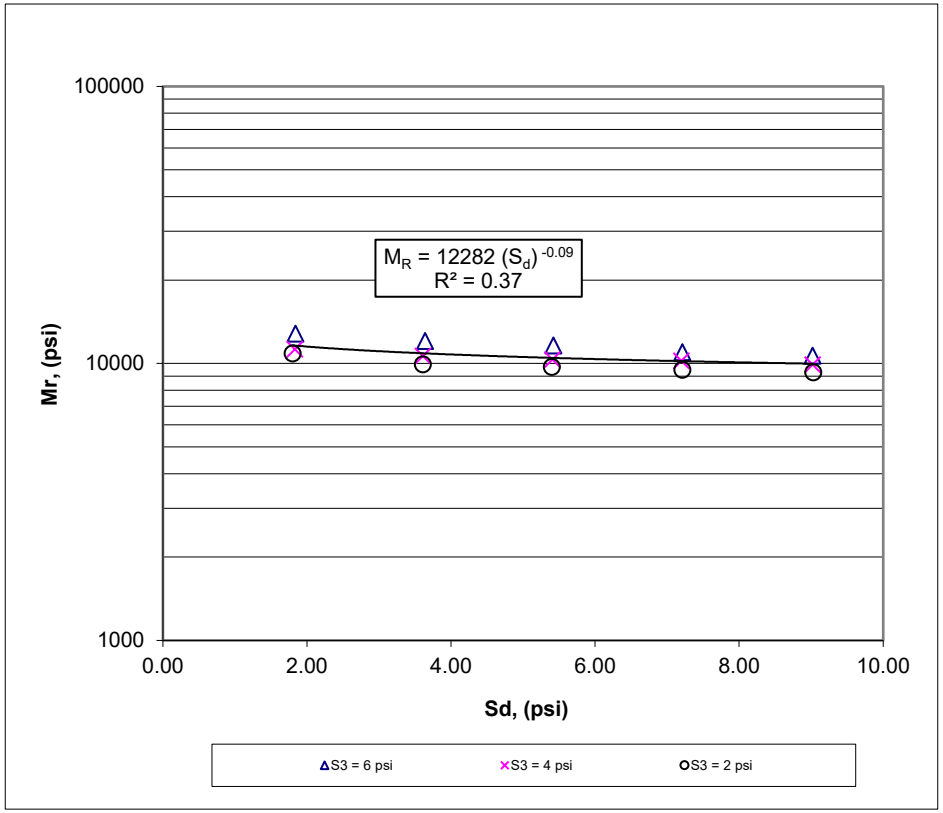
* Reported results are based on the average of the last 5 cycles of each load sequence

Resilient Modulus of Subgrade Soils (Recompacted Samples)

(Plot)

1. Sample Number	Bulk 2 (Compacted @ OMC)
2. Material Type	2
3. Soil Series	n/a
4. Horizon	n/a
5. Test Date	6/19/2023

Column #	1	**2**	3	4	**5**
Parameter	Chamber Confining Pressure	**Desired Applied Cyclic Stress**	Actual Applied Cyclic Stress	Actual Resilient Modulus	**Predicted Resilient Modulus***
Designation	S3	**Scyclic**	Scyclic	Mr	**Mr**
Unit	psi	**psi**	psi	psi	**psi**
Precision	—	**—**	—	—	**—**
Sequence 1	6	**1.80**	1.84	12814	**11619**
Sequence 2	6	**3.60**	3.64	12059	**10883**
Sequence 3	6	**5.40**	5.42	11606	**10474**
Sequence 4	6	**7.20**	7.21	10994	**10193**
Sequence 5	6	**9.00**	9.02	10672	**9981**
Sequence 6	4	**1.80**	1.83	11253	**11619**
Sequence 7	4	**3.60**	3.61	10627	**10883**
Sequence 8	4	**5.40**	5.41	10332	**10474**
Sequence 9	4	**7.20**	7.20	10232	**10193**
Sequence 10	4	**9.00**	9.02	9889	**9981**
Sequence 11	2	**1.80**	1.80	10872	**11619**
Sequence 12	2	**3.60**	3.61	9913	**10883**
Sequence 13	2	**5.40**	5.40	9720	**10474**
Sequence 14	2	**7.20**	7.21	9490	**10193**
Sequence 15	2	**9.00**	9.03	9288	**9981**
*Predicted Mr values at the desired applied cyclic stresses using Model #1					



Model #1; Mr = K1 x Sd ^{K2}

S3 (psi)	K1	K2	R^2
6	13869	-0.11	0.98
4	11767	-0.08	0.98
2	11386	-0.09	0.97
All	12282	-0.09	0.37

Resilient Modulus of Subgrade Soils (Recompacted Samples)

1. Project Number I-35 Shoulder Soils Survey 35589(04)
2. County//State Name McClain // Oklahoma
3. Test Date 6/19/2023

4.Sample Number Bulk 2 (Compacted @ OMC +2%)
5. Material Type 2
6. Soil Series n/a
7. Horizon n/a

9. Soil Properties

Optimum Moisture Content, (%)	9.70
Maximum Dry Density, pcf	121.20
95% MDD (pcf)	115.14

8. Specimen Properties

Compaction Water content, wc, %	11.54
Compaction Dry Density, pcf	116.53
Moisture Content After Mr Test, w(%)	11.21
Permanent Deformation (in)	0.240

10. Test Information

Preconditioning-Permanent Strain>5%	No
Testing-Permanent Strain >5%	No
Number of Load Sequences Completed	15
Quick Shear Test	No

Column #	1	2	3	4	5	6	7	8	9	10	11	12	13
Parameter	Chamber Confining Pressure	Nominal Maximum Axial Stress	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT # 1 Reading	Recov. Def. LVDT # 2 Reading	Average Recov. Def. LVDT 1 & 2	Resilient Strain	Resilient Modulus
Designation	S3	Scyclic	Pmax	Pcyclic	Pcontact	Smax	Scyclic	Scontact	H1	H2	Havg	er	Mr
Unit	psi	psi	lbs	lbs	lbs	psi	psi	psi	in	in	in	in/in	psi
Precision	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequence 1	6	2	24.37	21.85	2.51	1.94	1.74	0.20	0.0017	0.0019	0.0018	0.00022	7812
Sequence 2	6	4	49.74	44.59	5.15	3.96	3.55	0.41	0.0039	0.0044	0.0041	0.00052	6853
Sequence 3	6	6	74.73	67.07	7.66	5.95	5.34	0.61	0.0063	0.0067	0.0065	0.00081	6575
Sequence 4	6	8	99.35	89.05	10.30	7.91	7.09	0.82	0.0095	0.0102	0.0098	0.00123	5777
Sequence 5	6	10	125.22	112.41	12.81	9.97	8.95	1.02	0.0123	0.0132	0.0128	0.00159	5612
Sequence 6	4	2	24.24	21.73	2.51	1.93	1.73	0.20	0.0021	0.0023	0.0022	0.00027	6366
Sequence 7	4	4	49.61	44.71	4.90	3.95	3.56	0.39	0.0045	0.0048	0.0046	0.00058	6158
Sequence 8	4	6	74.73	67.20	7.54	5.95	5.35	0.60	0.0070	0.0075	0.0072	0.00090	5927
Sequence 9	4	8	98.97	89.05	9.92	7.88	7.09	0.79	0.0102	0.0109	0.0106	0.00132	5365
Sequence 10	4	10	124.60	112.54	12.06	9.92	8.96	0.96	0.0135	0.0145	0.0140	0.00175	5134
Sequence 11	2	2	24.62	22.23	2.39	1.96	1.77	0.19	0.0026	0.0028	0.0027	0.00034	5256
Sequence 12	2	4	50.49	45.34	5.15	4.02	3.61	0.41	0.0054	0.0058	0.0056	0.00070	5121
Sequence 13	2	6	75.11	67.57	7.54	5.98	5.38	0.60	0.0087	0.0093	0.0090	0.00112	4783
Sequence 14	2	8	99.48	89.30	10.17	7.92	7.11	0.81	0.0115	0.0124	0.0119	0.00149	4765
Sequence 15	2	10	125.47	113.29	12.18	9.99	9.02	0.97	0.0163	0.0173	0.0168	0.00210	4300

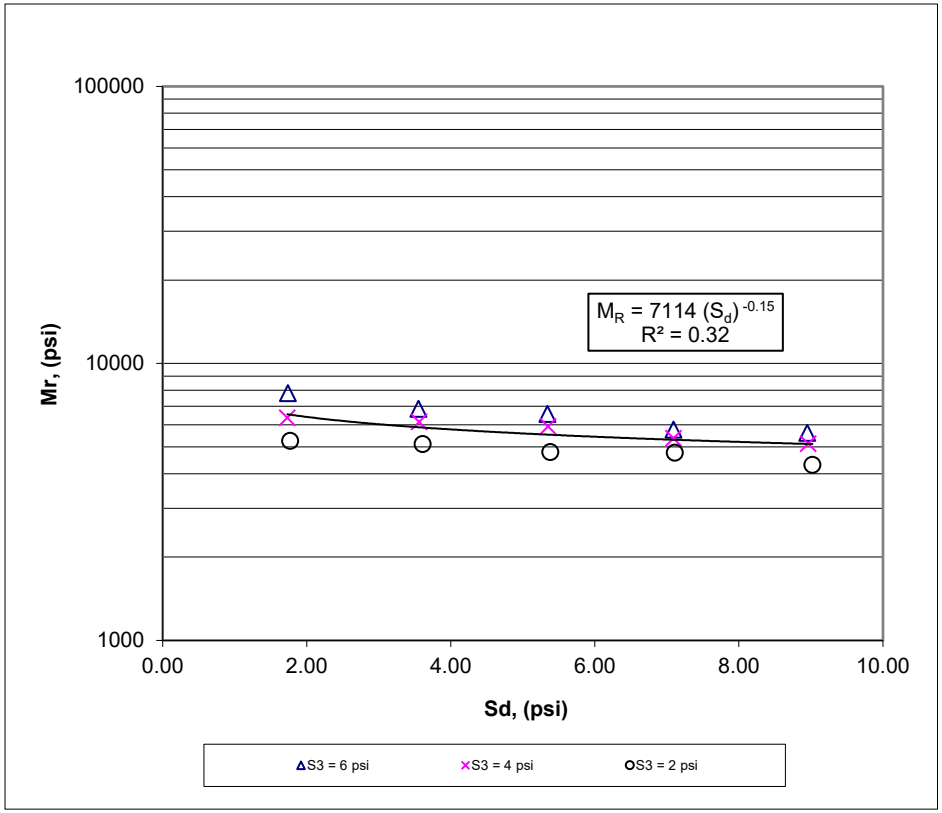
* Reported results are based on the average of the last 5 cycles of each load sequence

Resilient Modulus of Subgrade Soils (Recompacted Samples)

(Plot)

1. Sample Number	Bulk 2 (Compacted @ OMC +2%)
2. Material Type	Type 2
3. Soil Series	n/a
4. Horizon	n/a
5. Test Date	6/19/2023

Column #	1	**2**	3	4	**5**
Parameter	Chamber Confining Pressure	**Desired Applied Cyclic Stress**	Actual Applied Cyclic Stress	Actual Resilient Modulus	**Predicted Resilient Modulus***
Designation	S3	**Scyclic**	Scyclic	Mr	**Mr**
Unit	psi	**psi**	psi	psi	**psi**
Precision	—	**—**	—	—	**—**
Sequence 1	6	**1.80**	1.74	7812	**6514**
Sequence 2	6	**3.60**	3.55	6853	**5871**
Sequence 3	6	**5.40**	5.34	6575	**5525**
Sequence 4	6	**7.20**	7.09	5777	**5292**
Sequence 5	6	**9.00**	8.95	5612	**5118**
Sequence 6	4	**1.80**	1.73	6366	**6514**
Sequence 7	4	**3.60**	3.56	6158	**5871**
Sequence 8	4	**5.40**	5.35	5927	**5525**
Sequence 9	4	**7.20**	7.09	5365	**5292**
Sequence 10	4	**9.00**	8.96	5134	**5118**
Sequence 11	2	**1.80**	1.77	5256	**6514**
Sequence 12	2	**3.60**	3.61	5121	**5871**
Sequence 13	2	**5.40**	5.38	4783	**5525**
Sequence 14	2	**7.20**	7.11	4765	**5292**
Sequence 15	2	**9.00**	9.02	4300	**5118**
*Predicted Mr values at the desired applied cyclic stresses using Model #1					



Model #1; $Mr = K1 \times Sd^{K2}$

S3 (psi)	K1	K2	R^2
6	8850	-0.20	0.96
4	7041	-0.13	0.85
2	5728	-0.11	0.82
All	7114	-0.15	0.32

RED ROCK CONSULTING

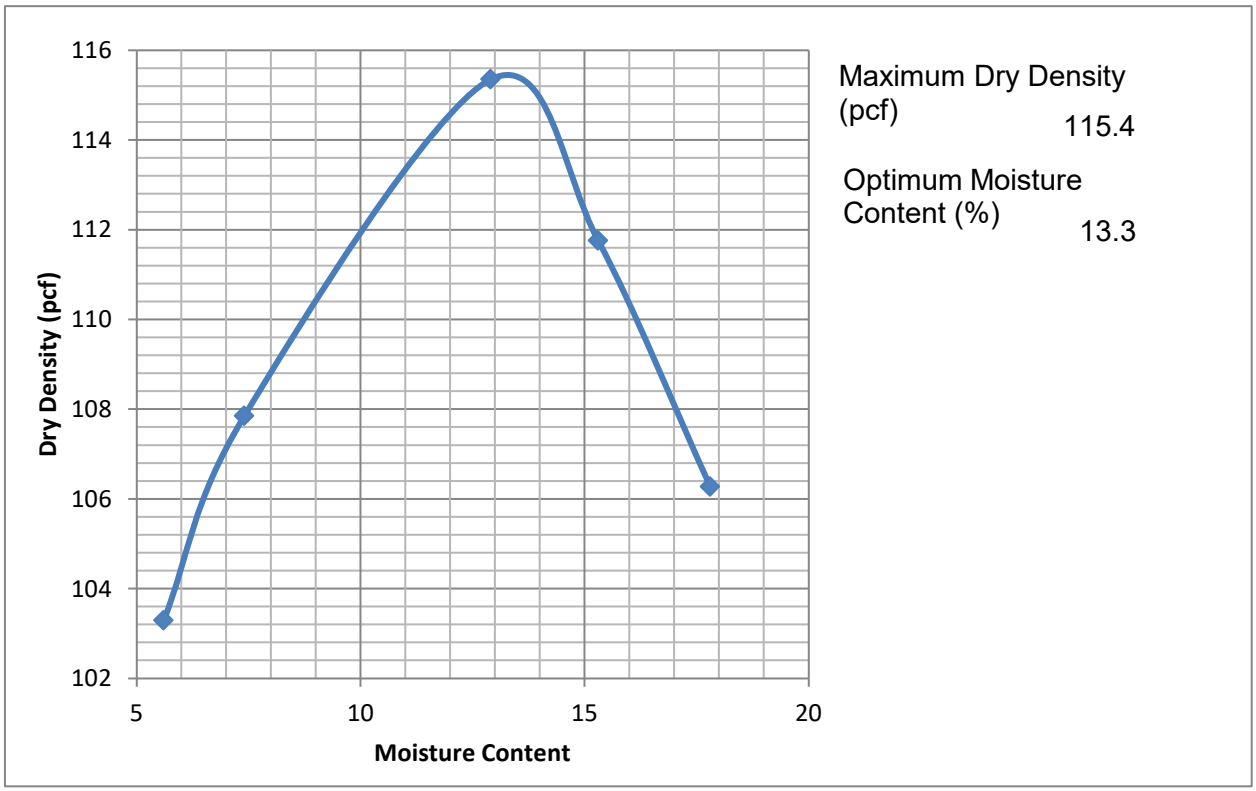
Proctor

Project #: 22117 Project Name: I-35 Shoulder Soils Survey 355889(04)

Tested By: CP Test Date: 6.9.23 Client: Olsson Associates

Weight of Hammer: 5.5 No. of Blows: 25

Bulk 3



Liquid Limit: 20 USCS CL-ML

Plasticity Index: 5 AASHTO A-4(0)

Method: A Soil Classification: Sandy, Silty Clay

Resilient Modulus of Subgrade Soils (Recompacted Samples)

1. Project Number I-35 Shoulder Soils Survey 35589(04)
2. County//State Name McClain // Oklahoma
3. Test Date 6/21/2023

4.Sample Number Bulk 3 (Compacted @ OMC)
5. Material Type 2
6. Soil Series n/a
7. Horizon n/a

9. Soil Properties

Optimum Moisture Content, (%)	13.30
Maximum Dry Density, pcf	115.40
95% MDD (pcf)	109.63

8. Specimen Properties

Compaction Water content, wc, %	13.56
Compaction Dry Density, pcf	110.23
Moisture Content After Mr Test, w(%)	13.10
Permanent Deformation (in)	0.07

10. Test Information

Preconditioning-Permanent Strain>5%	No
Testing-Permanent Strain >5%	No
Number of Load Sequences Completed	15
Quick Shear Test	No

Column #	1	2	3	4	5	6	7	8	9	10	11	12	13
Parameter	Chamber Confining Pressure	Nominal Maximum Axial Stress	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT # 1 Reading	Recov. Def. LVDT # 2 Reading	Average Recov. Def. LVDT 1 & 2	Resilient Strain	Resilient Modulus
Designation	S3	Scyclic	Pmax	Pcyclic	Pcontact	Smax	Scyclic	Scontact	H1	H2	Havg	er	Mr
Unit	psi	psi	lbs	lbs	lbs	psi	psi	psi	in	in	in	in/in	psi
Precision	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequence 1	6	2	24.99	22.61	2.39	1.99	1.80	0.19	0.0011	0.0012	0.0011	0.00014	12712
Sequence 2	6	4	50.37	45.34	5.02	4.01	3.61	0.40	0.0023	0.0025	0.0024	0.00030	12018
Sequence 3	6	6	75.49	67.82	7.66	6.01	5.40	0.61	0.0035	0.0038	0.0037	0.00046	11757
Sequence 4	6	8	100.23	90.31	9.92	7.98	7.19	0.79	0.0050	0.0055	0.0052	0.00065	10998
Sequence 5	6	10	125.47	113.04	12.43	9.99	9.00	0.99	0.0066	0.0072	0.0069	0.00086	10439
Sequence 6	4	2	24.99	22.73	2.26	1.99	1.81	0.18	0.0012	0.0013	0.0012	0.00015	11892
Sequence 7	4	4	50.37	45.22	5.15	4.01	3.60	0.41	0.0027	0.0028	0.0028	0.00034	10453
Sequence 8	4	6	75.23	67.70	7.54	5.99	5.39	0.60	0.0041	0.0044	0.0043	0.00053	10109
Sequence 9	4	8	99.98	90.18	9.80	7.96	7.18	0.78	0.0055	0.0060	0.0057	0.00072	10012
Sequence 10	4	10	125.85	113.04	12.81	10.02	9.00	1.02	0.0069	0.0075	0.0072	0.00090	9989
Sequence 11	2	2	24.99	22.48	2.51	1.99	1.79	0.20	0.0013	0.0014	0.0013	0.00016	10922
Sequence 12	2	4	49.86	45.09	4.77	3.97	3.59	0.38	0.0029	0.0030	0.0029	0.00037	9747
Sequence 13	2	6	75.61	67.95	7.66	6.02	5.41	0.61	0.0045	0.0048	0.0046	0.00058	9323
Sequence 14	2	8	100.35	90.18	10.17	7.99	7.18	0.81	0.0061	0.0066	0.0063	0.00079	9111
Sequence 15	2	10	124.97	113.04	11.93	9.95	9.00	0.95	0.0077	0.0083	0.0080	0.00100	8981

* Reported results are based on the average of the last 5 cycles of each load sequence

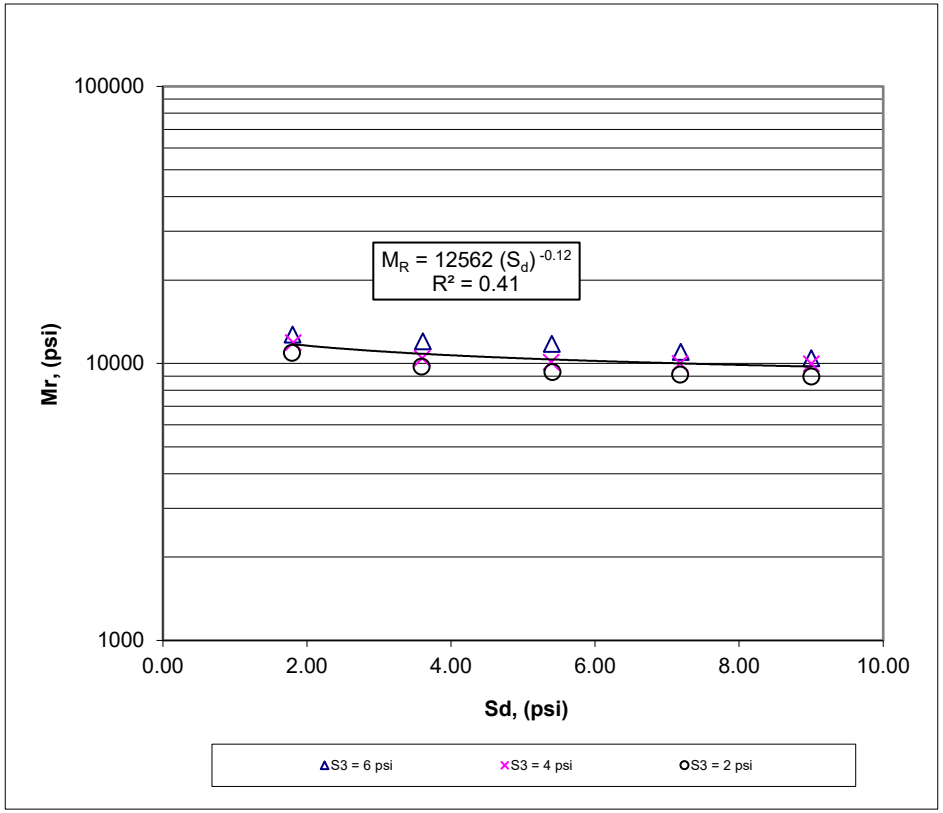
Resilient Modulus of Subgrade Soils (Recompacted Samples)

(Plot)

1. Sample Number	Bulk 3 (Compacted @ OMC)
2. Material Type	2
3. Soil Series	n/a
4. Horizon	n/a
5. Test Date	6/21/2023

Column #	1	**2**	3	4	**5**
Parameter	Chamber Confining Pressure	**Desired Applied Cyclic Stress**	Actual Applied Cyclic Stress	Actual Resilient Modulus	**Predicted Resilient Modulus***
Designation	S3	**Scyclic**	Scyclic	Mr	**Mr**
Unit	psi	**psi**	psi	psi	**psi**
Precision	—	**—**	—	—	**—**
Sequence 1	6	**1.80**	1.80	12712	**11737**
Sequence 2	6	**3.60**	3.61	12018	**10834**
Sequence 3	6	**5.40**	5.40	11757	**10338**
Sequence 4	6	**7.20**	7.19	10998	**10000**
Sequence 5	6	**9.00**	9.00	10439	**9746**
Sequence 6	4	**1.80**	1.81	11892	**11737**
Sequence 7	4	**3.60**	3.60	10453	**10834**
Sequence 8	4	**5.40**	5.39	10109	**10338**
Sequence 9	4	**7.20**	7.18	10012	**10000**
Sequence 10	4	**9.00**	9.00	9989	**9746**
Sequence 11	2	**1.80**	1.79	10922	**11737**
Sequence 12	2	**3.60**	3.59	9747	**10834**
Sequence 13	2	**5.40**	5.41	9323	**10338**
Sequence 14	2	**7.20**	7.18	9111	**10000**
Sequence 15	2	**9.00**	9.00	8981	**9746**

*Predicted Mr values at the desired applied cyclic stresses using Model #1



Model #1; Mr = K1 x Sd ^{K2}

S3 (psi)	K1	K2	R^2
6	13820	-0.12	0.91
4	12398	-0.11	0.89
2	11578	-0.12	0.97
All	12562	-0.12	0.41

Resilient Modulus of Subgrade Soils (Recompacted Samples)

1. Project Number I-35 Shoulder Soils Survey 35589(04)
2. County//State Name McClain // Oklahoma
3. Test Date 6/21/2023

4.Sample Number Bulk 3 (Compacted @ OMC +2%)
5. Material Type 2
6. Soil Series n/a
7. Horizon n/a

9. Soil Properties

Optimum Moisture Content, (%)	13.30
Maximum Dry Density, pcf	115.40
95% MDD (pcf)	109.63

8. Specimen Properties

Compaction Water content, wc, %	15.67
Compaction Dry Density, pcf	110.23
Moisture Content After Mr Test, w(%)	15.32
Permanent Deformation (in)	0.340

10. Test Information

Preconditioning-Permanent Strain>5%	No
Testing-Permanent Strain >5%	No
Number of Load Sequences Completed	15
Quick Shear Test	No

Column #	1	2	3	4	5	6	7	8	9	10	11	12	13
Parameter	Chamber Confining Pressure	Nominal Maximum Axial Stress	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT # 1 Reading	Recov. Def. LVDT # 2 Reading	Average Recov. Def. LVDT 1 & 2	Resilient Strain	Resilient Modulus
Designation	S3	Scyclic	Pmax	Pcyclic	Pcontact	Smax	Scyclic	Scontact	H1	H2	Havg	er	Mr
Unit	psi	psi	lbs	lbs	lbs	psi	psi	psi	in	in	in	in/in	psi
Precision	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequence 1	6	2	25.12	22.73	2.39	2.00	1.81	0.19	0.0024	0.0022	0.0023	0.00029	6229
Sequence 2	6	4	49.49	44.71	4.77	3.94	3.56	0.38	0.0049	0.0044	0.0047	0.00058	6102
Sequence 3	6	6	75.36	67.95	7.41	6.00	5.41	0.59	0.0078	0.0071	0.0075	0.00093	5787
Sequence 4	6	8	99.35	89.30	10.05	7.91	7.11	0.80	0.0119	0.0106	0.0112	0.00140	5068
Sequence 5	6	10	125.10	113.17	11.93	9.96	9.01	0.95	0.0155	0.0140	0.0147	0.00184	4889
Sequence 6	4	2	25.25	22.48	2.76	2.01	1.79	0.22	0.0025	0.0023	0.0024	0.00030	6012
Sequence 7	4	4	50.49	45.34	5.15	4.02	3.61	0.41	0.0058	0.0053	0.0055	0.00069	5232
Sequence 8	4	6	75.86	68.08	7.79	6.04	5.42	0.62	0.0092	0.0082	0.0087	0.00108	5011
Sequence 9	4	8	100.23	90.06	10.17	7.98	7.17	0.81	0.0132	0.0121	0.0126	0.00158	4535
Sequence 10	4	10	125.85	113.17	12.69	10.02	9.01	1.01	0.0172	0.0153	0.0163	0.00203	4430
Sequence 11	2	2	24.87	22.61	2.26	1.98	1.80	0.18	0.0029	0.0026	0.0027	0.00034	5302
Sequence 12	2	4	49.86	45.09	4.77	3.97	3.59	0.38	0.0064	0.0057	0.0061	0.00076	4727
Sequence 13	2	6	75.99	67.95	8.04	6.05	5.41	0.64	0.0103	0.0093	0.0098	0.00123	4412
Sequence 14	2	8	100.73	90.18	10.55	8.02	7.18	0.84	0.0147	0.0133	0.0140	0.00175	4102
Sequence 15	2	10	125.35	113.04	12.31	9.98	9.00	0.98	0.0205	0.0187	0.0196	0.00245	3675

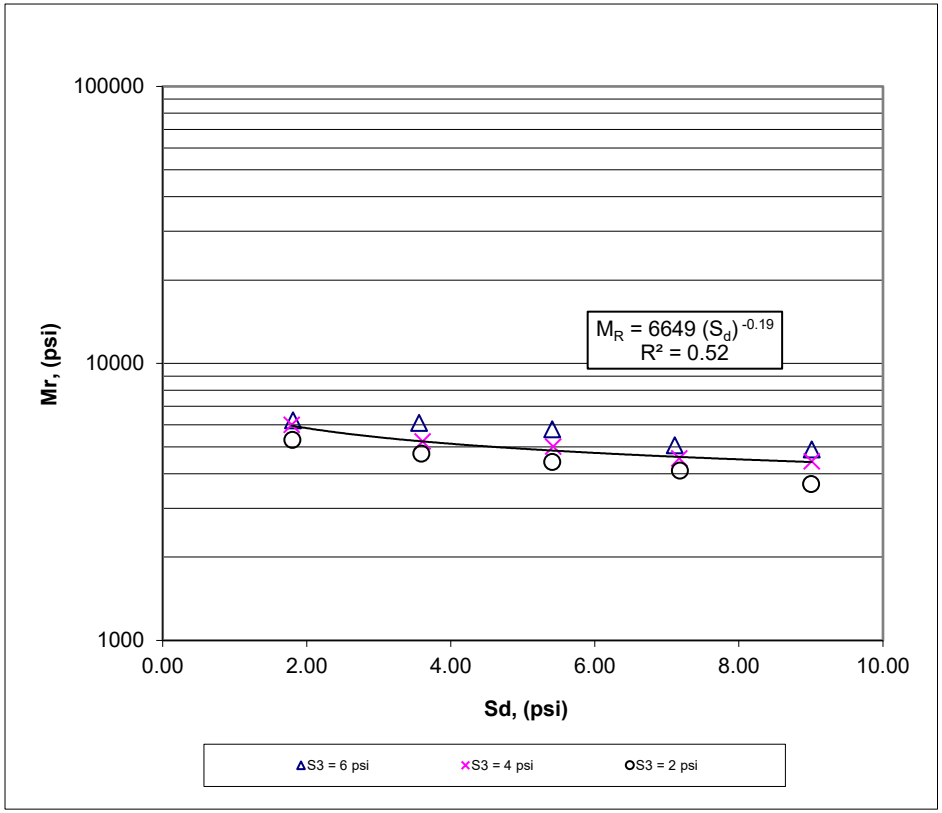
* Reported results are based on the average of the last 5 cycles of each load sequence

Resilient Modulus of Subgrade Soils (Recompacted Samples)

(Plot)

1. Sample Number	Bulk 3 (Compacted @ OMC +2%)
2. Material Type	Type 2
3. Soil Series	n/a
4. Horizon	n/a
5. Test Date	6/21/2023

Column #	1	**2**	3	4	**5**
Parameter	Chamber Confining Pressure	**Desired Applied Cyclic Stress**	Actual Applied Cyclic Stress	Actual Resilient Modulus	**Predicted Resilient Modulus***
Designation	S3	**Scyclic**	Scyclic	Mr	**Mr**
Unit	psi	**psi**	psi	psi	**psi**
Precision	—	**—**	—	—	**—**
Sequence 1	6	**1.80**	1.81	6229	**5956**
Sequence 2	6	**3.60**	3.56	6102	**5232**
Sequence 3	6	**5.40**	5.41	5787	**4849**
Sequence 4	6	**7.20**	7.11	5068	**4595**
Sequence 5	6	**9.00**	9.01	4889	**4407**
Sequence 6	4	**1.80**	1.79	6012	**5956**
Sequence 7	4	**3.60**	3.61	5232	**5232**
Sequence 8	4	**5.40**	5.42	5011	**4849**
Sequence 9	4	**7.20**	7.17	4535	**4595**
Sequence 10	4	**9.00**	9.01	4430	**4407**
Sequence 11	2	**1.80**	1.80	5302	**5956**
Sequence 12	2	**3.60**	3.59	4727	**5232**
Sequence 13	2	**5.40**	5.41	4412	**4849**
Sequence 14	2	**7.20**	7.18	4102	**4595**
Sequence 15	2	**9.00**	9.00	3675	**4407**
*Predicted Mr values at the desired applied cyclic stresses using Model #1					



Model #1; Mr = K1 x Sd ^{K2}

S3 (psi)	K1	K2	R^2
6	7112	-0.16	0.81
4	6730	-0.19	0.98
2	6130	-0.21	0.95
All	6649	-0.19	0.52

RED ROCK CONSULTING

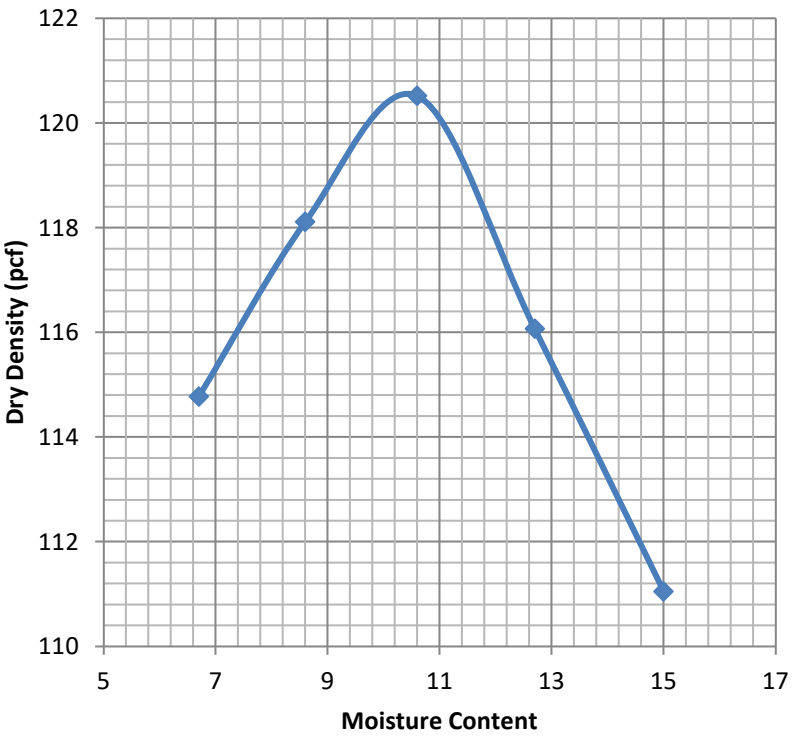
Proctor

Project #: 22117 Project Name: I-35 Shoulder Soils Survey 35589(04)

Tested By: CP Test Date: 6.12.23 Client: Olsson Associates

Weight of Hammer: 5.5 No. of Blows: 25

Bulk 4



Maximum Dry Density (pcf) 120.5

Optimum Moisture Content (%) 10.4

Liquid Limit: 21 USCS SC-SM

Plasticity Index: 4 AASHTO A-4(0)

Method: A Soil Classification: Silty, Clayey Sand

Resilient Modulus of Subgrade Soils (Recompacted Samples)

1. Project Number I-35 Shoulder Soils Survey 35589(04)
2. County//State Name McClain // Oklahoma
3. Test Date 6/21/2023

4.Sample Number Bulk 4 (Compacted @ OMC)
5. Material Type 2
6. Soil Series n/a
7. Horizon n/a

9. Soil Properties

Optimum Moisture Content, (%)	10.40
Maximum Dry Density, pcf	120.50
95% MDD (pcf)	114.48

8. Specimen Properties

Compaction Water content, wc, %	10.23
Compaction Dry Density, pcf	115.63
Moisture Content After Mr Test, w(%)	10.01
Permanent Deformation (in)	<1/16

10. Test Information

Preconditioning-Permanent Strain>5%	No
Testing-Permanent Strain >5%	No
Number of Load Sequences Completed	15
Quick Shear Test	No

Column #	1	2	3	4	5	6	7	8	9	10	11	12	13
Parameter	Chamber Confining Pressure	Nominal Maximum Axial Stress	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT # 1 Reading	Recov. Def. LVDT # 2 Reading	Average Recov. Def. LVDT 1 & 2	Resilient Strain	Resilient Modulus
Designation	S3	Scyclic	Pmax	Pcyclic	Pcontact	Smax	Scyclic	Scontact	H1	H2	Havg	er	Mr
Unit	psi	psi	lbs	lbs	lbs	psi	psi	psi	in	in	in	in/in	psi
Precision	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequence 1	6	2	26.00	23.24	2.76	2.07	1.85	0.22	0.0011	0.0012	0.0011	0.00014	13086
Sequence 2	6	4	51.62	45.97	5.65	4.11	3.66	0.45	0.0023	0.0024	0.0023	0.00029	12573
Sequence 3	6	6	75.99	68.20	7.79	6.05	5.43	0.62	0.0035	0.0036	0.0036	0.00045	12127
Sequence 4	6	8	101.11	90.81	10.30	8.05	7.23	0.82	0.0049	0.0051	0.0050	0.00063	11553
Sequence 5	6	10	126.23	113.29	12.94	10.05	9.02	1.03	0.0063	0.0066	0.0065	0.00081	11147
Sequence 6	4	2	26.00	23.36	2.64	2.07	1.86	0.21	0.0012	0.0013	0.0013	0.00016	11727
Sequence 7	4	4	51.37	45.72	5.65	4.09	3.64	0.45	0.0026	0.0026	0.0026	0.00032	11203
Sequence 8	4	6	75.86	67.95	7.91	6.04	5.41	0.63	0.0040	0.0041	0.0040	0.00050	10728
Sequence 9	4	8	100.98	90.68	10.30	8.04	7.22	0.82	0.0055	0.0057	0.0056	0.00070	10342
Sequence 10	4	10	125.47	113.29	12.18	9.99	9.02	0.97	0.0070	0.0073	0.0071	0.00089	10102
Sequence 11	2	2	25.25	22.86	2.39	2.01	1.82	0.19	0.0014	0.0015	0.0014	0.00018	10138
Sequence 12	2	4	51.24	45.59	5.65	4.08	3.63	0.45	0.0029	0.0030	0.0029	0.00037	9891
Sequence 13	2	6	76.24	68.33	7.91	6.07	5.44	0.63	0.0045	0.0047	0.0046	0.00057	9505
Sequence 14	2	8	101.23	90.56	10.68	8.06	7.21	0.85	0.0059	0.0062	0.0061	0.00076	9486
Sequence 15	2	10	125.60	113.29	12.31	10.00	9.02	0.98	0.0075	0.0078	0.0076	0.00096	9444

* Reported results are based on the average of the last 5 cycles of each load sequence

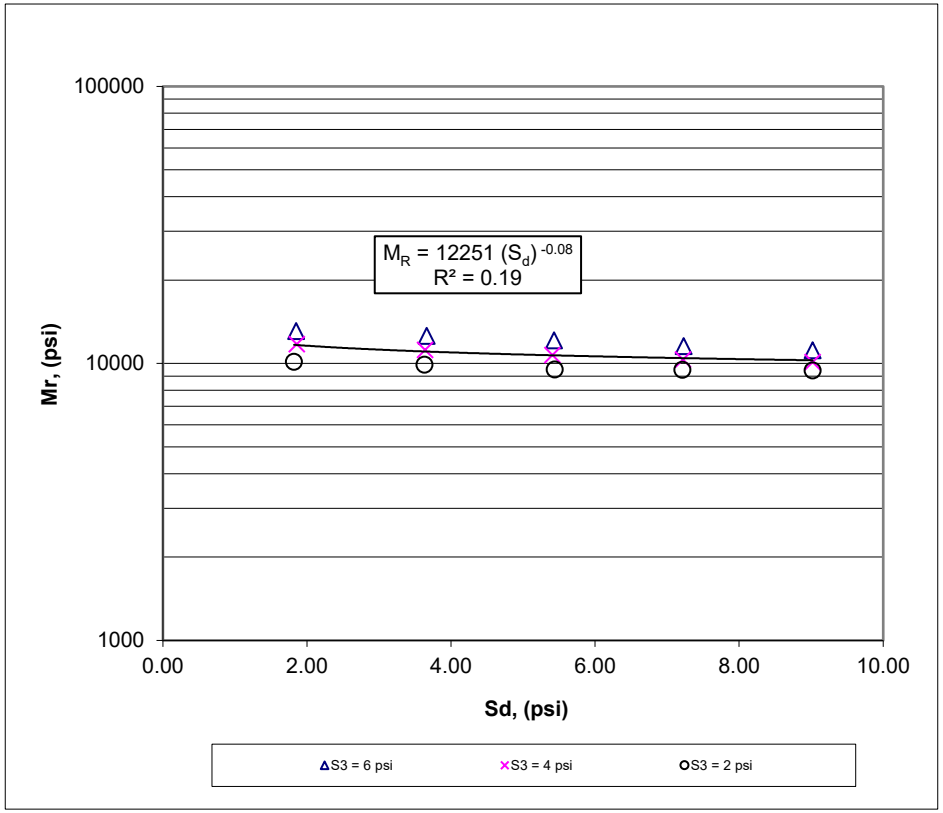
Resilient Modulus of Subgrade Soils (Recompacted Samples)

(Plot)

1. Sample Number	Bulk 4 (Compacted @ OMC)
2. Material Type	2
3. Soil Series	n/a
4. Horizon	n/a
5. Test Date	6/21/2023

Column #	1	**2**	3	4	**5**
Parameter	Chamber Confining Pressure	**Desired Applied Cyclic Stress**	Actual Applied Cyclic Stress	Actual Resilient Modulus	**Predicted Resilient Modulus***
Designation	S3	**Scyclic**	Scyclic	Mr	**Mr**
Unit	psi	**psi**	psi	psi	**psi**
Precision	—	**—**	—	—	**—**
Sequence 1	6	**1.80**	1.85	13086	**11686**
Sequence 2	6	**3.60**	3.66	12573	**11053**
Sequence 3	6	**5.40**	5.43	12127	**10699**
Sequence 4	6	**7.20**	7.23	11553	**10455**
Sequence 5	6	**9.00**	9.02	11147	**10269**
Sequence 6	4	**1.80**	1.86	11727	**11686**
Sequence 7	4	**3.60**	3.64	11203	**11053**
Sequence 8	4	**5.40**	5.41	10728	**10699**
Sequence 9	4	**7.20**	7.22	10342	**10455**
Sequence 10	4	**9.00**	9.02	10102	**10269**
Sequence 11	2	**1.80**	1.82	10138	**11686**
Sequence 12	2	**3.60**	3.63	9891	**11053**
Sequence 13	2	**5.40**	5.44	9505	**10699**
Sequence 14	2	**7.20**	7.21	9486	**10455**
Sequence 15	2	**9.00**	9.02	9444	**10269**

*Predicted Mr values at the desired applied cyclic stresses using Model #1



Model #1; Mr = K1 x Sd ^{K2}

S3 (psi)	K1	K2	R^2
6	14102	-0.10	0.94
4	12541	-0.10	0.98
2	10441	-0.05	0.94
All	12251	-0.08	0.19

Resilient Modulus of Subgrade Soils (Recompacted Samples)

1. Project Number I-35 Shoulder Soils Survey 35589(04)
2. County//State Name McClain // Oklahoma
3. Test Date 6/21/2023

4.Sample Number Bulk 4 (Compacted @ OMC +2%)
5. Material Type 2
6. Soil Series n/a
7. Horizon n/a

9. Soil Properties

Optimum Moisture Content, (%)	10.40
Maximum Dry Density, pcf	120.50
95% MDD (pcf)	114.48

8. Specimen Properties

Compaction Water content, wc, %	12.13
Compaction Dry Density, pcf	115,21
Moisture Content After Mr Test, w(%)	12
Permanent Deformation (in)	0.280

10. Test Information

Preconditioning-Permanent Strain>5%	No
Testing-Permanent Strain >5%	No
Number of Load Sequences Completed	15
Quick Shear Test	No

Column #	1	2	3	4	5	6	7	8	9	10	11	12	13
Parameter	Chamber Confining Pressure	Nominal Maximum Axial Stress	Actual Applied Max. Axial Load	Actual Applied Cyclic Load	Actual Applied Contact Load	Actual Applied Max. Axial Stress	Actual Applied Cyclic Stress	Actual Applied Contact Stress	Recov. Def. LVDT # 1 Reading	Recov. Def. LVDT # 2 Reading	Average Recov. Def. LVDT 1 & 2	Resilient Strain	Resilient Modulus
Designation	S3	Scyclic	Pmax	Pcyclic	Pcontact	Smax	Scyclic	Scontact	H1	H2	Havg	er	Mr
Unit	psi	psi	lbs	lbs	lbs	psi	psi	psi	in	in	in	in/in	psi
Precision	—	—	—	—	—	—	—	—	—	—	—	—	—
Sequence 1	6	2	25.12	22.48	2.64	2.00	1.79	0.21	0.0019	0.0020	0.0020	0.00024	7323
Sequence 2	6	4	49.86	44.84	5.02	3.97	3.57	0.40	0.0041	0.0044	0.0042	0.00053	6757
Sequence 3	6	6	75.36	67.82	7.54	6.00	5.40	0.60	0.0065	0.0071	0.0068	0.00085	6343
Sequence 4	6	8	99.98	90.06	9.92	7.96	7.17	0.79	0.0099	0.0105	0.0102	0.00127	5637
Sequence 5	6	10	125.98	113.29	12.69	10.03	9.02	1.01	0.0129	0.0137	0.0133	0.00166	5432
Sequence 6	4	2	25.25	22.73	2.51	2.01	1.81	0.20	0.0022	0.0024	0.0023	0.00029	6323
Sequence 7	4	4	49.99	45.09	4.90	3.98	3.59	0.39	0.0046	0.0048	0.0047	0.00059	6102
Sequence 8	4	6	75.36	67.82	7.54	6.00	5.40	0.60	0.0076	0.0080	0.0078	0.00097	5544
Sequence 9	4	8	99.85	89.93	9.92	7.95	7.16	0.79	0.0109	0.0115	0.0112	0.00140	5123
Sequence 10	4	10	124.72	112.66	12.06	9.93	8.97	0.96	0.0142	0.0151	0.0147	0.00183	4898
Sequence 11	2	2	24.74	22.36	2.39	1.97	1.78	0.19	0.0023	0.0025	0.0024	0.00030	5898
Sequence 12	2	4	50.11	44.96	5.15	3.99	3.58	0.41	0.0050	0.0053	0.0051	0.00064	5575
Sequence 13	2	6	75.36	67.82	7.54	6.00	5.40	0.60	0.0079	0.0084	0.0081	0.00101	5323
Sequence 14	2	8	100.23	90.06	10.17	7.98	7.17	0.81	0.0117	0.0124	0.0120	0.00150	4774
Sequence 15	2	10	125.85	113.17	12.69	10.02	9.01	1.01	0.0153	0.0164	0.0158	0.00198	4554

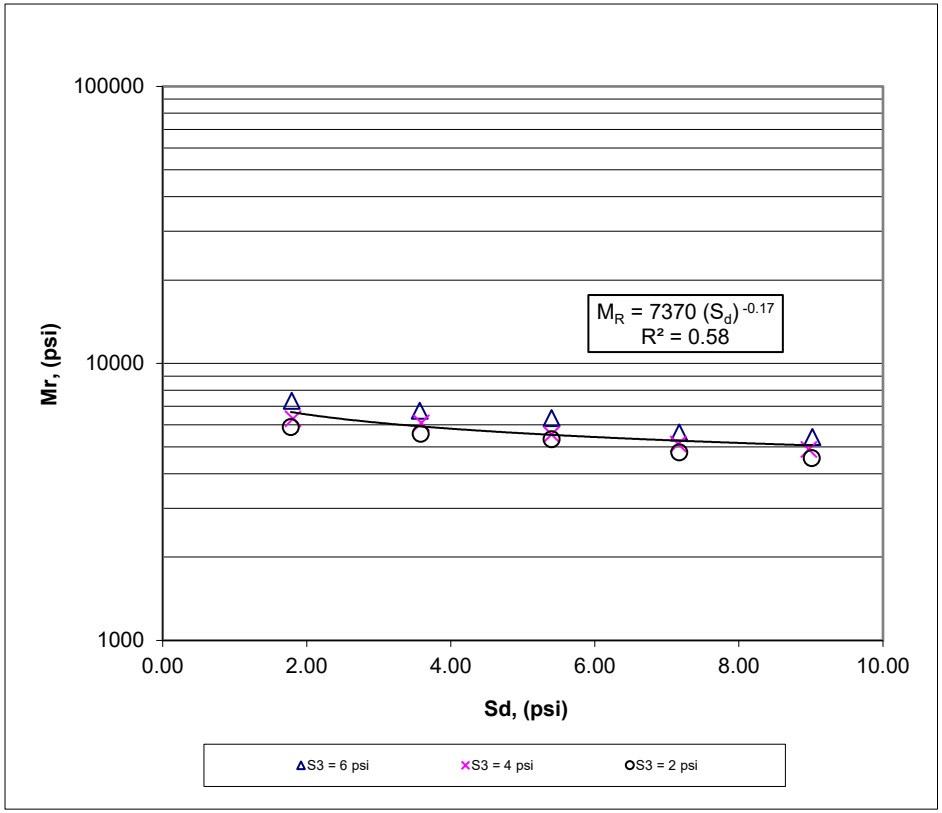
* Reported results are based on the average of the last 5 cycles of each load sequence

Resilient Modulus of Subgrade Soils (Recompacted Samples)

(Plot)

1. Sample Number	Bulk 4 (Compacted @ OMC +2%)
2. Material Type	Type 2
3. Soil Series	n/a
4. Horizon	n/a
5. Test Date	6/21/2023

Column #	1	**2**	3	4	**5**
Parameter	Chamber Confining Pressure	**Desired Applied Cyclic Stress**	Actual Applied Cyclic Stress	Actual Resilient Modulus	**Predicted Resilient Modulus***
Designation	S3	**Scyclic**	Scyclic	Mr	**Mr**
Unit	psi	**psi**	psi	psi	**psi**
Precision	—	**—**	—	—	**—**
Sequence 1	6	**1.80**	1.79	7323	**6665**
Sequence 2	6	**3.60**	3.57	6757	**5920**
Sequence 3	6	**5.40**	5.40	6343	**5523**
Sequence 4	6	**7.20**	7.17	5637	**5258**
Sequence 5	6	**9.00**	9.02	5432	**5061**
Sequence 6	4	**1.80**	1.81	6323	**6665**
Sequence 7	4	**3.60**	3.59	6102	**5920**
Sequence 8	4	**5.40**	5.40	5544	**5523**
Sequence 9	4	**7.20**	7.16	5123	**5258**
Sequence 10	4	**9.00**	8.97	4898	**5061**
Sequence 11	2	**1.80**	1.78	5898	**6665**
Sequence 12	2	**3.60**	3.58	5575	**5920**
Sequence 13	2	**5.40**	5.40	5323	**5523**
Sequence 14	2	**7.20**	7.17	4774	**5258**
Sequence 15	2	**9.00**	9.01	4554	**5061**
*Predicted Mr values at the desired applied cyclic stresses using Model #1					



Model #1; $Mr = K1 \times Sd^{K2}$

S3 (psi)	K1	K2	R^2
6	8372	-0.19	0.94
4	7195	-0.17	0.91
2	6645	-0.16	0.90
All	7370	-0.17	0.58

APPENDIX D

RED ROCK CONSULTING

GENERAL NOTES

SOIL PROPERTY ABBREVIATIONS

N	Uncorrected SPT Penetration, blows per foot
N_{60}	Corrected SPT Penetration, blows per foot
Q_u	Unconfined Compressive Strength, psf
Mc	Moisture Content, %
LL	Liquid Limit, %
PL	Plastic Limit, %
PI	Plasticity Index, %

DRILLING & SAMPLING ABBREVIATIONS

BS	Bag Sample
SPT	Split Spoon Sample
ST	Shelby Tube Sample
AU	Auger Sample
TC	Texas Cone Penetrometer
DCP	Dynamic Cone Penetrometer

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)
-- used to classify all soils unless otherwise noted --

Major Divisions			Group Symbol	Typical Names
Course-Grained Soils >50% retained on #200 sieve	**Gravels** 50% + of course fraction retained on #4 sieve	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		Gravels with Fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sands 50% + of course fraction passes #4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		Sands with Fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine-Grained Soils <50% passes #200 sieve	**Silts and Clays** Liquid Limit ≤ 50%		ML	Inorganic silts, very fine sands, rock four, silty or clayey fine sands
			CL	Inorganic clays of low to medium plasticity, gravelly/sandy/silty/lean clays
			OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays Liquid Limit > 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
			CH	Inorganic clays or high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat, muck, and other highly organic soils

Prefix: G = Gravel, S = Sand, M = Silt, C = Clay, O = Organic **Suffix:** W = Well Graded, P = Poorly Graded, M = Silty, L = Clay, LL < 50%, H = Clay, LL > 50%

PLASTICITY OF COHESIVE SOIL

Degree of Plasticity	Plasticity Index	Swell Potential
None	0 to 4	Very Low
Slight	5 to 9	Low
Medium	10 to 19	Low to Medium
High	20 to 39	Medium to High
Very High	40+	Very High

MOISTURE OF COHESIVE SOIL

Description	Condition	Moisture Content
Dry, Dusty	Dry	0 to 10%
Damp	Moist	10 to 30%
Free Water	Wet	30 to 70%

CONSISTENCY - COHESIVE SOILS

Consistency	SPT
Very Soft	<2
Soft	2 to 4
Medium Stiff	5 to 8
Stiff	9 to 14
Very Stiff	15 to 30
Hard	31+

DENSITY – COHESIONLESS SOILS

Relative Density	SPT
Very Loose	<4
Loose	4 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	51+

ROCK HARDNESS

SPT (in/50)	TCP (in/100)	Rock Description
6+	6+	Very Soft / Very Poorly Cemented
5 - 6	3 - 6	Soft / Poorly Cemented
4 - 5	2 - 3	Moderately Hard / Cemented
3 - 4	1 - 2	Hard / Well Cemented
<3	<1	Very Hard / Very Well Cemented

ROCK CORE QUALITY

Core Quality	RQD
Excellent Quality	90 – 100%
Good Quality	75 – 90%
Fair Quality	50 – 75%
Poor Quality	25 – 50%
Very Poor Quality	<25%