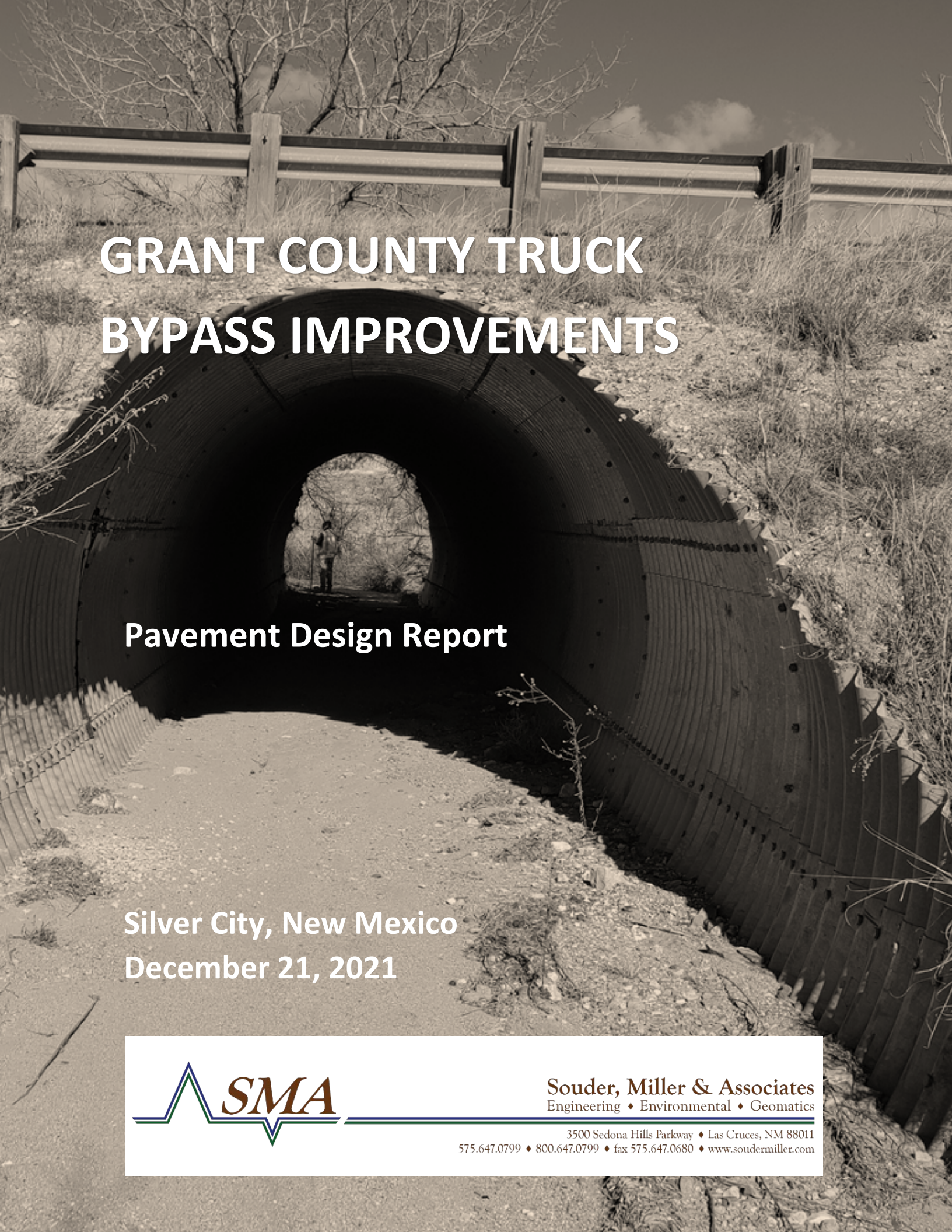

GRANT COUNTY TRUCK BYPASS IMPROVEMENTS

Pavement Design Report

Silver City, New Mexico
December 21, 2021

SMA
Souder, Miller & Associates
Engineering ♦ Environmental ♦ Geomatics
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December 21, 2021 #7328699

Ms. Priscilla A. Shoup
Planning & Community Development Director
Grant County
1400 East Highway 180
Silver City, New Mexico 88061

RE: Grant County Truck Bypass Road Improvements, Silver City New Mexico
Pavement Design Report

Dear Ms. Shoup:

Souder, Miller and Associates is pleased to present the enclosed final Pavement Design Report for the above referenced project. The report analyzes the existing subgrade soils within the right-of-way of an approximate 1.90-mile stretch of the Truck Bypass Road in Silver City, New Mexico and recommends applicable pavement sections for the improvements of Truck Bypass Road.

Should you have any questions, require any further information or if any portion of the report requires modification to meet your specific needs, please do not hesitate to contact our office.

Sincerely,

MILLER ENGINEERS, INC. D/B/A
SOUDER, MILLER & ASSOCIATES

Sarah V. Garduño, EIT
Staff Civil Designer
sarah.garduno@soudermiller.com

Paul J. Pompeo, PE
Technical Sector Director
paul.pompeo@soudermiller.com

Enc: Grant County Truck Bypass Road Improvements Project Pavement Design Report

PAVEMENT DESIGN

GRANT COUNTY TRUCK
BYPASS ROAD IMPROVEMENTS

SILVER CITY, NEW MEXICO

Prepared for

Grant County
Roads Department
1400 East Highway 180
Silver City, New Mexico 88061

December 21, 2021

This document was prepared under the supervision and direction of the undersigned whose seal as a Professional Engineer, licensed to practice as such in the State of New Mexico, is affixed below.

Paul J. Pompeo, P.E.

11490 — NMPE Number

12/21/2021 — Date

Table of Contents

List of Appendices

PAVEMENT DESIGN REPORT

GRANT COUNTY TRUCK BYPASS IMPROVEMENTS
Silver City, New Mexico

December 21, 2021

1.0 Introduction

Souder, Miller and Associates (SMA) was retained by Ms. Priscilla A. Shoup, the Planning and Community Development Director of Grant County to prepare the following pavement design report. From the site's subsurface investigation through obtaining soil test borings, the nature of the substrata soils will be determined, and its characteristics ascertained. This information shall then be used to provide pavement design for approximately 1.90-mile stretch of the Truck Bypass Roadway. A project location map and boring location maps are in Appendix A.

2.0 Scope of Work

The intent of the investigation is to obtain subsurface data at the site and provide recommendations for the pavement design of Truck Bypass roadway. The extent of this subsurface study included the drilling of 15 soil test borings and the laboratory testing of these soil samples collected from the site. In addition, 2 pavement cores were completed to determine the existing pavement structure composition within the project area. All testing and drilling were completed by technicians from the drilling and soils testing subcontractor, Southwest Engineering, Inc. (SEI). Further discussion of the findings is in Section 5.0. These findings include:

- A review of site and subsurface conditions
- Boring logs and laboratory test results
- Determine applicable traffic loads based on anticipated traffic volumes
- Provide pavement section design options.

3.0 Site Description

A review of the project site was made by SMA personnel prior to drilling operations to document the current site conditions and characteristics. Truck Bypass Road is located southwestern portion of Silver City, New Mexico. The repairs are anticipated to begin approximately at the intersection of U.S Highway 180 and Truck Bypass Road continuing southwest for approximately 1.90-miles to the intersection of New Mexico Highway 90 and Truck Bypass Road. This report will evaluate pavement design options that can be utilized for Truck Bypass Road when subjected to applicable loading. For the purpose of this report, the pavement loadings for the rehabilitated roadway shall use the current NMDOT traffic counts for the existing roadway, adjusted for the 20-year pavement life period. These current traffic counts are attached in Appendix C.

4.0 Geometric Evaluations

The proposed pavement improvements will be located within existing Truck Bypass Road right-of-way with the following parameters.

Roadway Geometric Properties				
Segment Name	Disposition	Right-of-Way Width (ft)	Traveled Surface Width (ft)	Surfacing
Grant County Truck Bypass	Right-of-Way	100	22 to 24 total based on final design.	HMA

5.0 Subsurface Conditions

The subsurface condition of the project area was determined from 15 soil test borings. The boring locations were selected by SMA and the Client after a review of the project site. The soil test borings were drilled at the locations shown on project maps attached in Appendix A. From the existing site grade, the soil test borings were advanced to a depth of 6.5-feet. Disturbed samples were obtained during this test and were used to classify the soils.

The subsurface conditions encountered are shown in the boring logs in Appendix B. These records represent our interpretation of the subsurface conditions based on field logs, visual examination of field samples and laboratory testing of representative field samples. The lines designating the interface between various strata on the boring logs represent the approximate interface location. In reality, the transition between strata may actually be gradual.

5.1 Soil And Rock Conditions

The soil profile of the test holes shows the following:

Boring Number 1								
		% Passing			Design			
Depth, (ft)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Dark Brown Sandy Fat Clay w. Gravel	61	46	37	46	66	A-7	5.0
2.0 to 5.0 +/-	Dark Brown Gravelly Fat Clay	55	48	43	47	67		
5.0 to 6.5 +/-	Brown Sandy Fat Clay w. Gravel	71	52	40.2	41	62		

Boring Number 2								
		% Passing			Design			
Depth, (ft)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Dark Brown Sandy Lean Clay w. Gravel	58	40	29.1	37	48	A-2-7	5
2.0 to 5.0 +/-	Burnt Red Sandy Fat Clay	94	77	64.3	34	52		
5.0 to 6.5 +/-	Burnt Red Sandy Lean Clay w. Gravel	63	46	26.9	25	46		

Boring Number 3								
		% Passing			Design			
Depth, (ft)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Dark Brown Clayey Silty Sand w. Gravel	60	42	29	S/NP	S/NP	A-2-4	50
2.0 to 5.0 +/-	Dark Brown Sandy Fat Clay w. Gravel	62	47	35.4	38	59		
5.0 to 6.5 +/-	Dark Brown Sandy Fat Clay w. Gravel	-	-	-	38	58		

Boring Number 4								
		% Passing						
Depth, (ft)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Brown Sandy Fat Clay w. Gravel	63	53	41.3	27	50	A-7	5
2.0 to 5.0 +/-	Brownish Red Sandy Lean Clay w. Gravel	68	49	39.2	25	45	A-7	5
5.0 to 6.5 +/-	Brownish Red Sandy Lean Clay w. Gravel	66	46	33.8	17	36	A-2-6	25

Boring Number 5								
		% Passing						
Depth, (ft)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Dark Brown Sandy Lean Clay w. Gravel	63	47	35.7	20	41	A-7	7.0
2.0 to 5.0 +/-	Light Brown Silty Sand w. Gravel	63	43	29.9	S/NP	S/NP	A-2-4	50
5.0 to 6.5 +/-	Brown Sandy Lean Clay	70	44	28	22	43	A-2-7	8

Boring Number 6								
		% Passing						
Depth, (ft)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Dark Brown Sandy Fat Clay w. Gravel	63	51	38.1	31	50	A-7	5
2.0 to 5.0 +/-	Dark Brown Sandy Fat Clay	90	74	65	34	55	A-7	5
5.0 to 6.5 +/-	Brown Sandy Lean Clay	82	55	43	26	45	A-7	6

Boring Number 7								
		% Passing						
Depth, (ft)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Brown Silty Sand w. Gravel	48	32	20	S/NP	S/NP	A-2-4	50
2.0 to 5.0 +/-	Light Brown Sandy Lean Clay	74	52	38.2	22	44	A-7	7
5.0 to 6.5 +/-	Light Brown Silty Sand w. Gravel	63	41	28.4	S/NP	S/NP	A-2-4	50

Boring Number 8								
		% Passing						
Depth, (ft)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Dark Brown Sandy Lean Clay w. Gravel	61	37	22.6	15	34	A-2-6	28
2.0 to 5.0 +/-	Light Brown Gravelly Lean Clay w. Sand	43	30	20.5	15	37	A-2-6	28
5.0 to 6.5 +/-	Gray Silty Sand w. Gravel	54	37	27	S/NP	S/NP	A-2-4	50

Boring Number 9								
		% Passing						
Depth, (in)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Dark Brown Sandy Lean Clay w. Gravel	53	35	22.2	S/NP	S/NP	A-2-4	50
2.0 to 5.0 +/-	Light Brown Silty Sand w. Gravel	60	49	23.8	S/NP	S/NP	A-2-4	50
5.0 to 6.5 +/-	No Recovery	-	-	-	-	-	-	-

Boring Number 10								
		% Passing						
Depth, (ft)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Dark Brown Sandy Lean Clay w. Gravel	51	30	17	23	46	A-2-7	8
2.0 to 5.0 +/-	Dark Brown Sandy Lean Clay w. Gravel	71	50	34.6	28	46	A-2-7	8
5.0 to 6.5 +/-	Dark Brown Silty Clayey Sand w. Gravel	64	44	29.6	S/NP	S/NP	A-2-4	50

Boring Number 11								
		% Passing						
Depth, (ft)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Brown Sandy Lean Clay w. Gravel	63	42	27.5	14	35	A-2-6	30
2.0 to 5.0 +/-	Brown Sandy Fat Clay w. Gravel	71	54	38.4	33	56	A-7	5
5.0 to 6.5 +/-	Brown Sandy Lean Clay	80	53	39.8	19	40	A-7	7

Boring Number 12								
		% Passing						
Depth, (ft)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Dark Brown Silty Sand w. Gravel	64	39	24.3	S/NP	S/NP	A-2-4	50
2.0 to 5.0 +/-	No Recovery	-	-	-	-	-	-	-
5.0 to 6.5 +/-	Gray Sandy Lean Clay w. Gravel	41	22	12.1	23	41	A-2-7	16

Boring Number 13								
		% Passing						
Depth, (ft)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Dark Brown Silty Sand w. Gravel	54	34	22.7	S/NP	S/NP	A-2-4	50
2.0 to 5.0 +/-	Greyish Brown Silty Sand w. Gravel	70	47	27.6	S/NP	S/NP	A-2-4	50
5.0 to 6.5 +/-	Light Brown Silty Sand	80	56	31.1	S/NP	S/NP	A-2-4	50

Boring Number 14								
		% Passing						
Depth, (ft)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Dark Brown Sandy Lean Clay w. Gravel	56	36	25.4	30	48	A-2-7	5
2.0 to 5.0 +/-	Dark Brown Gravelly Fat Clay w. Sand	39	26	17.1	32	55	A-2-7	5
5.0 to 6.5 +/-	Dark Brown Sandy Lean Clay	79	61	49	26	44	A-7	6

Boring Number 15								
		% Passing						
Depth, (ft)	Material Description	#10	#40	#200	PI	LL	AASHTO Class	"R" Value
0 to 2.0 +/-	Dark Brown Sandy Lean Clay w. Gravel	48	31	19.4	19	49	A-2-7	5
2.0 to 5.0 +/-	Reddish Brown Silty Clayey Sand w. Gravel	98	36	25.4	S/NP	S/NP	A-2-4	50
5.0 to 6.5 +/-	Brown Silty Clayey Sand w. Gravel	67	44	27.6	S/NP	S/NP	A-2-4	50

The existing roadway alignment was found to have an "R"-values of 5 to 50. Due to these varying values a calculated weighted R-value of 27 shall be used for the pavement design.

5.2 Existing Pavement Structure Composition

The following outlines the findings of pavement coring completed in the project area:

Pavement Coring		
Location	HMAC Thickness (in)	Base Course Thickness (in)
P-1	2.5	5.0
P-2	2.5	5.4

6.0 Traffic Volumes and Pavement Loading

As outlined in the attached Appendix C, the NMDOT has determined the traffic volume on Track Bypass Road between US Highway 180 and New Mexico Highway 90 to be 579 vehicles per day in the 2019 year. Based on growth projections established for this roadway by NMDOT, the total traffic volume is expected to be 735 in 2040 or at the end of the 20 year pavement life. The NMDOT has determined that the percentage of traffic from truck or other heavier vehicles (FHWA Vehicle Classes 4 through 13) is 8%.

Traffic Volumes – Total Trips per Day				
Vehicle Type	FHWA Class	2019 AADT	2021 AADT	2040 AADT
Percent Truck Traffic		8%	8%	8%
Bus	4	4	4	5
2-Axle 6-Tire Trucks	5	26	27	34
3-Axle Single Unit Trucks	6	5	5	6
4-Axle Single Trailer Trucks	7	0	0	0
3-Axle Single Unit Trucks	8	8	8	10
3-Axle Multi-Axle Trailer Trucks	9	3	3	4
6-Axle Single Trailer Trucks	10	0	0	0
5-Axle Multi Trailer Trucks	11	0	0	0
6-Axle Multi Trailer Trucks	12	0	0	0
7-Axle Multi Trailer Trucks	13	0	0	0
Total AADT		46	47	59

From the above outlined traffic volumes and using the FHWA Equivalent 18-kip Single Axle Loading per vehicle class, the total average daily loading exerted onto the pavement structure is summarized below:

Pavement Loadings - Per Day in One Lane	
Grant County Bypass Road Main Roadway	
Percent Truck Traffic	8%
2040 Average Daily Lane Loading	15
Grant County Bypass Road Turnouts	
2040 Average Daily Turn Out Loading (20% of Main Line ADL)	3

7.0 Discussion and Recommendations

7.1 Pavement Structure Design Methodology

This pavement design follows the procedures outlined in the latest edition of the NMDOT Design Manual, Section 620 "Surfacing Materials and Pavement Design", "Guidelines for Design of Pavement Structures" by the American Association of State Highway and Transportation Officials (AASHTO), the latest edition of the "Structural Design Guide for Flexible Pavements", Bulletin 102 by the New Mexico Department of Transportation.

7.2 Pavement Structure Design Summary

The following outlined values will be used in the design of each proposed pavement section. These are as follows:

Soil Design Parameters	
Subgrade R-Value [(1)]	27
Soil Support Value (S) R = 27	4.6

[(1)]– Weighted Average Value was used for design purposes and was based on the soil parameters outlined in Section 5

Pavement Design Parameters (As Applicable)	
Pavement Design Life, years	20
Initial Serviceability Index, P_i	4.2
Terminal Serviceability Index, P_t	2.5
Area Subgrade Drainage Coefficient	2.0
Pavement Reliability, % (NMDOT Exhibit 620-4)	95
Base Course Resistance Value (R-Value)	78
Base Course Layer Coefficient (NMDOT Exhibit 620-14)	0.11
Blended Recycled HMAC/Base Course Layer Coefficient (NMDOT Exhibit 620-14)	0.20
HMAC Layer Coefficient (NMDOT Exhibit 620-14)	0.44

Pavement Design Traffic and Structural Number Parameters	
Grant County Truck Bypass Main Roadway Road	
Percent Truck Traffic	8%
2040 Average Daily Lane Loading	15
Calculated Required Structural Number (SN_R)	1.91
Grant County Truck Bypass Turnouts	
2040 Average Daily Lane Loading (20% of Main Line ADL)	3.0
Calculated Required Structural Number (SN_R)	1.43

Pavement Design Recommendations						
The following recommendation lists options for the minimum pavement design thicknesses for new structures in the project area.						
Options Based on Truck Traffic	HMA Surfacing (in)	New Base Course (in)	Existing 2.5" HMAC & 5.0" Existing Base Course (in) (2)	Subgrade Preparation (in)(1)	Required Structural Number $SN_{(R)}$	Provided Structural Number $SN_{(P)}$
Main Roadway 8% Truck Traffic	3.0	6.0	*	12.0	1.90	1.98
	3.0	*	6.0 (3)	12.0		1.98
Turn Outs	2.0	6.0	*	12.0	1.43	1.54

(1) As required in areas of existing pavements
(2) Due to the low percentage of RAP in the blended HMAC & base course matrix, the overall blended section shall be considered base course for analysis purposes.
(3) To account for deviations in the existing pavement structure thickness, only 6.0 inches of the anticipated 7.5 inches of material shall be considered for design purposes.

Pavement Section Design Notes:

(1) The proposed project hot mix asphalt will be supplied meeting the specifications of Superpave SP-III. The Performance Graded (PG) Binder Grade is proposed to be PG 64-22 as specified in Exhibit 620-5 with "Fort Bayard" being the closest defined location to the project site.
(2) The proposed project base course will be supplied meeting the specifications of "NMDOT Base Course Type 1".
(3) For primary roadways of this type, SMA does not recommend the design of pavement structures with base course layers less than 6 inches in thickness or HMAC layers less than 3 inches in thickness

8.0 Limitations

SMA prepared this report for the specific project and location described here. SMA conducted this study using the standard level of care and diligence normally practiced by recognized engineering firms now performing services of a similar nature under similar circumstances. This report, including all illustrations, is intended to be used in its entirety.

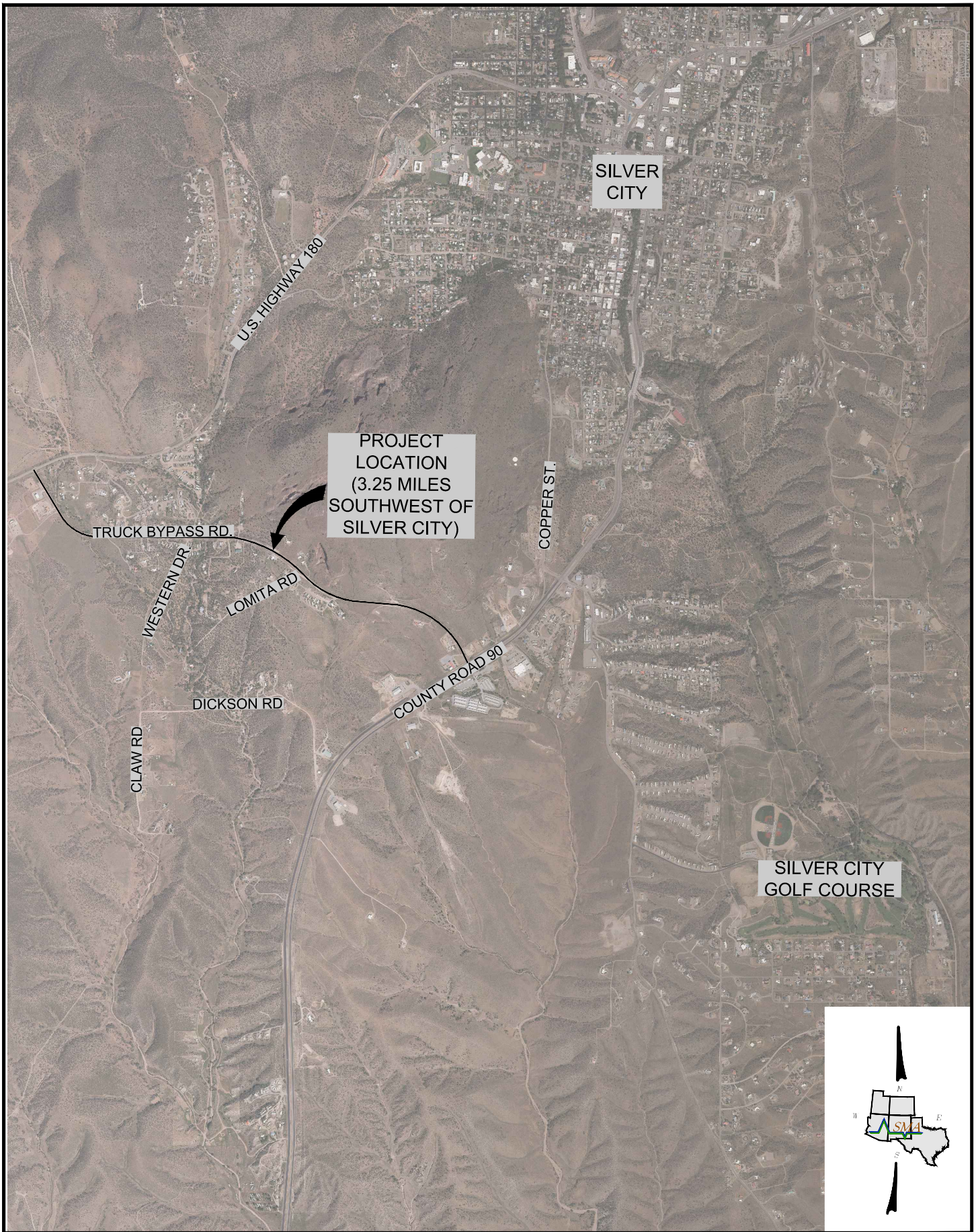
This report describes SMA's findings and conclusions about subsurface conditions at the locations identified and has based interpretation of the soil and groundwater conditions on data obtained from the borings drilled for this study. Although SMA has allowed for minor variations in subsurface conditions, recommendations may not be appropriate if soil conditions change or are found to significantly vary (as a result of localized geologic conditions) from those encountered during site evaluation. SMA recommends informing and retaining SMA if unanticipated soil conditions are encountered during construction and, if necessary, revise these conclusions.

SMA provided recommendations for pavement modifications based on soil conditions and assumptions of applied loads. Recommendations may not be appropriate if loading changes. As such, SMA recommends informing and retaining SMA, when finalized loads are determined in order for SMA to revise soil design parameters, as applicable.

SMA prepared this report for the exclusive use of the Client and Engineer. The purpose is to evaluate the design of the project as it relates to SMA's interpretation of the geotechnical aspects discussed here. This report should be available to potential contractors for information only and not as a warranty of subsurface conditions.

Appendix G.R.1

Project Vicinity Map & Bore Locations



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VICINITY MAP

GRANT COUNTY TRUCK BYPASS & CULVERT REPLACEMENT
SILVER CITY, NEW MEXICO

Designed	Drawn	Checked
SVG	SVG	PJP

Date: 01/05/2021
Scale: NONE
Project No: 7328699
V-1

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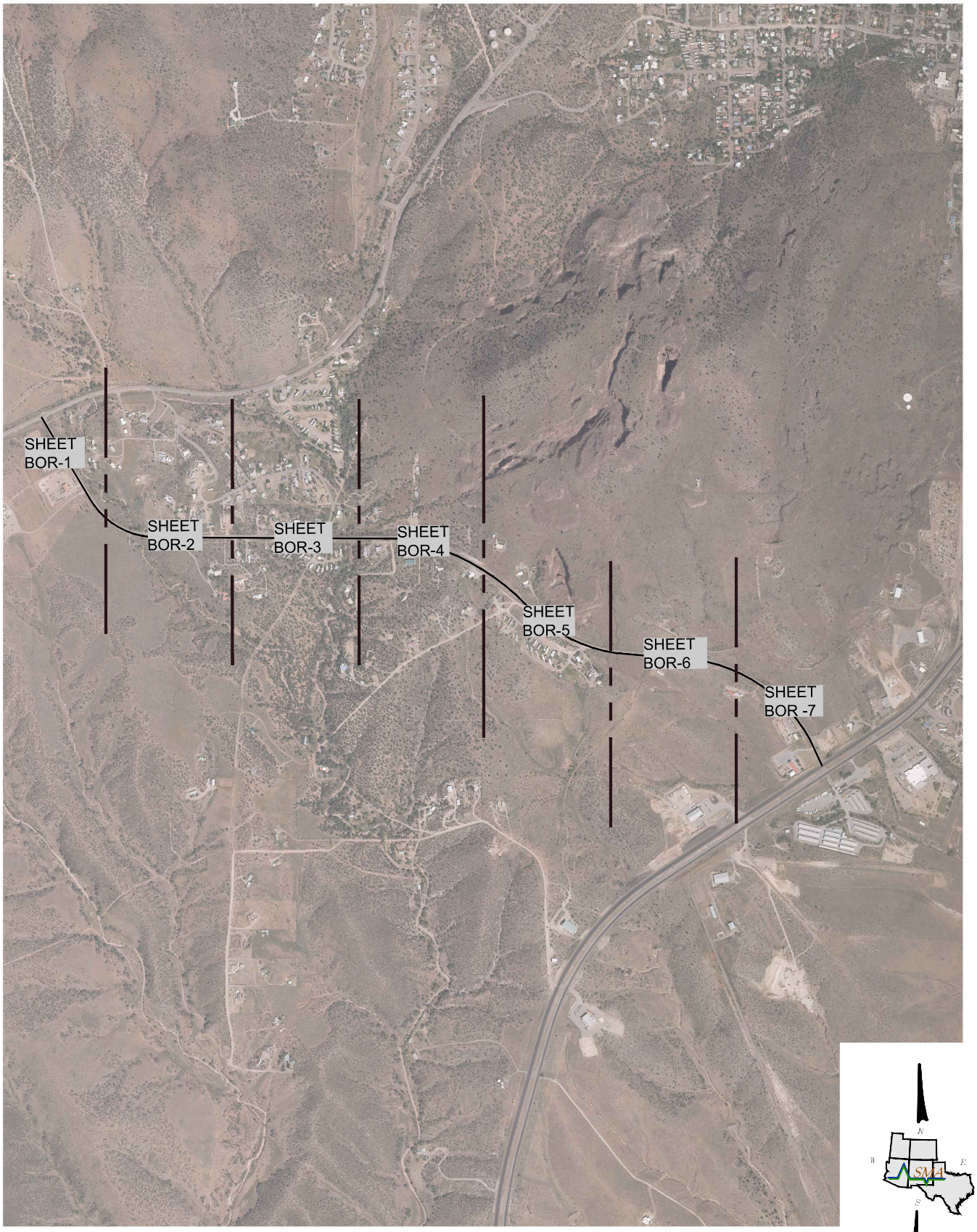

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BORE LOCATION SHEET INDEX MAP

GRANT COUNTY TRUCK BYPASS &
CULVERT REPLACEMENT
SILVER CITY, NEW MEXICO

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SVG	SVG	PJP

Date: 01/05/2021
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IND-1

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BORE LOCATION MAP

GRANT COUNTY TRUCK BYPASS &
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SILVER CITY, NEW MEXICO

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BOR-1

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BORE LOCATION MAP

GRANT COUNTY TRUCK BYPASS & CULVERT REPLACEMENT
SILVER CITY, NEW MEXICO

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BORE LOCATION MAP

GRANT COUNTY TRUCK BYPASS & CULVERT REPLACEMENT
SILVER CITY, NEW MEXICO

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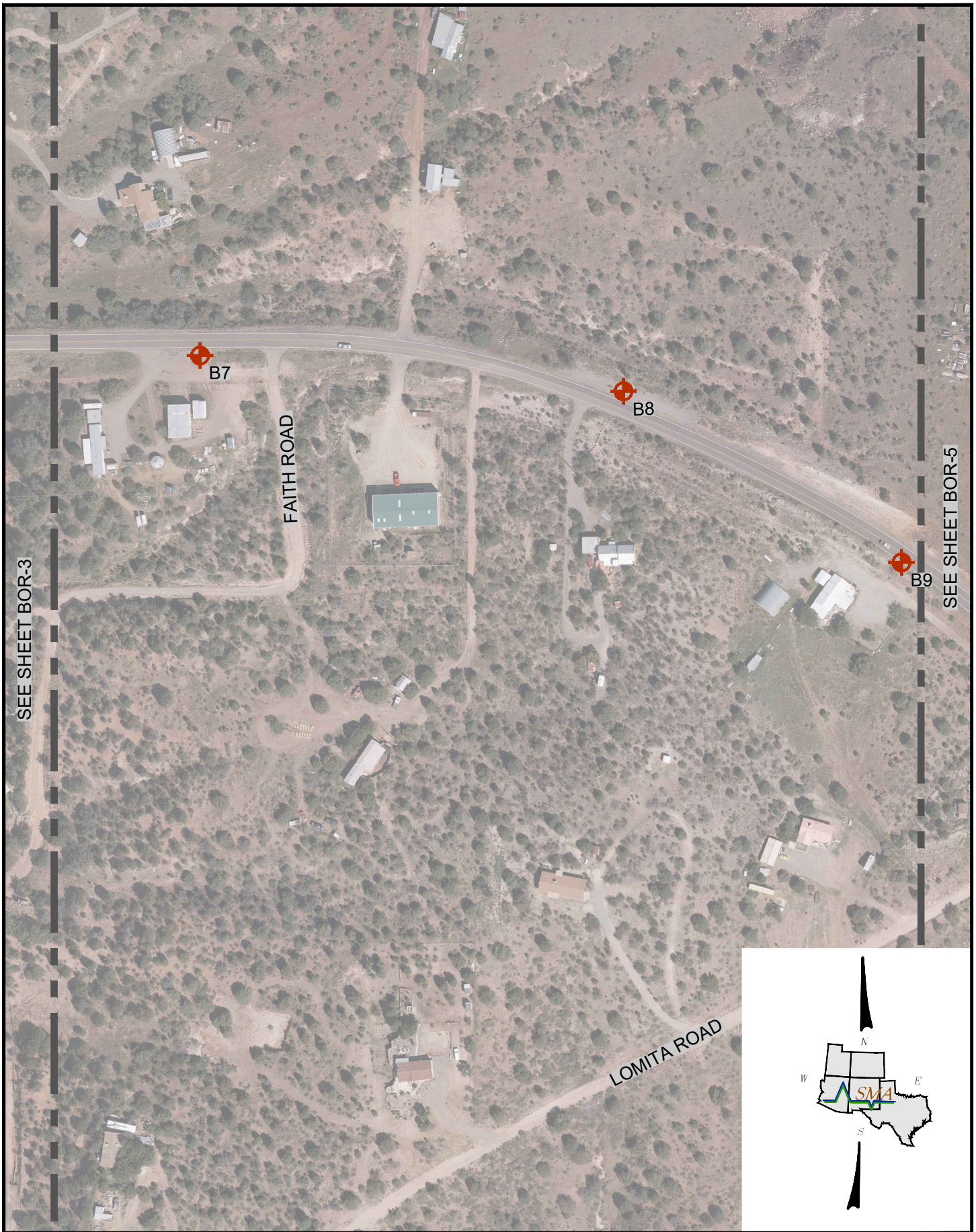

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BORE LOCATION MAP

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SILVER CITY, NEW MEXICO

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Date: 01/05/2021
Scale: NONE
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BOR-4

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BORE LOCATION MAP

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BORE LOCATION MAP

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SILVER CITY, NEW MEXICO

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Date: 01/05/2021
Scale: NONE
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BOR-6

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BORE LOCATION MAP

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Scale: NONE
Project No: 7328699
BOR-7

P:\7-Grant Co Truck Bypass Culvert Replacement (7328699)\Design\Geotechnical Report - Grant Co. Bypass Culvert Replacement\CAD File\Boring Location Map.dwg, SVG, 1/6/2021 10:29 AM

Appendix G.R.2

Soil Boring Logs

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B1
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				4.5.9					
0			S	14	66	46	13.4	CH	Dark brown sandy fat clay with gravel
1									
2				20.17.16					
2.5			S	33	67	47	12.2	CH	Dark brown gravelly fat clay
3									
4				8.10.6					
5			S	16	62	41	11.8	CH	Brown sandy fat clay with gravel
6.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B2
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				4.5.3					
0			S	8	48	37	12.5	CL	Dark brown sandy lean clay with gravel
1									
2				6.7.12					
2.5			S	19	52	34	17.9	CH	Burnt red sandy fat clay
3									
4				10.13.14					
5			S	27	46	25	16.5	CL	Burnt red sandy lean clay with gravel
6.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

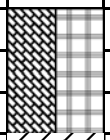
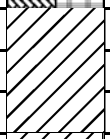
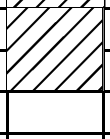
Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B3
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				15.9.4					
0			S	13	S/NP	S/NP	11.7	SC/SM	Dark brown clayey silty sand with gravel
1									
2				7.7.6					
2.5			S	13	59	38	13.9	CH	Dark brown sandy fat clay with gravel
3									
4				10.8.7					
5			S	15	58	38	N/A	CH	Dark brown sandy fat clay with gravel
6.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B4
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				3.3.7					
0			S	10	50	27	19.5	CH	Brown sandy fat clay with gravel
1									
2				5.8.28					
2.5			S	36	45	25	18.4	CL	Brownish red sandy lean clay with gravel
3									
4				5.15.30					
5			S	45	36	17	13.9	CL	Brownish red sandy lean clay with gravel
6.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B5
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				8.9.20					
0			S	29	41	20	10.7	CL	Dark brown sandy lean clay with gravel
1									
2				15.18.28					
2.5			S	46	S/NP	S/NP	9.9	SM	Light brown silty sand with gravel
3									
4				50+					
5			S	50+	43	22	16.1	CL	Brown sandy lean clay
6.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B6
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				3.4.6					
0			S	10	50	31	13.9	CH	Dark brown snady fat clay with gravel
1									
2				6.8.10					
2.5			S	18	55	34	21.4	CH	Dark brown sandy fat clay
3									
4				8.10.13					
5			S	23	45	26	15.1	CL	Brown sandy lean clay
6.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B7
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				8.10.12					
0			S	22	S/NP	S/NP	7.0	SM	Brown silty sand with gravel
1									
2				12.13.19					
2.5			S	32	44	22	10.2	CL	Light brown sandy lean clay
3									
4				22.18.16					
5			S	34	S/NP	S/NP	7.7	SM	Light brown silty sand with gravel
6.5									

Sample Type

D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B8
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				8.7.9					
0			S	16	34	15	11.6	CL	Dark brown sandy lean clay with gravel
1									
2				12.10.10					
2.5			S	20	37	15	11.3	CL	Light brown gravelly lean clay with sand
3									
4				50+					
5			S	50+	S/NP	S/NP	4.1	SM	Gray silty sand with gravel
6.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

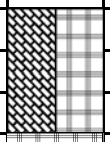
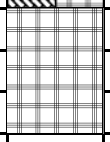
Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B9
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				2.4.8					
0			S	12	S/NP	S/NP	10.0	SC/SM	Dark brown sandy lean clay with gravel
1									
2				6.12.13					
2.5			S	25	S/NP	S/NP	9.1	SM	Light brown silty sand with gravel
3									
4									
5									No recovery
6.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B10
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				12.6.6					
0			S	12	46	23	11.1	CL	Dark brown sandy lean clay with gravel
1									
2				5.10.18					
2.5			S	18	46	28	15.4	CL	Dark brown sandy lean clay with gravel
3									
4				6.6.13					
5			S	19	S/NP	S/NP	10.0	SC/SM	Dark brown silty clayey sand with gravel
6.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B11
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				10.8.6					
0			S	14	35	14	9.3	CL	Brown sandy lean clay with gravel
1									
2				5.10.23					
2.5			S	23	56	33	18.1	CH	Brown sandy fat clay with gravel
3									
4				10.5.8					
5			S	13	40	19	10.2	CL	Brown sandy lean clay
6.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B12
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				18.10.8					
0			S	18	S/NP	S/NP	6.6	SM	Dark brown silty sand with gravel
1									
2									
2.5									No recovery
3									
4				8.14.17					
5			S	31	41	23	14.6	CL	Gray sandy lean clay with gravel
6.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B13
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				19.10.13					
0			S	23	S/NP	S/NP	9.5	SM	Dark brown silty sand with gravel
1									
2				20.11.12					
2.5			S	23	S/NP	S/NP	8.6	SM	Greyish brown silty sand with gravel
3									
4				9.13.13					
5			S	26	S/NP	S/NP	11.4	SM	Light brown silty sand
6.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B14
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				3.5.2					
0			S	7	48	30	12.2	CL	Dark brown sandy lean clay with gravel
1									
2				4.4.3					
2.5			S	7	55	32	16.3	CH	Dark brown gravelly fat clay with sand
3									
4				2.3.2					
5			S	5	44	26	17.3	CL	Dark brown sandy lean clay
6.5									

Sample Type
D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

SOUTHWEST ENGINEERING, INC.

GEOTECHNICAL BORING LOG

Project Name	Grant County Truck Bypass	Date of Field Operations	1-Feb-21
Project Number	41026	Laboratory Number	B15
Client	Souder, Miller & Associates		

Depth, ft	Graphic Log	Sample	Sample Type	Standard Penetration Blows per Foot	Liquid Limit	Plasticity Index	Moisture Content, %	Unified Soil Classification	Visual Classification & Description
				10.5.3					
0			S	8	49	30	11.1	CL	Dark brown sandy lean clay with gravel
1									
2				9.6.4					
2.5			S	10	S/NP	S/NP	11.7	SC/SM	Reddish brown silty clayey sand with gravel
3									
4				6.5.5					
5			S	10	S/NP	S/NP	11.7	SC/SM	Brown silty clayey sand with gravel
6.5									

Sample Type

D - Disturbed
S - Standard Pentration
U - Thin Wall Shelby Tube

Water Table

Water Table at __ Below Existing Site Grade

Appendix G.R.3

Laboratory Analysis

APPENDIX C - LABORATORY ANALYSIS

SAMPLE HANDLING

After recovery, our engineering staff removed the soil samples from the samplers in field. They examined the samples, visually classified them, and preserved representative portions of each sample for laboratory testing. They also obtained strength estimates of most cohesive samples in the field using a calibrated hand penetrometer or a Torvane.

SOIL CLASSIFICATION

Soil Classifications provide a general guide to the engineering properties of various soil types. Representative samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The soils are classified according to consistency (based on number of blows from standard penetration tests), color and texture. These classification descriptions are included on our Test Boring Records.

The classification system discussed above is primarily qualitative and for detailed soil classification two laboratory tests are necessary: grain size tests and index tests. Using these test results the soil can be classified according to the AASHTO, FAA, or Unified Classification Systems (ASTM D2487). These soil classifications and the in-place physical soil properties provide and index for estimating the behavior of the soil.

GRAIN SIZE TESTS

Grain size tests are performed to determine the distribution of particle sizes. The soil samples are prepared for testing according to ASTM D421 (dry preparation) or ASTM D2217 (wet preparation). The grain size distribution of soils coarser than a number 200 sieve (0.074 mm opening) is determined by passing the samples through a standard set of nested sieves. Usually, these are sandy or gravelly soils. Materials passing the No. 200 sieve are the percent fines (silt and clay sizes). Using a hydrometer, these particles are suspended in water and the particle size distribution calculated from the measured settlement rate.

INDEX TESTING

Index tests are performed to determine the soil classification and plasticity characteristics. Generally, index tests are conducted on clayey and silty soils. The soil plasticity characteristics are defined by the Plastic Limit (PL) and the Liquid Limit (LL). The PL and LL are determined in accordance with ASTM D4318 and are referred to as the Atterberg Limits.

PHYSICAL SOIL PROPERTIES

The in-place physical properties are described by the specific gravity, wet unit weight, moisture content, dry unit weight, void ratio, and percent saturation of the soil. The specific gravity and moisture content are determined according to ASTM D854 and D2216, respectively. The wet unit weight is found by obtaining a known volume of the soil and dividing the wet sample weight by the known volume. The dry unit weight, void ratio and percent saturation are calculated values.

SOUTHWEST ENGINEERING, INC.

TABULATION OF LABORATORY LAB RESULTS

PROJECT: Grant County Truck Bypass

PROJECT#: 41026

CLIENT: Souder, Miller & Assoicates

01-Feb-21

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole D1	0.0 - 2.5	12			100	98	91	85	69	53	28	21	17.7	S/NP	S/NP	SC/SM
	2.5 - 5.0	14.2				100	96	90	69	51	35	29	26.4	46	56	CH
	5.0 - 7.5	15				100	90	88	83	71	53	47	42.6	45	61	CH
	7.5 - 10.0	14.9					100	86	79	69	65	55	47	31	52	CH
	10.0 - 15.0	11.1				100	90	85	75	62	44	37	32.4	24	44	CL
	15.0 - 20.0	6			100	73	62	58	52	44	30	24	19.2	S/NP	S/NP	SM
	20.0 - 25.0	18.3				100	99	98	93	82	62	54	50.6	32	49	CL
	25.0 - 30.0	20.9					100	99	92	84	69	62	59.5	37	57	CH
	30.0 - 31.5	21.3						100	99	93	73	66	63.5	34	55	CH

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole D2	0.0 - 2.5	10.8				100	97	92	78	58	32	27	24.6	S/NP	S/NP	SC/SM
	2.5 - 5.0	11.8				100	95	92	83	64	41	36	32.9	28	48	CL
	5.0 - 7.5	11.3				100	93	90	80	64	41	35	31	27	47	CL
	7.5 - 10.0	11.9			100	93	93	91	76	63	42	36	31.8	22	46	CL
	10.0 - 15.0	11.6			100	93	87	87	75	63	43	37	34	24	46	CL
	15.0 - 20.0	13.2				100	91	91	87	82	70	64	55.8	22	39	CL
	20.0 - 25.0	12.3					100	97	94	81	52	45	26.7	26	42	CL
	25.0 - 30.0	11.7			100	96	95	94	85	59	48	44	34.2	31	50	CH
	30.0 - 31.5	14.8						100	94	82	56	46	40.8	29	47	CL

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B1	0.0 - 2.5	13.4				100	88	86	72	61	46	40	37	46	66	CH
	2.5 - 5.0	12.2			100	63	63	63	59	55	48	45	43	47	67	CH
	5.0 - 6.5	11.8				100	93	91	83	71	52	44	40.2	41	62	CH

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B2	0.0 - 2.5	12.5				100	89	86	71	58	40	33	29.1	37	48	CL
	2.5 - 5.0	17.9							100	94	77	68	64.3	34	52	CH
	5.0 - 6.5	16.5				100	92	88	77	63	46	42	26.9	25	46	CL

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B3	0.0 - 2.5	11.7				100	94	88	74	60	42	34	29	S/NP	S/NP	SC/SM
	2.5 - 5.0	13.9				100	84	84	72	62	47	39	35.4	38	59	CH
	5.0 - 6.5	N/A												38	58	CH

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B4	0.0 - 2.5	19.5				100	96	92	74	63	53	44	41.3	27	50	CH
	2.5 - 5.0	18.4				100	97	95	85	68	49	43	39.2	25	45	CL
	5.0 - 7.5	13.9					100	98	85	66	46	39	33.8	17	36	CL

SOUTHWEST ENGINEERING, INC.

TABULATION OF LABORATORY LAB RESULTS

PROJECT: Grant County Truck Bypass

PROJECT#: 41026

CLIENT: Souder, Miller & Assoicates

01-Feb-21

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing 2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200	Plasticity Index	Liquid Limit	ASTM
Test Hole B5	0.0 - 2.5	10.7				100	98	94	76	63	47	40	35.7	20	41	CL
	2.5 - 5.0	9.9				100	93	93	81	63	43	35	29.9	S/NP	S/NP	SM
	5.0 - 6.5	16.1						100	88	70	44	34	28	22	43	CL
Test Hole B6	0.0 - 2.5	13.9				100	94	94	76	63	51	44	38.1	31	50	CH
	2.5 - 5.0	21.4				100	96	96	96	90	74	68	65	34	55	CH
	5.0 - 6.5	15.1				100	98	98	92	82	55	47	43	26	45	CL
Test Hole B7	0.0 - 2.5	7			100	88	80	76	62	48	32	26	20	S/NP	S/NP	SM
	2.5 - 5.0	10.2					100	97	87	74	52	44	38.2	22	44	CL
	5.0 - 6.5	7.7					100	95	81	63	41	33	28.4	S/NP	S/NP	SM
Test Hole B8	0.0 - 2.5	11.6				100	91	88	77	61	37	28	22.6	15	34	CL
	2.5 - 5.0	11.3			100	77	66	59	51	43	30	25	20.5	15	37	CL
	5.0 - 7.5	4.1				100	83	77	66	54	37	31	27	S/NP	S/NP	SM
Test Hole B9	0.0 - 2.5	10			100	88	88	85	71	53	35	27	22.2	S/NP	S/NP	SC/SM
	2.5 - 5.0	9.1				100	97	95	80	60	49	30	23.8	S/NP	S/NP	SM
	5.0 - 7.5				No Recovery											
Test Hole B10	0.0 - 2.5	11.1			100	97	92	85	68	51	30	21	17	23	46	CL
	2.5 - 5.0	15.4				100	88	88	80	71	50	41	34.6	28	46	CL
	5.0 - 7.5	10					100	94	70	64	44	35	29.6	S/NP	S/NP	SC/SM
Test Hole B11	0.0 - 2.5	9.3			100	96	93	90	78	63	42	33	27.5	14	35	CL
	2.5 - 5.0	18.1				100	92	88	81	71	54	45	38.4	33	56	CH
	5.0 - 7.5	10.2					100	99	94	80	53	45	39.8	19	40	CL
Test Hole B12	0.0 - 2.5	6.6				100	97	92	82	64	39	30	24.3	S/NP	S/NP	SM
	2.5 - 5.0				No Recovery											
	5.0 - 7.5	14.6				100	77	73	58	41	22	15	12.1	23	41	CL

SOUTHWEST ENGINEERING, INC.

TABULATION OF LABORATORY LAB RESULTS

PROJECT: Grant County Truck Bypass

PROJECT#: 41026

CLIENT: Souder, Miller & Assoicates 01-Feb-21

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B13	0.0 - 2.5	9.5				100	93	87	71	54	34	27	22.7	S/NP	S/NP	SM
	2.5 - 5.0	8.6			100	93	90	89	83	70	47	36	27.6	S/NP	S/NP	SM
	5.0 - 6.5	11.4					100	99	92	80	56	42	31.1	S/NP	S/NP	SM

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B14	0.0 - 2.5	12.2				100	92	87	74	56	36	30	25.4	30	48	CL
	2.5 - 5.0	16.3			100	88	68	63	48	39	26	21	17.1	32	55	CH
	5.0 - 6.5	17.3					100	99	91	79	61	54	49	26	44	CL

LOCATION	Depth (feet)	Moisture (%)	Sieve Analysis - Accumlative Passing											Plasticity Index	Liquid Limit	ASTM
			2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#80	#200			
Test Hole B7	0.0 - 2.5	11.1				100	90	78	62	48	31	24	19.4	30	49	CL
	2.5 - 5.0	11.7			100	84	81	80	70	58	36	30	25.4	S/NP	S/NP	SC/SM
	5.0 - 6.5	11.7				100	94	92	82	67	44	34	27.6	S/NP	S/NP	SC/SM