ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
FAX (719) 531-5238

April 17, 2019
Revised April 30, 2019

SR Land, LLC
20 Boulder Crescent Street, 2nd Floor
Colorado Springs, Colorado 80903

Attn: Chaz Collins

Approved
By: Elizabeth NijKamp
Date:06/13/2019
El Paso County Planning & Community Development

Re: Pavement Recommendations
Vollmer Road Improvements
Vollmer Road and Dines Boulevard
El Paso County, Colorado

Dear Mr. Collins:

As requested, Entech Engineering, Inc. has obtained samples of the subgrade soils from a section of the roadway for proposed acceleration and deceleration lanes and widening at the intersection of Vollmer Road and Dines Boulevard, in El Paso County, Colorado. The roadway improvements extend both sides of the intersection of Dines Boulevard and Vollmer Road. Laboratory testing to determine the pavement support characteristics of the soils was performed. This letter presents the results of the laboratory testing and pavement recommendations for the roadways.

Project Description

The project consists of the paving of the widening of Vollmer Road and acceleration/deceleration lanes for Vollmer Road at the intersection of Dines Boulevard. Subsurface Soil Investigation and laboratory testing was performed to determine the pavement support characteristics of the soils. The extent of the roadway construction is shown in the Test Boring Location Plan, Figure 1.

Subgrade Conditions

Five exploratory test borings were drilled in the roadway to depths of approximately 5 to 10 feet. The Boring Logs are presented in Appendix A. Sieve Analysis and Atterberg Limit testing were performed on soil samples obtained from the test borings for the purpose of classification. Sieve analyses performed indicated the percent passing the No. 200 sieve for the roadway subgrade soils ranged from approximately 18 to 30 percent. Atterberg Limit Tests performed on the samples resulted in Liquid Limits ranging from 31 to 39 and no value and Plastic Indexes of 16 to 20 and non-plastic. Three general soil types were encountered at the subgrade depth (Soil Types 1, 2, and 3). Soil Type 1 consisted of silty sand fill and clayey sand fill which classified as A-1-b and A-2-6 soils based on the AASHTO classification system. Soil Type 2 consisted of native silty sand fill with thin clay lenses which classified as A-1-b and A-2-6 soils. Soil Type 3 consisted of silty sandstone which classified as A-1-b and A-2-4 soils. The Type 1, 2, and 3 soils encountered in the area of the proposed roadway improvements typically have good pavement support characteristics. Mitigation of sandstone may be required and discussed in the mitigation section of this report. Sulfate testing of the subgrade indicated that the soils exhibit a negligible potential for sulfate attack. Groundwater was not encountered in the test borings.

Swell testing conducted on Soil Types 1 and 2 showed swells ranging between 0.2 and 0.7 percent, indicating low expansion potentials. These limits are below the level in which mitigation is required (2.0 percent). Laboratory test results are presented in Appendix B and are summarized on Table 1.

California Bearing Ratio (CBR) testing was performed on a sample of Soil Type 1 to determine the support characteristic of the subgrade soils for the roadway sections. The results of the CBR testing, are presented in Appendix B and summarized as follows:

CBR Test Results
Soil Type 1 – Clayey Sand Fill
R @ 90% = 12.0
R @ 95% = 22.0
Use R = 22.0 for design

Classification Testing	
Liquid Limit	39
Plasticity Index	20
Percent Passing 200	24.5
AASHTO Classification	A-2-6
Group Index	1
Unified Soils Classification	SC

Pavement Design

The CBR testing was used to determine pavement sections for this site. The pavement sections were determined utilizing the El Paso County "Pavement Design Criteria and Report". The following classification and ESAL value were used for this roadway improvement project. Vollmer Road classifies as an urban minor arterial which uses an 18K ESAL value of 1,971,000 for design. Composite and full depth pavement sections are provided. Design parameters used in the pavement analysis are as follows:

Reliability (Urban Minor Arterial)	85%
Serviceability Index Rural Minor Arterial	2.5
"R" Value Subgrade – ST 1	22.0
Resilient Modulus	5,273 psi
Structural Coefficients:	
Hot Bituminous Pavement	0.44
Aggregate Base Course	0.11
Recycled Concrete Base Course	0.11

Pavement calculations are attached in Appendix C. Pavement sections recommended for this project are summarized as follows:

Pavement Sections – Soil Type 1 – R=22

Urban Minor Arterial – ESAL = 1,971,000 – Vollmer Road

Alternatives	Asphalt (in)	Base Course (in)
1 – Asphalt Over Aggregate Base Course	5.5	13.5 (aggregate)
2 – Asphalt Over Recycled Concrete Base Course**	5.5	13.5 (recycled conc.)
3 – Full Depth Asphalt[1]	9.0	–

[1] Full depth sections are only allowed over chemically treated or suitable subgrade.
* Minimum sections required by the El Paso County Pavement Design Criteria and Report.
** Class 5 or 6 from an approved source as required by the El Paso County Pavement Design Criteria and Report

It should be noted that construction activity for the acceleration and decelerations has not begun at the time of this investigation. Fill is proposed south of the existing roadway to develop the intersection with Dines Boulevard. Entech has been involved with the overlot grading for the subdivision south of this intersection. It is our understanding that the fill will be generated from this subdivision which contains similar soil properties and should perform similarly to the soils in the drill area along Vollmer Road. The fill proposed for construction should be submitted to Entech prior to construction to determine the suitability of the material and compatibility with the soil obtained from this investigation. The soil conditions within the new roadway subgrade areas should be reviewed after site grading is completed to determine if the existing road section thickness is appropriate versus the designed composite sections presented in this report.

Mitigation

El Paso County criteria requires mitigation of expansive soils for roadway subgrade that have a swell of 2 percent or greater with a 150 pound per square foot surcharge. Four samples at subgrade depth were tested that resulted in volume changes ranging between 0.2 to 0.7 percent. Based on the testing mitigation for expansive soils will not be required.

Mitigation for high bearing sandstone may be required and should be determined after the roadway grading is completed. Typical mitigation for sandstone can include removals of 12 to 18-inches of the material below the base course. The overexcavation should be observed by Entech prior to backfilling with fill. The fill should be approved as stated above before placement. The removed sandstone may be used as fill, however should not contain nodules larger than 2.5 inches nominal diameter.

Roadway Construction - Full Depth Asphalt and Asphalt on Aggregate Base Course Alternatives

Prior to placement of the asphalt, the subgrade should be proofrolled and compacted to a minimum of 95 percent of its maximum Standard Proctor Dry Density, ASTM D-698 at -1 to +2 percent of optimum moisture content or 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557 at ±2 percent of optimum moisture content. Any loose or soft areas should be removed and replaced with suitable materials. Base course materials should be compacted to a minimum of 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557 at ± 2 percent of optimum moisture content. Special attention should be given to areas adjacent to manholes, inlet structures and valves.

The road subgrade soils should be evaluated after grading is complete. Pavement sections provided should be reviewed after site grading is completed.

In addition to the above guidance, the asphalt, cement, subgrade conditions, compaction of materials and roadway construction methods shall meet the El Paso County specifications.

We trust that this has provided you with the information you required. If you have any questions or need additional information, please do not hesitate to contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Reviewed by:

COLORADO REGISTERED
STANLEY CLARE CULP
36723
4/30/19
PROFESSIONAL ENGINEER

Stan C. Culp, P.E.
Senior Engineer

Joseph C. Goode, Jr., P.E.
President

SCC/sc

Encl.

Entech Job No. 190249
AAprojects/2019/190249/190249 pr_r

TABLE

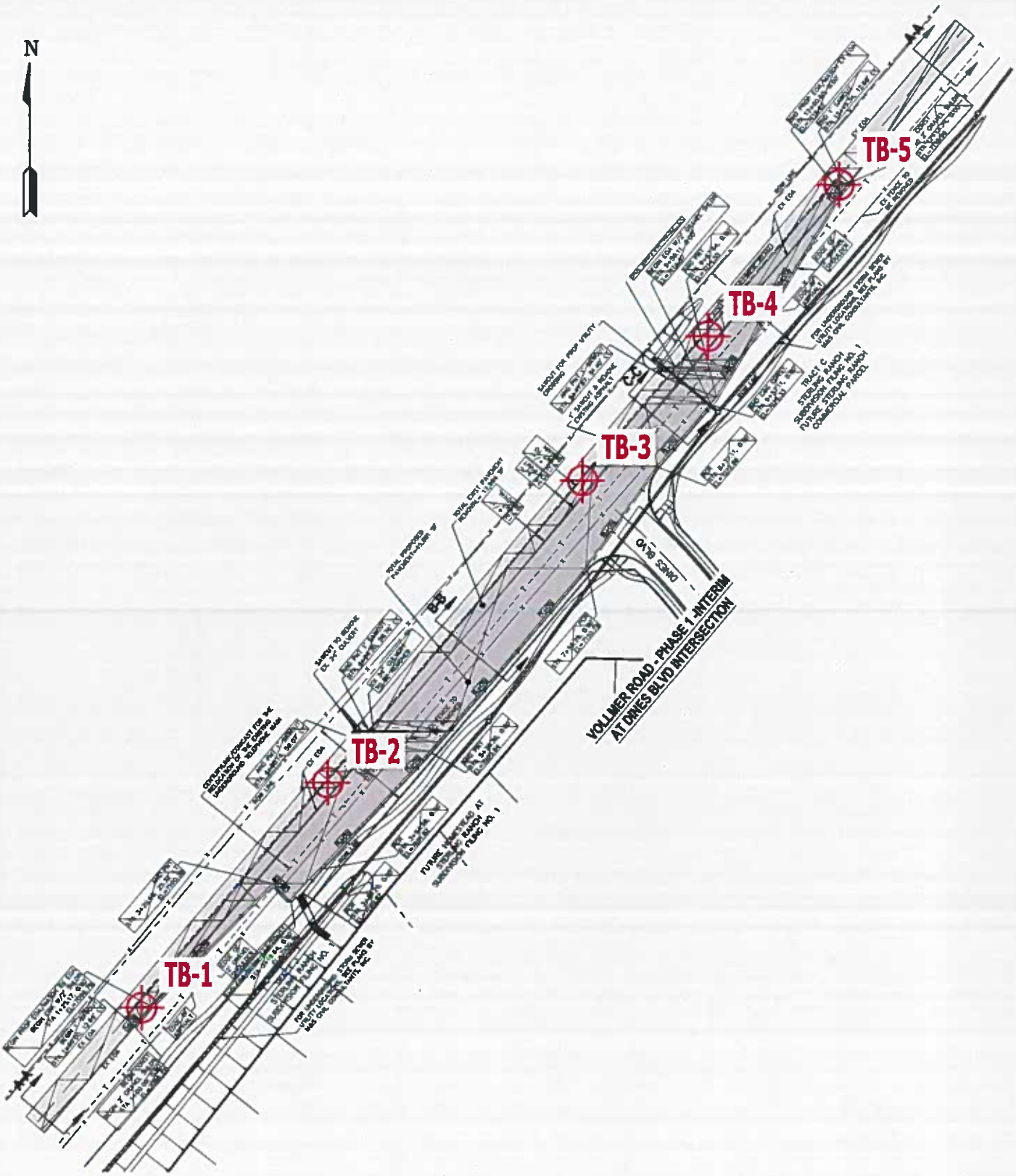
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT SR LAND, LLC
PROJECT VOLLMER RD. IMPROVEMENTS
JOB NO. 190249

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	AASHTO CLASS.	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1, CBR	1	0-3	11.8	112.5	24.5	39	20		A-2-6	0.2	SC	FILL, SAND, CLAYEY
1	1	1-2	12.3	113.5	23.1	36	20		A-2-6	0.6	SC	FILL, SAND, CLAYEY
1	2	1-2	11.8	113.0	29.6	33	17	<0.01	A-2-6	0.4	SC	FILL, SAND, CLAYEY
1	3	1-2			18.8	NV	NP		A-1-b		SM	FILL, SAND, SILTY
2	4	0-3			17.8	NV	NP		A-1-b		SM	SAND, SILTY
2	4	1-2	13.9	111.3	23.5	31	16	<0.01	A-2-6	0.7	SC	SAND, CLAYEY
3	5	1-2			19.3	NV	NP		A-1-b		SM	SANDSTONE, SILTY
3	3	10			31.9	NV	NP	<0.01	A-2-4		SM	SANDSTONE, SILTY
3	4	5			19.1	NV	NP		A-2-4		SM	SANDSTONE, SILTY

FIGURE



TB-2 - APPROXIMATE TEST BORING LOCATION AND NUMBER

ENTECH ENGINEERING, INC.
305 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-0599

TEST BORING LOCATION PLAN
VOLLMER ROAD IMPROVEMENTS
EL PASO COUNTY, CO
FOR: SR LAND, LLC

DRAWN BY:	DATE DRAWN:	DESIGNED BY:	CHECKED:
SCC	04/12/19	SC	SC

JOB NO.: 190249

FIG. NO.: 1

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 3/28/2019
Job # 190249

REMARKS

DRY TO 5', 3/28/19

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			9	14.9	1	FILL 0-5', SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, LOOSE TO MEDIUM DENSE, MOIST
5			17	10.9	1	
10						
15						
20						

TEST BORING NO. 2
DATE DRILLED 3/28/2019
CLIENT SR LAND, LLC
LOCATION VOLLMER RD. IMPROVEMENTS

REMARKS

DRY TO 5', 3/28/19

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			8	12.7	1	FILL 0-5', SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, LOOSE TO MEDIUM DENSE, MOIST
5			14	14.0	1	
10						
15						
20						

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TEST BORING LOG

DRAWN:	DATE:	CHECKED: SCC	DATE: 9/17/19

JOB NO.: 190249
FIG NO.: A- 1

TEST BORING NO. 3
DATE DRILLED 3/28/2019
Job # 190249

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 3/28/19						
FILL 0-9', SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST				21	7.2	1
	5			21	6.2	1
SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, DENSE, MOIST	10			36	8.0	3
	15					
	20					

TEST BORING NO. 4
DATE DRILLED 3/28/2019
CLIENT SR LAND, LLC
LOCATION VOLLMER RD. IMPROVEMENTS

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 3/28/19						
SAND, SILTY WITH A CLAY LENSE, FINE TO COARSE GRAINED, BROWN, LOOSE, MOIST				8	12.0	2
SANDSTONE, SILTY, FINE TO COARSE GRAINED, BROWN, DENSE, MOIST	5			42	11.4	3
	10					
	15					
	20					

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TEST BORING LOG

DRAWN:	DATE:	CHECKED: SCC	DATE: 4/17/19

JOB NO.: 190249
FIG NO.: A- 2

TEST BORING NO. 5
DATE DRILLED 3/28/2019
Job # 190249

TEST BORING NO.
DATE DRILLED
CLIENT SR LAND, LLC
LOCATION VOLLMER RD. IMPROVEMENTS

REMARKS

DRY TO 10', 3/28/19

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
					2
			46	9.8	3
5			50 8"	12.8	3
10			50 6"	8.2	3
15					
20					

SAND, SILTY, BROWN
SANDSTONE, SILTY, FINE TO COARSE GRAINED, BROWN, DENSE TO VERY DENSE, MOIST

REMARKS

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5					
10					
15					
20					

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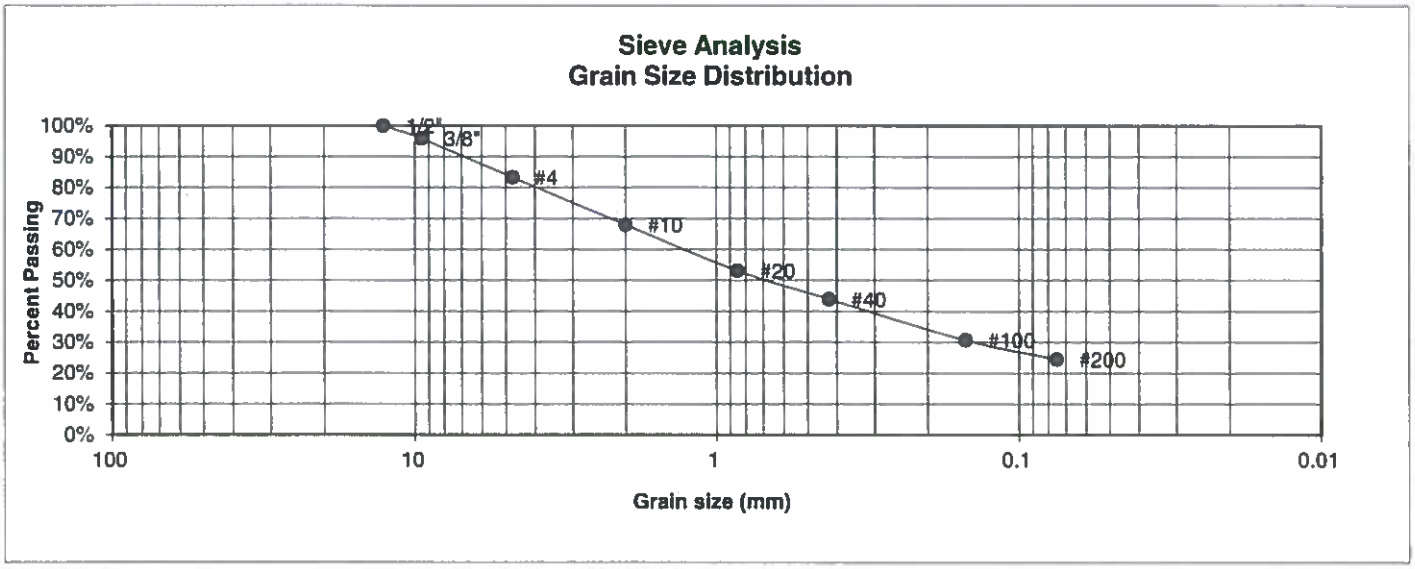
TEST BORING LOG

DRAWN:	DATE:	CHECKED: SCC	DATE: 4/17/19

JOB NO.: 190249
FIG NO.: A- 3

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SC	CLIENT	SR LAND, LLC
SOIL TYPE #	1, CBR	PROJECT	VOLLMER RD. IMPROVEMENTS
TEST BORING #	1	JOB NO.	190249
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	1



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	95.8%
4	83.3%
10	68.0%
20	53.1%
40	43.9%
100	30.7%
200	24.5%

Atterberg Limits

Plastic Limit	19
Liquid Limit	39
Plastic Index	20

Swell

Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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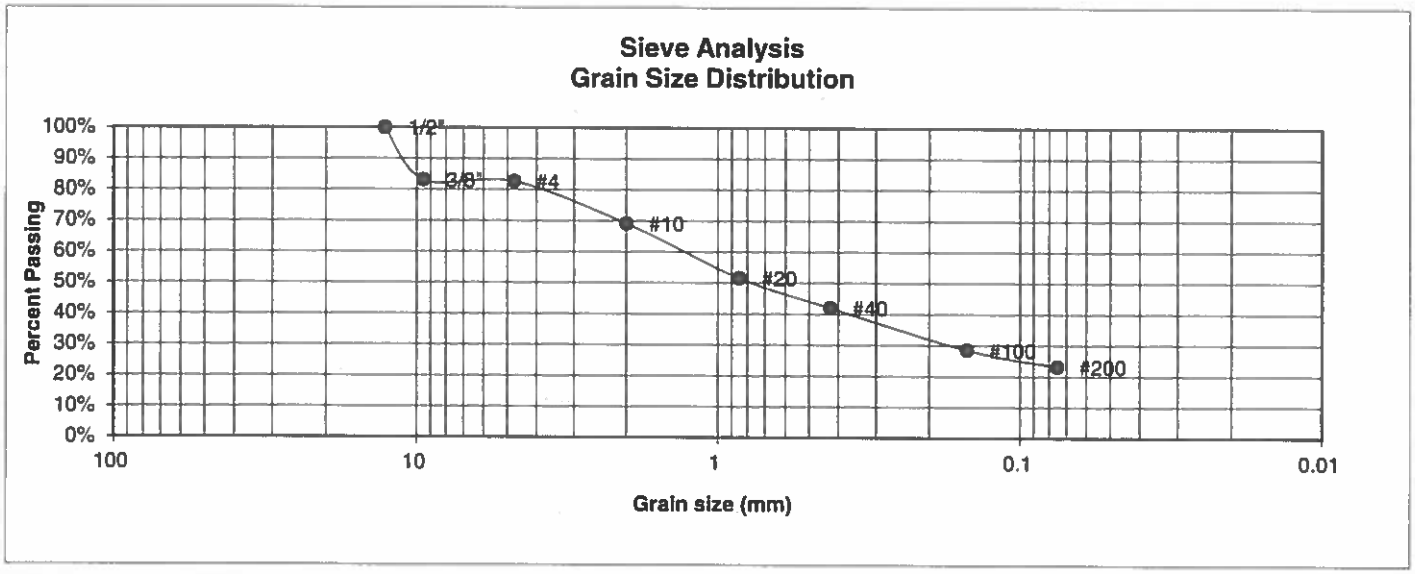
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	4/17/19

JOB NO.: 190249
FIG NO.: B-1

UNIFIED CLASSIFICATION	SC	CLIENT	SR LAND, LLC
SOIL TYPE #	1	PROJECT	VOLLMER RD. IMPROVEMENTS
TEST BORING #	1	JOB NO.	190249
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	1



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	83.1%
4	82.6%
10	69.1%
20	51.6%
40	42.0%
100	28.5%
200	23.1%

Atterberg Limits	
Plastic Limit	17
Liquid Limit	36
Plastic Index	20

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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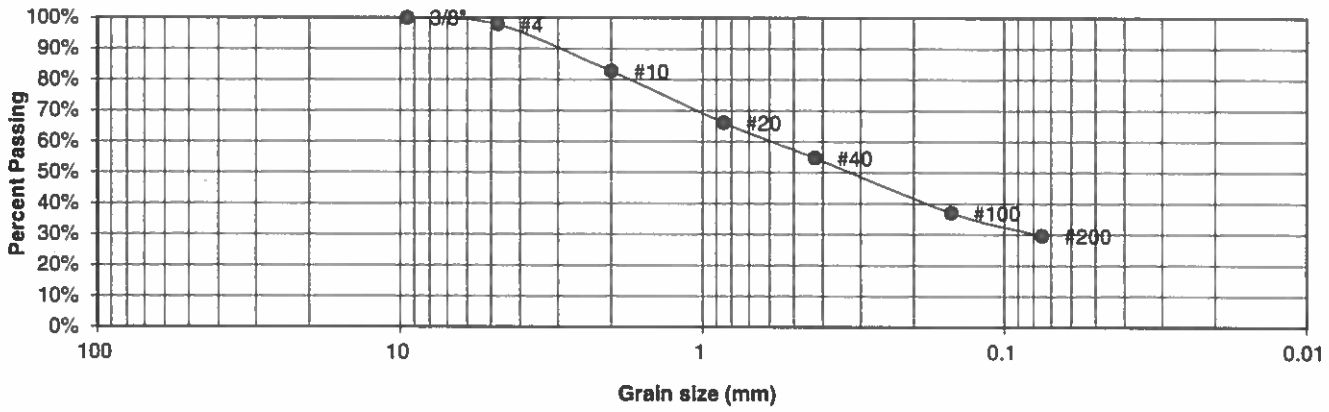
LABORATORY TEST RESULTS

DRAWN	DATE	CHECKED	DATE
		SCC	4/17/19

JOB NO.: 190249
FIG NO.: B-2

UNIFIED CLASSIFICATION	SC	CLIENT	SR LAND, LLC
SOIL TYPE #	1	PROJECT	VOLLMER RD. IMPROVEMENTS
TEST BORING #	2	JOB NO.	190249
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	1

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.8%
10	82.7%
20	66.1%
40	54.7%
100	37.0%
200	29.6%

Atterberg Limits	
Plastic Limit	16
Liquid Limit	33
Plastic Index	17

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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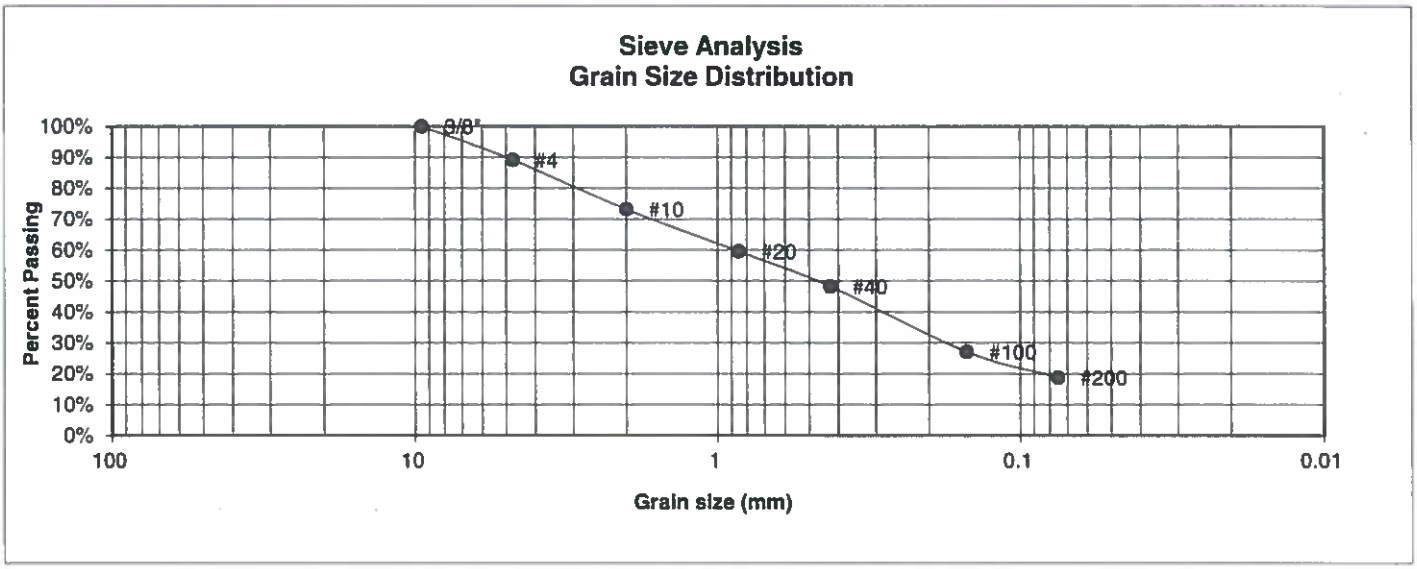
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	4/17/19

JOB NO.: 190249
FIG NO.: B-3

UNIFIED CLASSIFICATION	SM	CLIENT	SR LAND, LLC
SOIL TYPE #	1	PROJECT	VOLLMER RD. IMPROVEMENTS
TEST BORING #	3	JOB NO.	190249
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	89.2%
10	73.1%
20	59.6%
40	48.2%
100	27.1%
200	18.8%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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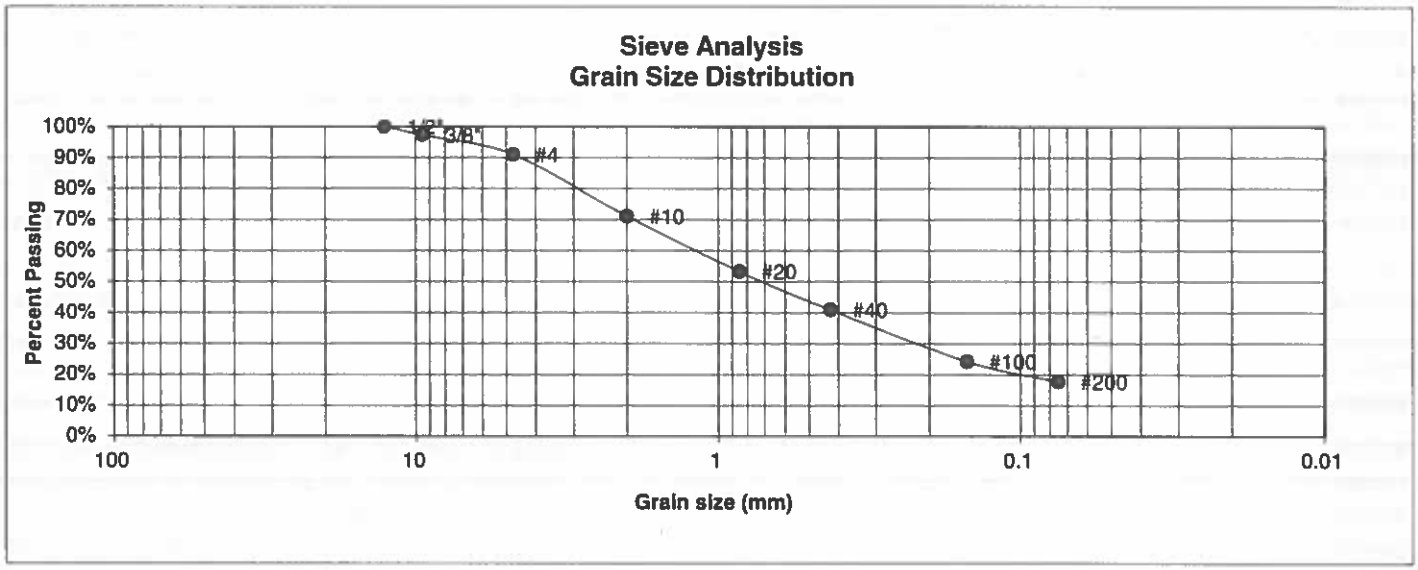
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	4/17/19

JOB NO.: 190249
FIG NO.: B-4

UNIFIED CLASSIFICATION	SM	CLIENT	SR LAND, LLC
SOIL TYPE #	2	PROJECT	VOLLMER RD. IMPROVEMENTS
TEST BORING #	4	JOB NO.	190249
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.3%
4	91.0%
10	71.1%
20	53.3%
40	41.0%
100	24.2%
200	17.8%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

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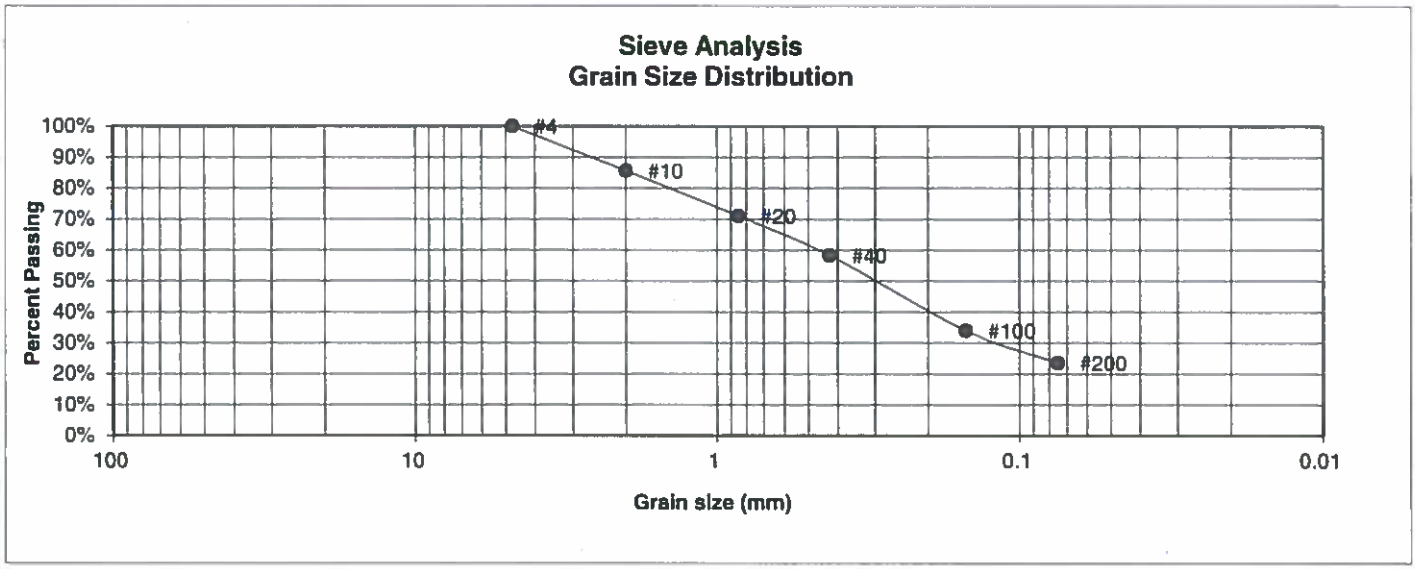
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	4/17/19

JOB NO.: 190249
FIG NO.: B-5

UNIFIED CLASSIFICATION	SC	CLIENT	SR LAND, LLC
SOIL TYPE #	2	PROJECT	VOLLMER RD. IMPROVEMENTS
TEST BORING #	4	JOB NO.	190249
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	1



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	85.7%
20	71.1%
40	58.3%
100	34.0%
200	23.5%

Atterberg Limits	
Plastic Limit	15
Liquid Limit	31
Plastic Index	16

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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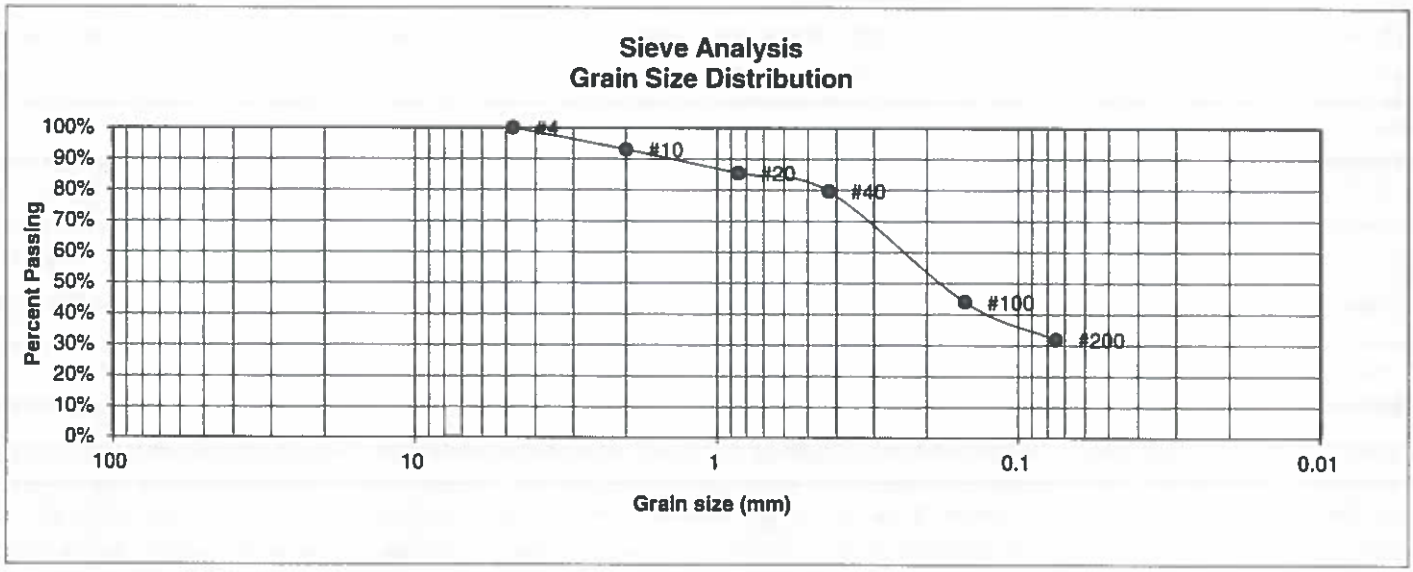
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	4/17/19

JOB NO.: 190249
FIG NO.: B-6

UNIFIED CLASSIFICATION	SM	CLIENT	SR LAND, LLC
SOIL TYPE #	3	PROJECT	VOLLMER RD. IMPROVEMENTS
TEST BORING #	3	JOB NO.	190249
DEPTH (FT)	10	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	93.1%
20	85.5%
40	79.7%
100	44.0%
200	31.9%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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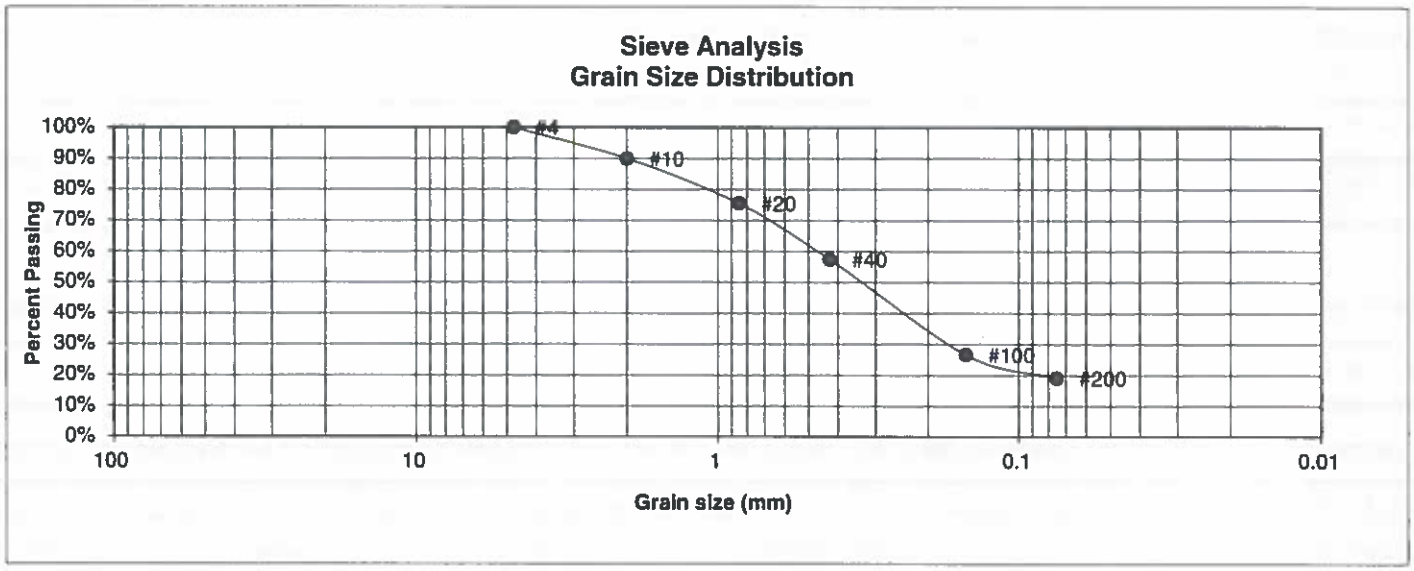
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	4/17/19

JOB NO.: 190249
FIG NO.: B-7

UNIFIED CLASSIFICATION	SM	CLIENT	SR LAND, LLC
SOIL TYPE #	3	PROJECT	VOLLMER RD. IMPROVEMENTS
TEST BORING #	4	JOB NO.	190249
DEPTH (FT)	5	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	90.0%
20	75.5%
40	57.5%
100	26.6%
200	19.1%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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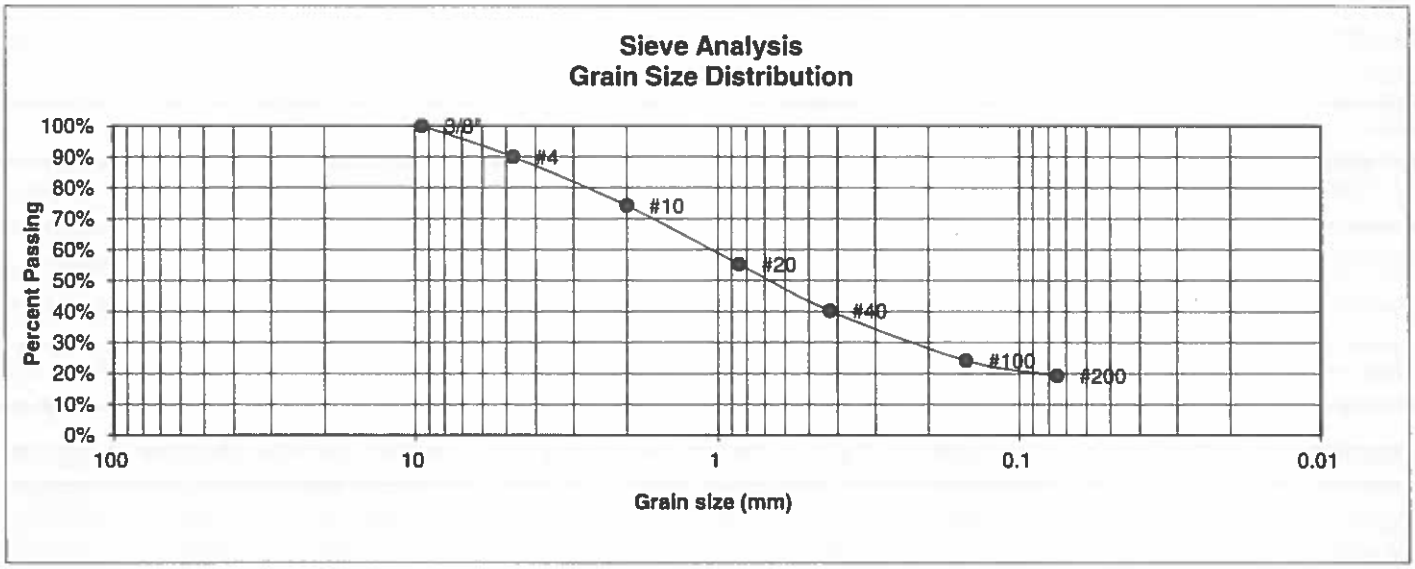
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	4/17/19

JOB NO.: 190249
FIG NO.: B-8

UNIFIED CLASSIFICATION	SM	CLIENT	SR LAND, LLC
SOIL TYPE #	3	PROJECT	VOLLMER RD. IMPROVEMENTS
TEST BORING #	5	JOB NO.	190249
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	89.9%
10	74.2%
20	55.3%
40	40.2%
100	24.2%
200	19.3%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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LABORATORY TEST RESULTS

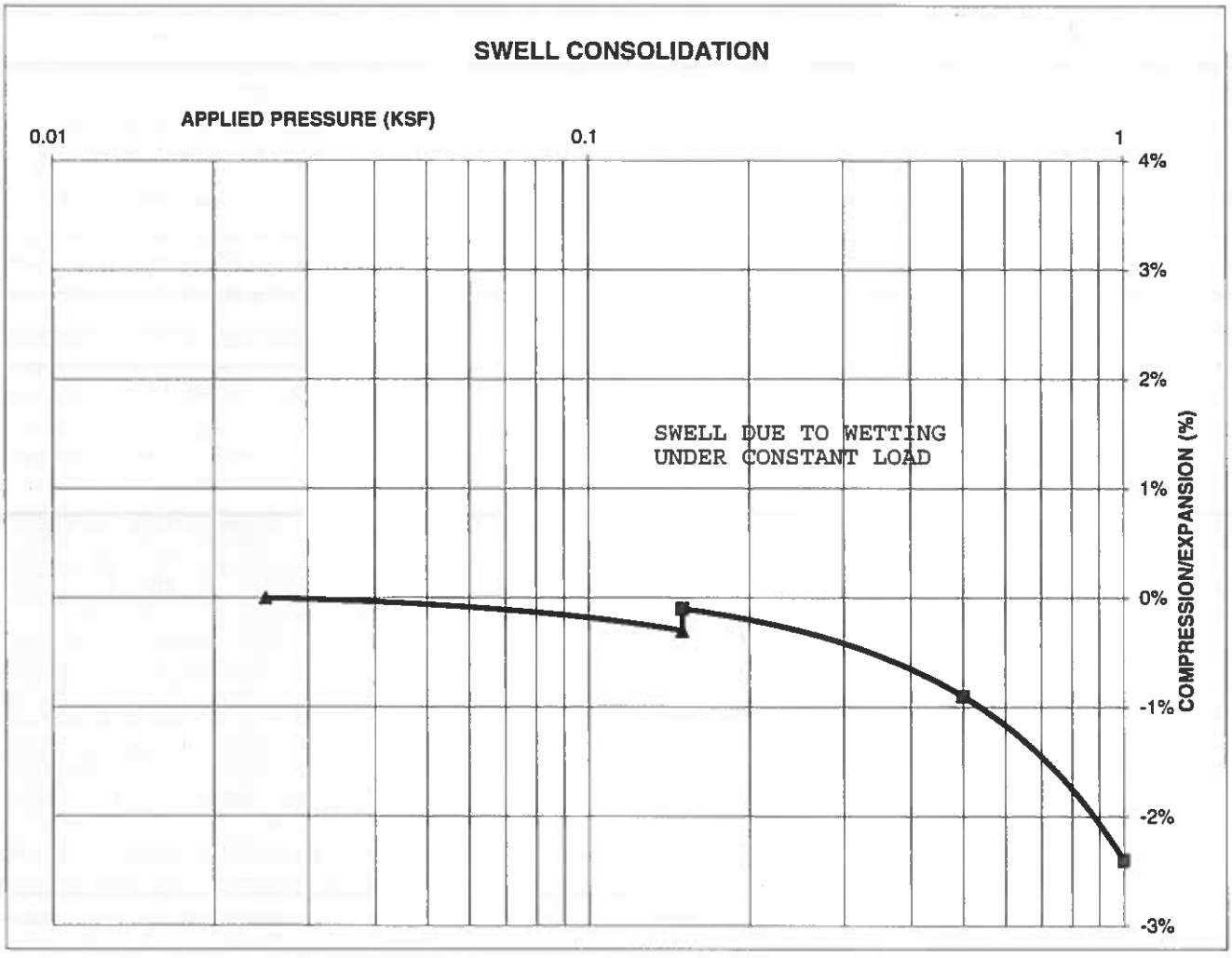
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	4/17/19

JOB NO.: 190249
FIG NO.: B-9

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(ft)	0-3
DESCRIPTION	SC	SOIL TYPE	1, CBR
NATURAL UNIT DRY WEIGHT (PCF)			112
NATURAL MOISTURE CONTENT			11.8%
SWELL/CONSOLIDATION (%)			0.2%

JOB NO. 190249
CLIENT SR LAND, LLC
PROJECT VOLLMER RD. IMPROVEMENTS



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SWELL CONSOLIDATION
TEST RESULTS

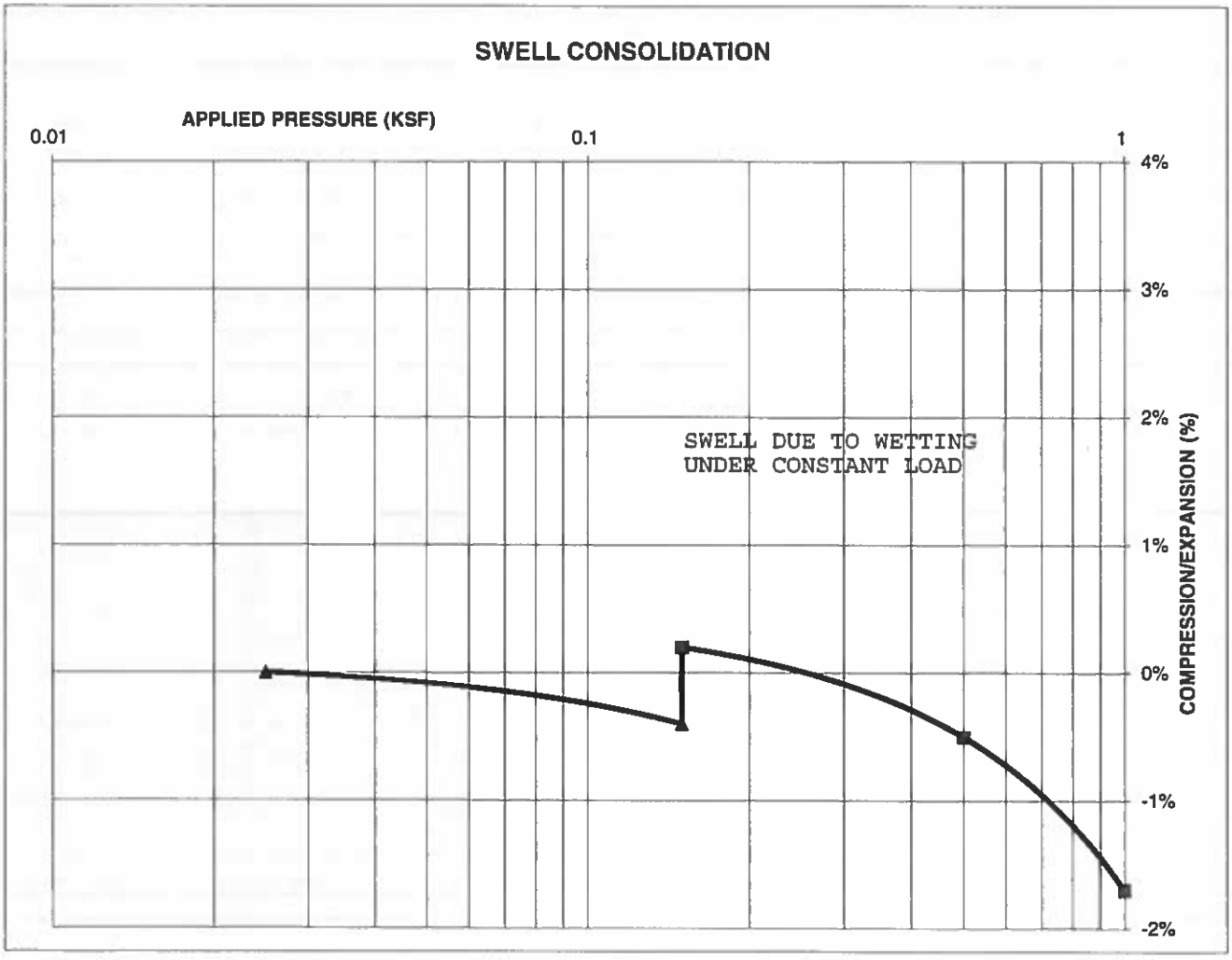
DRAWN:	DATE:	CHECKED:	DATE:
		SCL	4/17/19

JOB NO.: 190249
FIG NO.: B-10

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			113
NATURAL MOISTURE CONTENT			12.3%
SWELL/CONSOLIDATION (%)			0.6%

JOB NO. 190249
CLIENT SR LAND, LLC
PROJECT VOLLMER RD. IMPROVEMENTS



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SWELL CONSOLIDATION
TEST RESULTS

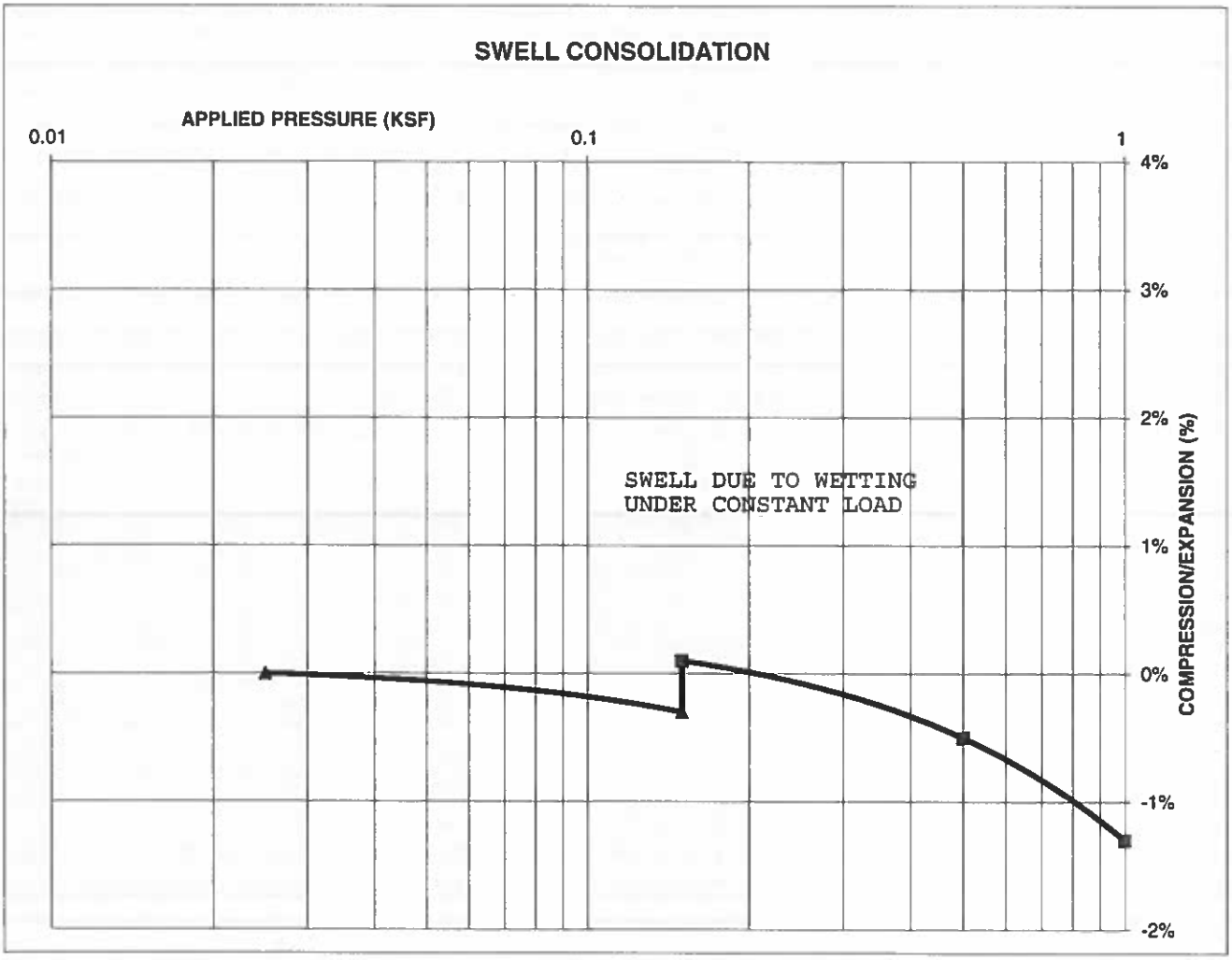
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	4/17/19

JOB NO.: 190249
FIG NO.: B-11

CONSOLIDATION TEST RESULTS

TEST BORING #	2	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			113
NATURAL MOISTURE CONTENT			11.8%
SWELL/CONSOLIDATION (%)			0.4%

JOB NO. 190249
CLIENT SR LAND, LLC
PROJECT VOLLMER RD. IMPROVEMENTS



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SWELL CONSOLIDATION
TEST RESULTS

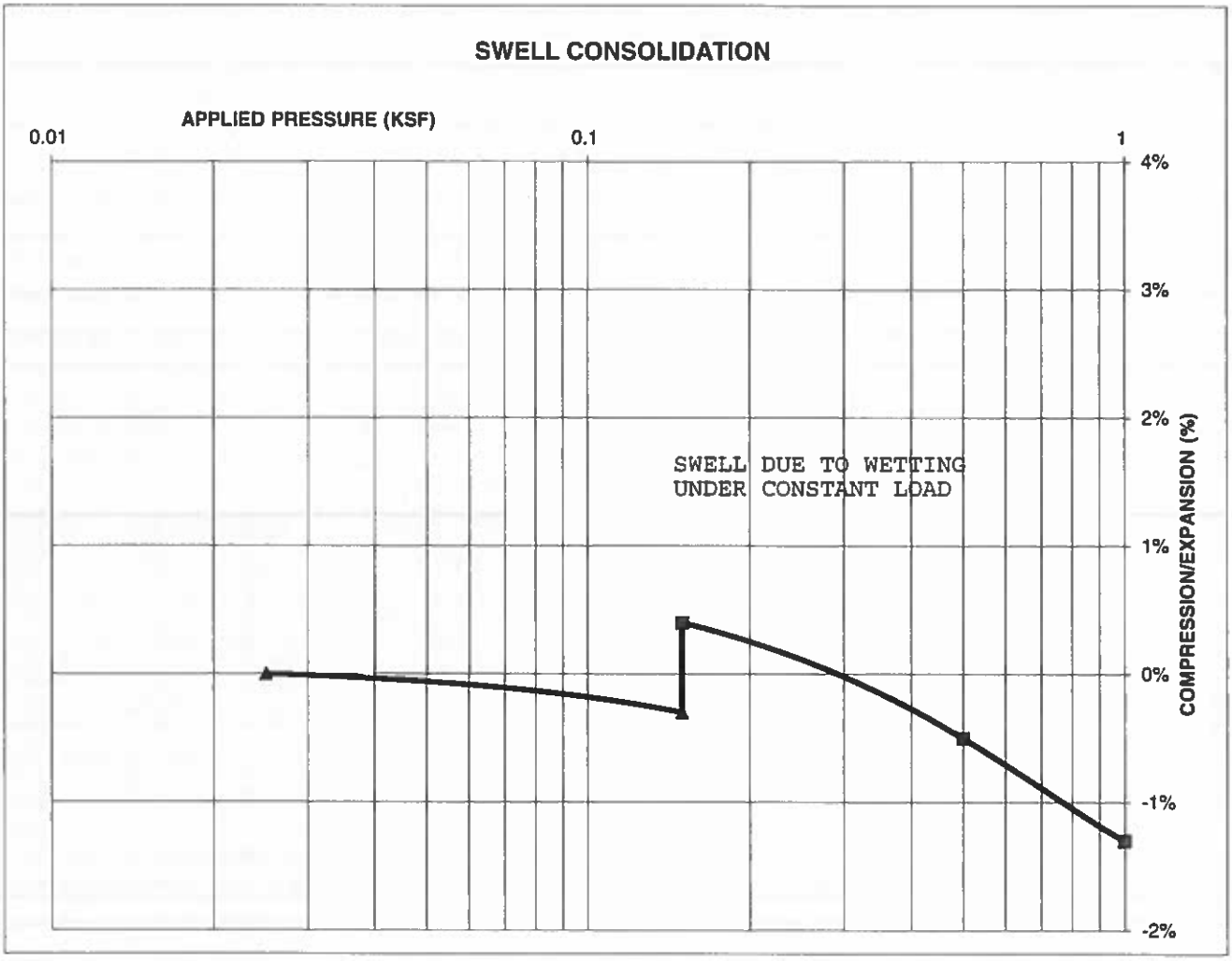
DRAWN:	DATE:	CHECKED:	DATE:
		SCC	4/17/19

JOB NO.: 190249
FIG NO.: B-12

CONSOLIDATION TEST RESULTS

TEST BORING #	4	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)			111
NATURAL MOISTURE CONTENT			13.9%
SWELL/CONSOLIDATION (%)			0.7%

JOB NO. 190249
CLIENT SR LAND, LLC
PROJECT VOLLMER RD. IMPROVEMENTS



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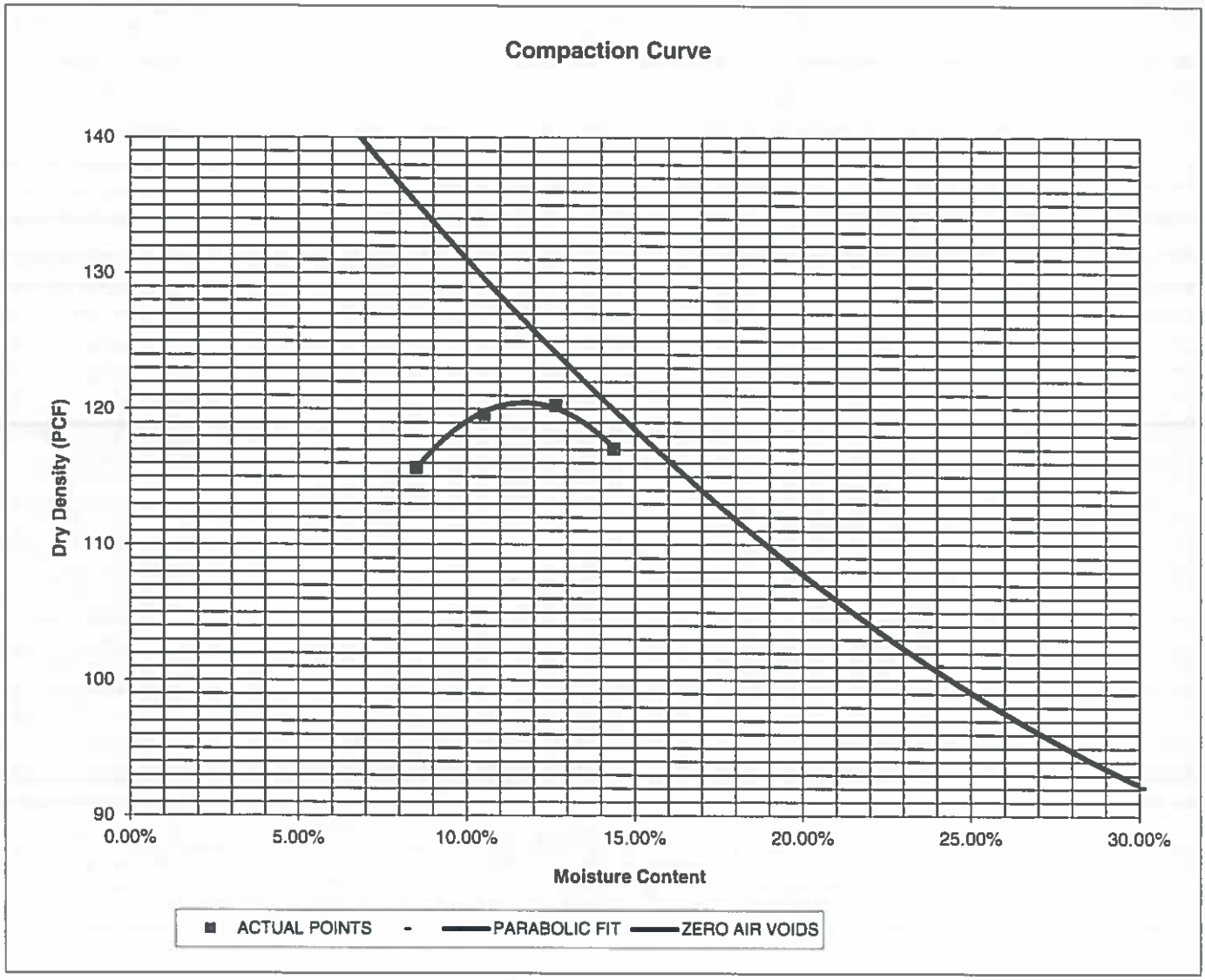
SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	4/17/19

JOB NO.: 190249
FIG NO.: B-13

PROJECT	VOLLMER RD. IMPROVEMENTS	CLIENT	SR LAND, LLC
SAMPLE LOCATION	TB-1 @ 0-3'	JOB NO.	190249
SOIL DESCRIPTION	FILL, SAND, CLAYEY, BROWN	DATE	04/04/19

IDENTIFICATION	SC	COMPACTION TEST #	1
TEST DESIGNATION / METHOD	ASTM D-1557-B	TEST BY	BL
MAXIMUM DRY DENSITY (PCF)	120.6	OPTIMUM MOISTURE	11.9%



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MOISTURE DENSITY RELATION

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	4/17/19

JOB NO.: 190249

FIG NO.: B-14

CBR TEST LOAD DATA

JOB NO: 190249
CLIENT: SR LAND, LLC
PROJECT: VOLLMER RD. IMPROVEMENTS
SOIL TYPE: 1

PISTON DIAMETER (cm)	PISTON AREA (in^2)
4.958	2.99250919

PENETRATION DEPTH (INCHES)	*10 BLOWS* MOLD # 7 LOAD(LBS) (LBS)	STRESS (PSI)	*25 BLOWS* MOLD # 6 LOAD(LBS) (LBS)	STRESS (PSI)	*56 BLOWS* MOLD # 12 LOAD(LBS) (LBS)	STRESS (PSI)
0.000	0	0.00	0	0.00	0	0.00
0.025	59	19.72	88	29.41	96	32.08
0.050	86	28.74	138	46.12	187	62.49
0.075	121	40.43	174	58.15	254	84.88
0.100	143	47.79	216	72.18	299	99.92
0.125	184	61.49	267	89.22	330	110.28
0.150	191	63.83	309	103.26	392	130.99
0.175	211	70.51	354	118.30	415	138.68
0.200	237	79.20	395	132.00	476	159.06
0.300	325	108.60	535	178.78	601	200.83
0.400	390	130.33	640	213.87	723	241.60
0.500	461	154.05	741	247.62	851	284.38

FINAL MOISTURE CONTENT

	MOLD #	7	MOLD #	6	MOLD #	12
CAN #		359		356		353
WT. CAN		6.75		6.86		6.82
WT. CAN+WET		177.81		196.61		182.09
WT. CAN+DRY		157.54		175.48		163.5
WT. H20		20.27		21.13		18.59
WT. DRY SOIL		150.79		168.62		156.68
MOISTURE CONTENT		13.44%		12.53%		11.86%
WET DENSITY (PCF)		120.5		125.8		135.8
DRY DENSITY (PCF)		107.7		112.5		121.4
BEARING RATIO		4.78		7.22		9.99

90% OF DRY DENSITY	109.2
95% OF DRY DENSITY	115.3

BEARING RATIO AT 90% OF MAX	5.56	~ R VALUE	12
BEARING RATIO AT 95% OF MAX	8.11	~ R VALUE	22

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CBR TEST DATA

DRAWN:	DATE:	CHECKED:	DATE:
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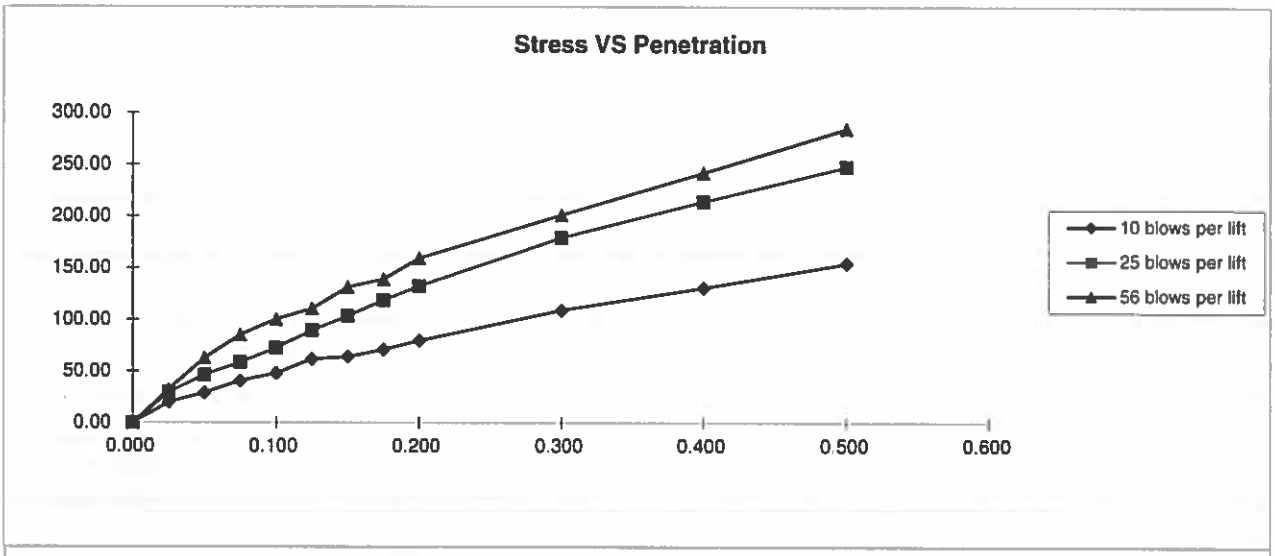
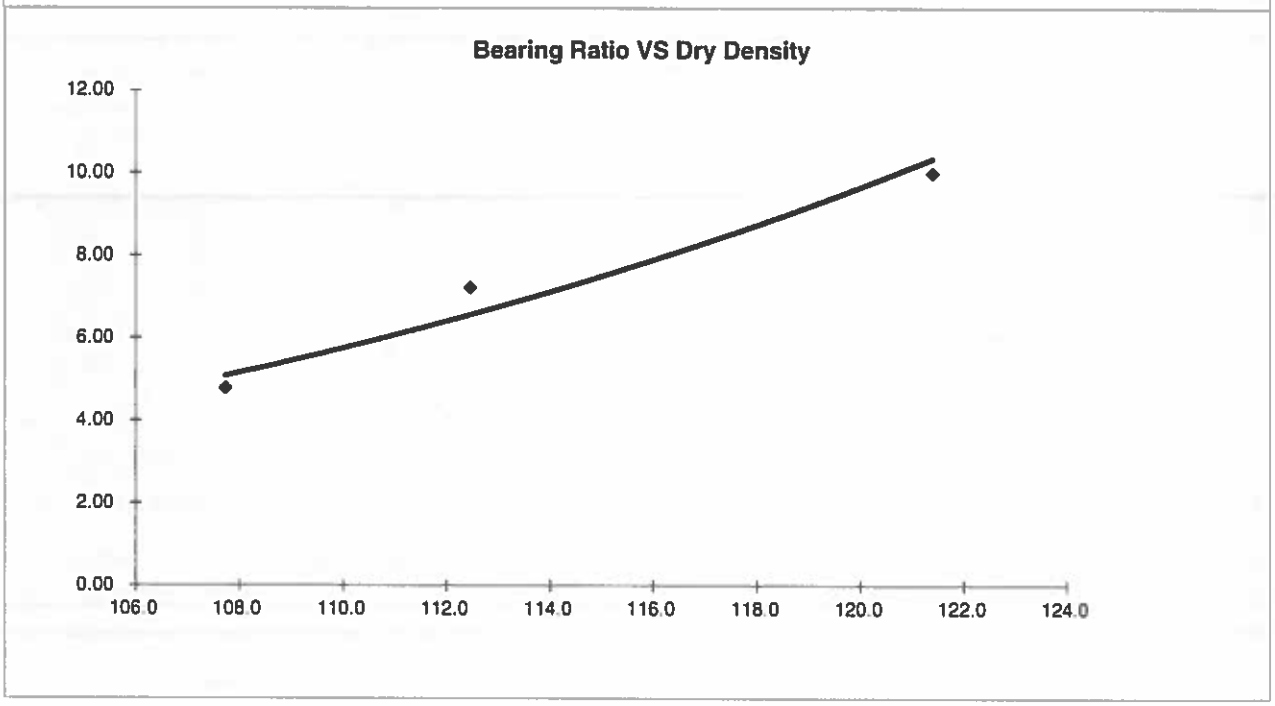
JOB NO.: 190249
FIG NO.: B-15





BEARING RATIO AT 90% OF MAX	5.56	~ R VALUE	12.00
BEARING RATIO AT 95% OF MAX	8.11	~ R VALUE	22.00

JOB NO: 190249
SOIL TYPE: 1

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CALIFORNIA BEARING RATIO

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	4/17/19

JOB NO.: 190249
FIG NO.: B-16

CLIENT	SR LAND, LLC	JOB NO.	190249
PROJECT	VOLLMER RD. IMPROVEMENTS	DATE	4/12/2019
LOCATION	VOLLMER RD. IMPROVEMENTS	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-1	1-2	1	SC	<0.01
TB-4	1-2	2	SC	<0.01
TB-3	10	3	SM	<0.01

QC BLANK PASS

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LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SCC	4/17/19

JOB NO.: 190249
FIG NO.: B-17

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA VOLLMER ROAD IMPROVEMENTS - URBAN MINOR ARTERIAL

SOIL TYPE 1, CBR # 1

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	1,971,000
Hveem Stabilometer (R Value) Results:	R =	22
Standard Deviation	S_o =	0.45
Loss in Serviceability	Δpsi =	2.5
Reliability	Reliability =	85
Reliability (z-statistic)	Z_R =	-1.04
Soil Resilient Modulus	M_R =	5273

Weighted Structural Number (WSN): → WSN = 3.88

DESIGN TABLES AND EQUATIONS

$S_1 = [(R - 5) / 11.29] + 3$

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$

$k = M_R / 19.4$

Where:

M_R = resilient modulus (psi)

S_1 = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

Reliability (%)	Z_R (z-statistic)
80	-0.84
85	-1.04
90	-1.28
93	-1.48
94	-1.56
95	-1.65
96	-1.75
97	-1.88
98	-2.05
99	-2.33
99.9	-3.09
99.99	-3.75

$$\log_{10}W_{18} = Z_R * S_O + 9.36*\log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32*\log_{10}M_R - 8.07$$

Left	Right	Difference
6.29	6.29	0.0

Job No. 190249
Fig. No. C-1

DESIGN CALCULATIONS

DESIGN DATA VOLLMER ROAD IMPROVEMENTS - URBAN MINOR ARTERIAL

SOIL TYPE 1, CBR # 1

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 1,971,000
Hveem Stabilometer (R Value) Results:	R = 22
Weighted Structural Number (WSN):	WSN = 3.88

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.11 Strength Coefficient - Aggregate Base Course

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1$ = 8.8 inches of Full Depth Asphalt
Use 9.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = 5.5 inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 13.3 inches of Aggregate
Base Course, use 13.5 inches

RECOMMENDED ALTERNATIVES

1. 5.5 inches of Asphalt + 13.5 inches of Aggregate Base Course, or
2. 9.0 inches of Asphalt

Job No. 190249
Fig. No. C-2

DESIGN CALCULATIONS

DESIGN DATA VOLLMER ROAD IMPROVEMENTS - URBAN MINOR ARTERIAL

SOIL TYPE 1, CBR # 1

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL = 1,971,000
Hveem Stabilometer (R Value) Results:	R = 22
Weighted Structural Number (WSN):	WSN = 3.88

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.11 Strength Coefficient - Recyled Concrete Base Course

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1$ = 8.8 inches of Full Depth Asphalt
Use 9.0 inches Full Depth

FOR ASPHALT + RECYCLED CONCRETE BASE COURSE SECTION

Asphalt Thickness (t) = 5.5 inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 13.3 inches of Recycled Concrete
Base Course, use 13.5 inches

RECOMMENDED ALTERNATIVES

1. 5.5 inches of Asphalt + 13.5 inches of Recycled Concrete Base Course, or
2. 9.0 inches of Asphalt

Job No. 190249
Fig. No. C-3