ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
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July 26, 2021
Revised: August 4, 2021

Glen Development
c/o Cross Company
3140 Shadybrook Lane
Colorado Springs, CO 80904

Attn: Rudy Cross

Re: Pavement Recommendations - Revised
The Glen at Widefield, Filing No. 10
El Paso County, Colorado

Dear Mr. Cross:

As requested, Entech Engineering, Inc. has obtained samples of the subgrade soils from sections of the roadways in the Glen at Widefield Subdivision, Filing 10, in El Paso County, Colorado. 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 roadways in this project consist of a section of Pennycress Drive and Buffalo Bur Trail. The site layout and the locations of the test borings are shown on the Test Boring Location Map, Figure 1.

Subgrade Conditions

Three exploratory test borings were drilled in the roadways to depths of approximately 5 to 10 feet. The borings were spaced within the limits set forth in the El Paso County Criteria ECM Section D.2.1. The subgrade soils consisted of sandy clay fill and very clayey sand fill (Soil Type 1). The Boring Logs are presented in Appendix A.

Sieve Analyses and Atterberg Limit testing were performed on all of the subgrade soil samples obtained from the test borings for the purpose of classification. Sieve analyses indicated the percent passing the No. 200 sieve ranged from approximately 43 to 70 percent. Atterberg Limit Tests resulted in Liquid Limits ranging from 30 to 41 and Plastic Indexes of 15 to 26.

Swell/Consolidation Testing was required due to the plastic index values of the subgrade soils. Swell/Consolidation Tests performed on in-situ subgrade soil samples showed volume changes ranging from 0.9 to 8.3 percent, and testing on a remolded Type 1 soils sample, moisture-conditioned to 4 percent over optimum, showed a volume change of 1.8 percent.

Based on the results of the laboratory testing, one pavement subgrade soil type was determined. The subgrade soils classify as A-6 and A-7-6 soils using the AASHTO Classification System, which typically have poor pavement support characteristics. The laboratory testing results are presented in Appendix B and are summarized in Table 1.

Sulfate testing indicated that the clay soils exhibit negligible potential for sulfate attack.

California Bearing Ratio (CBR) testing was conducted on a representative subgrade sample for the roadways in this filing. The CBR and laboratory test results are summarized in Table 1 and included in Appendix B. The laboratory classification testing results are included in the following table.

Soil Type 1 – Very Clayey Sand Fill

R @ 90% = 6.0
R @ 95% = 10.0
Use R = 10.0 for design

Classification Testing

Liquid Limit	30
Plasticity Index	15
Percent Passing 200	42.7
AASHTO Classification	A-6
Group Index	3
Unified Soils Classification	SC
M_R	3,562 psi

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" and the recommended street classifications by LSC Transportation Consultants, Inc. Buffalo Bur Trail classifies as an urban local low-volume road, which used an 18k ESAL value of 36,500 to determine the pavement sections. Pennycress Drive classifies as an urban local road, which used an 18k ESAL value of 292,000. Pavement sections for asphalt over aggregate basecourse and asphalt on cement-stabilized subgrade are provided. Design parameters used in the pavement analysis are as follows:

Serviceability Index:	
Urban Local / Urban Local Low Volume	2.0
Reliability:	
Urban Local / Urban Local Low Volume	80%
"R" Value Subgrade	10.0
Resilient Modulus	3,562 psi
Structural Coefficients:	
Hot Bituminous Pavement	0.44
Basecourse	0.11
Cement Stabilized Subgrade	0.12

Pavement calculations are attached in Appendix C. Pavement sections recommended for the site are summarized as follows:

Pavement Sections – Urban Local (low volume)
ESAL = 36,500: Buffalo Bur Trail

Alternative	Asphalt (in)	Basecourse (in)	Cement-Stabilized Subgrade (in)
1. Asphalt over Basecourse	3.5	8.5	—
2. Asphalt over Stabilized Subgrade	3.5	—	8.0

Pavement Sections – Urban Local
ESAL = 292,000: Pennycress Drive

Alternative	Asphalt (in)	Basecourse (in)	Cement-Stabilized Subgrade (in)
1. Asphalt over Basecourse	5.0	11.0	—
2. Asphalt over Stabilized Subgrade	5.0	—	10.0

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. One sample resulted in a volume change of 8.3 percent. A remolded swell test moisture conditioned to 4 percent over optimum, exhibited a swell of 1.8 percent. This swell level is below the threshold for mitigation. The roadway subgrade soils were initially moisture conditioned and processed during utility installation. The subgrade was conditioned and compacted to specified requirements during the utility installations. Prior to paving, the subgrade should be evaluated for proper moisture conditions. In areas that need additional moisture-conditioning, we recommend that the top 12-inches of the subgrade be scarified and moisture-conditioned to 0 to 4 percent over optimum moisture content and be recompacted. Specific areas requiring mitigation should be field determined. The subgrade soils should be observed and tested by Entech personnel prior to paving.

Roadway Construction

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 0 to 4 percent over optimum moisture content. Any 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. Full-depth asphalt sections are currently not allowed by El Paso County.

Roadway Construction – Cement Stabilized Subgrade

Prior to placement of the asphalt, the subgrade may be stabilized by addition of cement to a depth of at least 8 to 10 inches. The amount of cement applied shall be 2.0 percent (by weight) of the subgrade's maximum dry density as determined by the Modified Proctor Test (ASTM D-1557) and based on laboratory cement stabilization testing. The cement should be spread evenly on the subgrade surface and be thoroughly mixed into the subgrade over an 8 to 10-inch

depth such that a uniform blend of soil and cement is achieved. Prior to application or mixing of the cement, the upper 8 to 10 inches of subgrade should be thoroughly moisture conditioned to the soil's optimum water content or as much as 2 percent more than the optimum water content as necessary to provide a compactable soil condition. Densification of the cement-stabilized subgrade should be completed to obtain a compaction of at least 95 percent of the subgrade maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). Satisfactory compaction of the subgrade shall occur within 90 minutes from the time of mixing the cement into the subgrade.

The following conditions shall be observed as part of the subgrade stabilization:

- Type I/II cement as supplied; a local supplier shall be used. All cement used for stabilization should come from the same source. If cement sources are changed a new laboratory mix design should be completed.

- Moisture conditioning of the subgrade and/or mixing of the cement into the subgrade shall not occur when soil temperatures are below 40° F. Cement treated subgrades should be maintained at a temperature of 40° F or greater until the subgrade has been compacted as required.

- Cement placement, cement mixing and compaction of the cement treated subgrade should be observed by a Soils Engineer. The Soils Engineer should complete in situ compaction tests and construct representative compacted specimens of the treated subgrade material for subsequent laboratory quality assurance testing.

If significant grading is performed, the soils at subgrade may change. Modification to the pavement sections should be evaluated after site grading is completed.

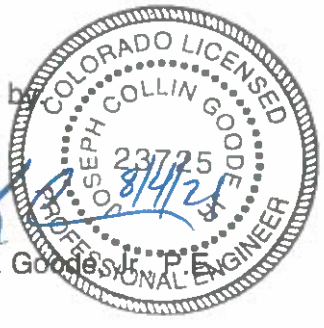
In addition to the above guidance, the asphalt, subgrade conditions, compaction of materials and roadway construction methods shall meet the El Paso County specifications.

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



Daniel P. Stegman

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

DPS/am

Encl.
Entech Job No. 211646
AAprojects/2021/211646 pr-rev

TABLE

TABLE 1

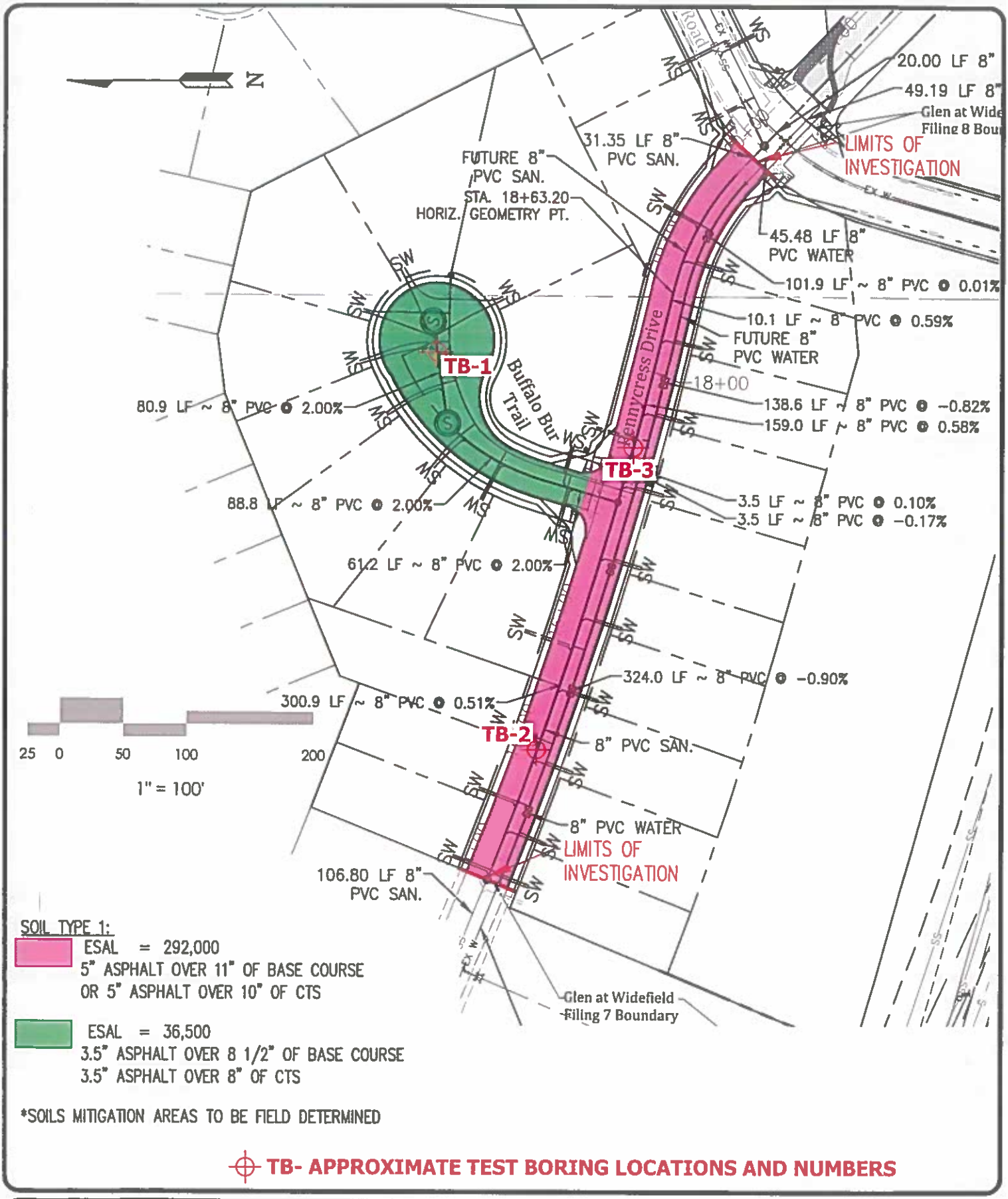
SUMMARY OF LABORATORY TEST RESULTS

CLIENT GLEN DEVELOPMENT
PROJECT GLEN AT WIDEFIELD, F-10
JOB NO. 211646

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	15.8	109.4	42.7	30	15		A-6	0.9	SC	SAND, VERY CLAYEY
1	1	1-2	11.6	121.5	48.6	32	18		A-6	1.8	SC	SAND, VERY CLAYEY
1	2	1-2	11.8	113.3	69.9	41	26	<0.01	A-7-6	8.3	CL	CLAY, SANDY
1	2	1-2	13.9	112.4						4.2*	CL	CLAY, SANDY
1	2	1-2	16.2	112.3						1.8*	CL	CLAY, SANDY
1	3	1-2	12.3	109.5	49.1	31	17		A-6	1.6	SC	SAND, VERY CLAYEY
1	2	0-3			55.8	36	25		A-6		CL	CLAY, VERY SANDY

* - Remolded samples

FIGURE



SOIL TYPE 1:

ESAL = 292,000
5" ASPHALT OVER 11" OF BASE COURSE
OR 5" ASPHALT OVER 10" OF CTS

ESAL = 36,500
3.5" ASPHALT OVER 8 1/2" OF BASE COURSE
3.5" ASPHALT OVER 8" OF CTS

*SOILS MITIGATION AREAS TO BE FIELD DETERMINED

⊕ TB- APPROXIMATE TEST BORING LOCATIONS AND NUMBERS

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TEST BORING LOCATION MAP
GLEN AT WIDEFIELD, FILING 10
EL PASO COUNTY, CO
FOR: GLEN DEVELOPMENT COMPANY

DRAWN:	DATE:	CHECKED:	DATE:
JAC	07/20/21	KAH	07/20/21

JOB NO.: 211646

FIG NO.: 1

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 6/23/2021
Job # 211646

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 6/23/21						
FILL 0-10', SAND, VERY CLAYEY, FINE GRAINED, GRAY BROWN, MEDIUM DENSE TO LOOSE, MOIST				10	11.3	1
	5			17	11.7	1
GRAVELLY LENSE	10			8	4.3	1
	15					
	20					

TEST BORING NO. 2
DATE DRILLED 6/23/2021
CLIENT GLEN DEVELOPMENT
LOCATION GLEN AT WIDEFIELD, F-10

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 6/23/21						
FILL 0-5', CLAY, SANDY, GRAY, STIFF, MOIST				15	11.1	1
	5			16	9.6	1
	10					
	15					
	20					

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TEST BORING LOG

DRAWN:	DATE	CHECKED:	DATE:
			7/12/21

JOB NO: 211646
FIG NO: A- 1

TEST BORING NO. 3
DATE DRILLED 6/23/2021
Job # 211646

TEST BORING NO.
DATE DRILLED
CLIENT GLEN DEVELOPMENT
LOCATION GLEN AT WIDEFIELD, F-10

REMARKS

DRY TO 5', 6/23/21

REMARKS

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			20	11.6	1	FILL 0-5', SAND, VERY CLAYEY, FINE GRAINED, GRAY, MEDIUM DENSE, MOIST
5			11	10.9	1	
10						
15						
20						

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

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TEST BORING LOG

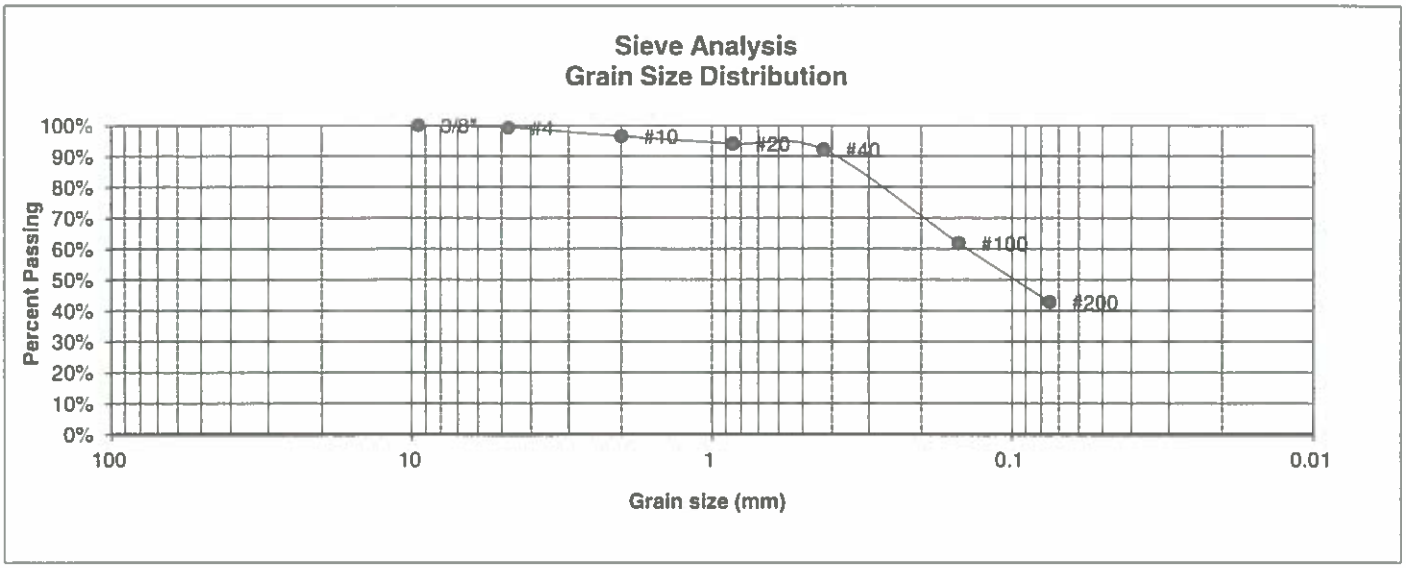
DRAWN:	DATE:	CHECKED:	DATE:
			7/12/21

JOB NO.: 211646

FIG NO.: A- 2

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SC	CLIENT	GLEN DEVELOPMENT
SOIL TYPE #	1, CBR	PROJECT	GLEN AT WIDEFIELD, F-10
TEST BORING #	1	JOB NO.	211646
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION	A-6	GROUP INDEX	3



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.3%
10	96.4%
20	94.0%
40	92.1%
100	61.8%
200	42.7%

Atterberg Limits	
Plastic Limit	15
Liquid Limit	30
Plastic Index	15

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

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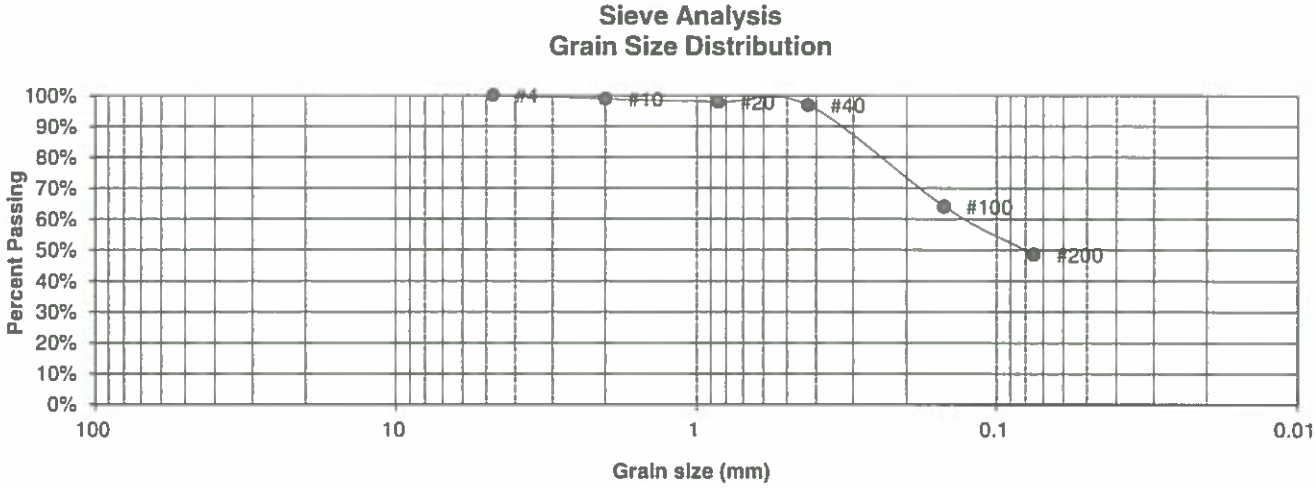
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			7/12/21

JOB NO.
211646
FIG NO.
B-1

UNIFIED CLASSIFICATION	SC	CLIENT	GLEN DEVELOPMENT
SOIL TYPE #	1	PROJECT	GLEN AT WIDEFIELD, F-10
TEST BORING #	1	JOB NO.	211646
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-6	GROUP INDEX	5



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	98.8%
20	97.8%
40	96.8%
100	64.0%
200	48.6%

Atterberg Limits	
Plastic Limit	14
Liquid Limit	32
Plastic Index	18

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

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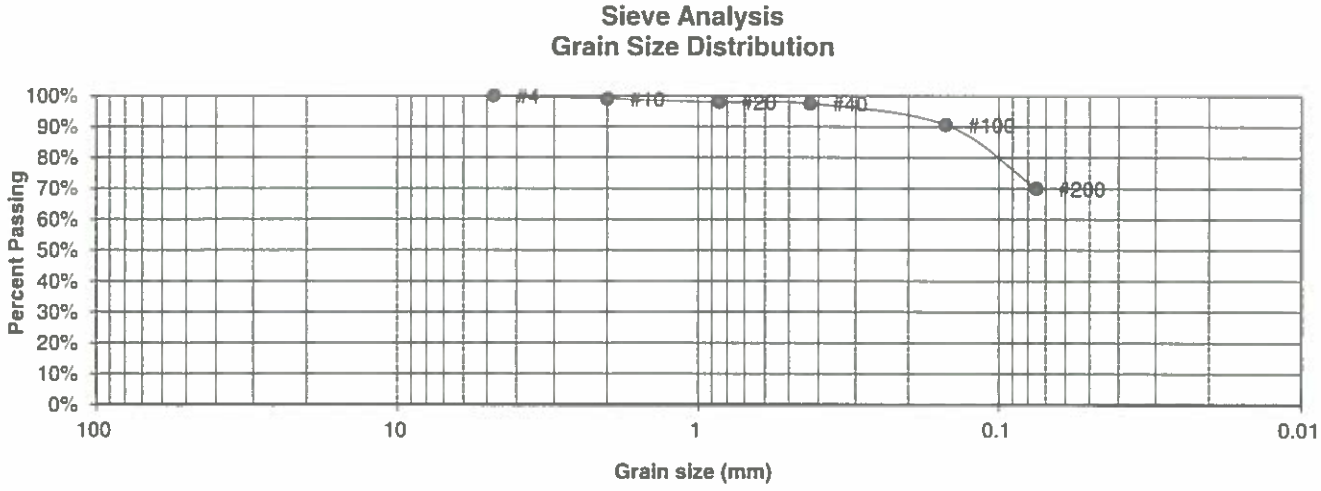
LABORATORY TEST RESULTS

DRAWN	DATE	CHECKED:	DATE:
			7/12/21

JOB NO.: 211646
FIG NO.: B-2

UNIFIED CLASSIFICATION	CL	CLIENT	GLEN DEVELOPMENT
SOIL TYPE #	1	PROJECT	GLEN AT WIDEFIELD, F-10
TEST BORING #	2	JOB NO.	211646
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-7-6	GROUP INDEX	16



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.0%
20	97.9%
40	97.5%
100	90.6%
200	69.9%

Atterberg Limits	
Plastic Limit	15
Liquid Limit	41
Plastic Index	26

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

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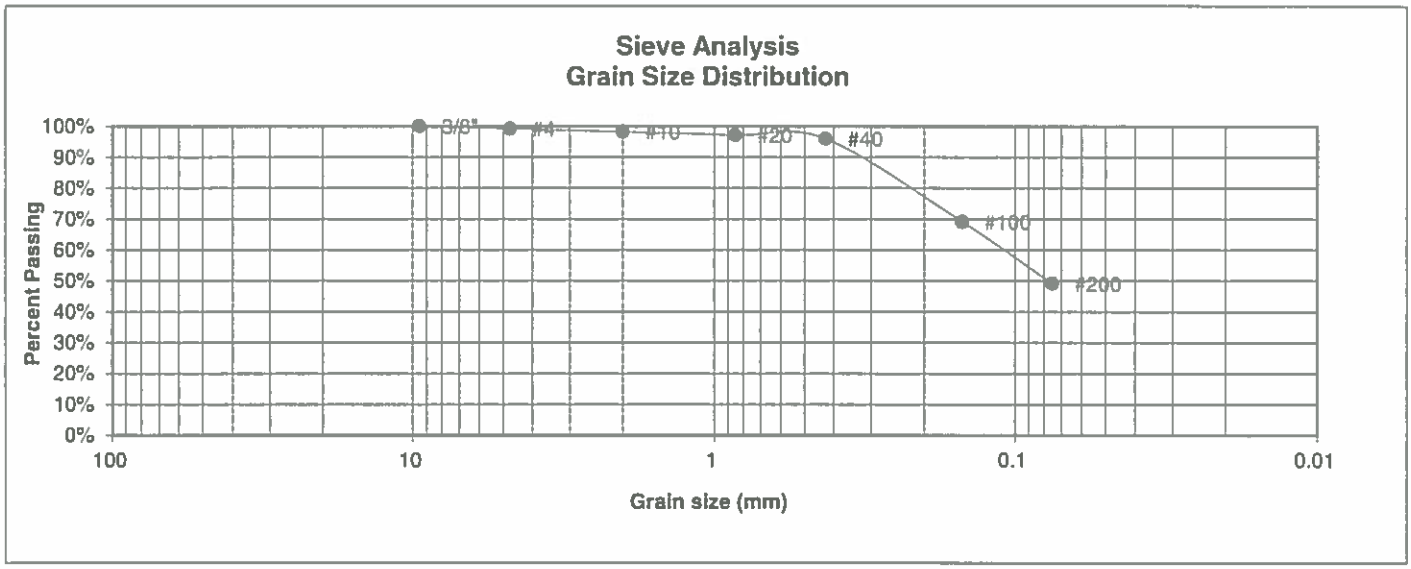
LABORATORY TEST RESULTS

DRAWN	DATE	CHECKED	DATE
			7/12/24

JOB NO. 211646
FIG NO. B-3

UNIFIED CLASSIFICATION	SC	CLIENT	GLEN DEVELOPMENT
SOIL TYPE #	1	PROJECT	GLEN AT WIDEFIELD, F-10
TEST BORING #	3	JOB NO.	211646
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-6	GROUP INDEX	4



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.2%
10	98.2%
20	97.1%
40	96.0%
100	69.1%
200	49.1%

Atterberg Limits	
Plastic Limit	15
Liquid Limit	31
Plastic Index	17

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

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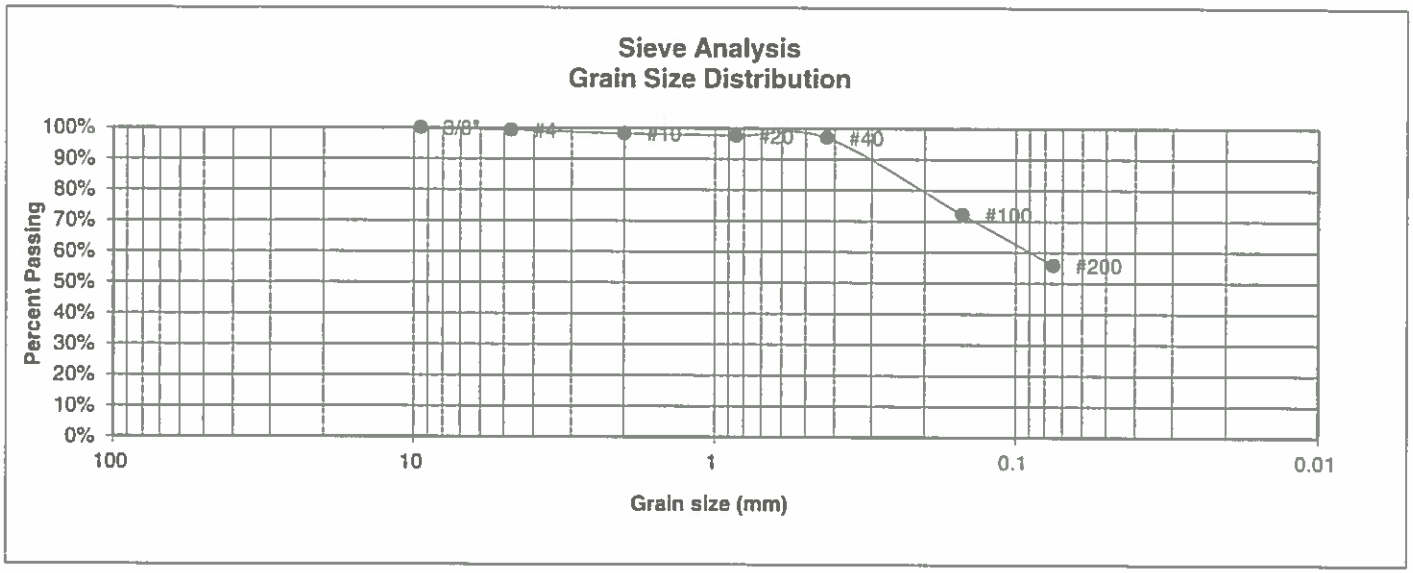
LABORATORY TEST RESULTS

DRAWN	DATE	CHECKED	DATE
			7/12/21

JOB NO. 211646
FIG NO. B-4

UNIFIED CLASSIFICATION	CL	CLIENT	GLEN DEVELOPMENT
SOIL TYPE #	1	PROJECT	GLEN AT WIDEFIELD, F-10
TEST BORING #	2	JOB NO.	211646
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION	A-6	GROUP INDEX	10



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.3%
10	98.2%
20	97.6%
40	97.0%
100	72.2%
200	55.8%

Atterberg Limits	
Plastic Limit	12
Liquid Limit	36
Plastic Index	25

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

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LABORATORY TEST RESULTS

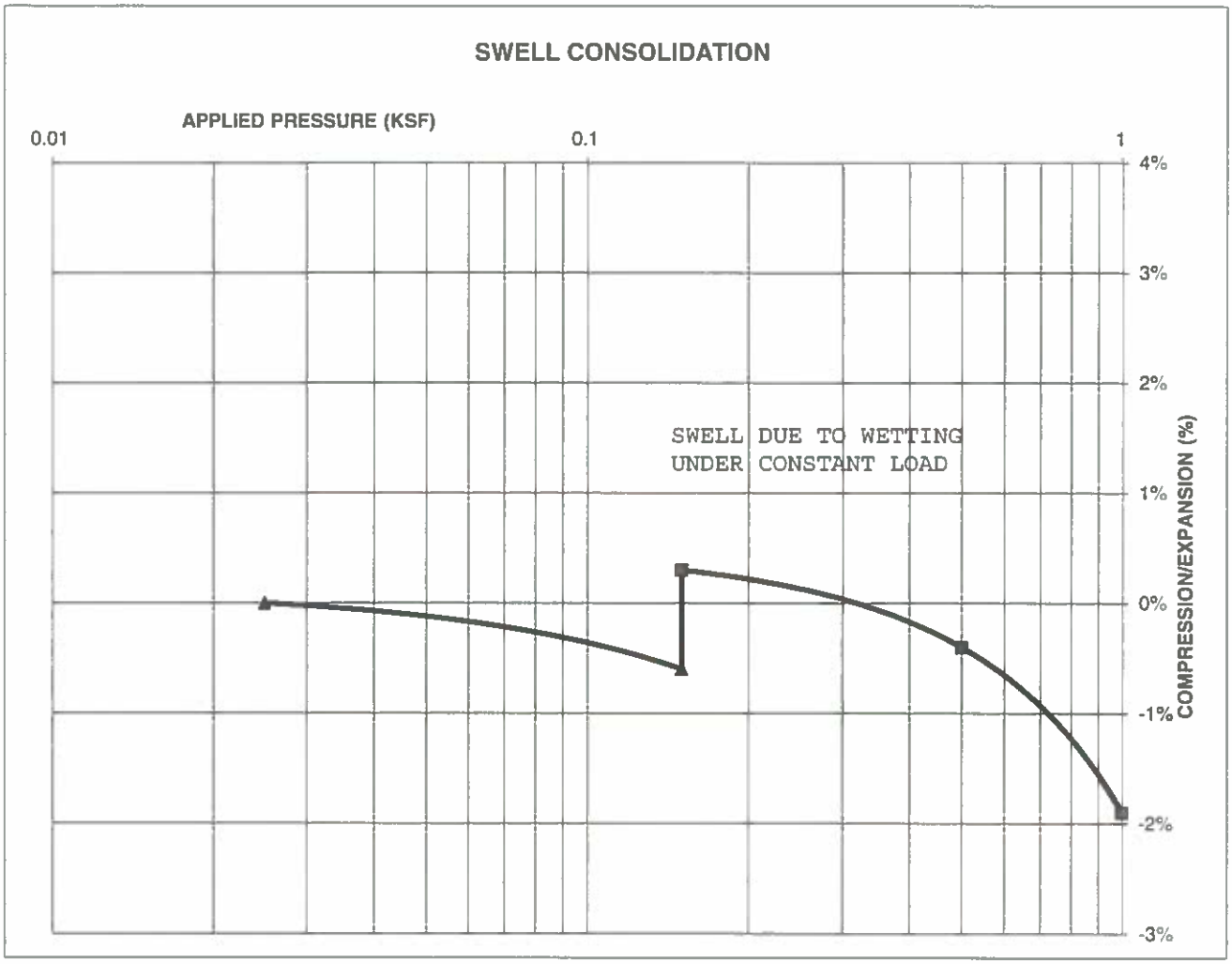
DRAWN:	DATE:	CHECKED:	DATE:
			2/12/21

JOB NO. 211646
FIG NO. B-5

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(ft)	0-3
DESCRIPTION	SC	SOIL TYPE	1, CBR
NATURAL UNIT DRY WEIGHT (PCF)			109
NATURAL MOISTURE CONTENT			15.8%
SWELL/CONSOLIDATION (%)			0.9%

JOB NO. 211646
CLIENT GLEN DEVELOPMENT
PROJECT GLEN AT WIDEFIELD, F-10



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SWELL CONSOLIDATION
TEST RESULTS

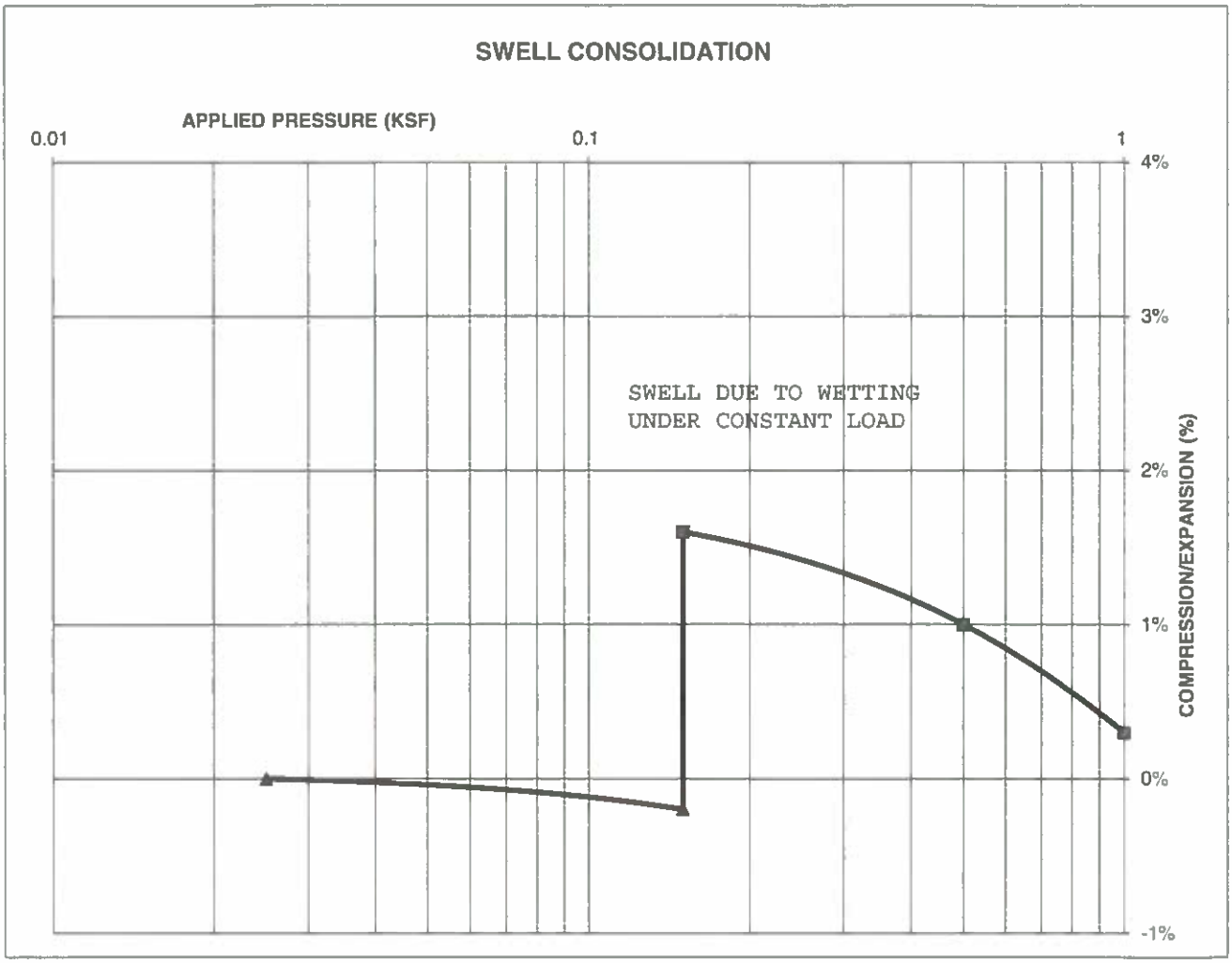
DRAWN	DATE	CHECKED	DATE
			7/12/21

JOB NO.: 211646
FIG NO.: B-6

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			121
NATURAL MOISTURE CONTENT			11.6%
SWELL/CONSOLIDATION (%)			1.8%

JOB NO. 211646
CLIENT GLEN DEVELOPMENT
PROJECT GLEN AT WIDEFIELD, F-10



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SWELL CONSOLIDATION
TEST RESULTS

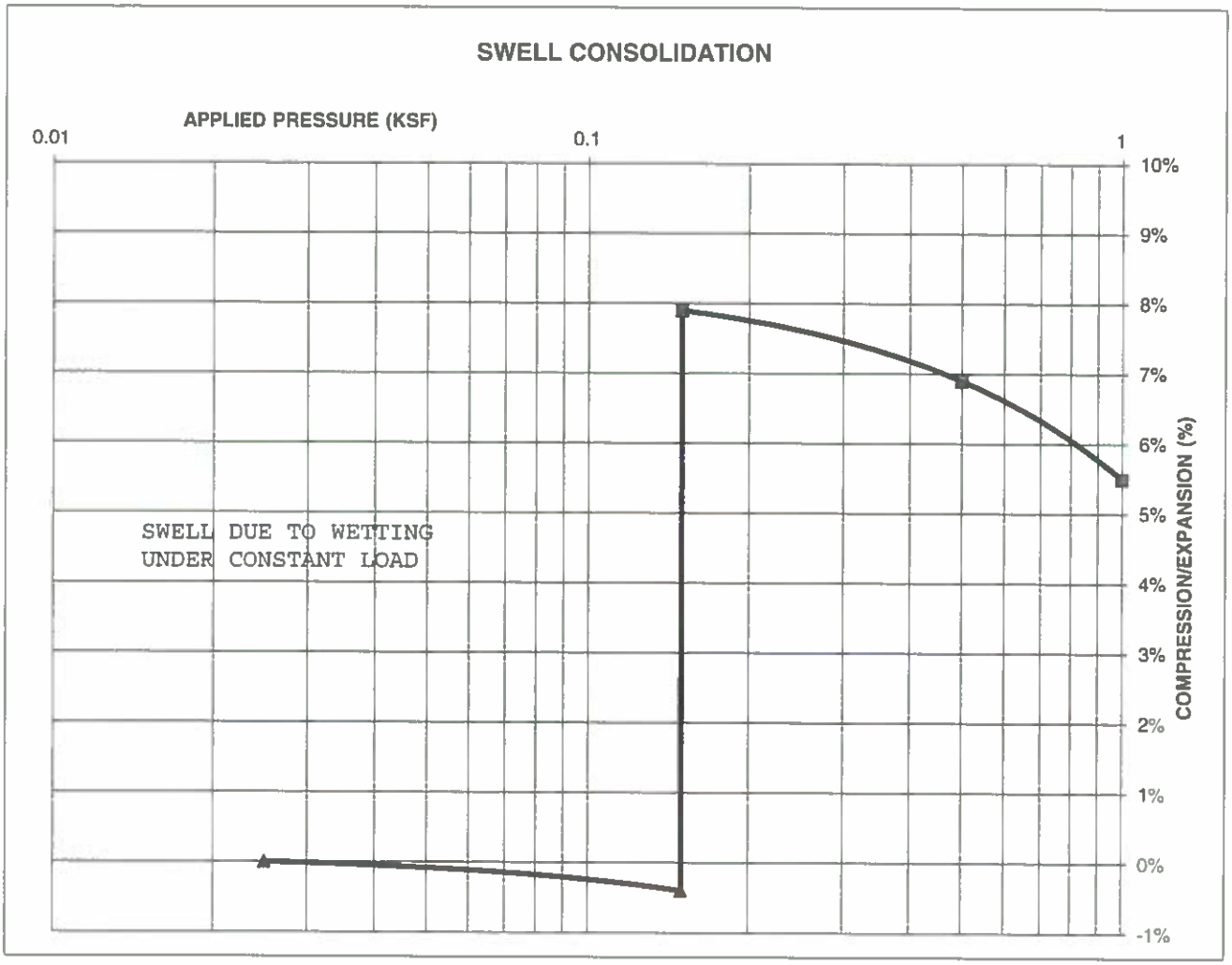
DRAWN:	DATE:	CHECKED:	DATE:
			7/12/24

JOB NO.: 211646
FIG NO.: B-7

CONSOLIDATION TEST RESULTS

TEST BORING #	2	DEPTH(ft)	1-2
DESCRIPTION	CL	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			113
NATURAL MOISTURE CONTENT			11.8%
SWELL/CONSOLIDATION (%)			8.3%

JOB NO. 211646
CLIENT GLEN DEVELOPMENT
PROJECT GLEN AT WIDEFIELD, F-10



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SWELL CONSOLIDATION
TEST RESULTS

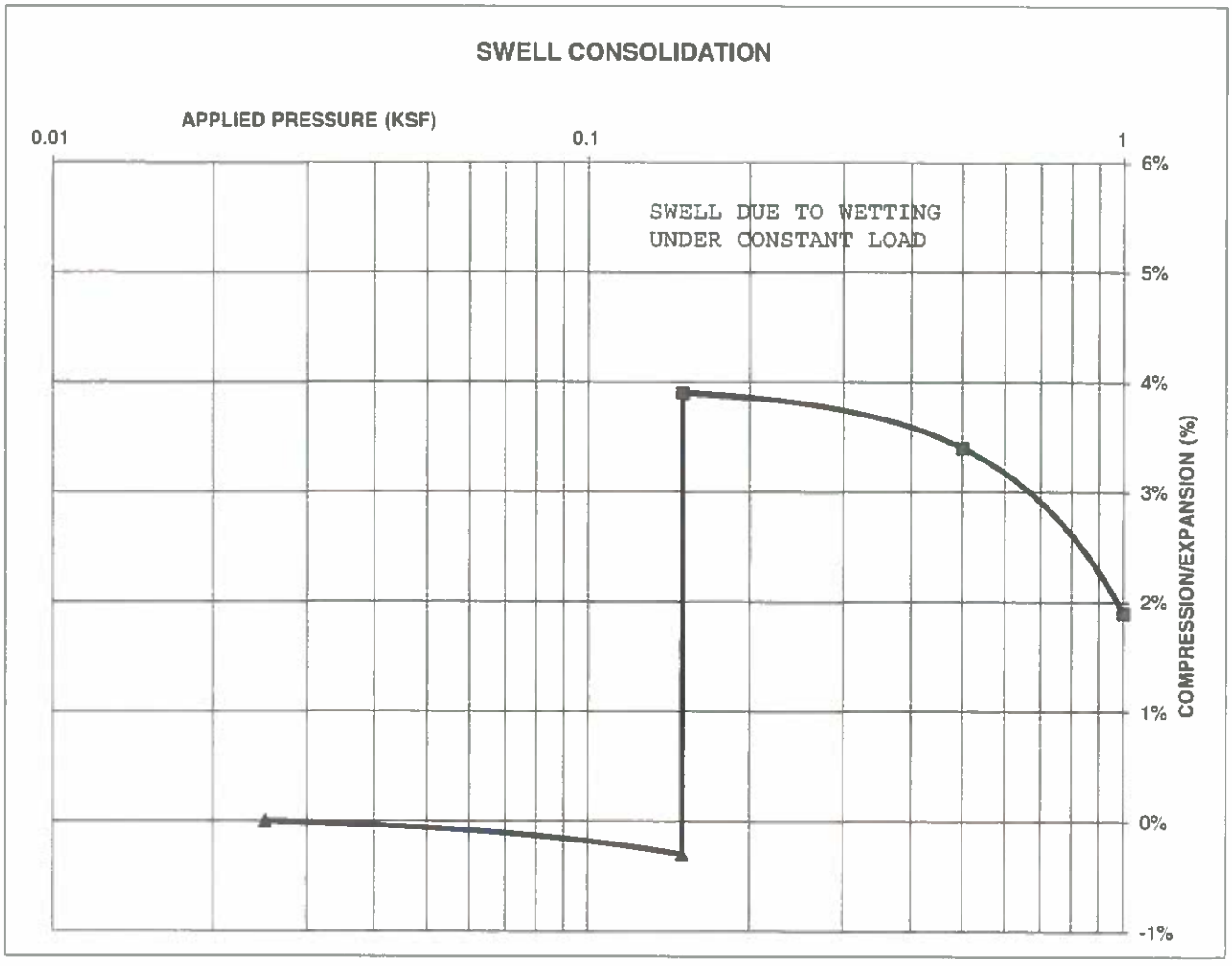
DRAWN:	DATE:	CHECKED:	DATE:
			7/12/21

JOB NO.: 211646
FIG NO.: B-8

CONSOLIDATION TEST RESULTS

TEST BORING #	2	DEPTH(ft)	1-2
DESCRIPTION	CL	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			112
NATURAL MOISTURE CONTENT			13.9%
SWELL/CONSOLIDATION (%)			4.2%

JOB NO. 211646
CLIENT GLEN DEVELOPMENT
PROJECT GLEN AT WIDEFIELD, F-10



REMOLDED AT +2% MOISTURE

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SWELL CONSOLIDATION
TEST RESULTS

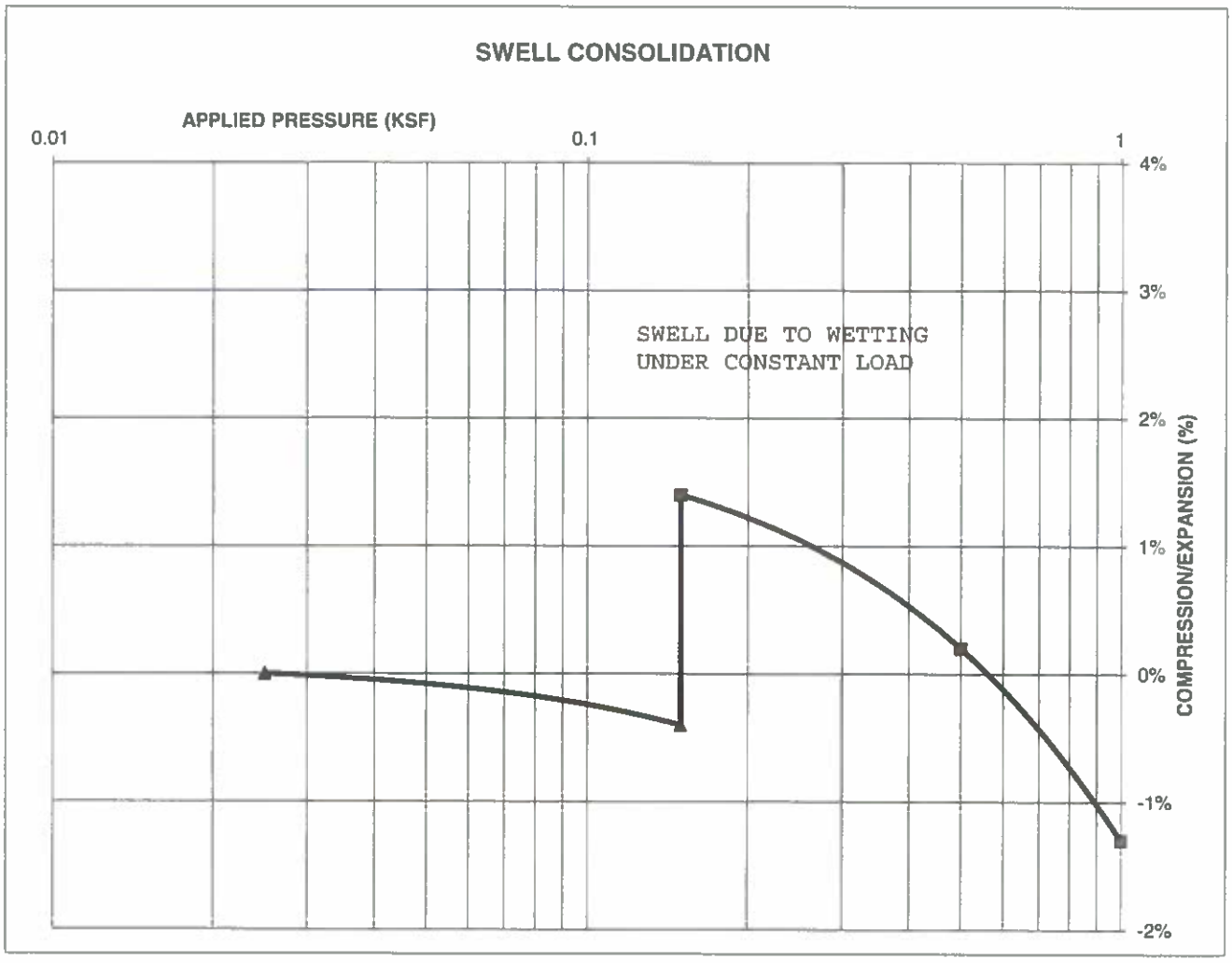
DRAWN:	DATE:	CHECKED:	DATE:
		TJS	7/26/21

JOB NO.: 211646
FIG NO.: B-9

CONSOLIDATION TEST RESULTS

TEST BORING #	2	DEPTH(ft)	1-2
DESCRIPTION	CL	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			112
NATURAL MOISTURE CONTENT			16.2%
SWELL/CONSOLIDATION (%)			1.8%

JOB NO. 211646
CLIENT GLEN DEVELOPMENT
PROJECT GLEN AT WIDEFIELD, F-10



REMOLDED AT +4% MOISTURE

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SWELL CONSOLIDATION
TEST RESULTS

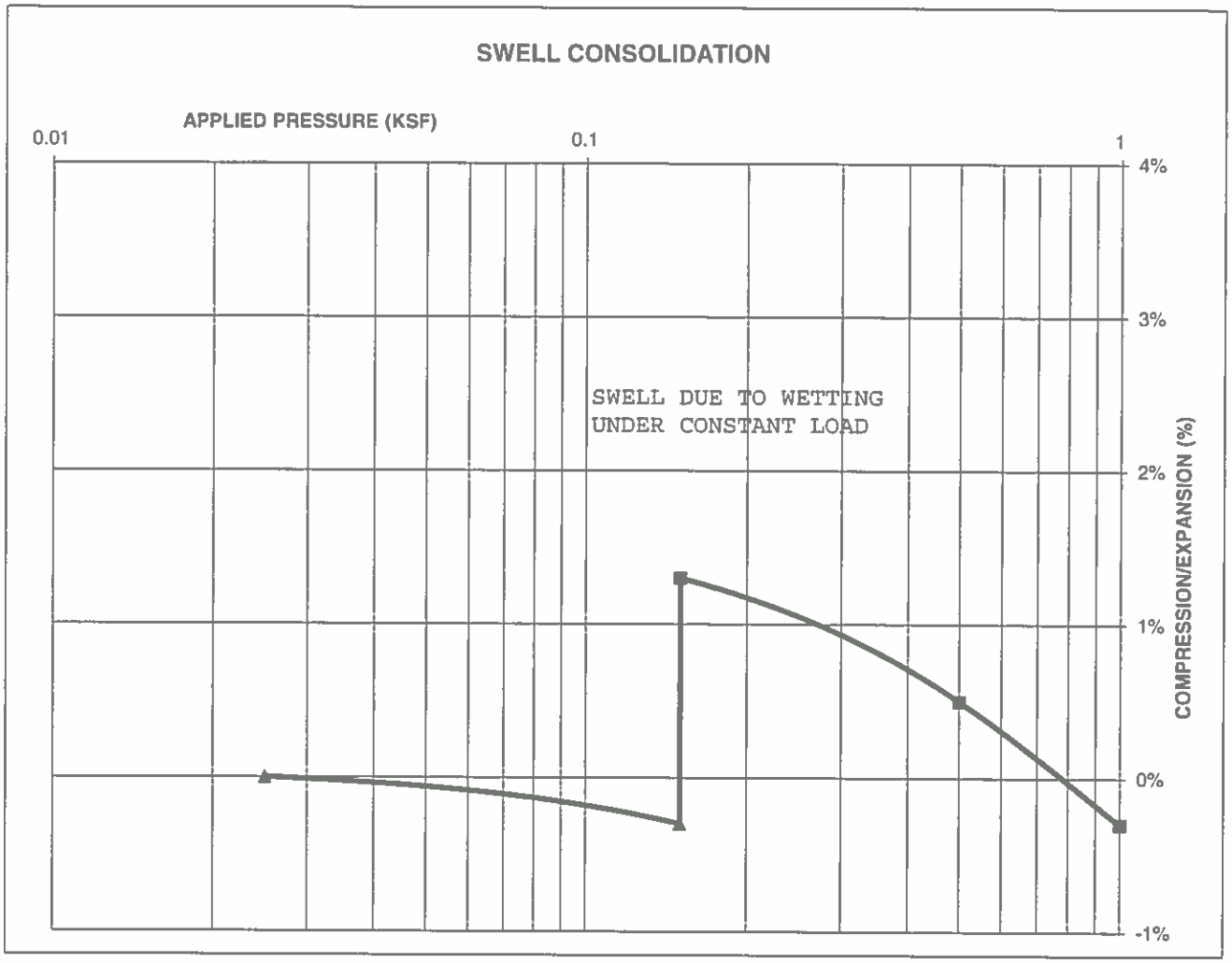
DRAWN:	DATE:	CHECKED:	DATE:
		BS	7/26/21

JOB NO.: 211646
FIG NO.: B-6

CONSOLIDATION TEST RESULTS

TEST BORING #	3	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			109
NATURAL MOISTURE CONTENT			12.3%
SWELL/CONSOLIDATION (%)			1.6%

JOB NO. 211646
CLIENT GLEN DEVELOPMENT
PROJECT GLEN AT WIDEFIELD, F-10



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE
			7/12/21

JOB NO.: 211646
FIG NO.: B-11

CLIENT	GLEN DEVELOPMENT	JOB NO.	211646
PROJECT	GLEN AT WIDEFIELD, F-10	DATE	7/6/2021
LOCATION	GLEN AT WIDEFIELD, F-10	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-2	1-2	1	CL	<0.01

QC BLANK PASS

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COLORADO SPRINGS, COLORADO 80907

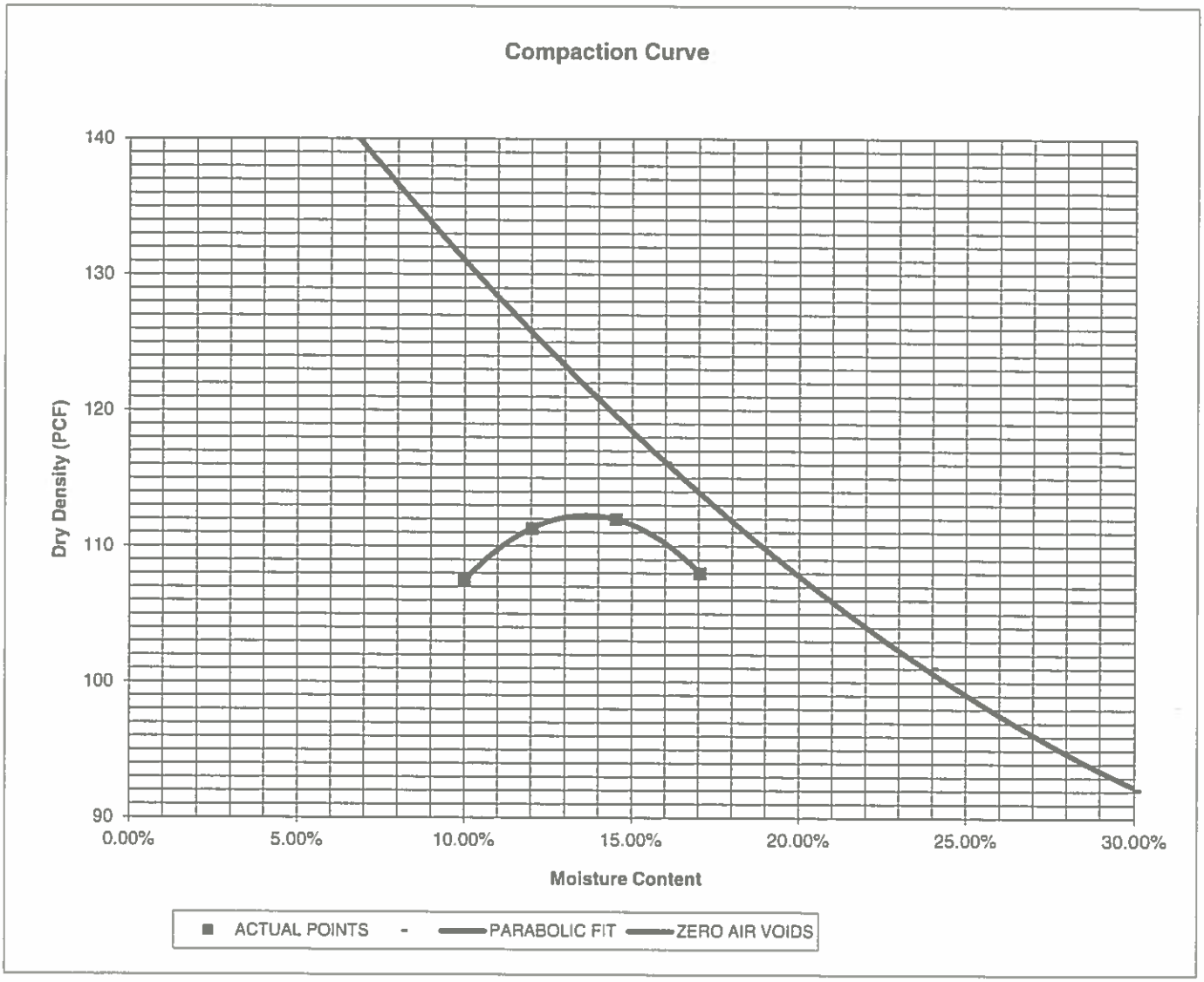
LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 7/12/21

JOB NO.: 211646
FIG NO.:

PROJECT	GLEN AT WIDEFIELD, F-10	CLIENT	GLEN DEVELOPMENT
SAMPLE LOCATION	TB-1 @ 0-3'	JOB NO.	211646
SOIL DESCRIPTION	SAND, VERY CLAYEY, GRAY	DATE	06/14/21

IDENTIFICATION	SC	COMPACTION TEST #	1
TEST DESIGNATION / METHOD	ASTM D-698-A	TEST BY	BL
MAXIMUM DRY DENSITY (PCF)	112.2	OPTIMUM MOISTURE	13.6%



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COLORADO SPRINGS, COLORADO 80907

MOISTURE DENSITY RELATION

DRAWN:	DATE:	CHECKED:	DATE:
			7/12/21

JOB NO.: 211646

FIG NO.: B-13

CBR TEST LOAD DATA

JOB NO: 211646
CLIENT: GLEN DEVELOPMENT
PROJECT: GLEN AT WIDEFIELD, F-10
SOIL TYPE: 1

PISTON DIAMETER (cm)	PISTON AREA (in^2)
4.958	2.993

PENETRATION DEPTH (INCHES)	*10 BLOWS* MOLD # 1 LOAD(LBS) (LBS)	STRESS (PSI)	*25 BLOWS* MOLD # 2 LOAD(LBS) (LBS)	STRESS (PSI)	*56 BLOWS* MOLD # 3 LOAD(LBS) (LBS)	STRESS (PSI)
0.000	0	0.00	0	0.00	0	0.00
0.025	23	7.69	40	13.37	94	31.41
0.050	26	8.69	54	18.05	146	48.79
0.075	28	9.36	62	20.72	189	63.16
0.100	31	10.36	76	25.40	216	72.18
0.125	35	11.70	84	28.07	231	77.19
0.150	36	12.03	89	29.74	244	81.54
0.175	38	12.70	96	32.08	254	84.88
0.200	41	13.70	101	33.75	271	90.56
0.300	41	13.70	101	33.75	330	110.28
0.400	40	13.37	113	37.76	367	122.64
0.500	43	14.37	123	41.10	409	136.67

FINAL MOISTURE CONTENT

	MOLD # 1	MOLD # 2	MOLD # 3
CAN #	342	343	358
WT. CAN	6.87	6.95	6.73
WT. CAN+WET	144.96	119.44	185.78
WT. CAN+DRY	113.21	96.99	155.97
WT. H20	31.75	22.45	29.81
WT. DRY SOIL	106.34	90.04	149.24
MOISTURE CONTENT	29.86%	24.93%	19.97%

WET DENSITY (PCF)	105.3	117.5	127.0
DRY DENSITY (PCF)	92.7	103.5	111.8

BEARING RATIO	1.04	2.54	7.22

90% OF DRY DENSITY	101.0
95% OF DRY DENSITY	106.6

BEARING RATIO AT 90% OF MAX	2.20	~ R VALUE	6
BEARING RATIO AT 95% OF MAX	4.30	~ R VALUE	10

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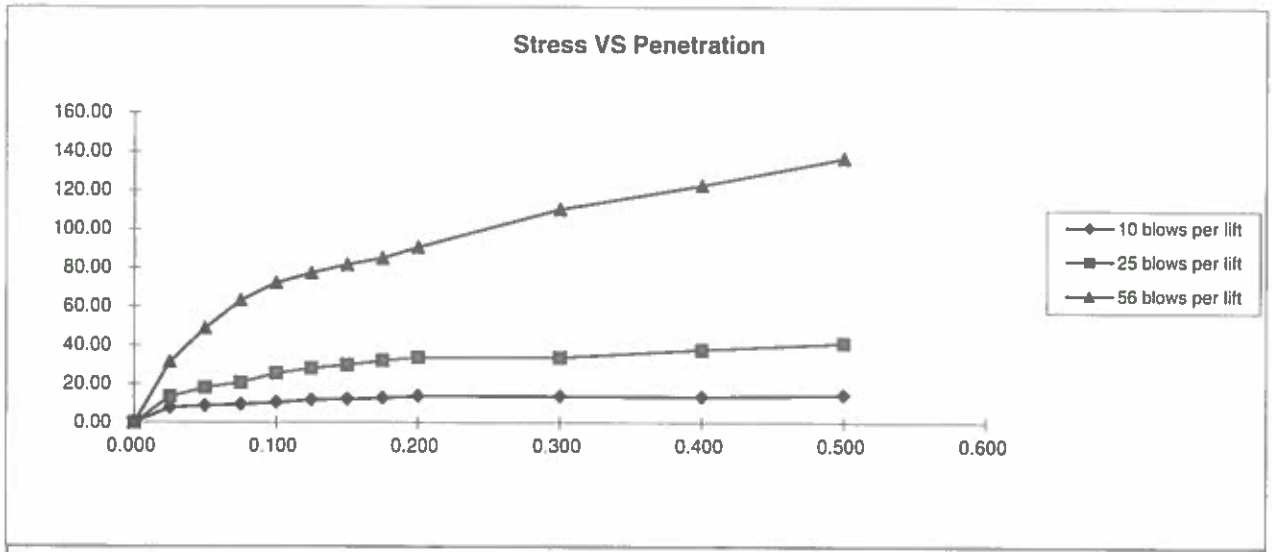
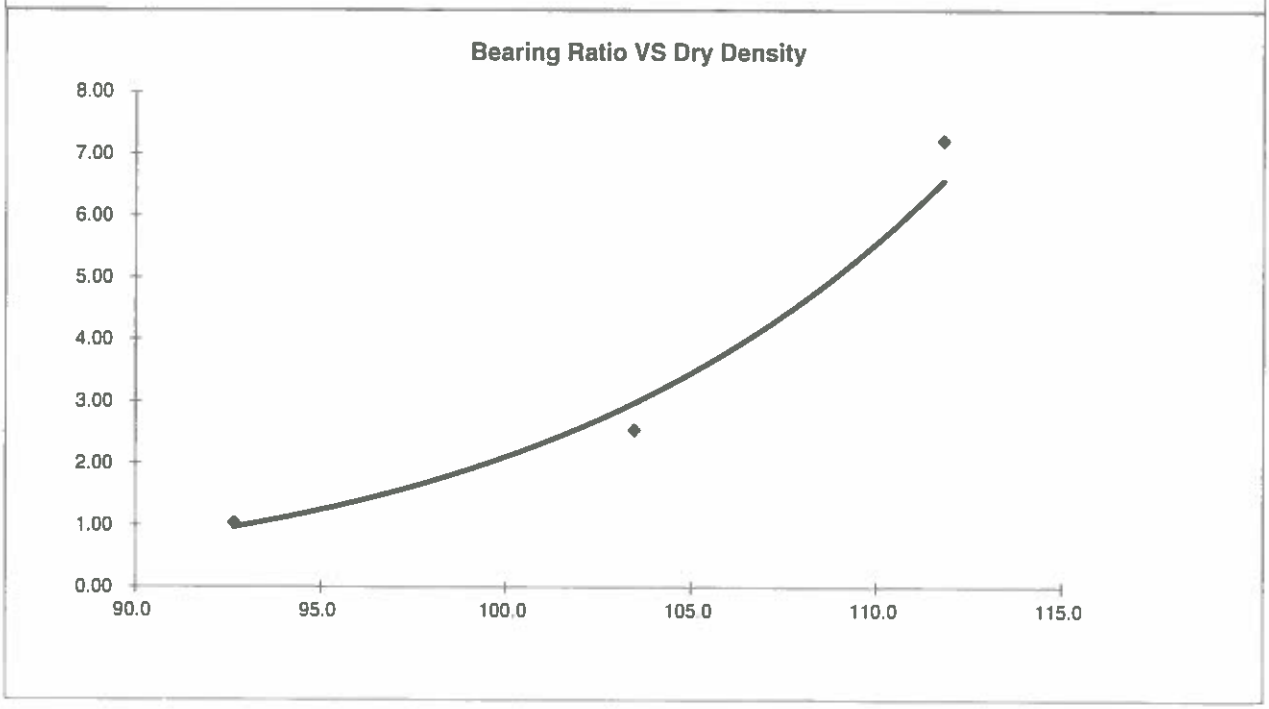
CBR TEST DATA

DRAWN:	DATE:	CHECKED:	DATE:
			7/12/21

JOB NO: 211646
FIG NO: B-14





BEARING RATIO AT 90% OF MAX	2.20	~ R VALUE	6.00
BEARING RATIO AT 95% OF MAX	4.30	~ R VALUE	10.00

JOB NO: 211646
SOIL TYPE: 1

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COLORADO SPRINGS, COLORADO 80907

CALIFORNIA BEARING RATIO

DRAWN	DATE	CHECKED:	DATE:
			7/12/21

JOB NO: 211646
FIG NO: B-5

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA — GLEN DEVELOPMENT - THE GELN AT WIDEFIELD FILING # 10
BUFFALO BUR TRAIL - SOIL TYPE 1 - URBAN LOCAL (LOW-VOLUME)

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	36,500
Hveem Stabilometer (R Value) Results:	R =	10
Standard Deviation	S_o =	0.44
Loss in Serviceability	Δpsi =	2.0
Reliability	Reliability =	80
Reliability (z-statistic)	Z_R =	-0.841
Soil Resilient Modulus	M_R =	3562

Weighted Structural Number (WSN): → WSN = 2.44

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)
50	0
60	-0.253
70	-0.524
75	-0.674
80	-0.841
90	-1.282
95	-1.65
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
4.56	4.56	0.0

Job No. 211646
Fig. No. C-1

DESIGN CALCULATIONS

DESIGN DATA GLEN DEVELOPMENT
BUFFALO BUR TRAIL - SOIL TYPE 1 - URBAN LOCAL (LOW-VOLUME)

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	36,500
Hveem Stabilometer (R Value) Results:	R =	10
Weighted Structural Number (WSN):	WSN =	2.44

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)

$D_1 = (WSN)/C_1$ = 5.5 inches of Full Depth Asphalt
Use 6.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = 3.5 inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 8.2 inches of Aggregate
Base Course, use 8.5 inches

RECOMMENDED ALTERNATIVES

1. 3.5 inches of Asphalt + 8.5 inches of Aggregate Base Course, or
2. 6.0 inches of Full-Depth Asphalt

Job No. 211646
Fig. No. C-2

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA — GLEN DEVELOPMENT - THE GELN AT WIDEFIELD FILING # 10
PENNYCRESS DRIVE - SOIL TYPE 1 - URBAN LOCAL

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	292,000
Hveem Stabilometer (R Value) Results:	R =	10
Standard Deviation	S_o =	0.44
Loss in Serviceability	Δpsi =	2.0
Reliability	Reliability =	80
Reliability (z-statistic)	Z_R =	-0.841
Soil Resilient Modulus	M_R =	3562

Weighted Structural Number (WSN): → WSN = 3.38

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)
50	0
60	-0.253
70	-0.524
75	-0.674
80	-0.841
90	-1.282
95	-1.65
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
5.47	5.47	0.0

Job No. 211646
Fig. No. C-3

DESIGN CALCULATIONS

DESIGN DATA GLEN DEVELOPMENT
PENNYCRESS DRIVE - SOIL TYPE 1 - URBAN LOCAL

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	292,000
Hveem Stabilometer (R Value) Results:	R =	10
Weighted Structural Number (WSN):	WSN =	3.38

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)

$D_1 = (WSN)/C_1$ = 7.7 inches of Full Depth Asphalt
Use 8.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = 5 inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 10.8 inches of Aggregate
Base Course, use 11.0 inches

RECOMMENDED ALTERNATIVES

1. 5.0 inches of Asphalt + 11.0 inches of Aggregate Base Course, or
2. 8.0 inches of Full-Depth Asphalt

Job No. 211646
Fig. No. C-4

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS

DESIGN DATA GLEN DEVELOPMENT
THE GLEN AT WIDEFIELD # 10 - URBAN LOCAL(LOW-VOLUME)

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	36,500
Hveem Stabilometer (R Value) Results:	R =	10
Weighted Structural Number (WSN):	WSN =	2.44

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.12 Strength Coefficient - Cement Stabilized Subgrade

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Cement Stabilized Subgrade(inches)

FOR FULL DEPTH ASPHALT SECTION(CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1$ = 5.5 inches of Full Depth Asphalt
Use 6.0 inches Full Depth

FOR ASPHALT + CEMENT STABILIZED SUBGRADE SECTION

Asphalt Thickness (t) = 3.5 inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 7.5 inches of Cement Stabilized Subgrade,
use 8.0 inches

RECOMMENDED ALTERNATIVES

1. 3.5 inches of Asphalt + 8.0 inches of Cement Stabilized Subgrade, or
2. 6.0 inches of Full-Depth Asphalt

Job No. 211646
Fig. No. C-5

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS

DESIGN DATA GLEN DEVELOPMENT
THE GLEN AT WIDEFIELD # 10 - URBAN LOCAL

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	292,000
Hveem Stabilometer (R Value) Results:	R =	10
Weighted Structural Number (WSN):	WSN =	3.38

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.12 Strength Coefficient - Cement Stabilized Subgrade

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Cement Stabilized Subgrade(inches)

FOR FULL DEPTH ASPHALT SECTION(CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1$ = 7.7 inches of Full Depth Asphalt
Use 8.0 inches Full Depth

FOR ASPHALT + CEMENT STABILIZED SUBGRADE SECTION

Asphalt Thickness (t) = [5] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 9.8 inches of Cement Stabilized Subgrade,
use 10.0 inches

RECOMMENDED ALTERNATIVES

1. 5.0 inches of Asphalt + 10.0 inches of Cement Stabilized Subgrade, or
2. 8.0 inches of Full-Depth Asphalt

Job No. 211646
Fig. No. C-6

August 6, 2021

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

Glen Development
c/o Cross Company
3140 Shadybrook Lane
Colorado Springs, CO 80904

Attn: Rudy Cross

Re: Cement Stabilized Subgrade Results - Laboratory Testing
The Glen at Widefield, Filing No. 10
El Paso County, Colorado

Ref: Pavement Recommendations Report by Entech Engineering, Inc., dated July 26, 2021, revised August 4, 2021, Entech Job No. 211646

Dear Mr. Cross:

As requested, personnel of Entech Engineering, Inc. have performed strength testing on two sets of three soil/cement composite samples for the above reference project. Testing was performed on soil samples prepared with 2% and 4% Portland Cement Type 1/2, from Martin Marietta, near Pueblo, Colorado.

A minimum compression strength of 160 psi is recommended for cement stabilized subgrade. The 7-day average strength values of the 2% mix was 243 psi. The 7-day average strength values of the 4% mix was 359 psi. A 2% mix is recommended based on the laboratory test results. A summary of the testing results is attached.

Pending the results of the field density testing, microfracturing of the stabilized subgrade will likely be required. Soil strengths in excess 200 psi require microfracturing.

We trust 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.

Daniel P. Stegman

Reviewed by:

Austin M. Nossokoff, P.E.

COLORADO LICENSED
AUSTIN M NOSSOKOFF
53477
8-6-21
PROFESSIONAL ENGINEER

DPS/bs

Encl.

Entech Job No. 211646
AAprojects/2021/211646 - cssr — lab

PCD File No. SF-1921

SUMMARY OF CTS TEST RESULTS

LAB TESTING

CLIENT GLEN DEVELOPMENT
PROJECT GLEN AT WIDEFIELD, F-10
FIELD SAMPLE ID TB-1 @ 0-3'
SOIL ADDITIVE TYPE I/II CEMENT

JOB NO 211646
DATE 8/6/21
BY BL

ADDITIVE %	*WATER %*	*DENSITY (dry)*	*AGE (days)*	*STRENGTH (psi)*
2	13.6	106.4	7	235
2	13.6	106.1	7	237
2	13.6	106.2	7	259
			AVERAGE:	**243**
4	13.6	106.2	7	378
4	13.6	106.2	7	333
4	13.6	106.0	7	367
			AVERAGE:	**359**

CURING METHOD

100° HUMIDIFIED OVEN