October 11, 2022

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

APPROVED
Engineering Department
10/18/2022 9:15:52 AM
dsdnijkamp
EPC Planning & Community
Development Department

O'Neil Group
455 East Pikes Peak Avenue, Suite 101
Colorado Springs, Colorado 80903

Attn: Nina Ruiz

Re: Gravel Roadway Recommendations
Mountain's Edge Subdivision
McClelland Road and Farmhouse Court
El Paso County, Colorado

Provide a sieve analysis report for the gravel material that will be used for the road. Gravel shall meet ECM Appendix D.5.6 criteria and come from a single source. Use Table D-7 for gradation.

Dear Ms. Ruiz:

As requested, Entech Engineering, Inc. obtained samples of the roadway subgrade soils from the proposed roadway section at the above referenced subdivision. Laboratory testing was performed in order to determine the support characteristics of the soil. This letter presents the results of the laboratory testing and gravel recommendations for the roadway.

Project Description

The project will consist of gravel sections for Farmhouse Court located at Mountain's Edge Subdivision. A Subsurface Soil Investigation and laboratory testing were performed to determine the support characteristics for the site subgrade soils. The general layout of the roadways within the filing are presented in the Test Boring Location Map, Figure 1.

Subgrade Conditions

Four exploratory test borings were drilled along the roadway alignment to depths of approximately 5 to 10 feet. Sieve Analysis and Atterberg Limits were performed on selected soil samples obtained from the test borings for the purpose of classification. Sieve analyses performed on the clayey to silty sand (Soil Type 1) indicated 13 to 35 percent of the soil size particles passing the No. 200 sieve, silty to clayey sandstone (Soil Type 2) indicated 20 to 24 percent of the soil size particles passing the No. 200 sieve, and very clayey sandstone (Soil Type 3) indicated 49 percent of the soil size particles passing the No. 200 sieve. Atterberg Limit Testing performed on Soil Type 1 resulted in Liquid Limits ranging from 24 to 27 and Plastic Indexes from 8 to 10, and non-plastic results. Atterberg Limit Testing performed on Soil Type 2 resulted in a Liquid Limit 23 and a Plastic Index of 10, and non-plastic results. Atterberg Limit Testing performed on Soil Type 3 resulted in a Liquid Limit of 24 and a Plastic Index of 11. The subgrade soils classify as A-2-4 and A-1-b (Soil Type 1), as A-2-4 (Soil Type 2), and as A-6 (Soil Type 3) based on the AASHTO classification system. Soil Types 1 and 2 typically provides good roadway support characteristics, and Soil Type 3 (very clayey sandstone) typically provides poor roadway support characteristics. The pavement section was calculated using the Type 1 testing data, as it was encountered in the majority of the test borings. Sulfate testing indicated that the soils exhibit a negligible potential for sulfate attack. Groundwater was not encountered in the test borings drilled in the filing. The subgrade was encountered at medium dense states for the sand and dense to very dense states for Soil Types 2 and 3. The Test Boring Logs are presented in Appendix A.

California Bearing Ratio (CBR) testing was performed on a representative soil sample to determine the support characteristics of the subgrade soils. The laboratory test results are presented in Appendix B in Table 1 and are summarized as follows:

Soil Type 1 – Silty Sand
CBR #1
R @ 90% = 65
R @ 95% = 74
Use R = 50 for design

Classification Testing

Liquid Limit	NV
Plasticity Index	NP
Percent Passing 200	30.6
AASHTO Classification	A-2-4
Group Index	0
Unified Soils Classification	SM

Typical design parameters used in the gravel section analysis for the project are as follows:

Reliability	75%
Serviceability Index	2.0
"R" Value Subgrade (Soil Type 1)	50

Gravel Road Design Parameters

The CBR test results were used to determine the required gravel sections for the roadway alignments. The gravel section was determined using the design criteria in the El Paso County Engineering Criteria Manual. An 18k ESAL value of 36,500 is used for rural local (Low-Volume) roads.

The gravel sections recommended is summarized as follows:

Pavement Sections – Soil Type 1
6" of Gravel

Roadway Construction

Prior to placement of the gravel, the subgrade should be scarified, moisture-conditioned, compacted to a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557-A at +/-2 percent of its optimum moisture content and proofrolled after properly compacted. Any soft areas should be removed and replaced with suitable materials approved by Entech. The gravel placed for the roadway should be well compacted. The roads should be crowned and graded so as to prevent ponding. Special attention should be given to areas adjacent to manholes, inlet structures and valves.

In addition to the above guidance the gravel materials, subgrade conditions, compaction of materials, testing, inspections, roadway construction methods, and recommended maintenance programs shall meet the latest version of the El Paso County Engineering Criteria Manual.

We trust that this has provided you with the information you required. The gravel sections provided are based on general site soil types. If you have any questions or need additional information, please do not hesitate to contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Logan L. Langford, P.G.
Geologist

Reviewed by:

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

LLL

Entech Job No. 221948
F:\AA projects\2022\221948-Mountain's Edge Subudivision-Gravel Roadway Recommendations

TABLE

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

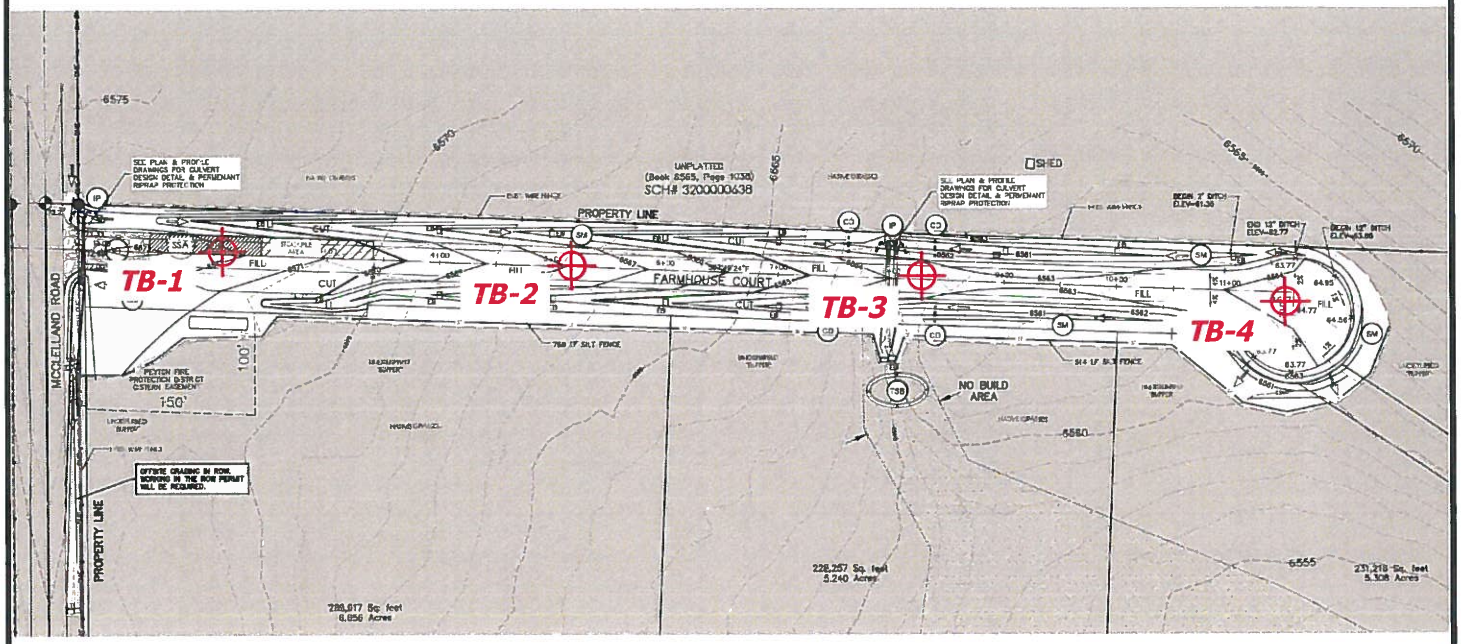
CLIENT O'NEIL GROUP
PROJECT FARMHOUSE COURT
JOB NO. 221948

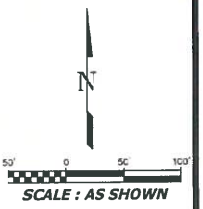
SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	AASHTO CLASS.	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1, CBR	3	0-3			30.6	NV	NP		A-2-4		SM	SAND, SILTY
1	1	1-2			13.1	NV	NP		A-1-b		SM	SAND, SILTY
1	2	1-2			31.7	27	10	<0.01	A-2-4		SC	SAND, CLAYEY
1	3	1-2			34.5	NV	NP		A-2-4		SM	SAND, SILTY
1	4	1-2			34.6	24	8		A-2-4		SC	SAND, CLAYEY
1	1	0-3			26.1						SM	SAND, SILTY
2	1	10			19.6	NV	NP		A-2-4		SM	SANDSTONE, SILTY
2	2	10			24.4	23	10		A-2-4		SC	SANDSTONE, CLAYEY
3	3	10			48.9	24	11	<0.01	A-6		SC	SANDSTONE, VERY CLAYEY

FIGURE

MOUNTAIN'S EDGE

GRADING AND EROSION CONTROL PLAN





⊕ **TB- APPROXIMATE TEST BORING LOCATION AND NUMBER**

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SITE PLAN/TEST BORING LOCATION MAP
MOUNTAIN'S EDGE SUBDIVISION
MCCLELLAND ROAD AND FARMHOUSE COURT
EL PASO COUNTY, COLORADO
FOR: O'NEIL GROUP

DRAWN:	DATE:	CHECKED:	DATE:
LLL	10/10/22		

JOB NO.: 221948

FIG NO.: 1

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 9/22/2022
Job # 221948

REMARKS

DRY TO 10', 9/22/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			36	2.8	1
			50 10"	2.9	2
			50 10"	7.1	2

SAND, SILTY, FINE TO COARSE GRAINED, TAN, DENSE, DRY

SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, DRY TO MOIST

TEST BORING NO. 2
DATE DRILLED 9/22/2022
CLIENT O'NEIL GROUP
LOCATION FARMHOUSE COURT

REMARKS

DRY TO 10', 9/22/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			35	3.9	1
			50 6"	2.1	2
			50 9"	4.9	2

SAND, CLAYEY, FINE TO COARSE GRAINED, TAN, DENSE, MOIST

SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, TAN, VERY DENSE, DRY TO MOIST

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: A- 1

TEST BORING NO. 3
DATE DRILLED 9/22/2022
Job # 221948

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 9/22/22						
SAND, SILTY, FINE TO COARSE GRAINED, DARK BROWN TO TAN, DENSE TO MEDIUM DENSE, MOIST				30	4.4	1
	5			27	4.1	1
SANDSTONE, VERY CLAYEY, FINE GRAINED, TAN, VERY DENSE, MOIST	10			50	3.9	3
	15					
	20					

TEST BORING NO. 4
DATE DRILLED 9/22/2022
CLIENT O'NEIL GROUP
LOCATION FARMHOUSE COURT

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 10', 9/22/22						
SAND, CLAYEY, FINE TO MEDIUM GRAINED, TAN, MEDIUM DENSE TO DENSE, MOIST TO DRY				24	4.2	1
	5			36	3.7	1
	10			36	2.7	1
	15					
	20					

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TEST BORING LOG

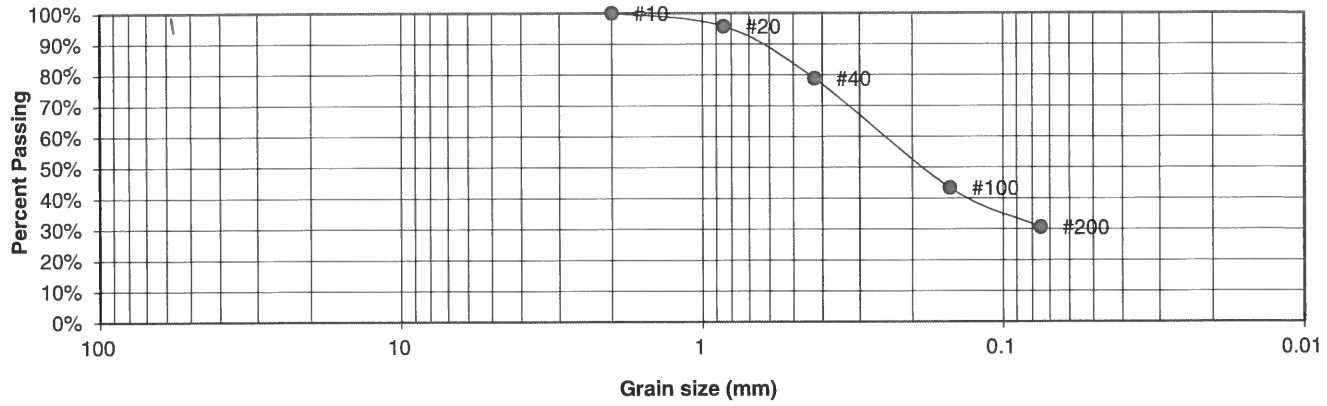
DRAWN:	DATE:	CHECKED:	DATE:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: A- 2

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SM	CLIENT	O'NEIL GROUP
SOIL TYPE #	1, CBR	PROJECT	FARMHOUSE COURT
TEST BORING #	3	JOB NO.	221948
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	95.8%
40	78.9%
100	43.3%
200	30.6%

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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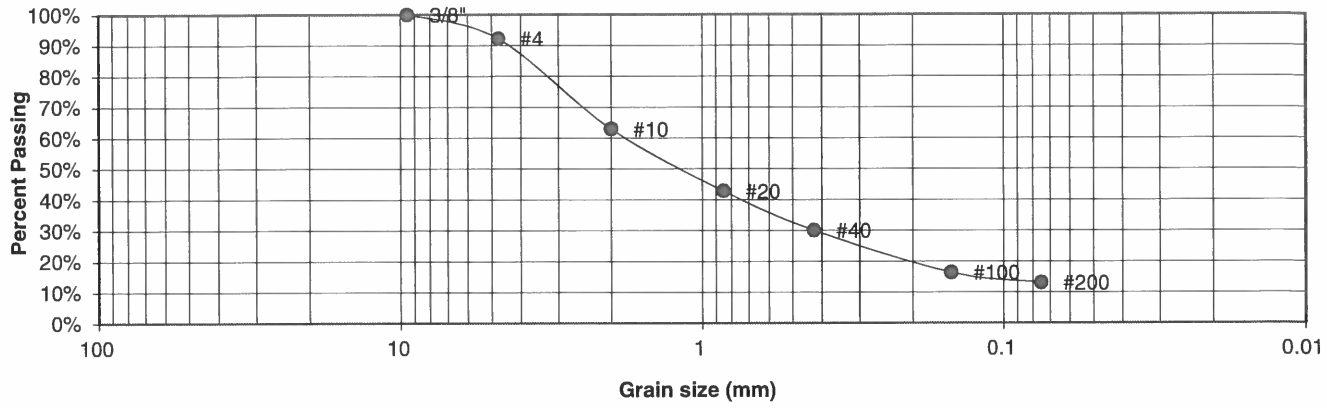
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: B-1

UNIFIED CLASSIFICATION	SM	CLIENT	O'NEIL GROUP
SOIL TYPE #	1	PROJECT	FARMHOUSE COURT
TEST BORING #	1	JOB NO.	221948
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	92.2%
10	62.9%
20	42.8%
40	30.1%
100	16.4%
200	13.1%

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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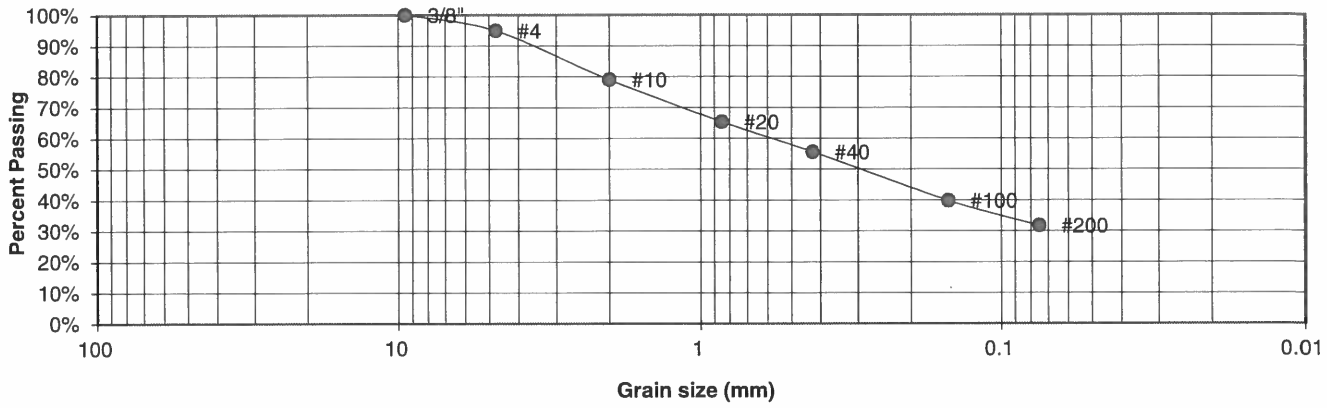
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: B-2

UNIFIED CLASSIFICATION	SC	CLIENT	O'NEIL GROUP
SOIL TYPE #	1	PROJECT	FARMHOUSE COURT
TEST BORING #	2	JOB NO.	221948
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.9%
10	79.0%
20	65.4%
40	55.6%
100	39.8%
200	31.7%

Atterberg Limits

Plastic Limit	17
Liquid Limit	27
Plastic Index	10

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

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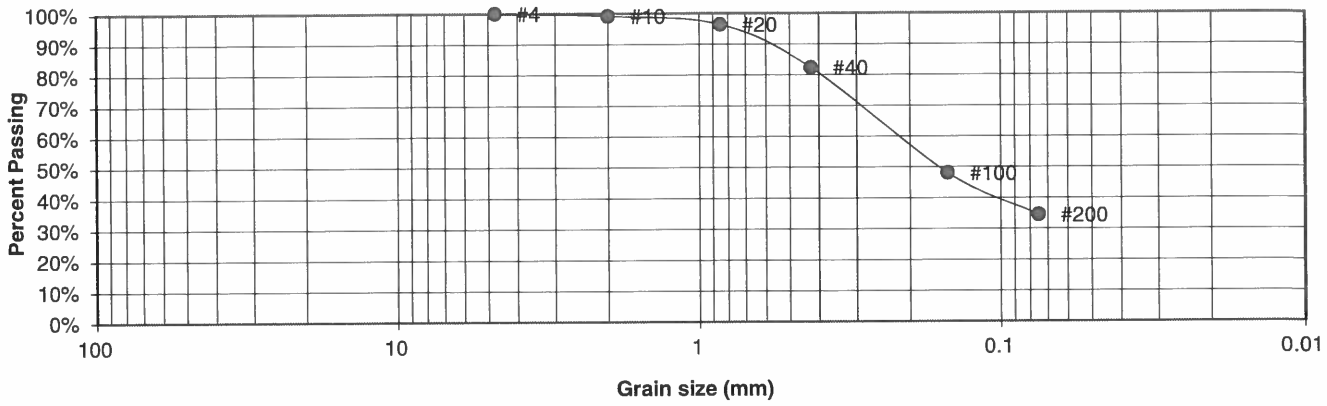
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: B-3

UNIFIED CLASSIFICATION	SM	CLIENT	O'NEIL GROUP
SOIL TYPE #	1	PROJECT	FARMHOUSE COURT
TEST BORING #	3	JOB NO.	221948
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.2%
20	96.4%
40	82.4%
100	48.1%
200	34.5%

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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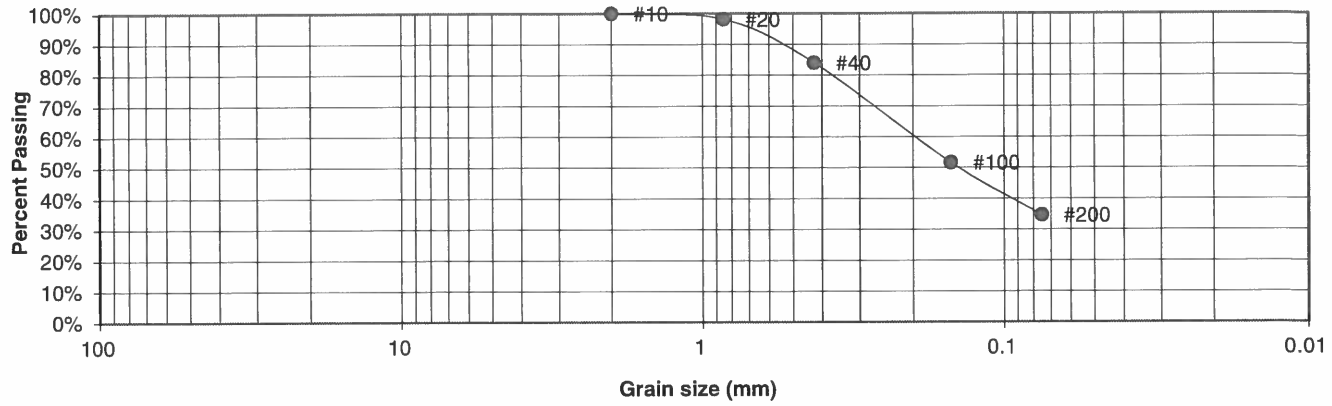
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: B-4

UNIFIED CLASSIFICATION	SC	CLIENT	O'NEIL GROUP
SOIL TYPE #	1	PROJECT	FARMHOUSE COURT
TEST BORING #	4	JOB NO.	221948
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	98.2%
40	84.1%
100	51.6%
200	34.6%

Atterberg Limits

Plastic Limit	17
Liquid Limit	24
Plastic Index	8

Swell

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

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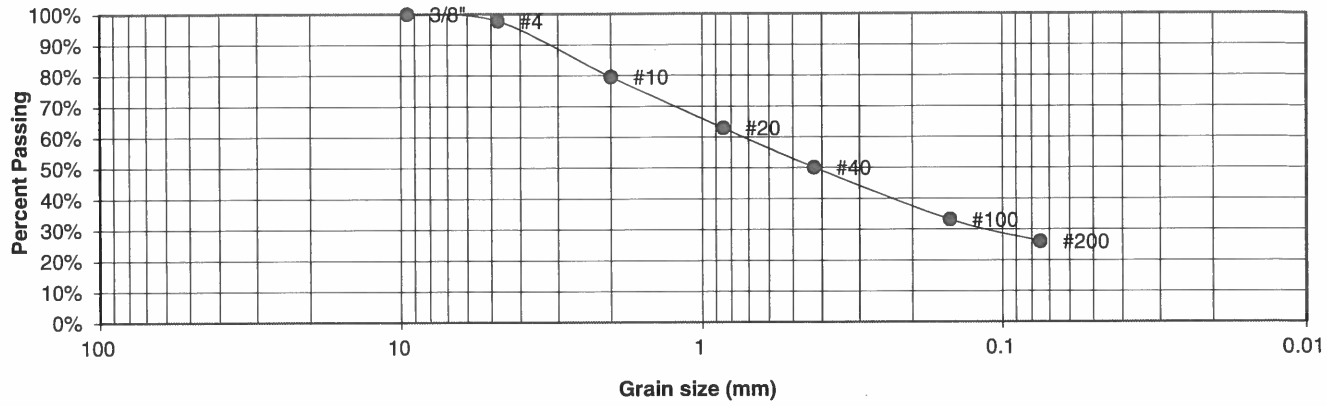
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: B-5

UNIFIED CLASSIFICATION	SM	CLIENT	O'NEIL GROUP
SOIL TYPE #	1	PROJECT	FARMHOUSE COURT
TEST BORING #	1	JOB NO.	221948
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION		GROUP INDEX	

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.7%
10	79.6%
20	62.9%
40	50.1%
100	33.1%
200	26.1%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

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

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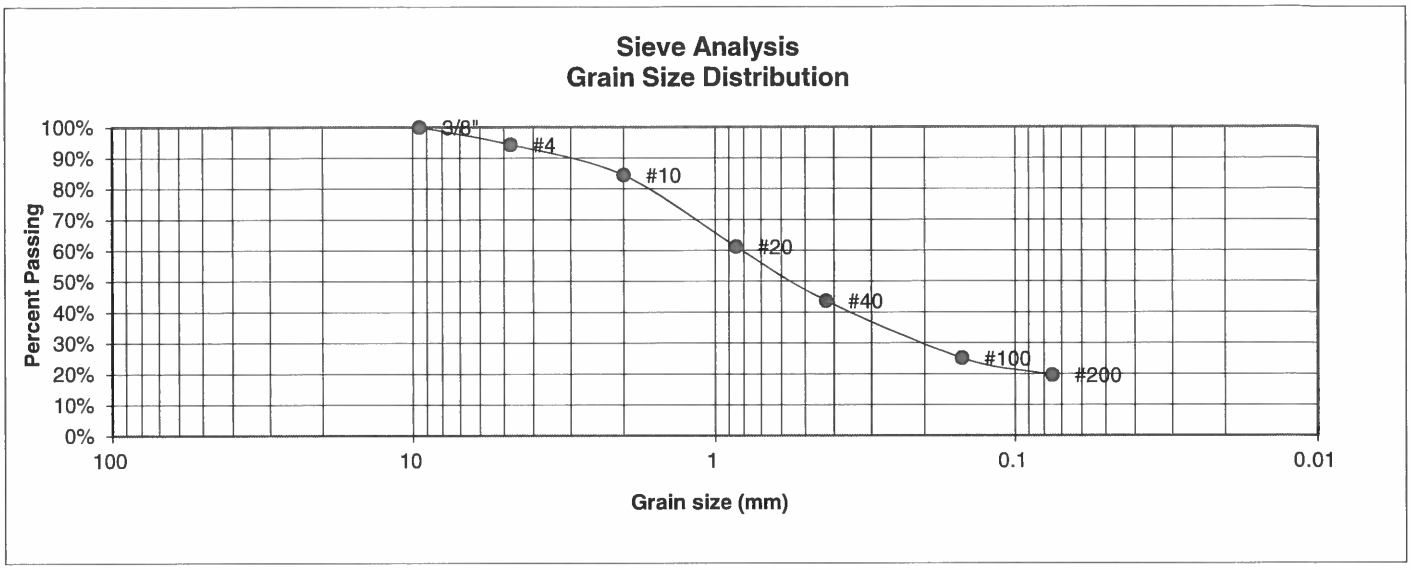
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: B-6

UNIFIED CLASSIFICATION	SM	CLIENT	O'NEIL GROUP
SOIL TYPE #	2	PROJECT	FARMHOUSE COURT
TEST BORING #	1	JOB NO.	221948
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"	100.0%
4	94.3%
10	84.4%
20	61.2%
40	43.7%
100	25.1%
200	19.6%

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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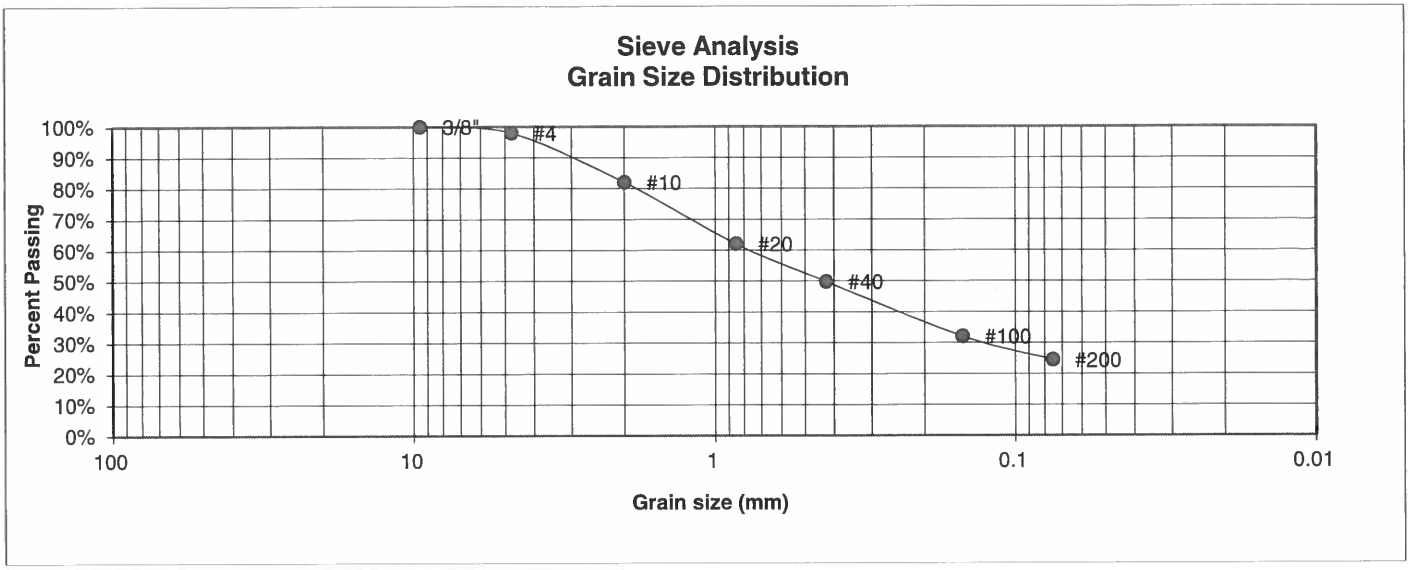
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: B-7

UNIFIED CLASSIFICATION	SC	CLIENT	O'NEIL GROUP
SOIL TYPE #	2	PROJECT	FARMHOUSE COURT
TEST BORING #	2	JOB NO.	221948
DEPTH (FT)	10	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	-1



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.9%
10	82.0%
20	62.0%
40	49.8%
100	32.0%
200	24.4%

Atterberg Limits	
Plastic Limit	13
Liquid Limit	23
Plastic Index	10

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

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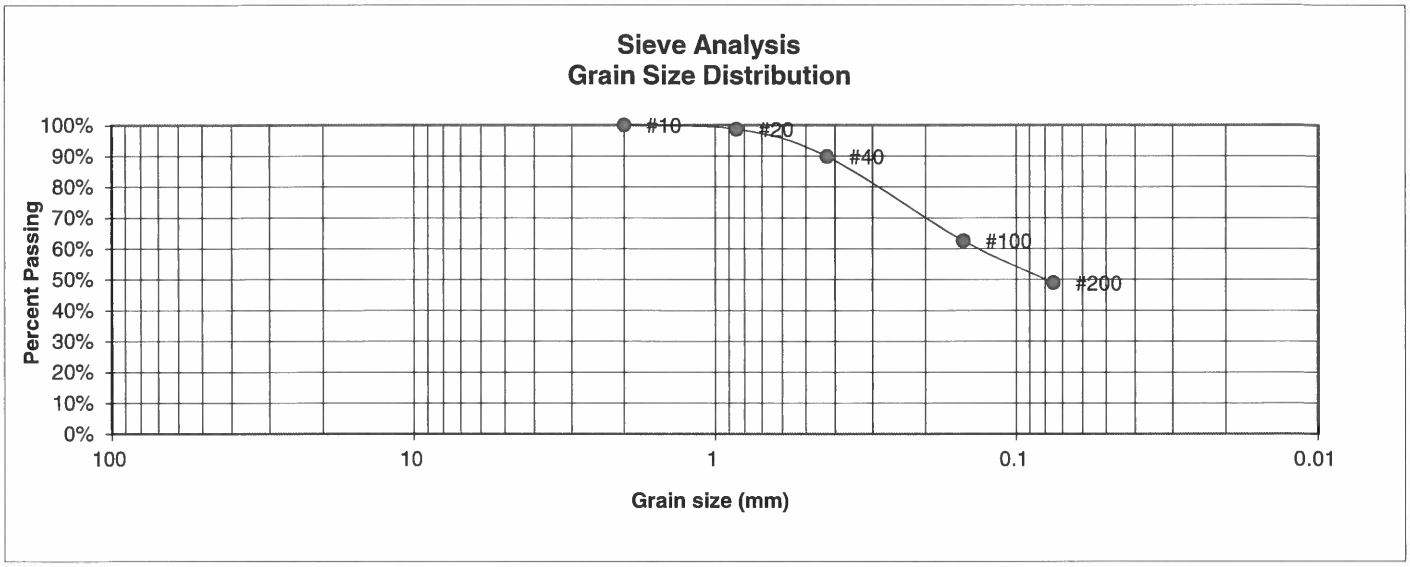
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: B-8

UNIFIED CLASSIFICATION	SC	CLIENT	O'NEIL GROUP
SOIL TYPE #	3	PROJECT	FARMHOUSE COURT
TEST BORING #	3	JOB NO.	221948
DEPTH (FT)	10	TEST BY	BL
AASHTO CLASSIFICATION	A-6	GROUP INDEX	2



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	98.7%
40	89.8%
100	62.5%
200	48.9%

Atterberg Limits	
Plastic Limit	13
Liquid Limit	24
Plastic Index	11

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:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: B-9

CLIENT	O'NEIL GROUP	JOB NO.	221948
PROJECT	FARMHOUSE COURT	DATE	10/10/2022
LOCATION	FARMHOUSE COURT	TEST BY	BL

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

QC BLANK PASS

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505 ELKTON DRIVE
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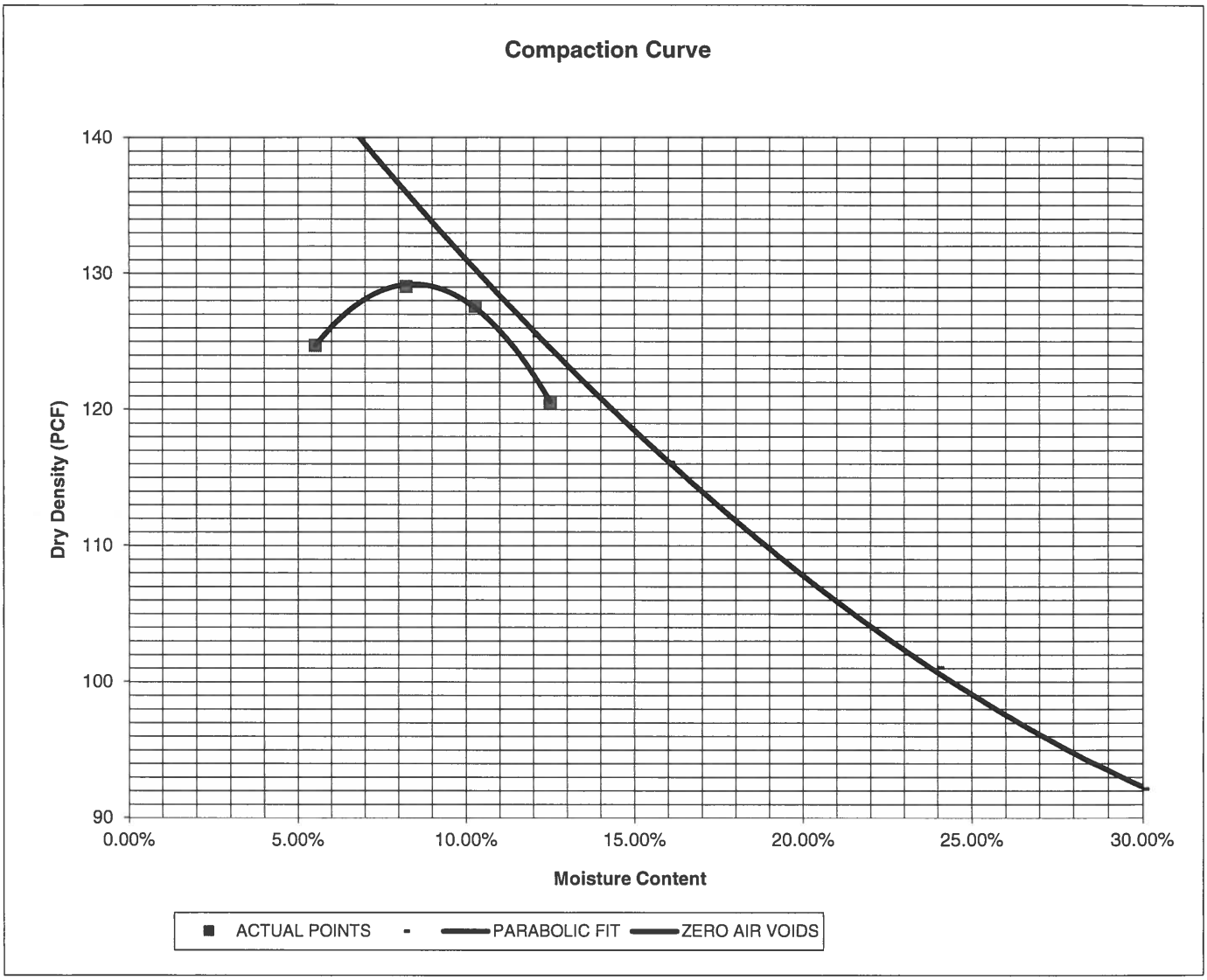
LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: B-10

PROJECT	FARMHOUSE COURT	CLIENT	O'NEIL GROUP
SAMPLE LOCATION	TB-3 @ 0-3'	JOB NO.	221948
SOIL DESCRIPTION	SAND, SILTY, TAN	DATE	09/29/22

IDENTIFICATION	SM	COMPACTION TEST #	1, SOIL TYPE #1
TEST DESIGNATION / METHOD	ASTM D-1557-A	TEST BY	BL
MAXIMUM DRY DENSITY (PCF)	129.1	OPTIMUM MOISTURE	8.4%



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MOISTURE DENSITY RELATION

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: B-11

CBR TEST LOAD DATA

JOB NO: 221948
CLIENT: O'NEIL GROUP
PROJECT: FARMHOUSE COURT
SOIL TYPE: 1, CBR #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	68	22.72	200	66.83	340	113.62
0.050	190	63.49	488	163.07	576	192.48
0.075	214	71.51	684	228.57	811	271.01
0.100	242	80.87	857	286.38	1092	364.91
0.125	263	87.89	980	327.48	1432	478.53
0.150	287	95.91	1088	363.57	1679	561.07
0.175	322	107.60	1191	397.99	1878	627.57
0.200	352	117.63	1245	416.04	2083	696.07
0.300	394	131.66	1454	485.88	2958	988.47
0.400	445	148.70	1601	535.00	3525	1177.94
0.500	518	173.10	1771	591.81	4150	1386.80

FINAL MOISTURE CONTENT

	MOLD # 1	MOLD # 2	MOLD # 3
CAN #	357	343	342
WT. CAN	7.85	8.59	8.6
WT. CAN+WET	176.65	156.73	170.34
WT. CAN+DRY	152.99	138.96	152.27
WT. H20	23.66	17.77	18.07
WT. DRY SOIL	145.14	130.37	143.67
MOISTURE CONTENT	16.30%	13.63%	12.58%

WET DENSITY (PCF)		122.5	129.1	137.5
DRY DENSITY (PCF)		113.0	119.1	126.9
BEARING RATIO		8.09	28.64	36.49
90% OF DRY DENSITY	116.2			
95% OF DRY DENSITY	122.6			

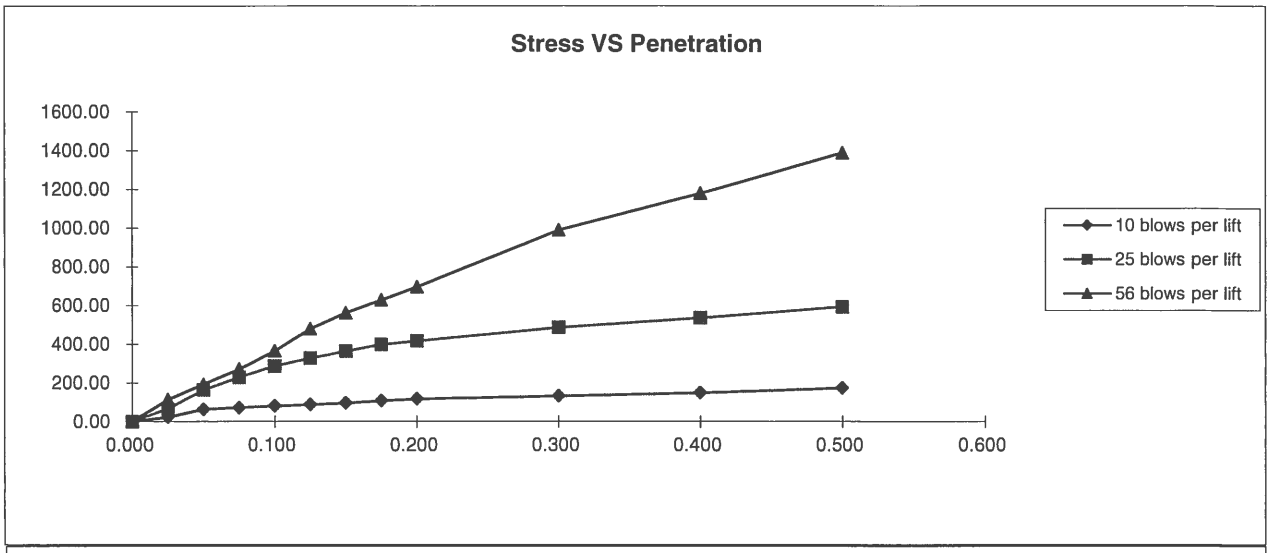
BEARING RATIO AT 90% OF MAX	18.89	~ R VALUE	65
BEARING RATIO AT 95% OF MAX	32.23	~ R VALUE	74

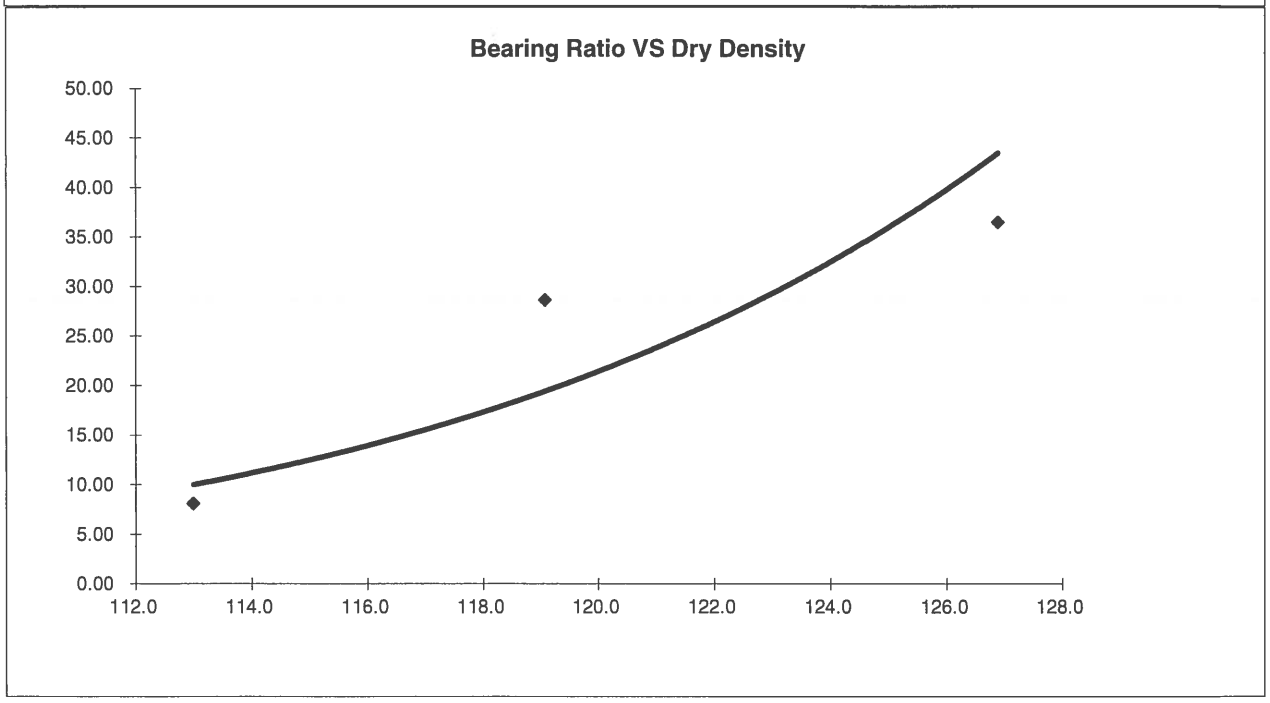
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

CBR TEST DATA

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: B-12





BEARING RATIO AT 90% OF MAX	18.89	~ R VALUE	65.00
BEARING RATIO AT 95% OF MAX	32.23	~ R VALUE	74.00

JOB NO: 221948
SOIL TYPE: 1, CBR #1

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CALIFORNIA BEARING RATIO

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	10/10/22

JOB NO.: 221948
FIG NO.: B-13