ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
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June 29, 2023
Revised July 18, 2023

Tech Contractors
3575 Kenyon Street, Suite 200
San Diego, California 92110

Attn: Raul Guzman

Re: Pavement Recommendations
Rex Road at Falcon Regional Park
El Paso County, Colorado
Entech Job No. 230707

Dear Mr. Guzman:

As requested, Entech Engineering, Inc. (Entech) obtained samples of the subgrade soils from a section of Rex Road extending from its current extents to Eastonville Road to provide pavement recommendations. The site is located on property of the Falcon Regional Park in El Paso County, Colorado. This letter presents the results of our Subsurface Soil Investigation, laboratory testing, and provides pavement recommendations for the roadway.

Project Description

The roadway in Falcon Regional Park consists of a section of Rex Road. The section to be paved is an approximately 2,000-foot-long section of Rex Road extending east from just east of Shelter Creek Drive to Eastonville Road.

Subsurface Explorations and Laboratory Testing

Subsurface conditions at the project site were explored by four test borings on May 23, 2023. The site layout and the locations of the test borings are shown on the Test Boring Location Map, Figure 1. The borings were drilled to depths of 5 to 10 feet below the existing ground surface (bgs). The drilling was performed using a truck-mounted, continuous flight auger drill rig supplied and operated by Entech. Descriptive boring logs of the subsurface conditions encountered during drilling are presented in Appendix A. Groundwater levels were measured in each of the open boreholes at the conclusion of drilling.

Soil and bedrock samples were obtained from the borings utilizing the Standard Penetration Test (ASTM D-1586) using a split-barrel California sampler. Results of the Standard Penetration Test (SPT) are included on the boring logs in terms of N-values expressed in blows per foot (bpf). Soil and bedrock samples recovered from the borings were visually classified and recorded on the boring logs. The soil and bedrock classifications were later verified utilizing laboratory testing and grouped by soil type. The soil and bedrock type numbers are included on the boring logs. It should be understood that the soil and bedrock descriptions shown on the boring logs may vary between boring location and sample depths. It should also be noted that the lines of stratigraphic separation shown on the boring logs represent approximate boundaries between soil and bedrock types and the actual stratigraphic transitions may be more gradual or variable with location.

Water content testing (ASTM D-2216) was performed on the samples recovered from the borings, and the results are shown on the boring logs. Grain-Size Analysis (ASTM D-422) and Atterberg

Limits testing (ASTM D-4318) were performed on selected samples to assist in classifying the materials encountered in the borings. A Swell/Consolidation test (ASTM D-4546) was performed to evaluate the expansive/compressive characteristics of the bedrock. Soluble sulfate testing was performed on select soil samples to evaluate the potential for below grade degradation of concrete due to sulfate attack. The laboratory testing results are summarized on Table B-1 and are presented in Appendix B.

Subgrade Conditions

The test borings were completed along the proposed roadway alignment. The soils encountered in the test borings consisted of four general soil types; Type 1; silty to clayey sand fill, Type 2; native sand with silt, Type 3; weathered sandstone bedrock (silty sand when classified as a soil), and Type 4; claystone (sandy clay when classified as a soil). The Type 1 subgrade soils classified as A-2-4, A-2-6, and A-1-b and the Type 2 and 3 Soils classified as A-1-b soils, based on the AASHTO classification system. The Type 4 claystone was generally encountered below the subgrade influence zone. Sulfate testing indicated that the soils exhibit a negligible potential for sulfate attack. Groundwater was not encountered in the test borings.

A Swell/Consolidation test performed on a sample of the subgrade indicated a volume change of 0.6 percent, which is a low swell potential. Swell tests on the claystone resulted in volume changes ranging from 1.2 to 3.0 percent, which are in the moderate to high swell potential. Due to its depth, the claystone will likely not affect the pavement subgrade. Laboratory test results are presented in Appendix B and are summarized on Table B-1.

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

Soil Type 1 – Clayey Sand Fill

CBR at 95% = 12.8
Use CBR = 10 for design.

Classification Testing

Liquid Limit	30
Plasticity Index	14
Percent Passing 200	34.8
AASHTO Classification	A-2-6
Group Index	0
Unified Soils Classification	SC

Pavement Design

The CBR testing was used to determine the design subgrade modulus for the roadway. The pavement sections were determined utilizing the El Paso County “Pavement Design Criteria and Report.” ESAL values were obtained from the Transportation Memorandum Report performed

Document in County File is dated May 3 2022. Provide the latest copy.

by LSC Transportation Consultants, LLC dated June 30, 2022, LSC Job No. S224190, PCD File No. SF2220. The new asphalt portion of Rex Road classifies as an urban minor arterial with an 18-kip equivalent single axle load (ESAL) value of 1,971,000.

The eastern 280 feet of Rex Road is a temporary section that will be upgraded with the improvements to Eastonville Road. Based on the interim traffic counts and agreement with El Paso County, an Urban Nonresidential Collector with an 18-kip ESAL value of 821,000 will be used for this section. The eastern segment of the roadway will be replaced in the future with a round-a-bout. Based on correspondence with El Paso County, the county approves use of the lower collector ESAL value for this section of Rex Road. Pavement alternatives for asphalt over aggregate base course and for asphalt over cement stabilized subgrade are provided. Design parameters used in the pavement analysis are as follows:

Reliability	85%
Standard Deviation	0.45
Serviceability Index	2.5
Design CBR	10
Resilient Modulus	15,000 psi
Structural Coefficients	
Hot Bituminous Pavement	0.44
Aggregate Basecourse	0.11
Cement Stabilized Subgrade	0.11

Pavement calculations are attached in Appendix C. Pavement sections recommended for this phase of the filing are summarized as follows:

Recommended Pavement Sections

Pavement Area	Design ESAL	Alternative
Rex Road – New Asphalt	1,971,000	1. 5.0 inches HMA over 8.0 inches ABC
		2. 5.0 inches HMA over 10.0 inches of CTS
Rex Road – Temporary Section	821,000	1. 4.0 inches HMA over 8.0 inches ABC
		2. 5.0 inches HMA over 10.0 inches of CTS

ABC = Aggregate Base Course; ESAL = equivalent single axle loads; HMA = Hot Mix Asphalt
CTS = Cement Treated Subgrade

Note:

1. Full depth sections are not allowed.

The recommended street sections and extents are shown in Figure 1.

Swelling Soils 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. Based on the swell

testing, mitigation for expansive soils will not be required for the subgrade soils on this site. Index testing on Soil Type 4 from Test Boring No. 1 indicated a plasticity index of 14 with 71 percent passing the No. 200 sieve. In our opinion, mitigation for swelling soils in not required at the site, considering that the Type 4 soils were encountered at depths below the subgrade influence zone. Based on the classification, swell test results, the Soil Type 1 subgrade soils and the discussion provide above, mitigation for to expansive soils is not required on this site.

Roadway Subgrade Preparation

Prior to placement of the asphalt, the subgrade should be proofrolled and compacted to a minimum of 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557 at ± 2 percent of optimum moisture content. Any loose or soft areas identified during proofrolling 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.

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

Based on the soils encountered, subgrade soil problem areas, if any, will be identified at proof roll. We do not anticipate issues with the subgrade in regards to shallow water, frost susceptible soils, groundwater or drainage conditions, soluble sulfates, or cold weather construction.

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.

Daniel P. Stegman

DPS:JCG/dps

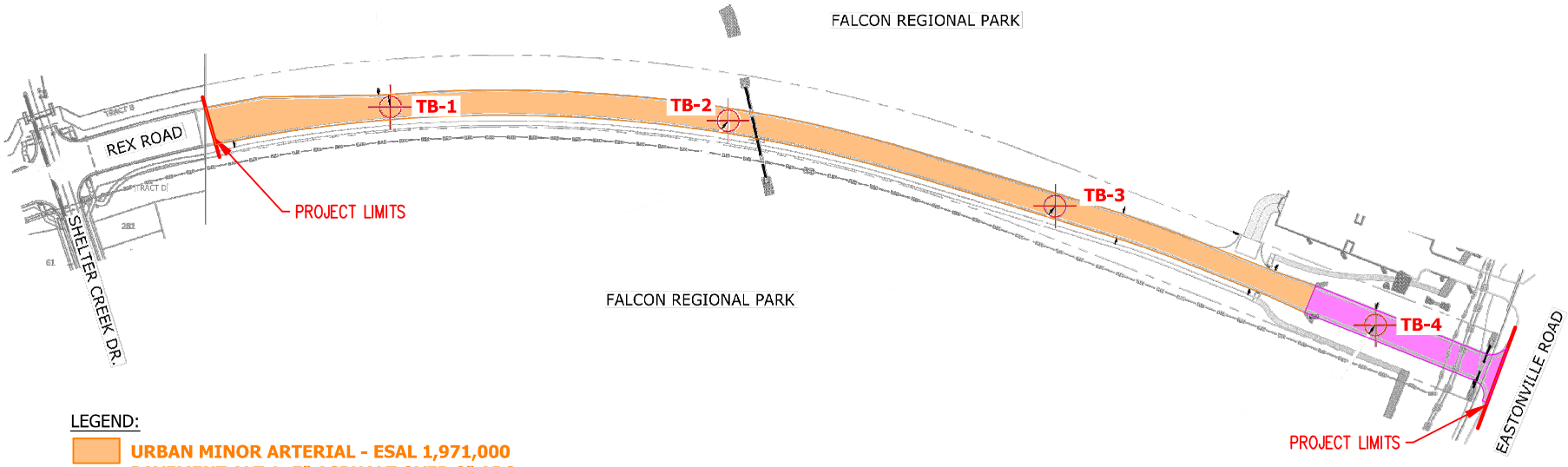
Encl.

Reviewed by:

COLORADO LICENSED
JOSEPH C GOODE III
52381
PROFESSIONAL ENGINEER

Digitally signed by Joseph C Goode III
Date: 2023.07.18 09:59:18 -06'00'

Joseph C. Goode III, P.E.
Project Engineer



LEGEND:

URBAN MINOR ARTERIAL - ESAL 1,971,000
PAVEMENT ALT 1: 5" ASPHALT OVER 8" ABC
PAVEMENT ALT 2: 5" ASPHALT OVER 10" CTS.

URBAN NON-RESIDENTIAL COLLECTOR - ESAL 821,000
PAVEMENT ALT 1: 4" ASPHALT OVER 8" ABC
PAVEMENT ALT 2: 5" ASPHALT OVER 10" CTS.

TB- APPROXIMATE TEST BORING LOCATION AND NUMBER

N

37.5' 0 75' 150' 300'

1" = 150'

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TEST BORING LOCATION MAP
FALCON REGIONAL PARK
TECH CONTRACTORS

JOB NO. 230707

FIG. 1

APPENDIX A: Test Boring Logs

TEST BORING 1
DATE DRILLED 5/23/2023

REMARKS

DRY TO 10', 5/23/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			6	7.4	1
5			50/6"	4.5	3
10			50/9"	14.5	4
15					
20					

FILL 0-3', SAND, SILTY, BROWN, LOOSE, MOIST

SANDSTONE, EXTREMELY WEAK, TAN, WEATHERED. (SAND, SILTY, VERY DENSE, MOIST)

CLAYSTONE, WEAK, OLIVE, WEATHERED. (CLAY, SANDY, HARD, MOIST)

TEST BORING 2
DATE DRILLED 5/23/2023

REMARKS

DRY TO 5', 5/23/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			6	6.4	1
5			9	5.8	1
10					
15					
20					

FILL 0-5, SAND, WITH SILT, BROWN, LOOSE, MOIST

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TEST BORING LOGS

FALCON REGIONAL PARK
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FIG. A-1

TEST BORING 3
DATE DRILLED 5/23/2023

REMARKS

DRY TO 5', 5/23/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			14	7.9	1	FILL 0-5', SAND, WITH SILT, BROWN, MEDIUM DENSE, MOIST
5			22	9.6	1	
10						
15						
20						

TEST BORING 4
DATE DRILLED 5/23/2023

REMARKS

DRY TO 5', 5/23/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			5	4.7	1	FILL 0-3', SAND, CLAYEY, SILTY, BROWN, LOOSE, MOIST
5			22	2.0	2	SAND, WITH SILT, TAN, MEDIUM DENSE, DRY
10						
15						
20						

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TEST BORING LOGS

FALCON REGIONAL PARK
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JOB NO. 230707

FIG. A-2

APPENDIX B: Laboratory Test Results

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TABLE B-1
SUMMARY OF LABORATORY TEST RESULTS

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	SULFATE (WT %)	SWELL/ CONSOL (%)	AASHTO CLASS.	USCS	SOIL DESCRIPTION
1, CBR	4	0-3	6.9	118.1	34.8	30	16	14		0.6	A-2-6	SC	FILL, SAND, CLAYEY
1	1	1-2			21.5	NV	NP	NP	0.00		A-1-b	SM	FILL, SAND, SILTY
1	2	1-2			5.1	NV	NP	NP			A-1-b	SW-SM	FILL, SAND, WITH SILT
1	3	1-2			8.8	NV	NP	NP			A-1-b	SW-SM	FILL, SAND, WITH SILT
1	4	1-2			32.9	22	16	6			A-2-4	SC-SM	FILL, SAND, CLAYEY, SILTY
2	4	5			5.7	NV	NP	NP	<0.01		A-1-b	SW-SM	SAND, WITH SILT
3	1	5			18.6	NV	NP	NP	<0.01		A-1-b	SM	SANDSTONE. (SAND, SILTY)
4	1	10	16.0	112.2	70.7	32	18	14	0.00	3.0	A-6	CL	CLAYSTONE. (CLAY, SANDY)
4	1	10	18.1	108.5						1.2		CL	CLAYSTONE. (CLAY, SANDY)

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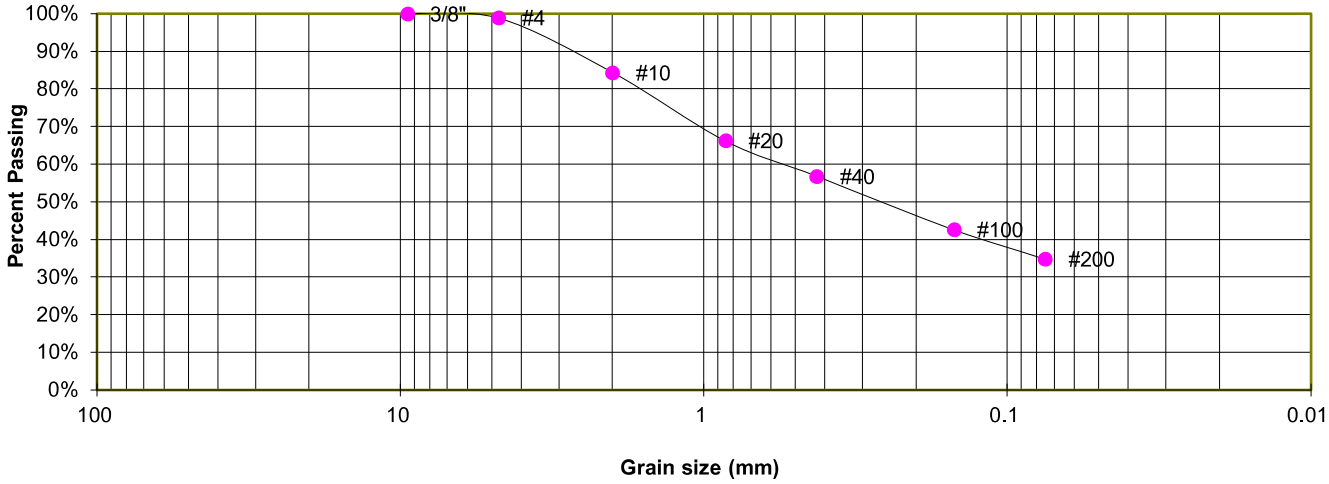
TEST BORING	4	SOIL DESCRIPTION	FILL, SAND, CLAYEY
DEPTH (FT)	0-3	SOIL TYPE	1, CBR



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.9%
10	84.4%
20	66.3%
40	56.8%
100	42.6%
200	34.8%

ATTERBERG LIMITS

Plastic Limit	16
Liquid Limit	30
Plastic Index	14

SOIL CLASSIFICATION

USCS CLASSIFICATION: SC
AASHTO CLASSIFICATION: A-2-6

ENTECH ENGINEERING, INC.

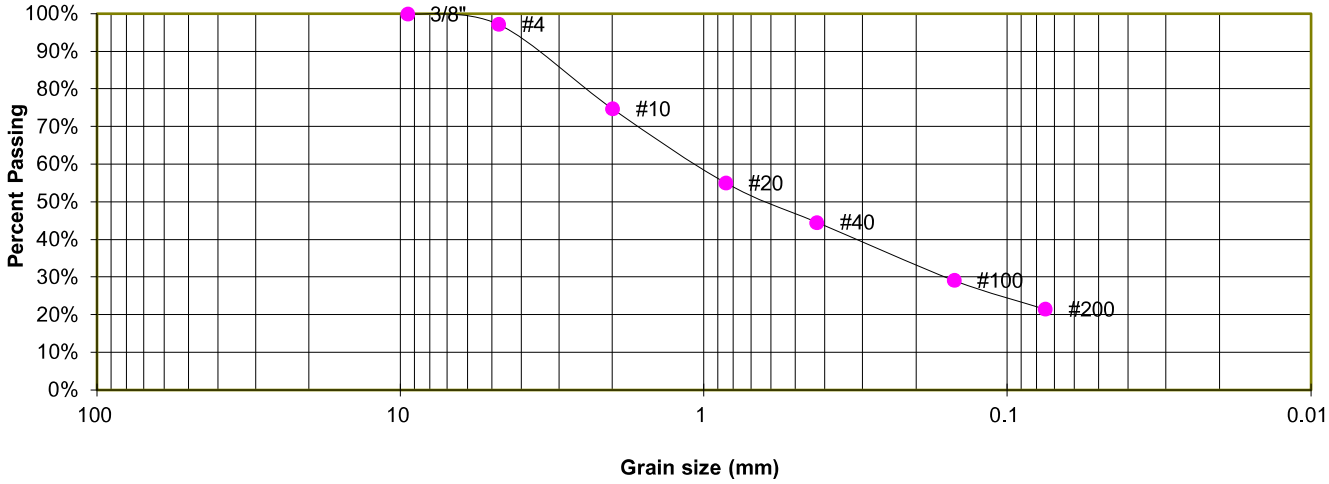
LABORATORY TEST RESULTS

FALCON REGIONAL PARK
TECH CONTRACTORS

JOB NO. 230707

FIG. B-1

TEST BORING	1	SOIL DESCRIPTION	FILL, SAND, SILTY
DEPTH (FT)	1-2	SOIL TYPE	1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.2%
10	74.7%
20	55.1%
40	44.6%
100	29.2%
200	21.5%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

USCS CLASSIFICATION: SM
AASHTO CLASSIFICATION: A-1-b

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

FALCON REGIONAL PARK
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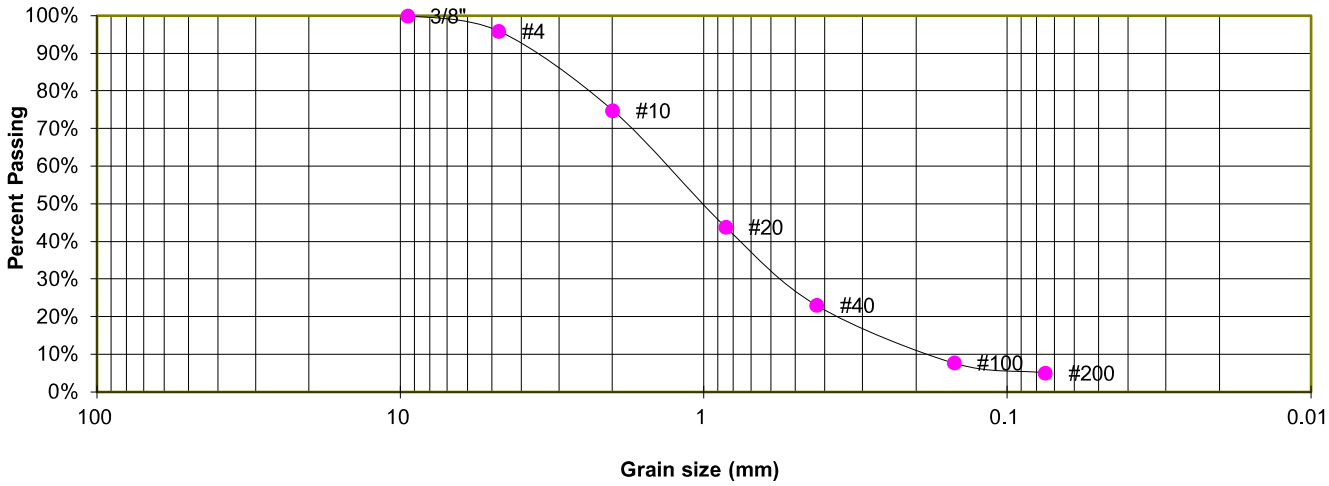
FIG. B-2

TEST BORING	2	SOIL DESCRIPTION	FILL, SAND, WITH SILT
DEPTH (FT)	1-2	SOIL TYPE	1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.9%
10	74.8%
20	43.9%
40	23.0%
100	7.7%
200	5.1%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

USCS CLASSIFICATION: SW-SM

AASHTO CLASSIFICATION: A-1-b

ENTECH ENGINEERING, INC.

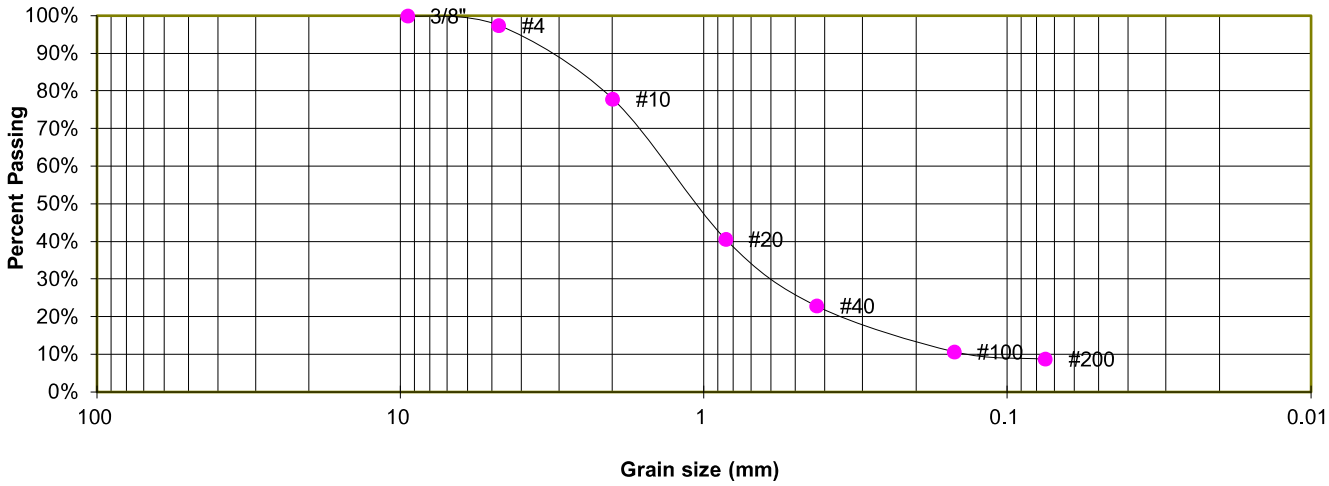
LABORATORY TEST RESULTS

FALCON REGIONAL PARK
TECH CONTRACTORS

JOB NO. 230707

FIG. B-3

TEST BORING	3	SOIL DESCRIPTION	FILL, SAND, WITH SILT
DEPTH (FT)	1-2	SOIL TYPE	1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.5%
10	77.9%
20	40.7%
40	22.9%
100	10.7%
200	8.8%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

USCS CLASSIFICATION: SW-SM
AASHTO CLASSIFICATION: A-1-b

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LABORATORY TEST RESULTS

FALCON REGIONAL PARK
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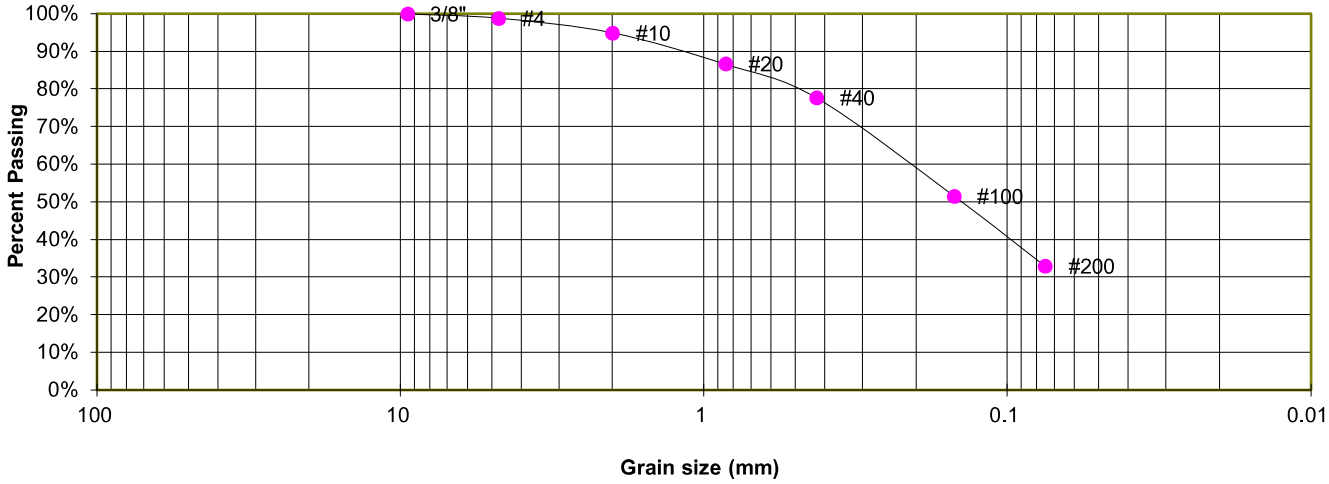
FIG. B-4

TEST BORING	4	SOIL DESCRIPTION	FILL, SAND, CLAYEY, SILTY
DEPTH (FT)	1-2	SOIL TYPE	1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.8%
10	94.9%
20	86.7%
40	77.7%
100	51.5%
200	32.9%

ATTERBERG LIMITS

Plastic Limit	16
Liquid Limit	22
Plastic Index	6

SOIL CLASSIFICATION

USCS CLASSIFICATION: SC-SM
AASHTO CLASSIFICATION: A-2-4

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

FALCON REGIONAL PARK
TECH CONTRACTORS

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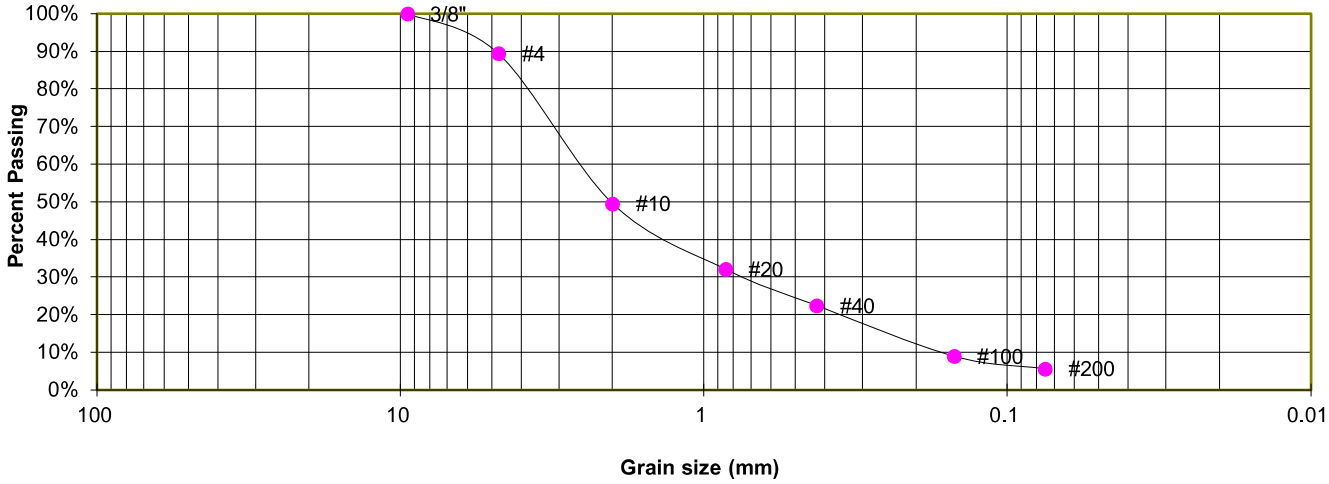
FIG. B-5

TEST BORING	4	SOIL DESCRIPTION	SAND, WITH SILT
DEPTH (FT)	5	SOIL TYPE	2



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	89.4%
10	49.5%
20	32.2%
40	22.5%
100	9.0%
200	5.7%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

USCS CLASSIFICATION: SW-SM

AASHTO CLASSIFICATION: A-1-b

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

FALCON REGIONAL PARK
TECH CONTRACTORS

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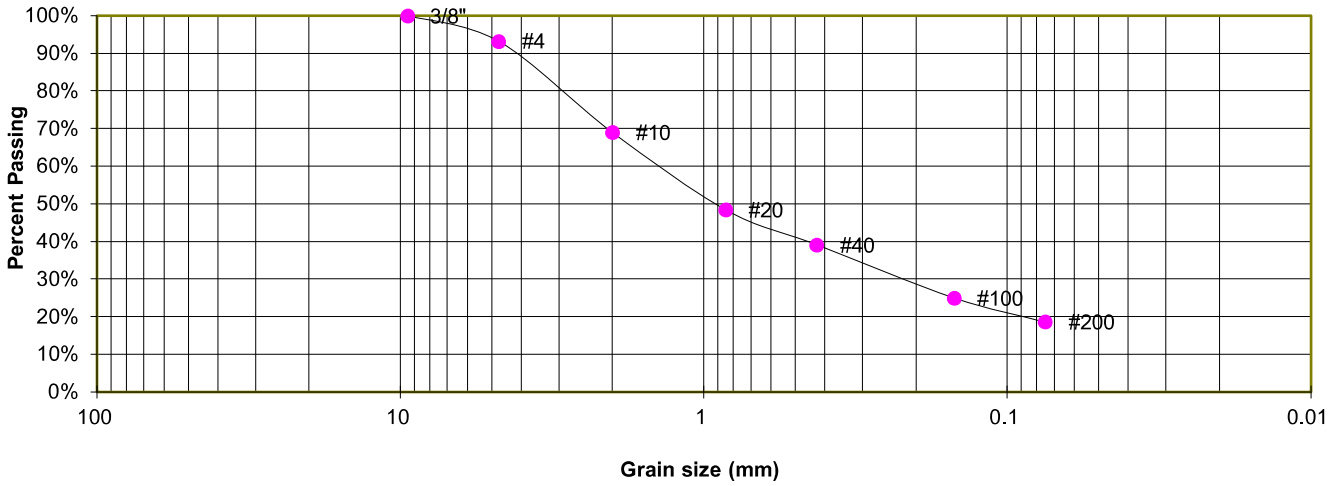
FIG. B-6

TEST BORING	1	SOIL DESCRIPTION	SANDSTONE. (SAND, SILTY)
DEPTH (FT)	5	SOIL TYPE	3



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.2%
10	69.0%
20	48.5%
40	39.1%
100	25.0%
200	18.6%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

USCS CLASSIFICATION: SM
AASHTO CLASSIFICATION: A-1-b

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

FALCON REGIONAL PARK
TECH CONTRACTORS

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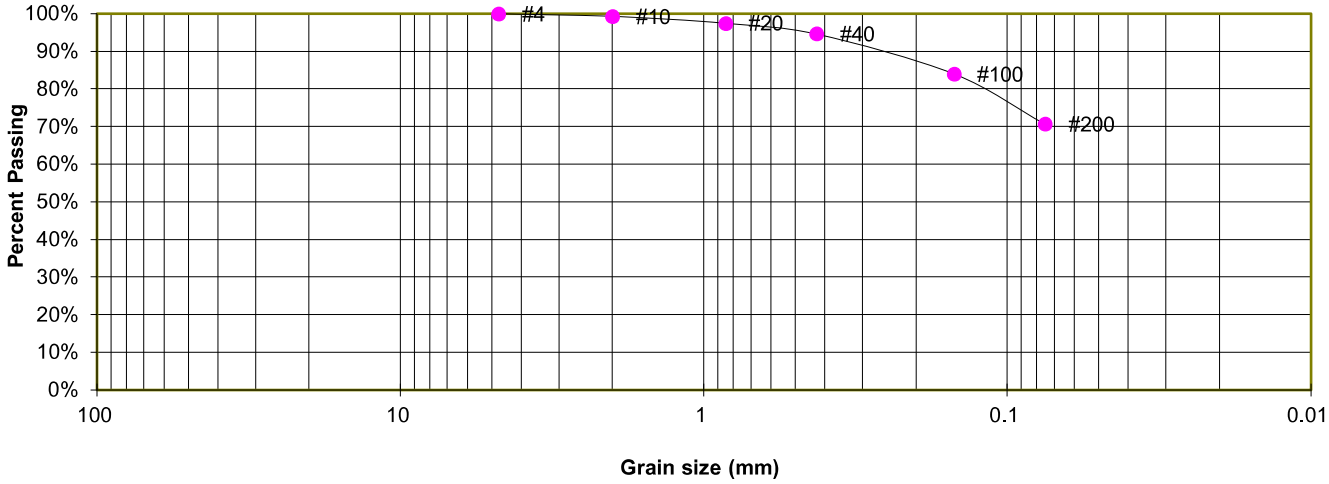
FIG. B-7

TEST BORING	1	SOIL DESCRIPTION	CLAYSTONE. (CLAY, SANDY)
DEPTH (FT)	10	SOIL TYPE	4



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.3%
20	97.5%
40	94.6%
100	84.0%
200	70.7%

ATTERBERG LIMITS

Plastic Limit	18
Liquid Limit	32
Plastic Index	14

SOIL CLASSIFICATION

USCS CLASSIFICATION:	CL
AASHTO CLASSIFICATION:	A-6

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

FALCON REGIONAL PARK
TECH CONTRACTORS

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FIG. B-8

TEST BORING	4	SOIL DESCRIPTION	CLAYSTONE. (CLAY, SANDY)
DEPTH (FT)	0-3	SOIL TYPE	1, CBR

SWELL/CONSOLIDATION TEST RESULTS

NATURAL UNIT DRY WEIGHT (PCF): 118
NATURAL MOISTURE CONTENT: 6.9%
SWELL/CONSOLIDATION (%): 0.6%

REMOLDED SAMPLE

ENTECH ENGINEERING, INC.

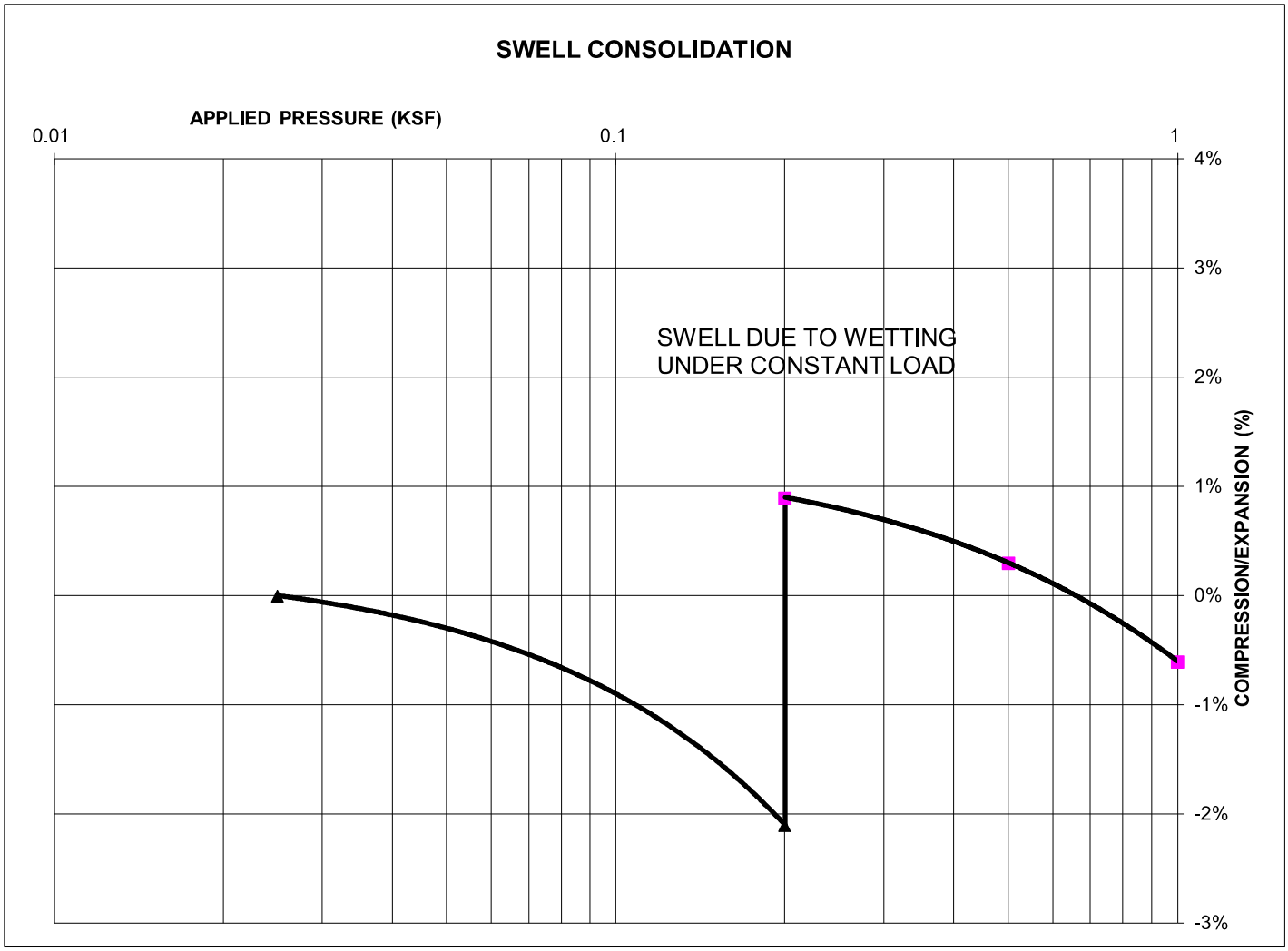
SWELL/CONSOLIDATION TEST RESULTS

FALCON REGIONAL PARK
TECH CONTRACTORS

JOB NO. 230707

FIG. B-9

TEST BORING	1	SOIL DESCRIPTION	CLAYSTONE. (CLAY, SANDY)
DEPTH (FT)	10	SOIL TYPE	4



SWELL/CONSOLIDATION TEST RESULTS

NATURAL UNIT DRY WEIGHT (PCF): 112
NATURAL MOISTURE CONTENT: 10.1%
SWELL/CONSOLIDATION (%): 3.0%

ENTECH ENGINEERING, INC.

SWELL/CONSOLIDATION TEST RESULTS

FALCON REGIONAL PARK
TECH CONTRACTORS

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FIG. B-10

TEST BORING	1	SOIL DESCRIPTION	CLAYSTONE. (CLAY, SANDY)
DEPTH (FT)	10	SOIL TYPE	4

SWELL/CONSOLIDATION TEST RESULTS

NATURAL UNIT DRY WEIGHT (PCF): 109
NATURAL MOISTURE CONTENT: 18.1%
SWELL/CONSOLIDATION (%): 1.2%

REMOLDED SAMPLE

ENTECH ENGINEERING, INC.

SWELL/CONSOLIDATION TEST RESULTS

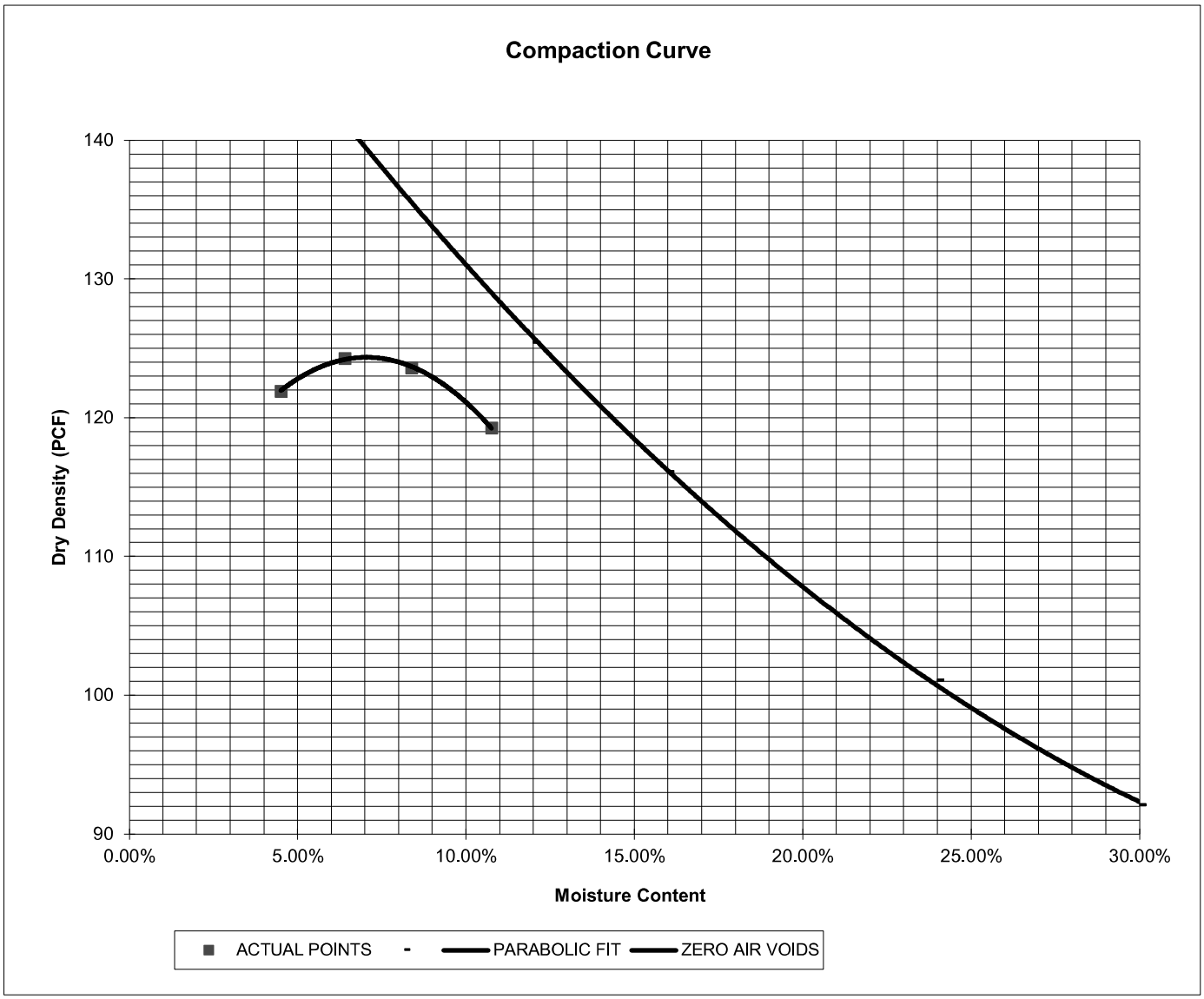
FALCON REGIONAL PARK
TECH CONTRACTORS

JOB NO. 230707

FIG. B-11

PROJECT	FALCON REGIONAL PARK	CLIENT	TECH CONTRACTORS
SAMPLE LOCATION	TB-4 @ 0-3'	JOB NO.	230707
SOIL DESCRIPTION	FILL, SAND, CLAYEY, BROWN	DATE	06/07/23

IDENTIFICATION	SC	PROCTOR TEST #	1
TEST DESIGNATION / METHOD	ASTM D-1557-A	TEST BY	AL
MAXIMUM DRY DENSITY (PCF)	124.4	OPTIMUM MOISTURE	6.9%



ENTECH ENGINEERING, INC.

MOISTURE DENSITY RELATION

FALCON REGIONAL PARK
TECH CONTRACTORS

JOB NO.
230707

FIG. B-12

CBR TEST LOAD DATA

JOB NO: 230707
CLIENT: TECH CONTRACTORS
PROJECT: FALCON REGIONAL PARK
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	104	34.75	209	69.84	357	119.30
0.050	198	66.17	395	132.00	671	224.23
0.075	250	83.54	502	167.75	874	292.06
0.100	291	97.24	621	207.52	1382	461.82
0.125	364	121.64	733	244.94	1558	520.63
0.150	409	136.67	831	277.69	1709	571.09
0.175	432	144.36	896	299.41	1972	658.98
0.200	478	159.73	955	319.13	2197	734.17
0.300	555	185.46	1138	380.28	3142	1049.96
0.400	633	211.53	1269	424.06	3625	1211.36
0.500	821	274.35	1399	467.50	4158	1389.47

FINAL MOISTURE CONTENT

	MOLD # 1	MOLD # 2	MOLD # 3
CAN #	349	399	420
WT. CAN	8.74	8.24	8.21
WT. CAN+WET	188.59	169.76	178.26
WT. CAN+DRY	169.11	150.93	160.57
WT. H20	19.48	18.83	17.69
WT. DRY SOIL	160.37	142.69	152.36
MOISTURE CONTENT	12.15%	13.20%	11.61%

WET DENSITY (PCF)	123.7	133.0	139.8
DRY DENSITY (PCF)	115.7	124.5	130.8

BEARING RATIO		9.72	20.75	46.18
90% OF DRY DENSITY	112.0			
95% OF DRY DENSITY	118.2			

BEARING RATIO AT 90% OF MAX	4.99	~ R VALUE	10
BEARING RATIO AT 95% OF MAX	12.84	~ R VALUE	37

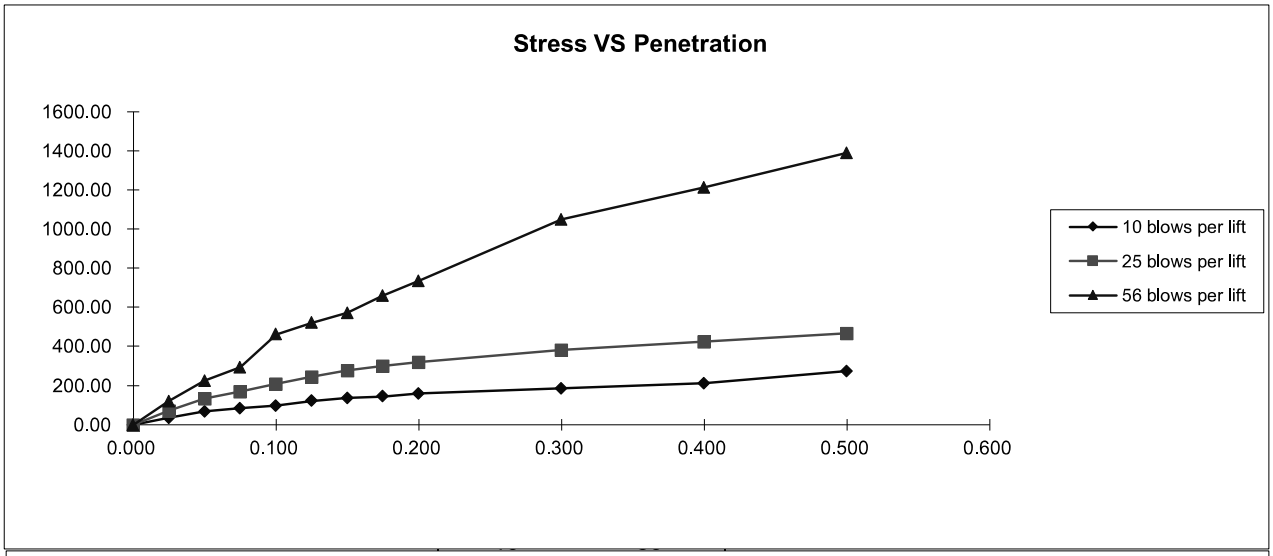
ENTECH ENGINEERING, INC.

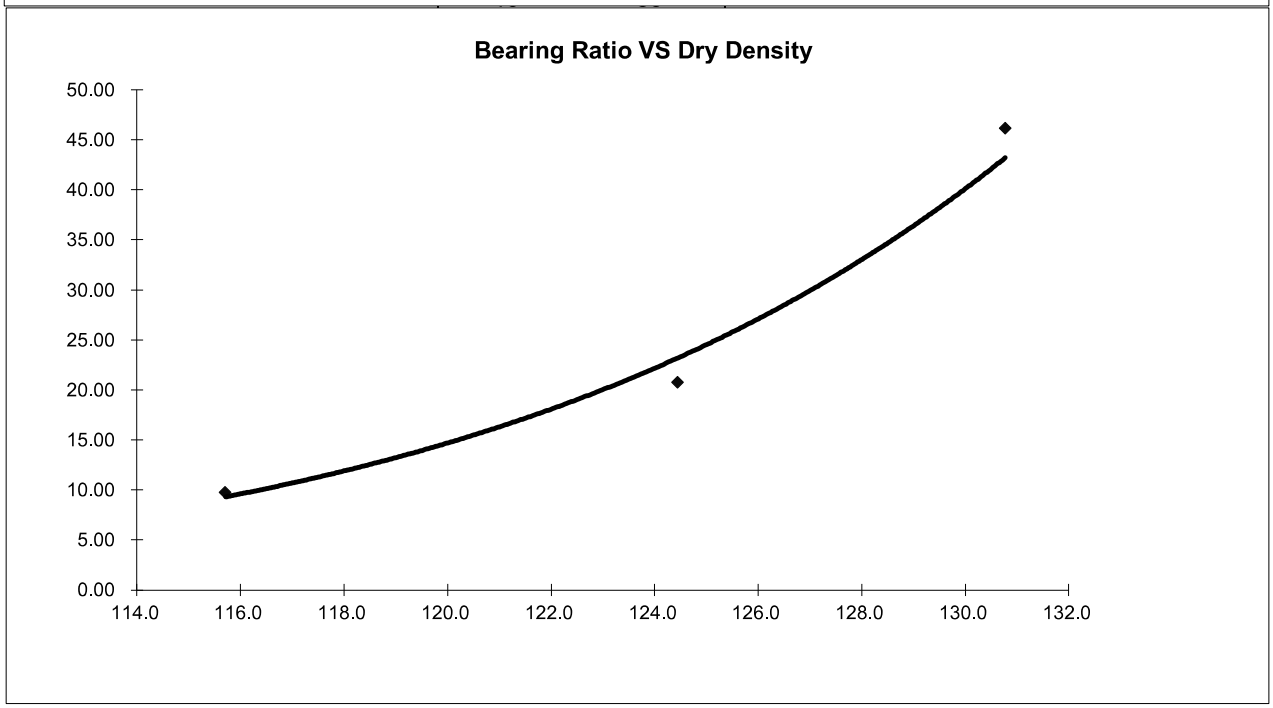
LABORATORY TEST RESULTS

FALCON REGIONAL PARK
TECH CONTRACTORS

JOB NO. 230707

FIG. B-13





BEARING RATIO AT 90% OF MAX	4.99	~ R VALUE	10.00
BEARING RATIO AT 95% OF MAX	12.84	~ R VALUE	37.00

JOB NO: 230707
SOIL TYPE: 1

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

FALCON REGIONAL PARK
TECH CONTRACTORS

JOB NO.
230707

FIG. B-14

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

PROJECT DATA

Project Location REX ROAD AT FALCON REGIONAL PARK

Job Number: 230707

DESIGN DATA

Equivalent (18-kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	821,000
Design CBR	CBR =	10
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 =	15,000 psi

Required Structural Number (SN): → SN = 2.40

DESIGN EQUATIONS

Resilient Modulus

If using CBR: M_R = (CBR) x 1,500

If using R-Value: $M_R = 10^{[(S_1 + 18.72) / 6.24]}$ where: S_1 = [(R-value - 5) / 11.29] + 3

Required Structural Number

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

Pavement Section Thickness

$SN^* = C_1D_1 + C_2D_2$ where:

C_1 = Strength Coefficient - Hot Bituminous Asphalt

C_2 = Strength Coefficient - Aggregate Base Course

D_1 = Depth of Asphalt (inches)

D_2 = Depth of Base Course (inches)

RECOMMENED THICKNESSES

Layer	Material	Structural Layer	Thickness (D^*_i)	SN^*_i	SN
1	HMA	C_1 = 0.44	4.0 inches	1.760	-
2	ABC	C_2 = 0.11	8.0 inches	0.880	
			SN*=	2.640	2.40

Pavement SN > Required SN, Design is Acceptable

Fig. No. C-1

FLEXIBLE PAVEMENT DESIGN

PROJECT DATA

Project Location REX ROAD AT FALCON REGIONAL PARK

Job Number: 230707

DESIGN DATA

Equivalent (18-kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	821,000
Design CBR	CBR =	10
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 =	15,000 psi

Required Structural Number (SN): ⟶ SN = 2.40

DESIGN EQUATIONS

Resilient Modulus

If using CBR: M_R = (CBR) x 1,500

If using R-Value: $M_R = 10^{[(S_1 + 18.72) / 6.24]}$ where: S_1 = [(R-value - 5) / 11.29] + 3

Required Structural Number

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

Pavement Section Thickness

$SN^* = C_1D_1 + C_2D_2$ where:

C_1 = Strength Coefficient - Hot Bituminous Asphalt

C_2 = Strength Coefficient - Aggregate Base Course

D_1 = Depth of Asphalt (inches)

D_2 = Depth of Base Course (inches)

RECOMMENED THICKNESSES

Layer	Material	Structural Layer	Thickness (D^*_i)	SN^*_i	SN
1	HMA	C_1 = 0.44	5.0 inches	2.200	-
2	CTS	C_2 = 0.11	10.0 inches	1.100	
			SN*=	3.300	2.40

Pavement SN > Required SN, Design is Acceptable

Fig. No. C-2

FLEXIBLE PAVEMENT DESIGN

PROJECT DATA

Project Location REX ROAD AT FALCON REGIONAL PARK

Job Number: 230707

DESIGN DATA

Equivalent (18-kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	1,971,000
Design CBR	CBR =	10
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 =	15,000 psi

Required Structural Number (SN): → SN = 2.74

DESIGN EQUATIONS

Resilient Modulus

If using CBR: M_R = (CBR) x 1,500

If using R-Value: $M_R = 10^{[(S_1 + 18.72) / 6.24]}$ where: S_1 = [(R-value - 5) / 11.29] + 3

Required Structural Number

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

Pavement Section Thickness

$SN^* = C_1D_1 + C_2D_2$ where:

C_1 = Strength Coefficient - Hot Bituminous Asphalt

C_2 = Strength Coefficient - Aggregate Base Course

D_1 = Depth of Asphalt (inches)

D_2 = Depth of Base Course (inches)

RECOMMENED THICKNESSES

Layer	Material	Structural Layer	Thickness (D^*_i)	SN^*_i	SN
1	HMA	C_1 = 0.44	5.0 inches	2.200	-
2	ABC	C_2 = 0.11	8.0 inches	0.880	
			SN*=	3.080	2.74

Pavement SN > Required SN, Design is Acceptable

Fig. No. C-3

FLEXIBLE PAVEMENT DESIGN

PROJECT DATA

Project Location REX ROAD AT FALCON REGIONAL PARK

Job Number: 230707

DESIGN DATA

Equivalent (18-kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	1,971,000
Design CBR	CBR =	10
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 =	15,000 psi

Required Structural Number (SN): → SN = 2.74

DESIGN EQUATIONS

Resilient Modulus

If using CBR: M_R = (CBR) x 1,500

If using R-Value: $M_R = 10^{[(S_1 + 18.72) / 6.24]}$ where: S_1 = [(R-value - 5) / 11.29] + 3

Required Structural Number

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

Pavement Section Thickness

$SN^* = C_1D_1 + C_2D_2$ where:

C_1 = Strength Coefficient - Hot Bituminous Asphalt

C_2 = Strength Coefficient - Aggregate Base Course

D_1 = Depth of Asphalt (inches)

D_2 = Depth of Base Course (inches)

RECOMMENED THICKNESSES

Layer	Material	Structural Layer	Thickness (D^*_i)	SN^*_i	SN
1	HMA	C_1 = 0.44	5.0 inches	2.200	-
2	CTS	C_2 = 0.11	10.0 inches	1.100	
			SN*=	3.300	2.74

Pavement SN > Required SN, Design is Acceptable

Fig. No. C-4