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PAVEMENT DESIGN REPORT
FLYING HORSE NORTH, FILING NO. 5
EL PASO COUNTY, COLORADO

PCD File No. SF2427

Prepared for:
Flying Horse North, LLC
2138 Flying Horse Club Drive
Colorado Springs, CO 80921

Attn: Adam Doyle

August 25, 2025

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Lucas J. Morrison
Geotechnical Engineering Staff

Reviewed by:

COLORADO LICENSED
JOSEPH C GOODE III
52381
PROFESSIONAL ENGINEER

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Date: 08/25/25

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El Paso County Department of Pubic Works

LJM:JCG/ed

Entech Job No. 241421

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1 Introduction

Entech Engineering, Inc. (Entech) completed this pavement design for the interior roadways within Flying Horse North, Filing No. 5. This report describes the subsurface exploration program and laboratory testing program conducted for the proposed roadway improvements and provides pavement section alternatives and construction recommendations. Entech participated in this project as a consultant to Flying Horse North, LLC. The contents of this report, including the pavement design recommendations, are subject to the limitations and assumptions presented in Section 7.

2 Project Description

The site is located south of Old Stagecoach Road and west of Black Forest Road within Flying Horse North, Filing No. 5, in El Paso County, Colorado (Figure 1). The proposed improvements include the paving of the entirety of Rough Trail and Sandbagger Drive. The extent of our investigation is shown in Figure 2.

At the time of our subsurface exploration program, the existing roadway was rough-graded. Surrounding properties are comprised of vacant land, land being developed for future rural residential lots, and existing residential properties. Based on the development plans, the roadways are designated as rural local roadways, per the *El Paso County Engineering Criteria Manual (ECM).*

3 Subsurface Explorations and Laboratory Testing

3.1 Subsurface Exploration Program

Subsurface conditions at the project site were explored by seven test borings, designated TB-1 through TB-7, drilled on July 16, 2025. The locations of the test borings are shown on the Site and Exploration Plan (Figure 2). 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 providing the lithologies 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 D1586) using a 2-inch outside diameter split spoon or a 2½-inch modified 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 samples recovered from the borings were visually classified and recorded on the boring logs. The soil classifications were later verified utilizing laboratory testing and grouped by soil type. The soil type numbers are included on the boring logs. It should be understood that the soil descriptions shown on the boring logs may vary between boring locations and sample depths. It should also be noted that the lines of stratigraphic separation shown on the boring logs represent approximate boundaries between soil types, and the actual stratigraphic transitions may be more gradual or variable with location.

3.2 Geotechnical Index and Engineering Property Testing

Water content testing (ASTM D2216) was performed on the samples recovered from the borings, and the results are shown on the boring logs. Grain-size analysis (ASTM D422) and Atterberg limits testing (ASTM D4318) were performed on selected samples to assist in classifying the materials encountered in the borings.

For pavement design, a Modified Proctor (ASTM D1557) and a California Bearing Ratio (CBR) test (ASTM D1883) were completed. 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 presented in Appendix B and summarized in Table B-1.

Compressive strength testing of cement-treated soils was conducted on representative soil samples collected from two borings (TB-5 and TB-1) and is presented and discussed in Section 5.2. A summary of the testing results is attached in Appendix B, Table B-2.

4 Subgrade Conditions

Three primary soil types and one bedrock type were encountered in the test borings drilled for the subsurface investigation. Each soil type was classified in accordance with the Unified Soil Classification System (USCS) and the American Association of State Highway and Transportation Officials (AASHTO) soil classification system using the laboratory testing results and the observations made during drilling.

4.1 Subsurface Conditions

Subsurface conditions along the proposed roadways consisted of medium dense to dense clayey sand fill (Soil Type 1, AASHTO A-2-4, A-4), stiff to very stiff sandy clay to clay with sand fill (Soil

Type 2, AASHTO A-4, A-6) and native medium dense clayey to silty sand to sand with silt (Soil Type 3, AASHTO A-1-b). Extremely weak to very weak sandstone bedrock, or very dense silty sand when classified as a soil (Soil Type 4, AASHTO A-1-b), was also encountered along the proposed roadway.

Laboratory test results are presented in Appendix B and summarized in Table B-1.

4.2 Groundwater

Groundwater was not encountered in the test borings. Groundwater fluctuations are possible and will depend on seasonal variations, local precipitation, runoff, and other factors; however, we do not anticipate groundwater to affect the proposed roadway construction.

5 Pavement Design Recommendations

Pavement design recommendations were made in accordance with the *El Paso County Engineering Criteria Manual (ECM).*

5.1 Subgrade Conditions

California Bearing Ratio (CBR) testing was performed on representative samples of the pavement subgrade, including clayey sand fill (Soil Type 1) and sandy clay fill (Soil Type 2) from boring TB-7 and TB-1, respectively, to determine the support characteristics of the subgrade soils for the roadway section. The results of the CBR testing are presented in Appendix B and summarized in Exhibit 1.

Exhibit 1: Subsurface Laboratory Testing Summary

Design Parameter	Value	
Soil Type	1 – Clayey Sand Fill	2 – Sandy Clay
CBR at 95%	7.5	4.3
Design CBR	7.5	4.3
Liquid Limit	27	28
Plasticity Index	8	7
Percent Passing 200	34.1	69.9
AASHTO Classification	A-2-4	A-4
Group Index	0	3
Unified Soils Classification	SC	CL

Notes:
Soil Type 1 was used for pavement design.

5.2 Cement-Treated Subgrade Design

Strength testing for the site subgrade soils was performed on a set of soil-cement samples from TB-5 (Soil Type 1) and TB-1 (Soil Type 2). Testing was performed on soil-cement samples prepared with 2% and 4% Portland Cement Type 1L. A compression strength of 125 pounds per square inch (psi) is recommended for cement-stabilized subgrade. The results of the strength testing, Modified Proctor (ASTM D1557), and Standard Proctor (ASTM D698) maximum dry density are presented in Appendix B and summarized in Exhibit 2. A **2% mix is recommended** for Soil Type 1 and Soil Type 2 based on the laboratory test results.

Exhibit 2: Subsurface Laboratory Testing Summary

Design Parameter	Value	
Soil Type	1 – Clayey Sand	2 – Sandy Clay
Design CBR	4.3	4.3
Average CTS Compressive Strength at 2% Mix (psi)	354	189
Average CTS Compressive Strength at 4% Mix (psi)	430	354
Optimum Moisture Content (%)	7.1	14.2
Maximum Dry Density (pcf)	130.1	108.9

The amount of cement applied shall be a minimum of 2% (by weight) of the subgrade's maximum dry density as determined by the Modified Proctor (ASTM D1557) for granular soils or by the Standard Proctor (ASTM D698) for cohesive soils.

5.3 Swell Mitigation

El Paso County requires swell mitigation for soils with swell testing results greater than 2% under a 150-pound-per-square-foot (psf) surcharge. Based on the subgrade soils classification and swell testing, mitigation for expansive soils will not be required for the majority of this site. For Sandbagger Drive, swelling soils were encountered in boring TB-4. To mitigate for swell, we recommend moisture conditioning the subgrade soils to a depth of 2 feet within 0% to 3% of the optimum moisture content.

5.4 Traffic Loading

Traffic data is not available for the future interior roads in the Flying Horse North, Filing No. 5 subdivision; however, the roads are classified as rural local roadways based on current development plans. The *El Paso County Engineering Criteria Manual* provides default 18-kip equivalent single axle loadings (ESAL) based on the street classification. For design, a default ESAL value of 36,500 was used for the local rural road designation.

5.5 Pavement Design

The pavement sections were determined utilizing the *El Paso County Engineering Criteria Manual*, the CBR testing, and default ESALs. Design parameters used in the pavement analysis are presented in Exhibit 3.

Exhibit 3: Pavement Design Parameters

Design Parameter	Value
Reliability	75%
Standard Deviation	0.45
Serviceability Loss (Δ psi)	2.5
Design CBR	4.3
Resilient Modulus	6,450 psi
Structural Coefficients	
Hot Bituminous Pavement	0.44
Aggregate Base Course	0.11
Recycled Concrete Base	0.11
Cement Stabilized Subgrade	0.11

Pavement section alternatives recommended for the roadways included in this phase filing are summarized in Exhibit 4. The pavement design calculations are presented in Appendix C.

Exhibit 4: Recommended Pavement Sections

Pavement Area	Design ESAL	Alternative [1]
Rough Trail, Sandbagger Drive	36,500	1. 4.0 inches HMA over 8.0 inches CTS
		2. 4.0 inches HMA over 4.0 inches ABC/RCB

ABC = Aggregate Base Course; ESAL = Equivalent Single Axle Loads; HMA = Hot Mix Asphalt; CTS = Cement-Treated Soil; RCB = Recycled Concrete Base

Notes:

1. The use of CTS will require a deviation request approval.

6 Construction Recommendations

Pavement design recommendations provided herein are contingent on good construction practices, and poor construction techniques may result in poor performance. Our analyses assumed that this project will be constructed according to the *El Paso County Engineering Criteria Manual* and the *Pikes Peak Region Asphalt Paving Specifications*.

6.1 Earthwork Recommendations for Pavement Subgrade

Proper subgrade preparation is required for adequate pavement performance. Paving areas should be cleared of all deleterious materials, including but not limited to existing pavements, utility poles, and fence poles. Surface vegetation should be removed by stripping, with the depth to be field-determined. Isolated pockets of expansive soils, such as those encountered in boring TB-4, should be moisture conditioned to a depth of 2 feet within +/- 2% of the optimum water content, and recompacted to 95% of the Modified Proctor (ASTM 1557) maximum dry density. Additionally, loose soils should be overexcavated to underlying dense and unyielding subgrade. Granular soils can be replaced in accordance with Section 6.1.3.

We do not anticipate issues with the subgrade in regard to shallow water, frost-susceptible soils, groundwater or drainage conditions, or cold weather construction.

6.1.1 Subgrade Preparation – Unbound Base Alternatives

If pavement section alternatives are selected utilizing aggregate base course (ABC) or Recycled Concrete Base (RCB), the final subgrade surface should be scarified to a depth of 8 inches, moisture conditioned within +/- 2% of the optimum water content, and recompacted to 95% of the Modified Proctor (ASTM 1557) maximum dry density.

The compacted surface below pavements should be proof rolled with a fully loaded, tandem-axle, 10-yard dump truck or equivalent. Any areas that are delineated to be soft, loose, or yielding during proof rolling should be removed and reconditioned, or replaced.

6.1.2 Subgrade Preparation – Cement-Treated Subgrade

If pavement section alternatives utilizing CTS are selected, a preliminary proof roll should be completed with a fully loaded, tandem-axle, 10-yard dump truck or equivalent prior to placement of cement stabilization. Any areas that are delineated to be soft, loose, or yielding during proof rolling should be removed and reconditioned, or replaced. Following the preliminary proof roll, the subgrade shall be stabilized by the addition of cement. The amount of cement applied shall be in accordance with Section 5.2. The cement should be spread evenly on the subgrade surface and thoroughly mixed into the subgrade such that a uniform blend of soil and cement is achieved to the CTS design depth. Compaction of the cement-stabilized subgrade should be completed to obtain at least 95% of the subgrade's maximum dry density as determined by the Modified Proctor (ASTM D1557) or by the Standard Proctor (ASTM D698). 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 1L 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 degrees F. Cement-treated subgrades should be maintained at a temperature of 40 degrees 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 Entech Engineering. Testing should include in-situ compaction tests and representative compacted specimens of the treated subgrade material for subsequent laboratory quality assurance testing.
- A minimum 7-day CTS compressive strength of 125 psi must be achieved.
- Soil strengths in excess of 200 psi will require microfracturing. Microfracturing will be performed with the same (or equivalent tonnage) steel drum vibratory roller used for compaction of the CTS. A roller with a minimum capacity of 12 tons shall be used. Three full passes with the roller operating at maximum amplitude and traveling at 2 to 3 miles per hour shall be applied. If the treated material breaks up excessively at the surface, the vibration amplitude shall be decreased or eliminated.

6.1.3 Fill Placement and Compaction

Granular fill placed as part of the pavement subgrade shall consist of nonexpansive, granular soil, free of organic matter, unsuitable materials, debris, and cobbles greater than 3 inches in diameter. Additionally, any granular fill placed as part of the roadway subgrade should have a minimum CBR of 5. All granular fill placed within the pavement subgrade should be compacted to a minimum of 95% of the Modified Proctor (ASTM D1557) maximum dry density at +/-2% of optimum moisture content. Fill material should be placed in horizontal lifts such that each finished lift has a compacted thickness of 6 inches or less. Entech should approve any imported fill to be used within the pavement subgrade area prior to delivery to the site.

6.1.4 Aggregate Base Course and Recycled Concrete Base

ABC or RCB materials shall conform to the *El Paso County Standard Specifications Manual*, Table D-6 Aggregate Base Course. ABC or RCB materials should be compacted to a minimum

of 95% of the Modified Proctor (ASTM D1557) maximum dry density within +/-2% of optimum moisture content.

6.2 Concrete Degradation Due to Sulfate Attack

Sulfate solubility testing was conducted on several samples recovered from the test borings to evaluate the potential for sulfate attack on concrete. The test results indicated less than 0.01% soluble sulfate (by weight). The test results indicate the sulfate component of the in-place soils presents a negligible exposure threat to concrete placed below the site grade.

Type 1L cement is recommended for concrete on the site. To further avoid concrete degradation during construction, it is recommended that concrete not be placed on frozen or wet ground. Care should be taken to prevent the accumulation or ponding of water in the concrete placement areas. If concrete is placed during periods of cold temperatures, the concrete must be kept from freezing. This may require covering the concrete with insulated blankets and adding heat to prohibit freezing.

As presented in the *Evaluation of Selected Pavement Specifications and Responses to Questions Relevant to Design and Construction of Cement-Treated Soil and Aggregate Layers in El Paso County, Colorado* report from Spencer Gutherie and Robert Stevens dated March 13, 2024, soils with less than 3,000 ppm (0.3%) do not require special construction practices.

6.3 Construction Observation

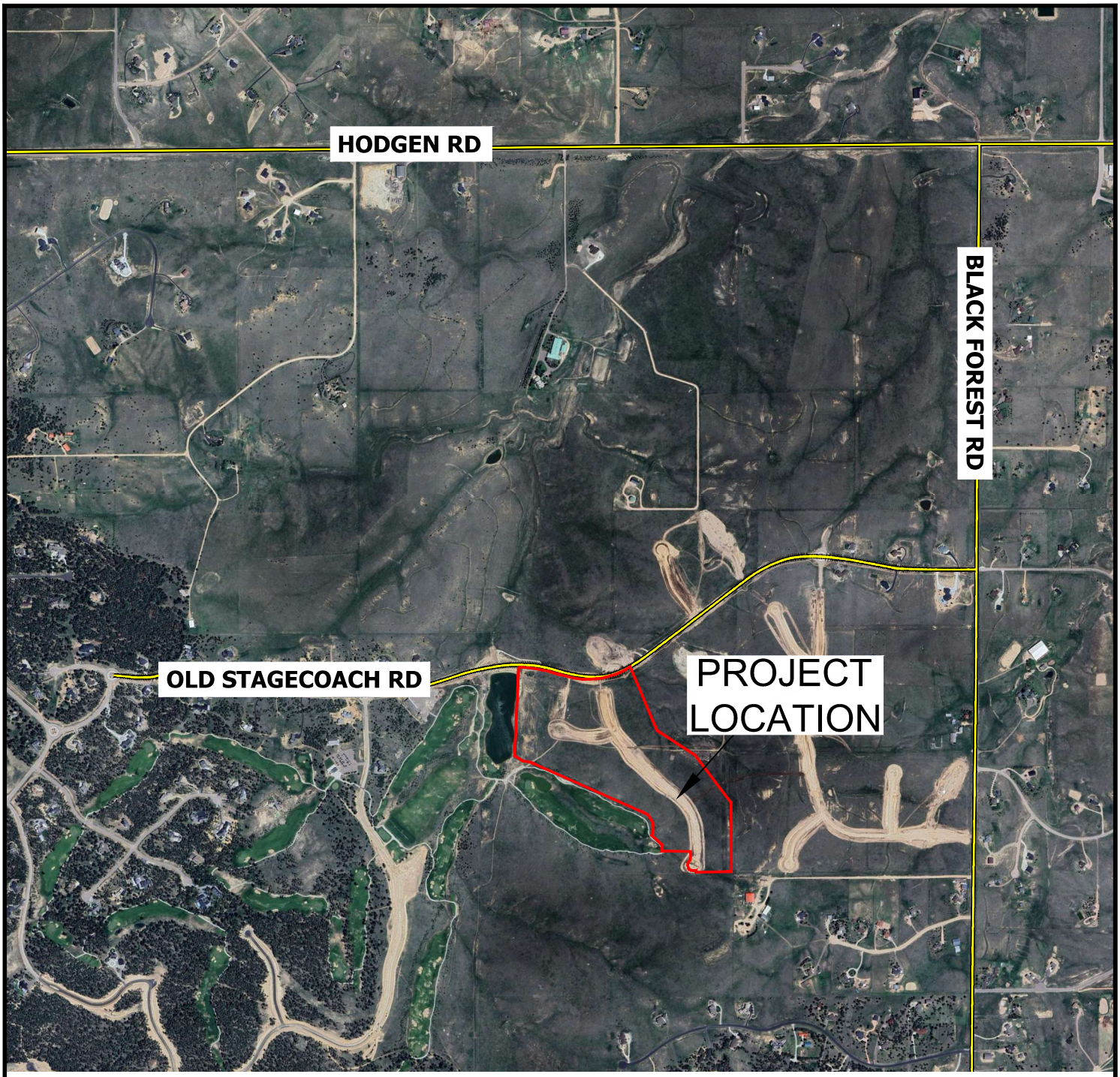
Subgrade preparation for pavement should be observed by Entech in order to verify that (1) no anomalies are present, (2) materials similar to those described in this report have been encountered or placed, and (3) no soft spots, expansive or organic soil, or debris are present in the pavement subgrade prior to paving.

7 Closure

The subsurface investigation, geotechnical evaluation, and recommendations presented in this report are intended for use by Flying Horse North, LLC, with application to the paving of the Flying Horse North, Filing No. 5 project in El Paso County, Colorado. In conducting the subsurface investigation, laboratory testing, engineering evaluation, and reporting, Entech Engineering, Inc. endeavored to work in accordance with generally accepted professional geotechnical and geologic practices and principles consistent with the level of care and skill ordinarily exercised by

members of the geotechnical profession currently practicing in the same locality and under similar conditions. No other warranty, expressed or implied, is made. During final design and/or construction, if conditions are encountered that appear different from those described in this report, Entech Engineering, Inc. requests to be notified so that the evaluation and recommendations presented herein can be reviewed and modified as appropriate.

If there are any questions regarding the information provided herein, or if Entech Engineering, Inc. can be of further assistance, please do not hesitate to contact us.



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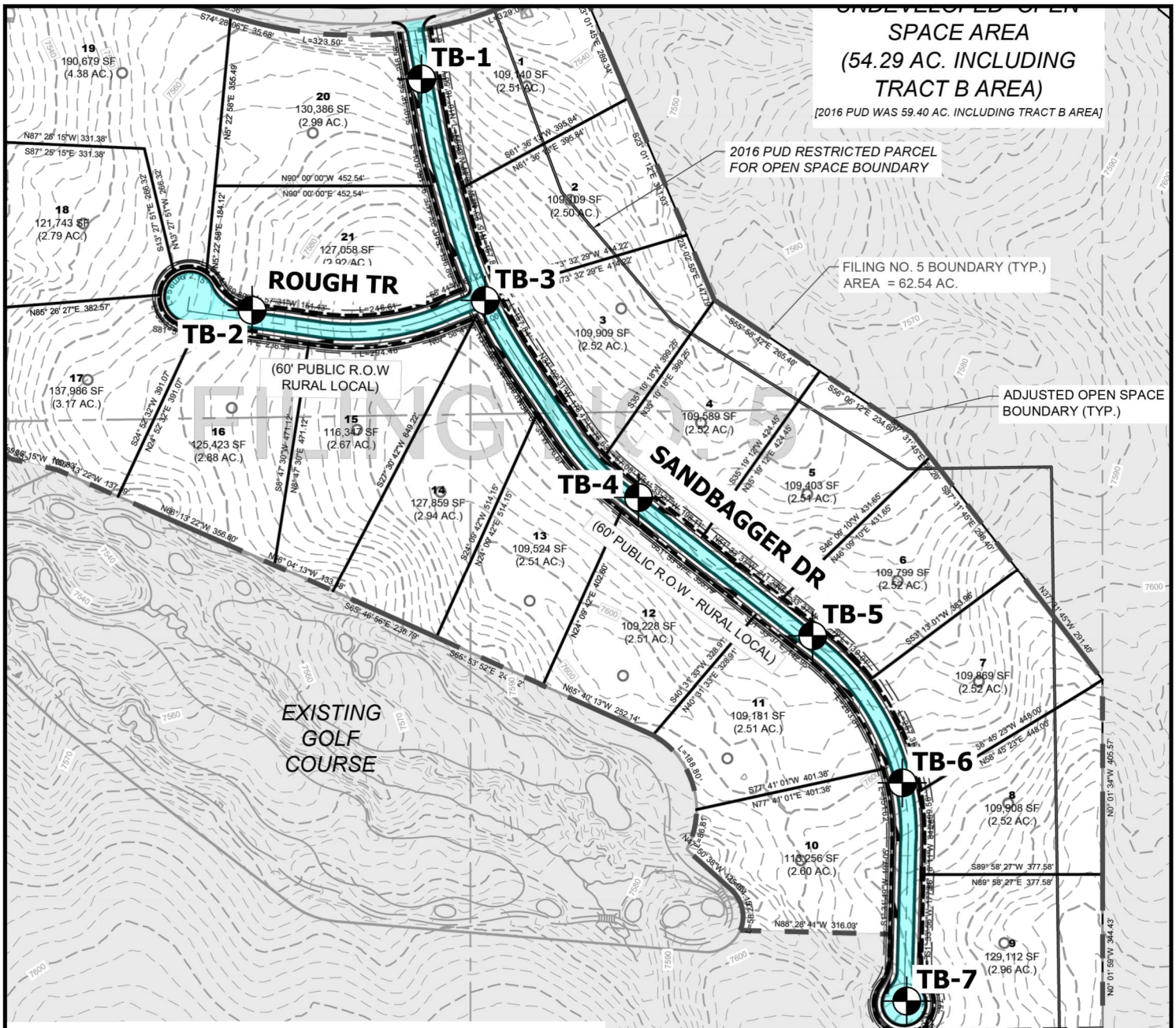
ENTECH ENGINEERING, INC.

VICINITY MAP

FLYING HORSE NORTH, F5
FLYING HORSE NORTH, LLC

JOB NO. 241421

FIG. 1



1. Sandbagger Drive & Rough Trail
Rural Local Residential
Design 18-KIP ESAL=36,500
Pavement Section:
4" HMA Over 8" CTS

- ROADWAYS INCLUDED WITH THIS INVESTIGATION

TB- APPROXIMATE TEST BORING LOCATION AND NUMBER

SCALE: 0 50 100

N

ENTECH ENGINEERING, INC.

SITE AND EXPLORATION PLAN

FLYING HORSE NORTH, F5
FLYING HORSE NORTH, LLC

JOB NO. 241421

FIG. 2

APPENDIX A: Test Boring Logs

TEST BORING 1
DATE DRILLED 7/16/2025

REMARKS

DRY TO 5', 7/16/25

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-4', CLAY, SANDY, BROWN, STIFF, MOIST			10	13.0	2
CLAY, WITH SAND, BROWN, MEDIUM DENSE, MOIST			13	3.1	3
5					
10					
15					
20					

TEST BORING 2
DATE DRILLED 7/16/2025

REMARKS

DRY TO 5', 7/16/25

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-5', CLAY, SANDY, BROWN, VERY STIFF, MOIST			25	8.1	2
			21	9.8	2
5					
10					
15					
20					

ENTECH ENGINEERING, INC.

TEST BORING LOGS

FLYING HORSE NORTH, FILING NO. 5
FLYING HORSE NORTH, LLC

JOB NO. 241421

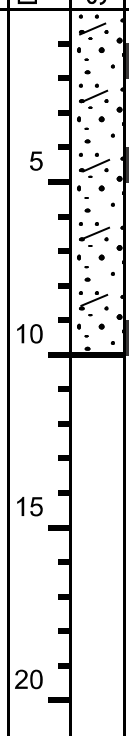
FIG. A-1

TEST BORING 3
DATE DRILLED 7/16/2025

REMARKS

DRY TO 10', 7/16/25

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL, SAND, CLAYEY, BROWN, MEDIUM DENSE, MOIST			29	4.8	1
5			26	6.3	1
10			23	5.7	1
15					
20					

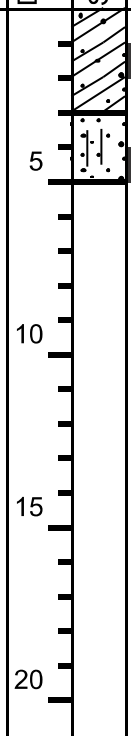


TEST BORING 4
DATE DRILLED 7/16/2025

REMARKS

DRY TO 5', 7/16/25

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-3', CLAY, WITH SAND, BROWN, VERY STIFF, MOIST			23	10.1	2
SAND, SILTY, BROWN, MEDIUM DENSE, MOIST			27	6.4	3
5					
10					
15					
20					



ENTECH ENGINEERING, INC.

TEST BORING LOGS

FLYING HORSE NORTH, FILING NO. 5
FLYING HORSE NORTH, LLC

JOB NO. 241421

FIG. A-2

TEST BORING 5
DATE DRILLED 7/16/2025

REMARKS

DRY TO 5', 7/16/25

SAND, SILTY, BROWN, MEDIUM DENSE to DENSE, MOIST

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			27	7.2	3
5			34	11.4	3
10					
15					
20					

TEST BORING 6
DATE DRILLED 7/16/2025

REMARKS

DRY TO 5', 7/16/25

FILL 0-2', SAND, CLAYEY, BROWN, MEDIUM DENSE, MOIST

SAND, CLAYEY, BROWN, DENSE, MOIST (SANDSTONE, EXTREMELY WEAK, HIGHLY WEATHERED)

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			36	8.7	1
5			42	7.5	3
10					
15					
20					

ENTECH ENGINEERING, INC.

TEST BORING LOGS

FLYING HORSE NORTH, FILING NO. 5
FLYING HORSE NORTH, LLC

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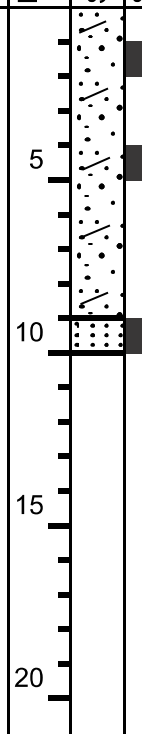
FIG. A-3

TEST BORING 7
DATE DRILLED 7/16/2025

REMARKS

DRY TO 10', 7/16/25



	Blows per foot	Watercontent %	Soil Type
FILL 0-9', SAND, CLAYEY, BROWN, DENSE to MEDIUM DENSE, MOIST	34	3.5	1
	18	12.5	1
SANDSTONE, VERY WEAK, BROWN, HIGHLY WEATHERED (SAND, SILTY, VERY DENSE, MOIST)	50/11"	8.0	4

ENTECH ENGINEERING, INC.

TEST BORING LOGS

FLYING HORSE NORTH, FILING NO. 5
FLYING HORSE NORTH, LLC

JOB NO. 241421

FIG. A-4

APPENDIX B: Laboratory Test Results

TABLE B-1
SUMMARY OF LABORATORY TEST RESULTS

ENTECH ENGINEERING, INC.

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	SULFATE (WT %)	SWELL/ COLLAPSE (%)	AASHTO CLASS. (GROUP INDEX)	USCS	SOIL DESCRIPTION
1, CBR #1	7	0-3	6.5		34.1	27	20	7			A-2-4 (0)	SC	FILL, SAND, CLAYEY
1	3	1-2	5.3		37.7	22	14	8			A-4 (0)	CL	FILL, SAND, CLAYEY
1	6	1-2	8.3		19.6	24	16	8			A-2-4 (0)	SC	FILL, SAND, CLAYEY
1	7	1-2	4.4		30.0	26	19	7			A-2-4 (0)	SC	FILL, SAND, CLAYEY
2, CBR #2	1	0-3	12.3		69.9	28	21	7			A-4 (3)	CL	FILL, CLAY, SANDY
2	4	0-3	9.6		54.5	28	20	8			A-4 (2)	SC	FILL, CLAY, SANDY
2	1	1-2	16.8	109.3	62.8	26	19	7	<0.01	0.4	A-4 (2)	CL	FILL, CLAY, SANDY
2	2	1-2	9.2	103.3	65.5	30	18	12		0.7	A-6 (5)	CL	FILL, CLAY, SANDY
2	4	1-2	10.4	113.6	72.2	28	20	8		2.6	A-4 (4)	CL	FILL, CLAY, WITH SAND
3	5	1-2	7.8		12.5	NV	NP	NP	0.00		A-1-b (0)	SM	SAND, SILTY
3	1	5	3.0		6.3	21	13	8	<0.01		A-1-b (0)	SW-SC	SAND, WITH CLAY
4	7	10	8.1		16.5	23	21	2	0.00		A-1-b (0)	SM	SANDSTONE (SAND, SILTY)

Project: Flying Horse North, Filing No. 5
Client: Flying Horse North, LLC
Job No: 241421

ENTECH ENGINEERING, INC.

TABLE B-2

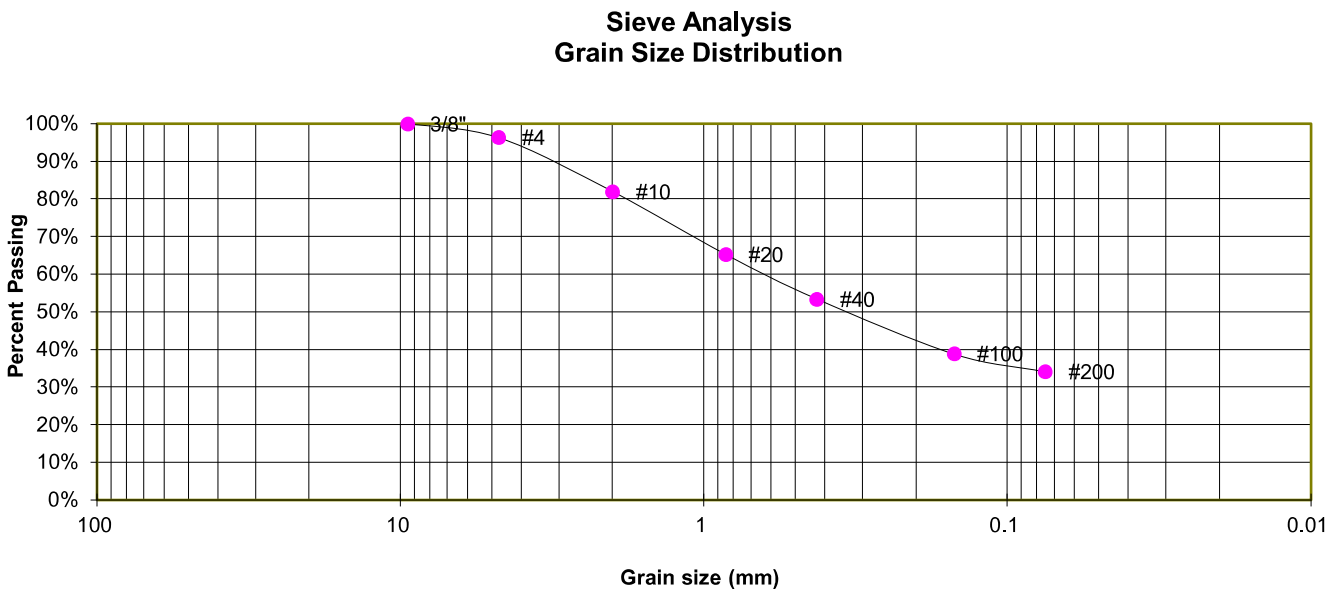
SUMMARY OF CTS TEST RESULTS

FIELD SAMPLE ID	*SOIL ADDITIVE*	*ADDITIVE PERCENTAGE (%)*	*WATER CONTENT (%)*	*DENSITY (dry)*	*AGE (days)*	*STRENGTH (psi)*
TB-5 @ 0-3'	TYPE IL CEMENT	2	7.1	123.1	4	324
				123.1		310
				123.2		430
					AVERAGE:	**354**
TB-5 @ 0-3'	TYPE IL CEMENT	4	7.1	123.1	4	430
				123.1		430
				123.1		430
					AVERAGE:	**430**
TB-1 @ 0-3'	TYPE IL CEMENT	2	14.2	103.3	4	158
				103.0		168
				103.1		243
					AVERAGE:	**189**
TB-1 @ 0-3'	TYPE IL CEMENT	4	14.2	102.9	4	329
				102.6		375
				103.1		357
					AVERAGE:	**354**

Notes:

1. CURING METHOD: 100° HUMIDIFIED OVEN

TEST BORING	7	SOIL DESCRIPTION	FILL, SAND, CLAYEY
DEPTH (FT)	0-3	SOIL TYPE	1, CBR #1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.4%
10	82.0%
20	65.3%
40	53.4%
100	38.8%
200	34.1%

ATTERBERG LIMITS

Plastic Limit	20
Liquid Limit	27
Plastic Index	7

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SC
AASHTO CLASSIFICATION:	A-2-4
AASHTO GROUP INDEX:	0

ENTECH ENGINEERING, INC.

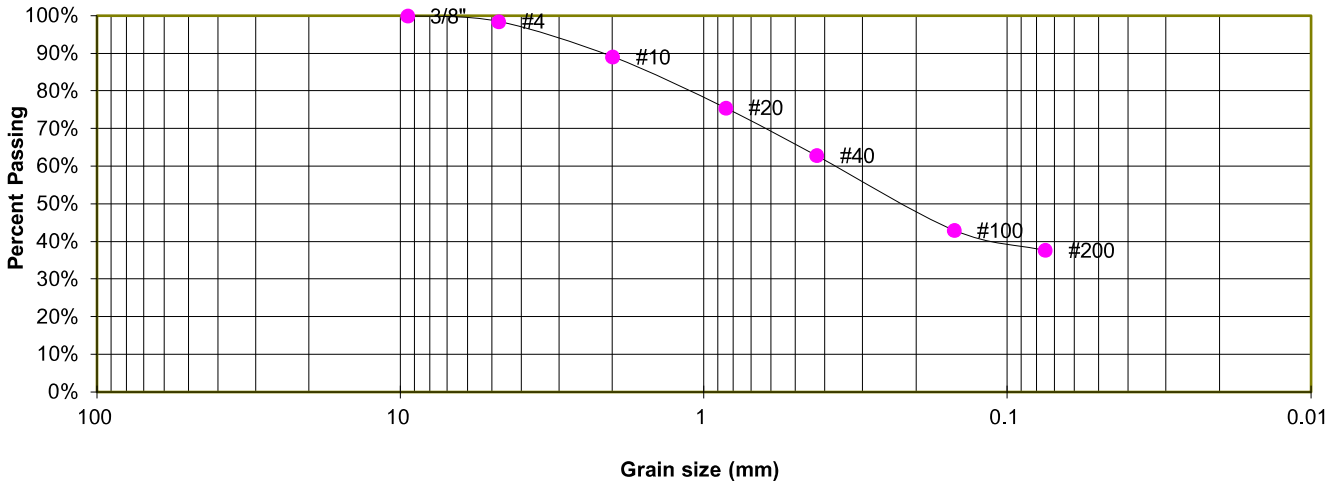
LABORATORY TEST RESULTS

FLYING HORSE NORTH, FILING NO. 5
FLYING HORSE NORTH, LLC

JOB NO. 241421

FIG. B-1

TEST BORING	3	SOIL DESCRIPTION	FILL, SAND, CLAYEY
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	98.5%
10	89.1%
20	75.6%
40	62.8%
100	43.0%
200	37.7%

ATTERBERG LIMITS

Plastic Limit	14
Liquid Limit	22
Plastic Index	8

SOIL CLASSIFICATION

USCS CLASSIFICATION:	CL
AASHTO CLASSIFICATION:	A-4
AASHTO GROUP INDEX:	0

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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FLYING HORSE NORTH, LLC

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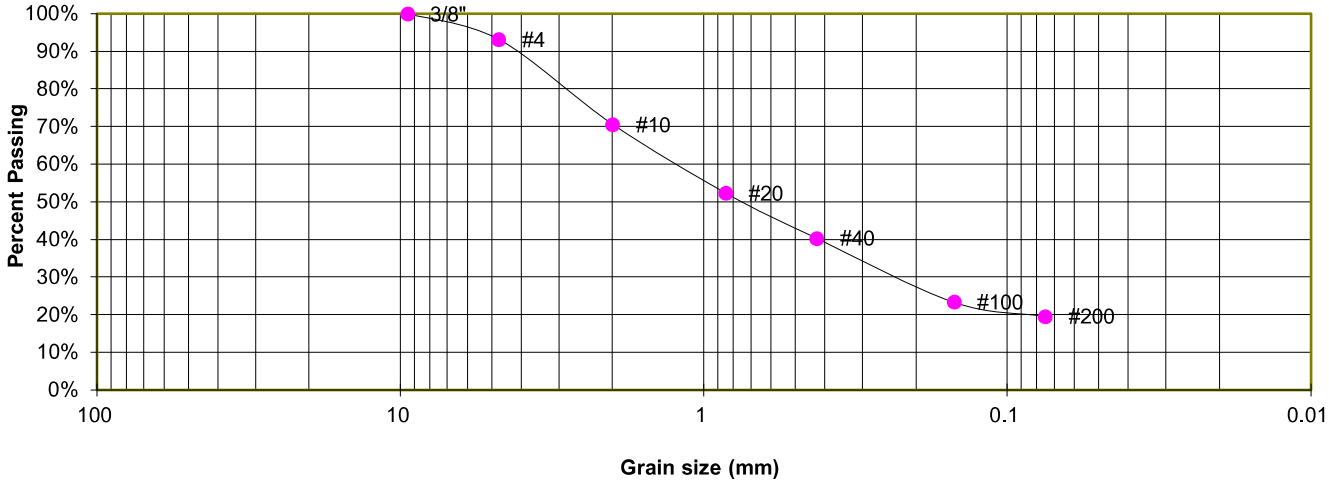
FIG. B-2

TEST BORING	6	SOIL DESCRIPTION	FILL, SAND, CLAYEY
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	93.2%
10	70.6%
20	52.4%
40	40.3%
100	23.4%
200	19.6%

ATTERBERG LIMITS

Plastic Limit	16
Liquid Limit	24
Plastic Index	8

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SC
AASHTO CLASSIFICATION:	A-2-4
AASHTO GROUP INDEX:	0

ENTECH ENGINEERING, INC.

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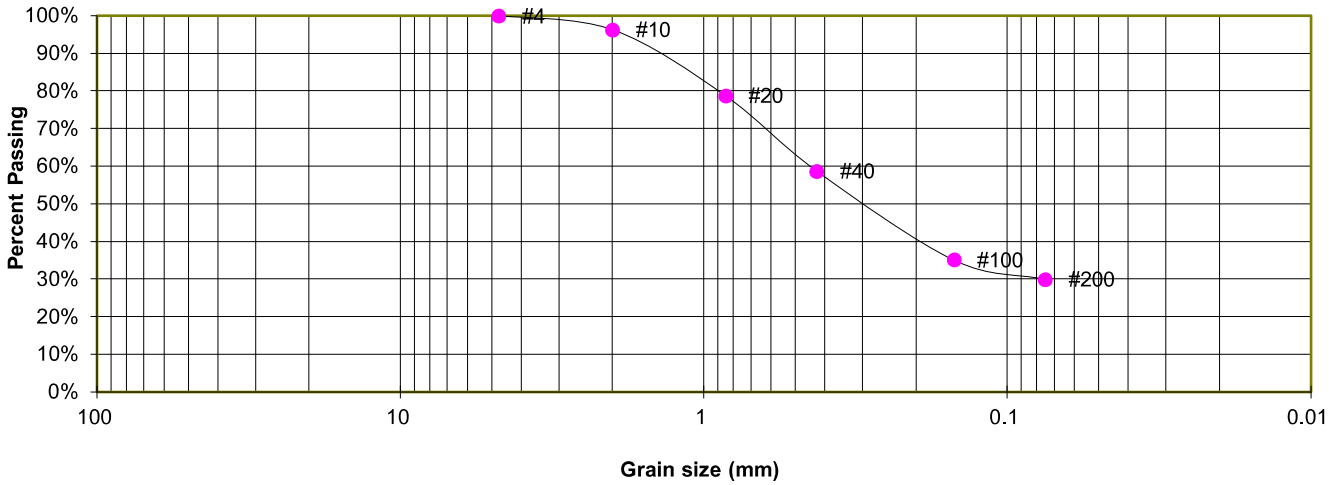
FIG. B-3

TEST BORING	7	SOIL DESCRIPTION	FILL, SAND, CLAYEY
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"	
4	100.0%
10	96.3%
20	78.8%
40	58.7%
100	35.1%
200	30.0%

ATTERBERG LIMITS

Plastic Limit	19
Liquid Limit	26
Plastic Index	7

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SC
AASHTO CLASSIFICATION:	A-2-4
AASHTO GROUP INDEX:	0

ENTECH ENGINEERING, INC.

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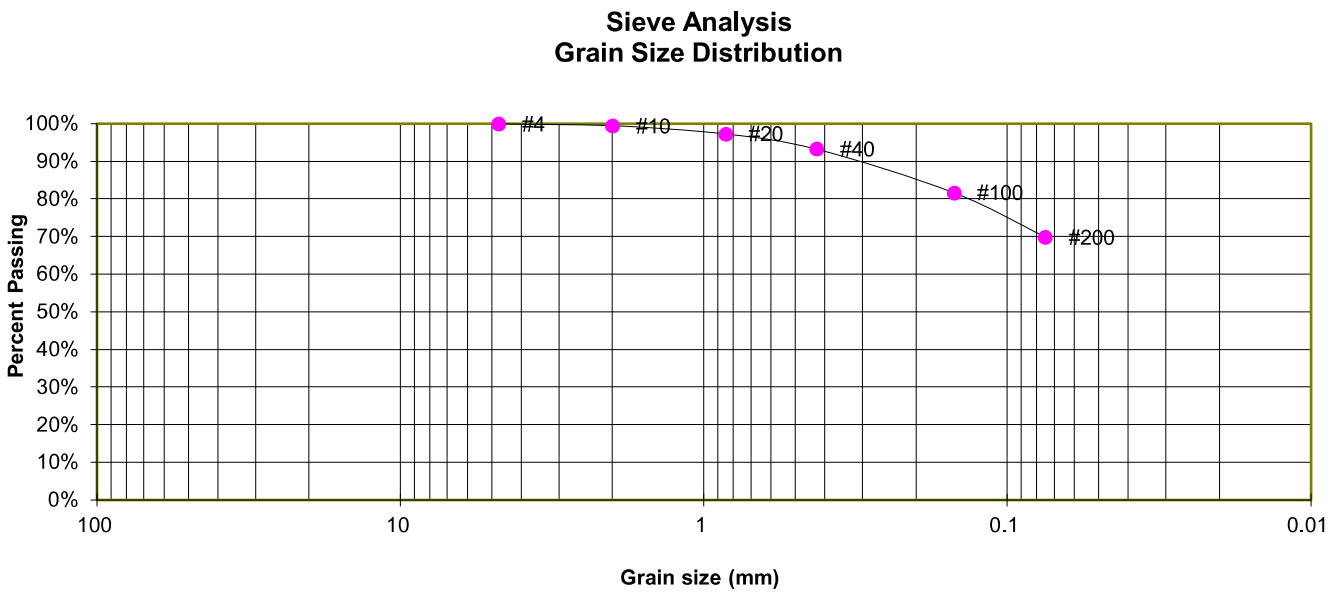
FIG. B-4

TEST BORING	1	SOIL DESCRIPTION	FILL, CLAY, SANDY
DEPTH (FT)	0-3	SOIL TYPE	2, CBR #2



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.5%
20	97.3%
40	93.3%
100	81.7%
200	69.9%

ATTERBERG LIMITS

Plastic Limit	21
Liquid Limit	28
Plastic Index	7

SOIL CLASSIFICATION

USCS CLASSIFICATION:	CL
AASHTO CLASSIFICATION:	A-4
AASHTO GROUP INDEX:	3

ENTECH ENGINEERING, INC.

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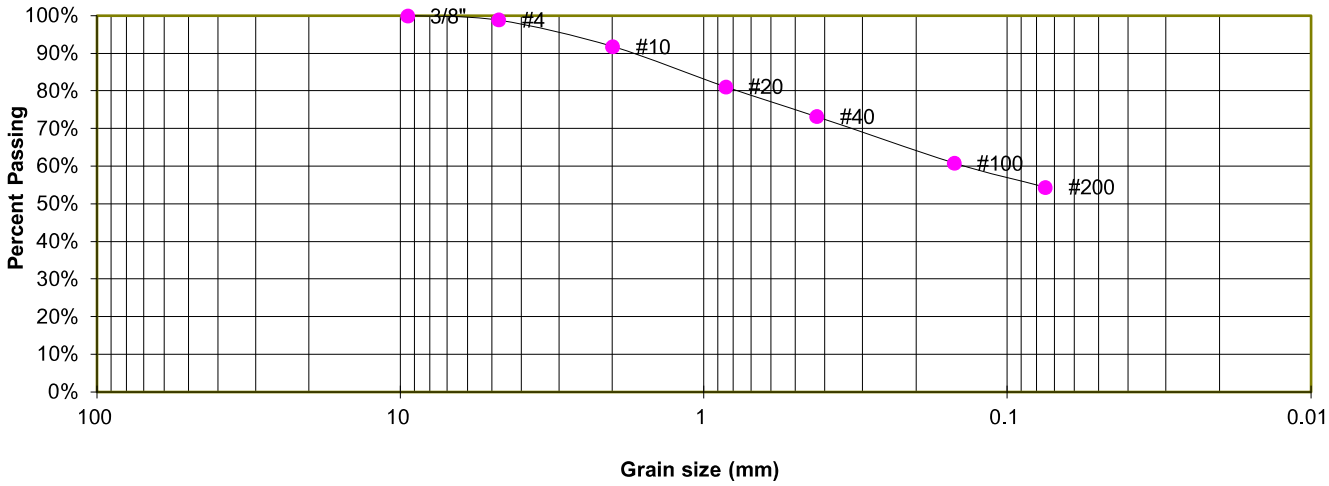
FIG. B-5

TEST BORING	4	SOIL DESCRIPTION	FILL, CLAY, SANDY
DEPTH (FT)	0-3	SOIL TYPE	2



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.9%
10	91.8%
20	81.2%
40	73.3%
100	60.9%
200	54.5%

ATTERBERG LIMITS

Plastic Limit	20
Liquid Limit	28
Plastic Index	8

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SC
AASHTO CLASSIFICATION:	A-4
AASHTO GROUP INDEX:	2

ENTECH ENGINEERING, INC.

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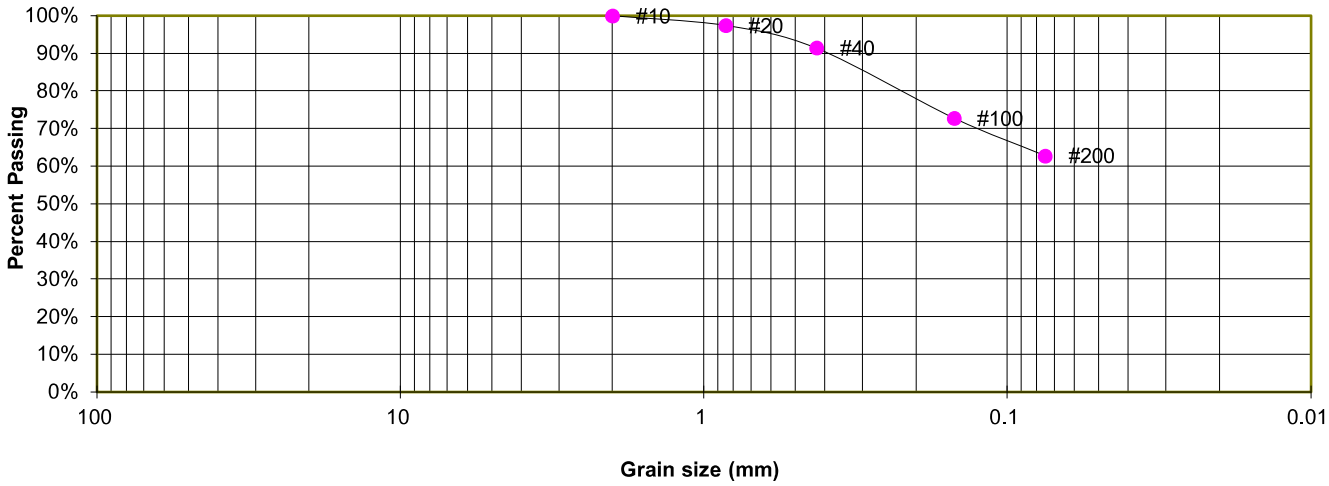
FIG. B-6

TEST BORING	1	SOIL DESCRIPTION	FILL, CLAY, SANDY
DEPTH (FT)	1-2	SOIL TYPE	2



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	97.4%
40	91.4%
100	72.8%
200	62.8%

ATTERBERG LIMITS

Plastic Limit	19
Liquid Limit	26
Plastic Index	7

SOIL CLASSIFICATION

USCS CLASSIFICATION:	CL
AASHTO CLASSIFICATION:	A-4
AASHTO GROUP INDEX:	2

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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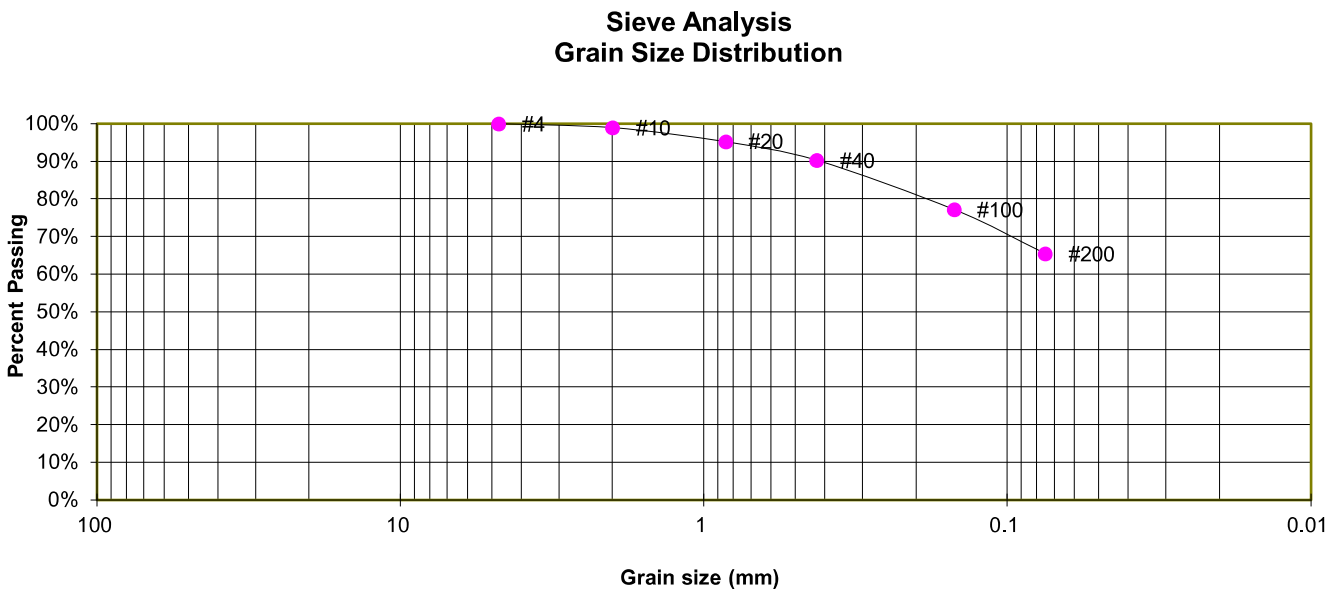
FIG. B-7

TEST BORING	2	SOIL DESCRIPTION	FILL, CLAY, SANDY
DEPTH (FT)	1-2	SOIL TYPE	2



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.0%
20	95.3%
40	90.3%
100	77.2%
200	65.5%

ATTERBERG LIMITS

Plastic Limit	18
Liquid Limit	30
Plastic Index	12

SOIL CLASSIFICATION

USCS CLASSIFICATION:	CL
AASHTO CLASSIFICATION:	A-6
AASHTO GROUP INDEX:	5

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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FLYING HORSE NORTH, LLC

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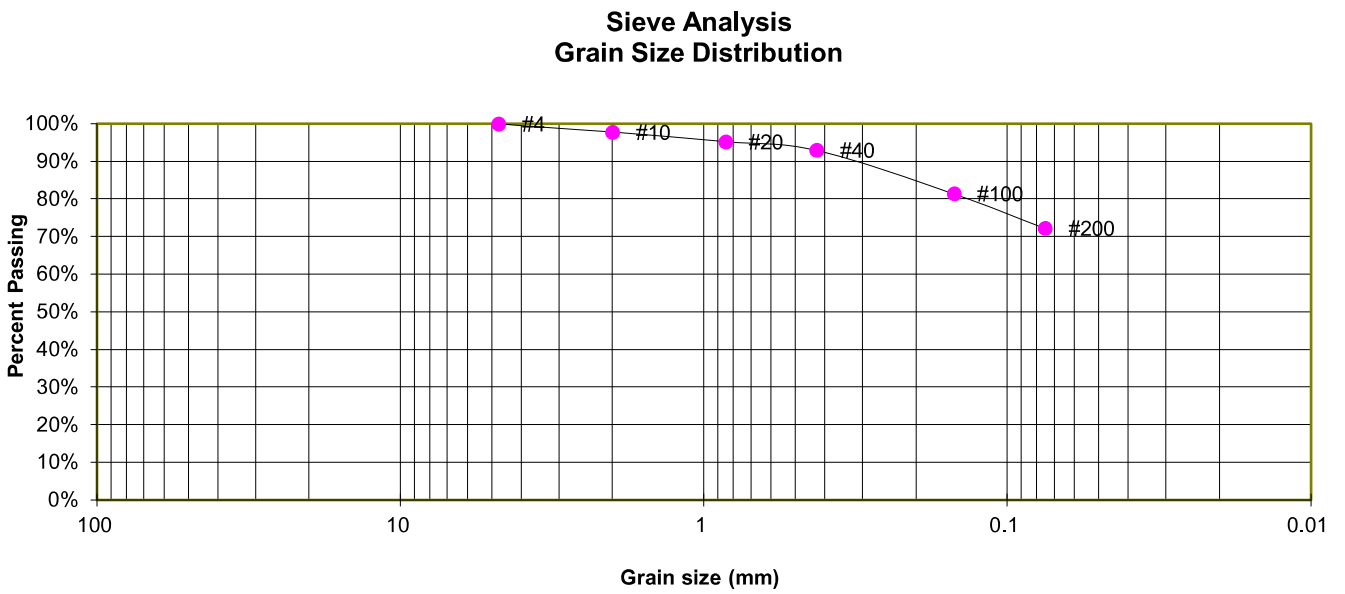
FIG. B-8

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



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	97.8%
20	95.3%
40	92.9%
100	81.4%
200	72.2%

ATTERBERG LIMITS

Plastic Limit	20
Liquid Limit	28
Plastic Index	8

SOIL CLASSIFICATION

USCS CLASSIFICATION:	CL
AASHTO CLASSIFICATION:	A-4
AASHTO GROUP INDEX:	4

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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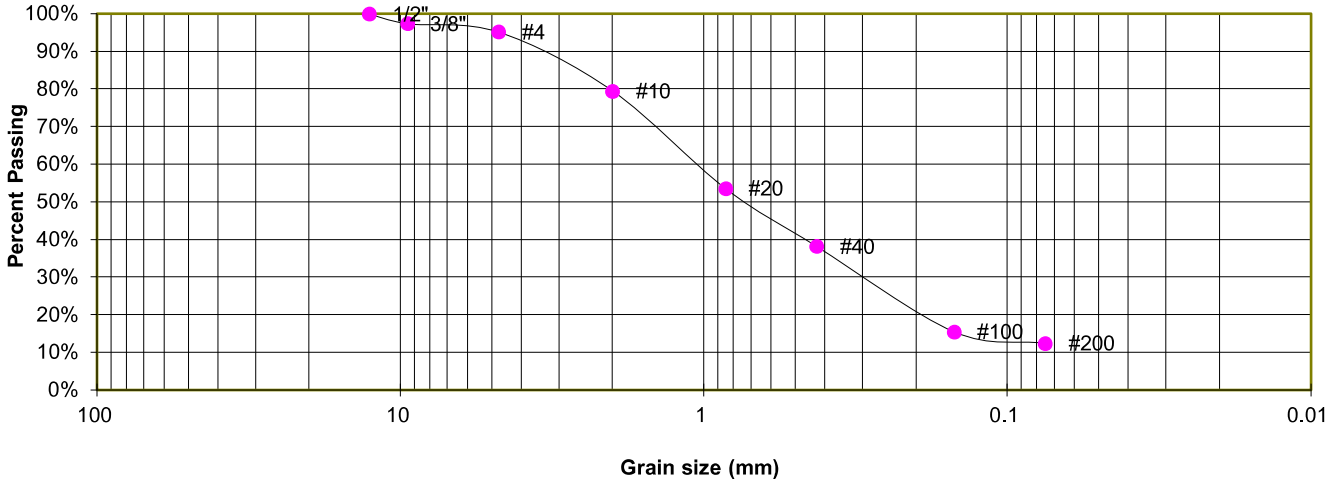
FIG. B-9

TEST BORING	5	SOIL DESCRIPTION	SAND, SILTY
DEPTH (FT)	1-2	SOIL TYPE	3



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.4%
4	95.2%
10	79.5%
20	53.6%
40	38.2%
100	15.5%
200	12.5%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SM
AASHTO CLASSIFICATION:	A-1-b
AASHTO GROUP INDEX:	0

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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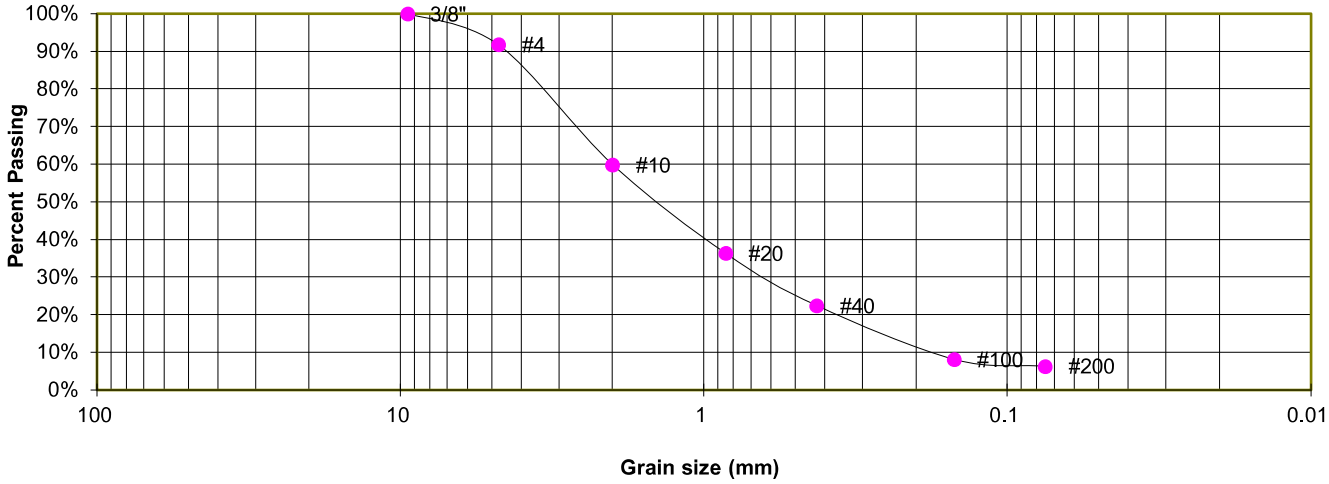
FIG. B-10

TEST BORING	1	SOIL DESCRIPTION	SAND, WITH CLAY
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	91.8%
10	59.9%
20	36.4%
40	22.4%
100	8.2%
200	6.3%

ATTERBERG LIMITS

Plastic Limit	13
Liquid Limit	21
Plastic Index	8

SOIL CLASSIFICATION

USCS CLASSIFICATION: SW-SC
AASHTO CLASSIFICATION: A-1-b
AASHTO GROUP INDEX: 0

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LABORATORY TEST RESULTS

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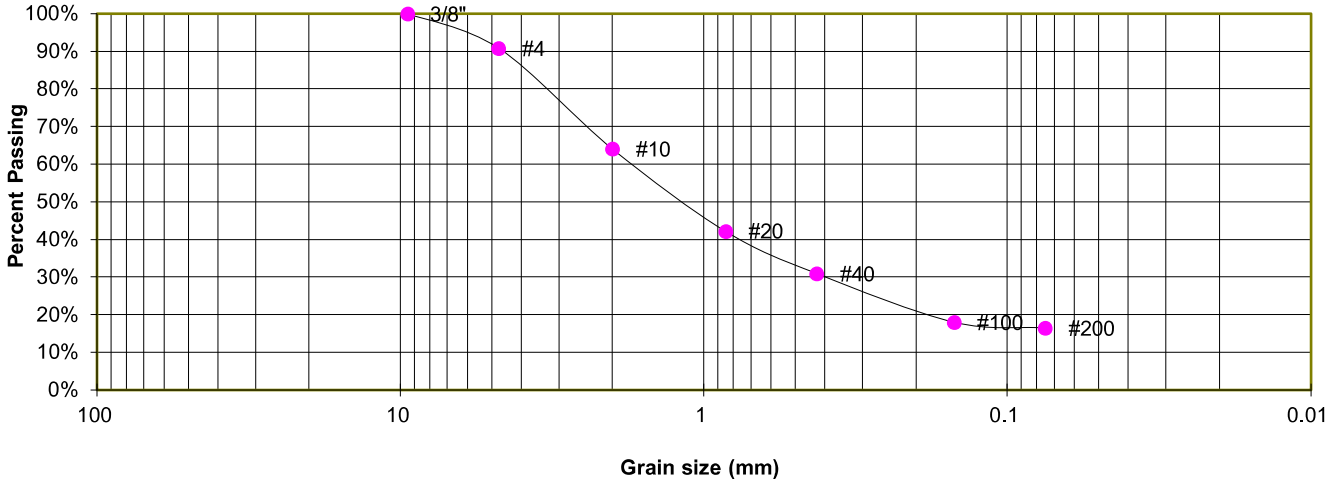
FIG. B-11

TEST BORING	7	SOIL DESCRIPTION	SANDSTONE (SAND, SILTY)
DEPTH (FT)	10	SOIL TYPE	4



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	90.8%
10	64.1%
20	42.2%
40	31.0%
100	18.1%
200	16.5%

ATTERBERG LIMITS

Plastic Limit	21
Liquid Limit	23
Plastic Index	2

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SM
AASHTO CLASSIFICATION:	A-1-b
AASHTO GROUP INDEX:	0

ENTECH ENGINEERING, INC.

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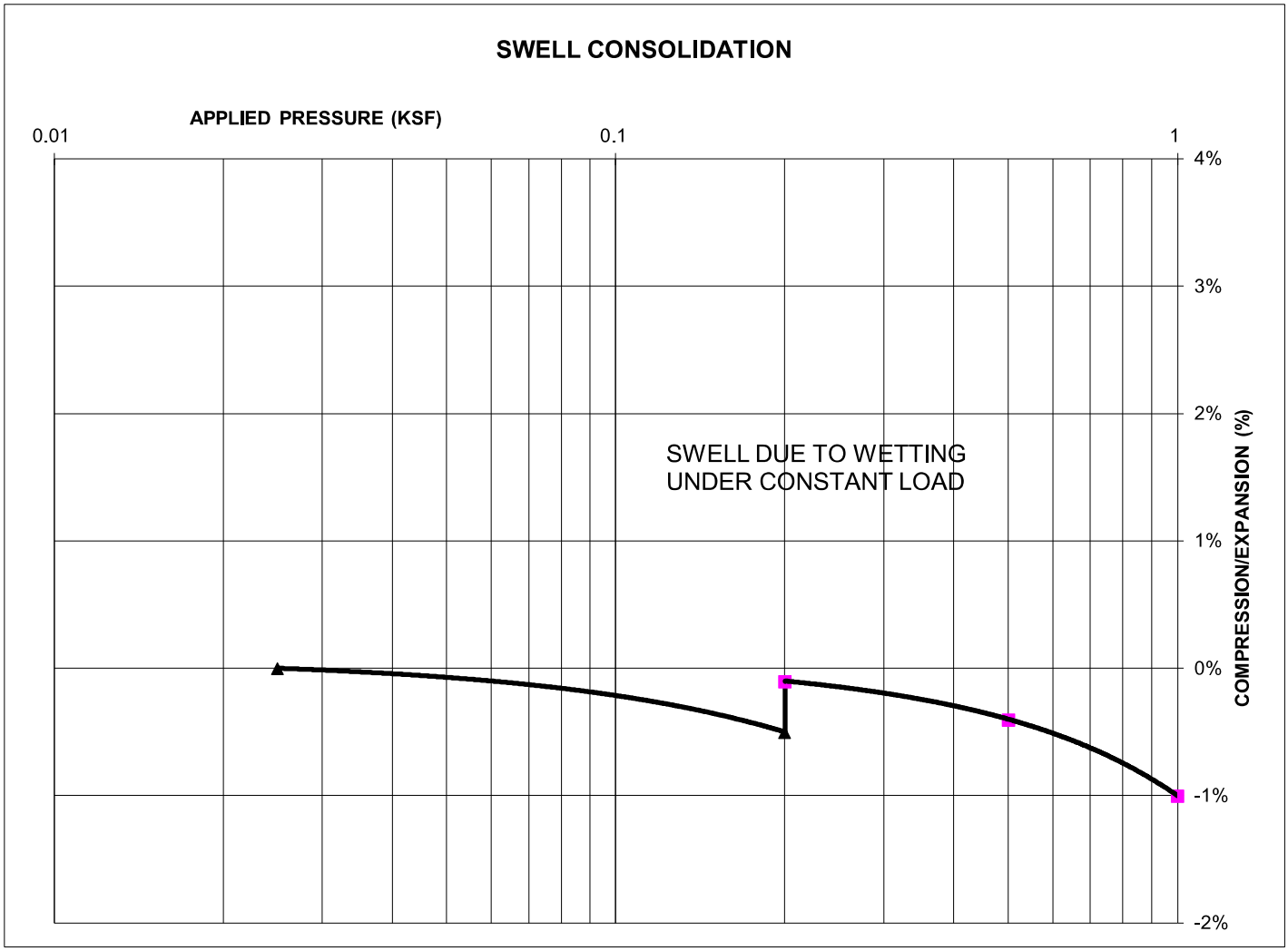
FIG. B-12

TEST BORING	1	SOIL DESCRIPTION	FILL, CLAY, SANDY
DEPTH (FT)	1-2	SOIL TYPE	2



SWELL/COLLAPSE TEST RESULTS

NATURAL UNIT DRY WEIGHT (PCF): 109
NATURAL MOISTURE CONTENT: 16.8%
SWELL/COLLAPSE (%): 0.4%

ENTECH ENGINEERING, INC.

SWELL TEST RESULTS

FLYING HORSE NORTH, FILING NO. 5
FLYING HORSE NORTH, LLC

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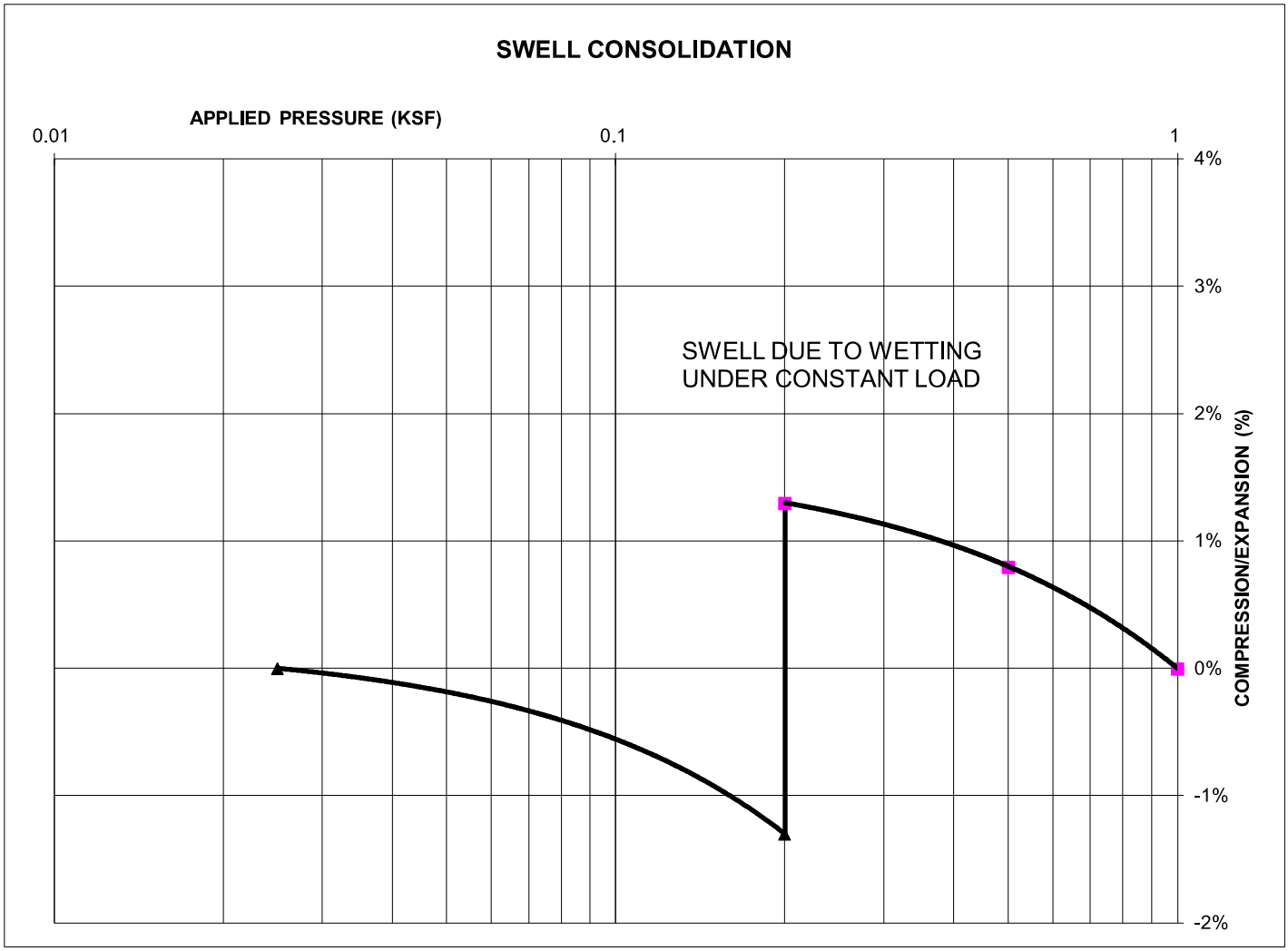
FIG. B-13

TEST BORING	4	SOIL DESCRIPTION	FILL, CLAY, SANDY
DEPTH (FT)	1-2	SOIL TYPE	2



SWELL/COLLAPSE TEST RESULTS

NATURAL UNIT DRY WEIGHT (PCF): 114
NATURAL MOISTURE CONTENT: 10.4%
SWELL/COLLAPSE (%): 2.6%

ENTECH ENGINEERING, INC.

SWELL TEST RESULTS

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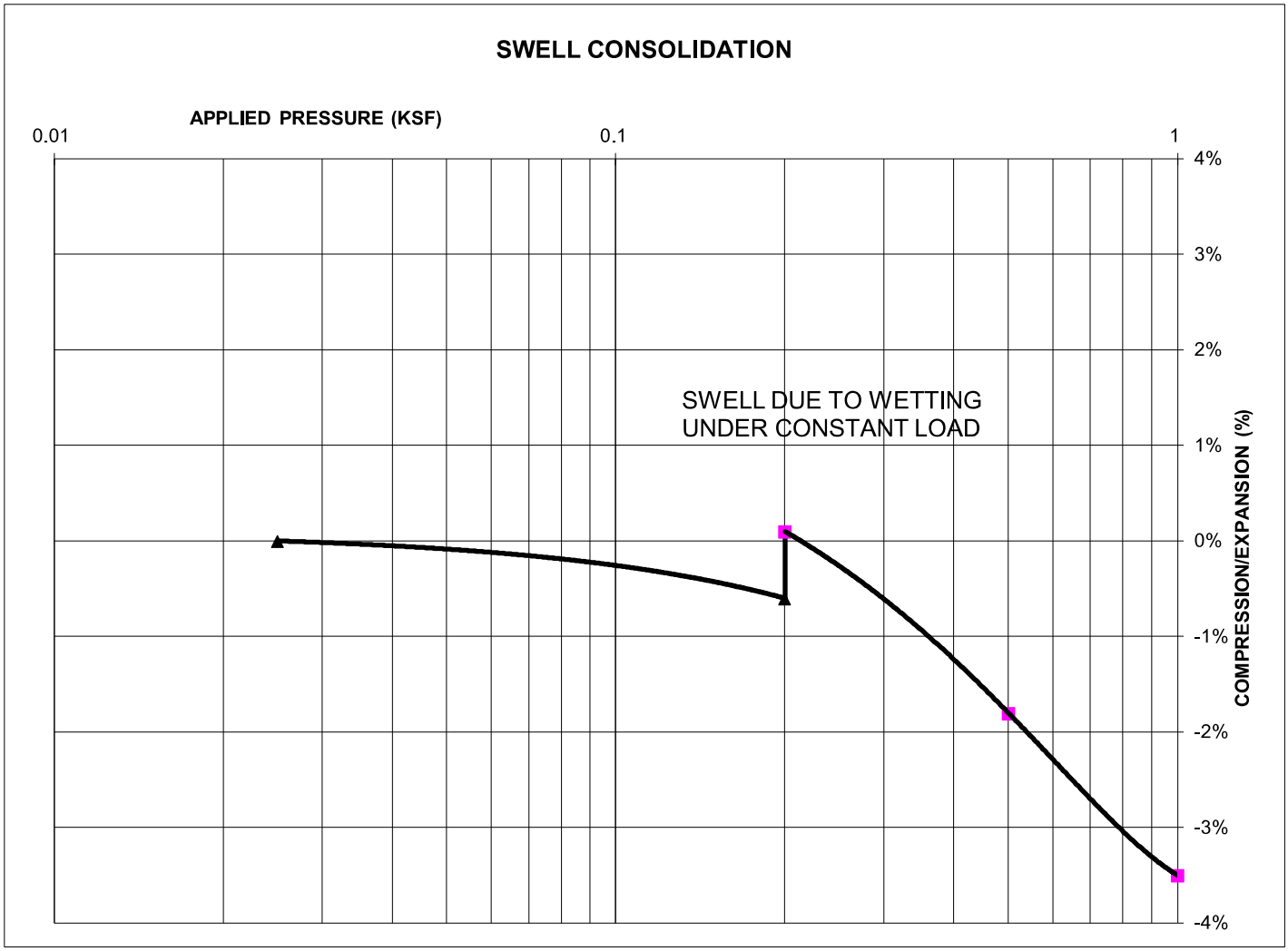
FLYING HORSE NORTH, LLC

JOB NO. 241421

FIG. B-14

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



SWELL/COLLAPSE TEST RESULTS

NATURAL UNIT DRY WEIGHT (PCF):	103
NATURAL MOISTURE CONTENT:	9.2%
SWELL/COLLAPSE (%):	0.7%

ENTECH ENGINEERING, INC.

SWELL TEST RESULTS

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FLYING HORSE NORTH, LLC

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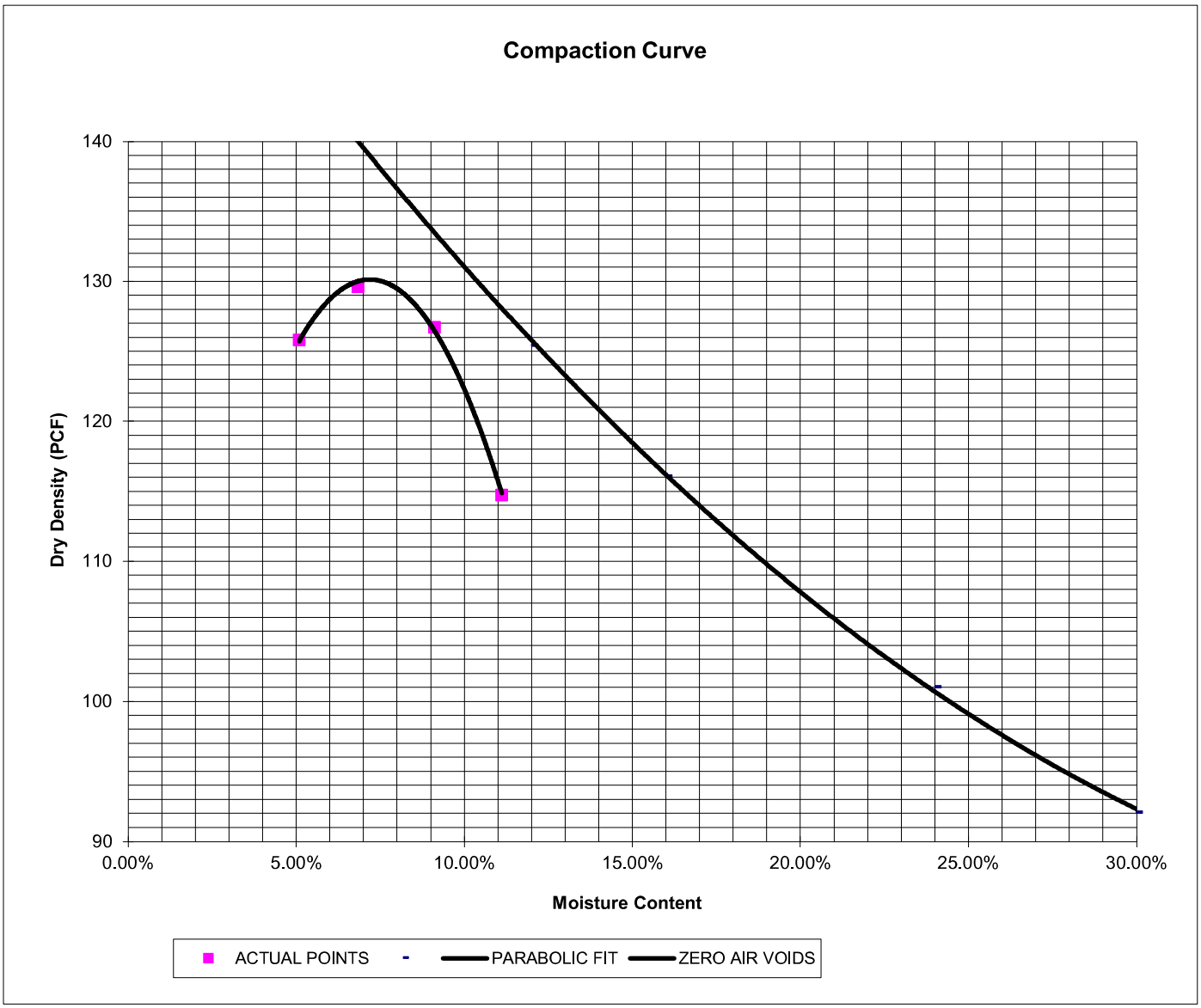
FIG. B-15

SAMPLE LOCATION TB-7 @ 0-3'	SOIL DESCRIPTION FILL, SAND, CLAYEY, BROWN SOIL TYPE 1

PROCTOR DATA

IDENTIFICATION:	SC
PROCTOR TEST #:	1
TEST BY:	DK
TEST DESIGNATION:	ASTM-1557-A
MAXIMUM DRY DENSITY (PCF):	130.1
OPTIMUM MOISTURE:	7.1



ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

FLYING HORSE NORTH, FILING NO. 5
FLYING HORSE NORTH, LLC

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FIG. B-16

SAMPLE LOCATION TB-7 @ 0-3' | SOIL DESCRIPTION FILL, SAND, CLAYEY, BROWN
SOIL TYPE 1

CBR TEST LOAD DATA

Piston Diameter (cm): 4.958
Piston Area (in^2): 2.993

Penetration Depth (inches)	*10 BLOWS* Mold # 1 Load (lbs)	Stress (psi)	*25 BLOWS* Mold # 2 Load (lbs)	Stress (psi)	*56 BLOWS* Mold # 3 Load (lbs)	Stress (psi)
0.000	0	0.00	0	0.00	0	0.00
0.025	134	44.78	153	51.13	139	46.45
0.050	166	55.47	236	78.86	260	86.88
0.075	182	60.82	307	102.59	324	108.27
0.100	201	67.17	360	120.30	410	137.01
0.125	226	75.52	475	158.73	720	240.60
0.150	272	90.89	635	212.20	871	291.06
0.175	287	95.91	686	229.24	964	322.14
0.200	309	103.26	731	244.28	1065	355.89
0.300	355	118.63	930	310.78	1560	521.30
0.400	402	134.34	1155	385.96	1769	591.14
0.500	461	154.05	1302	435.09	2078	694.40

MOISTURE AND DENSITY DATA

	Mold # 1	Mold # 2	Mold # 3
Can #	502	501	500
Wt. Can	8.15	8.18	8.25
Wt. Can+Wet	197.99	198.17	174.46
Wt. Can+Dry	174.94	177.41	154.12
Wt. H20	23.05	20.76	20.34
Wt. Dry Soil	166.79	169.23	145.87
Moisture Content	13.82%	12.27%	13.94%
Wet Density (PCF)	124.1	132.3	137.0
Dry Density (PCF)	115.9	123.6	127.9
% Compaction	89%	95%	98%
CBR	6.72	12.03	13.70

PROCTOR DATA

Maximum Dry Density (pcf)	130.1
Optimum Moisture	7.1
90% of Max. Dry Density (pcf)	117.1
95% of Max. Dry Density (pcf)	123.6

CBR at 90% of Max. Density = 7.5 ~ R VALUE 17
CBR at 95% of Max. Density = 12.0 ~ R VALUE 37

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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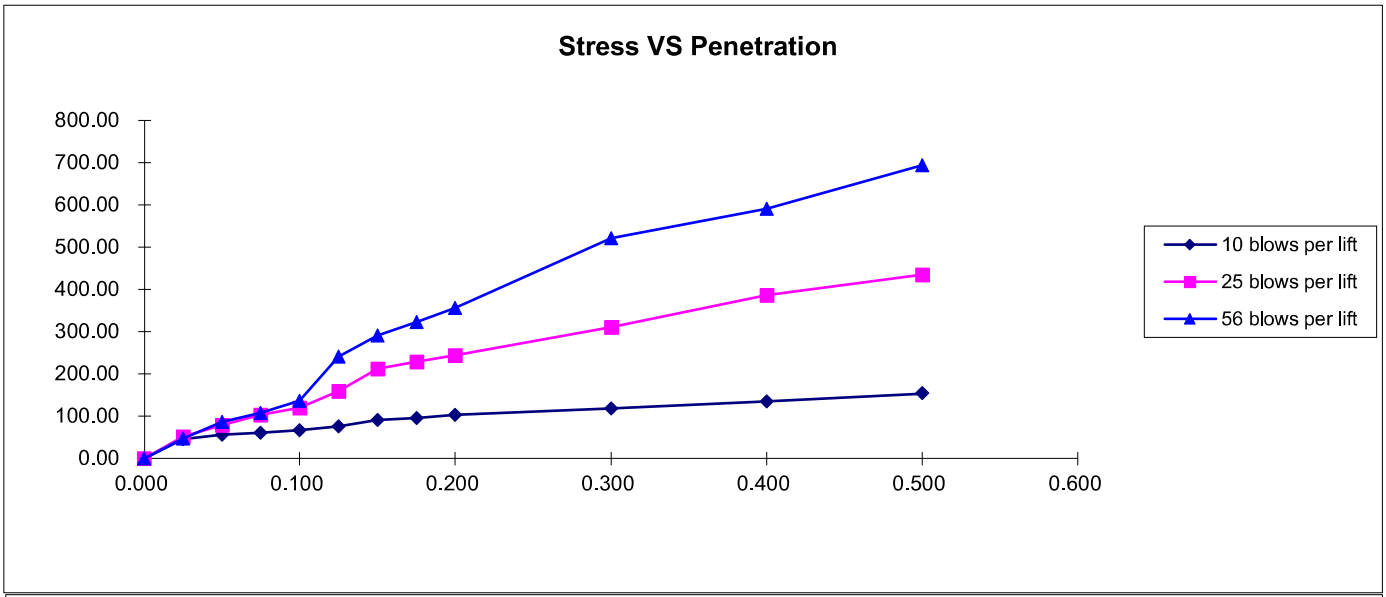
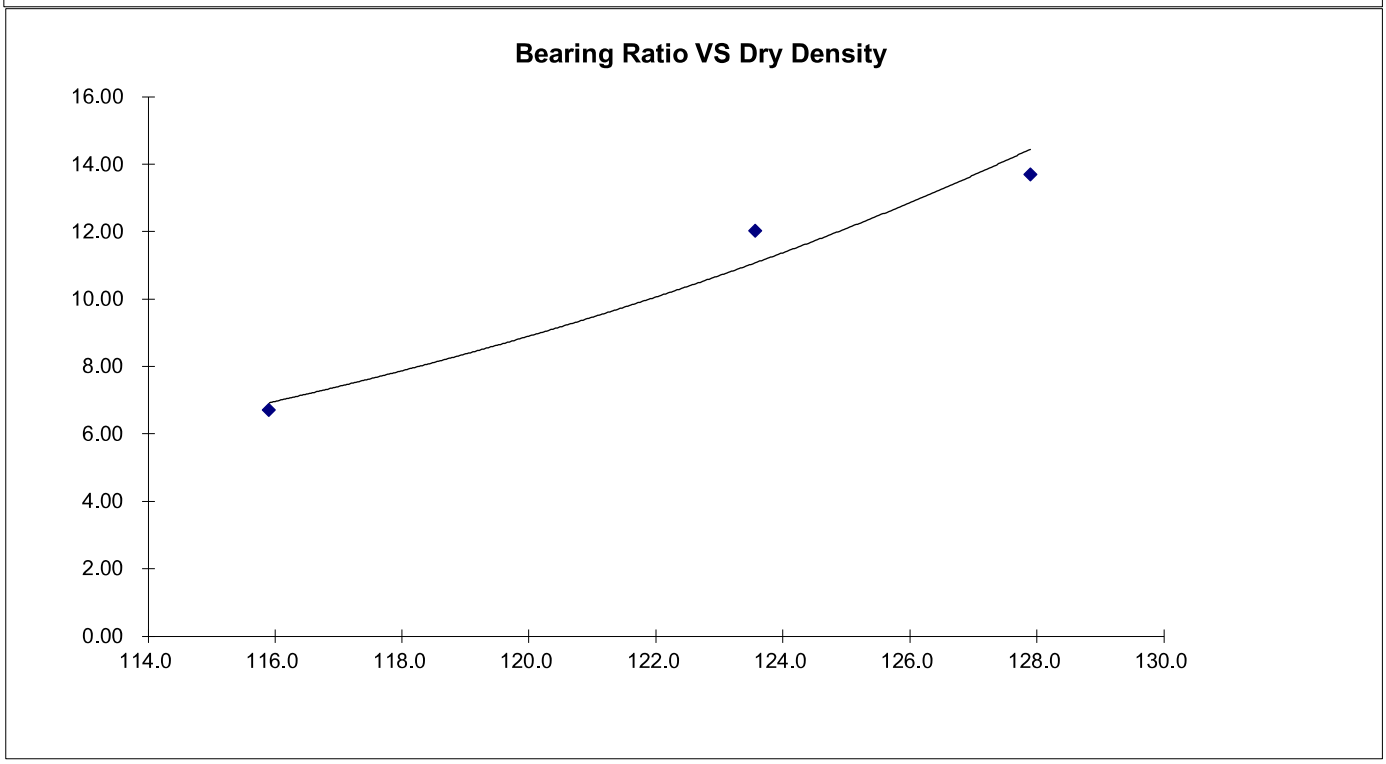
JOB NO. 241421

FIG. B-17

SAMPLE LOCATION TB-7 @ 0-3'

SOIL DESCRIPTION FILL, SAND, CLAYEY, BROWN
SOIL TYPE 1





ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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FLYING HORSE NORTH, LLC

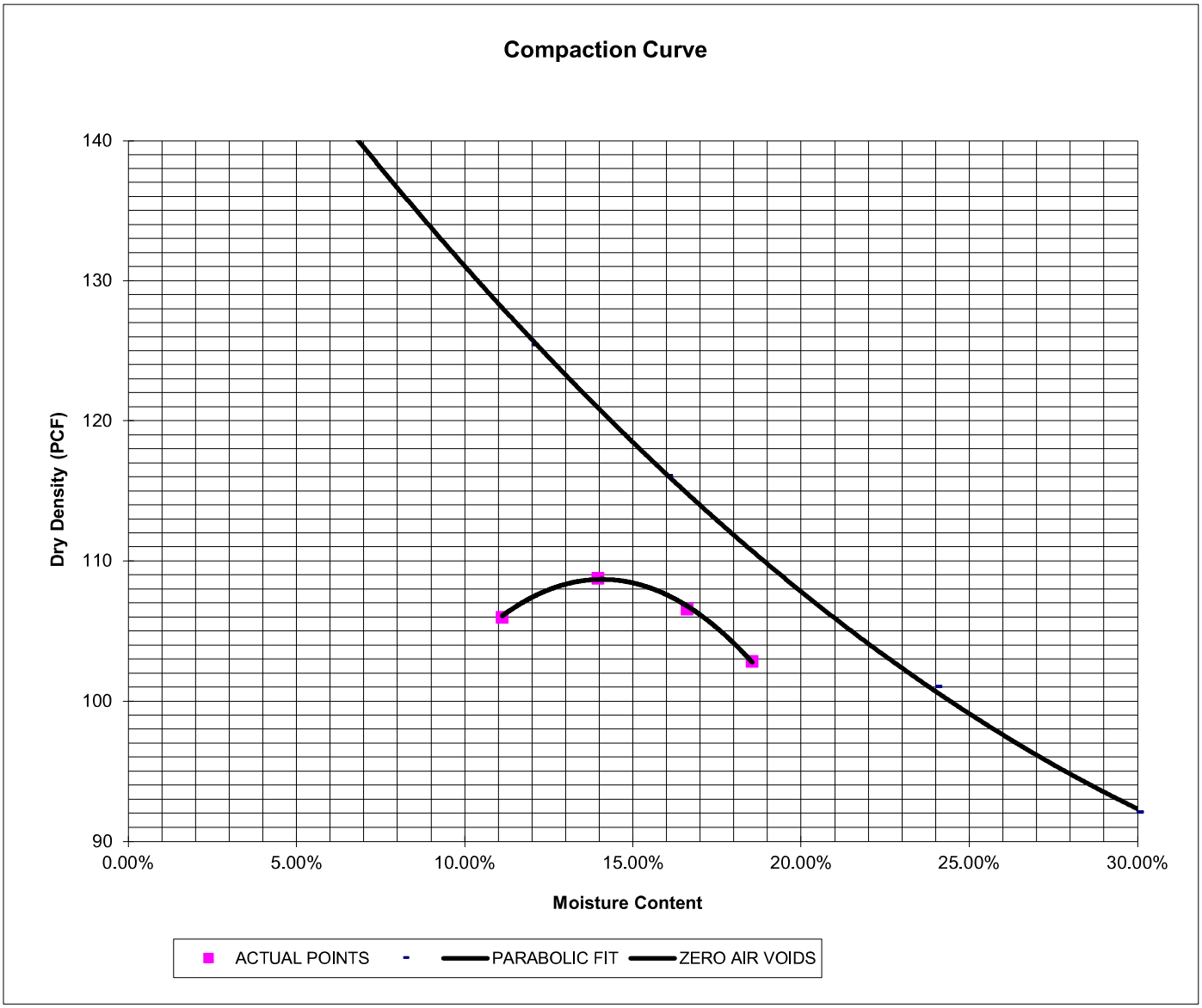
JOB NO. 241421

FIG. B-18

SAMPLE LOCATION TB-1 @ 0-3'	SOIL DESCRIPTION FILL, CLAY, SANDY, BROWN SOIL TYPE 1

PROCTOR DATA

IDENTIFICATION:	CL
PROCTOR TEST #:	2
TEST BY:	DK
TEST DESIGNATION:	ASTM-698-A
MAXIMUM DRY DENSITY (PCF):	108.9
OPTIMUM MOISTURE:	14.2



ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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FLYING HORSE NORTH, LLC

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FIG. B-19

SAMPLE LOCATION TB-1 @ 0-3' | SOIL DESCRIPTION FILL, CLAY, SANDY, BROWN
SOIL TYPE 1

CBR TEST LOAD DATA

Piston Diameter (cm): 4.958
Piston Area (in^2): 2.993

Penetration Depth (inches)	*10 BLOWS* Mold # 1 Load (lbs)	Stress (psi)	*25 BLOWS* Mold # 2 Load (lbs)	Stress (psi)	*56 BLOWS* Mold # 3 Load (lbs)	Stress (psi)
0.000	0	0.00	0	0.00	0	0.00
0.025	26	8.69	66	22.06	182	60.82
0.050	33	11.03	83	27.74	221	73.85
0.075	35	11.70	90	30.08	242	80.87
0.100	38	12.70	98	32.75	266	88.89
0.125	40	13.37	108	36.09	305	101.92
0.150	45	15.04	119	39.77	314	104.93
0.175	47	15.71	124	41.44	325	108.60
0.200	48	16.04	128	42.77	334	111.61
0.300	51	17.04	133	44.44	397	132.66
0.400	50	16.71	148	49.46	440	147.03
0.500	51	17.04	161	53.80	488	163.07

MOISTURE AND DENSITY DATA

	Mold # 1	Mold # 2	Mold # 3
Can #	508	507	506
Wt. Can	5.25	8.25	8.27
Wt. Can+Wet	206.44	214	168.26
Wt. Can+Dry	167.2	178.37	143.23
Wt. H20	39.24	35.63	25.03
Wt. Dry Soil	161.95	170.12	134.96
Moisture Content	24.23%	20.94%	18.55%
Wet Density (PCF)	105.1	117.1	122.7
Dry Density (PCF)	92.1	102.5	107.4
% Compaction	85%	94%	99%
CBR	1.27	3.27	8.89

PROCTOR DATA

Maximum Dry Density (pcf)	108.9
Optimum Moisture	14.2
90% of Max. Dry Density (pcf)	98.0
95% of Max. Dry Density (pcf)	103.5

CBR at 90% of Max. Density = 2.4 ~ R VALUE 6
CBR at 95% of Max. Density = 4.3 ~ R VALUE 10

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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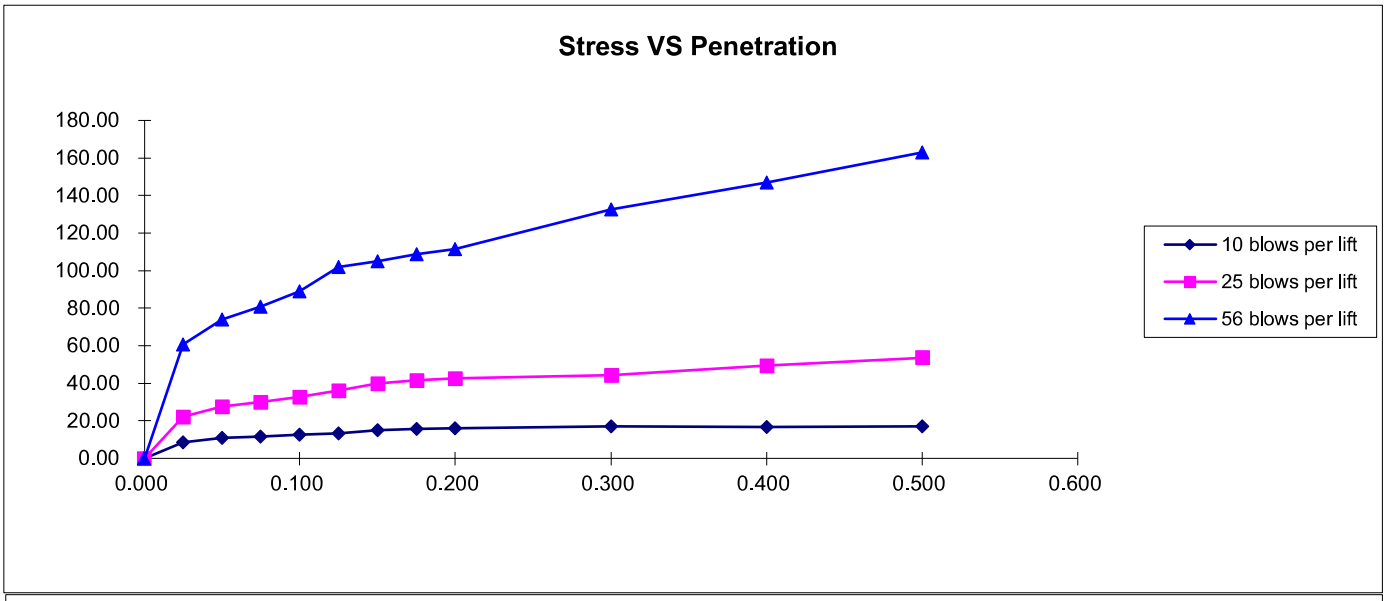
FLYING HORSE NORTH, LLC

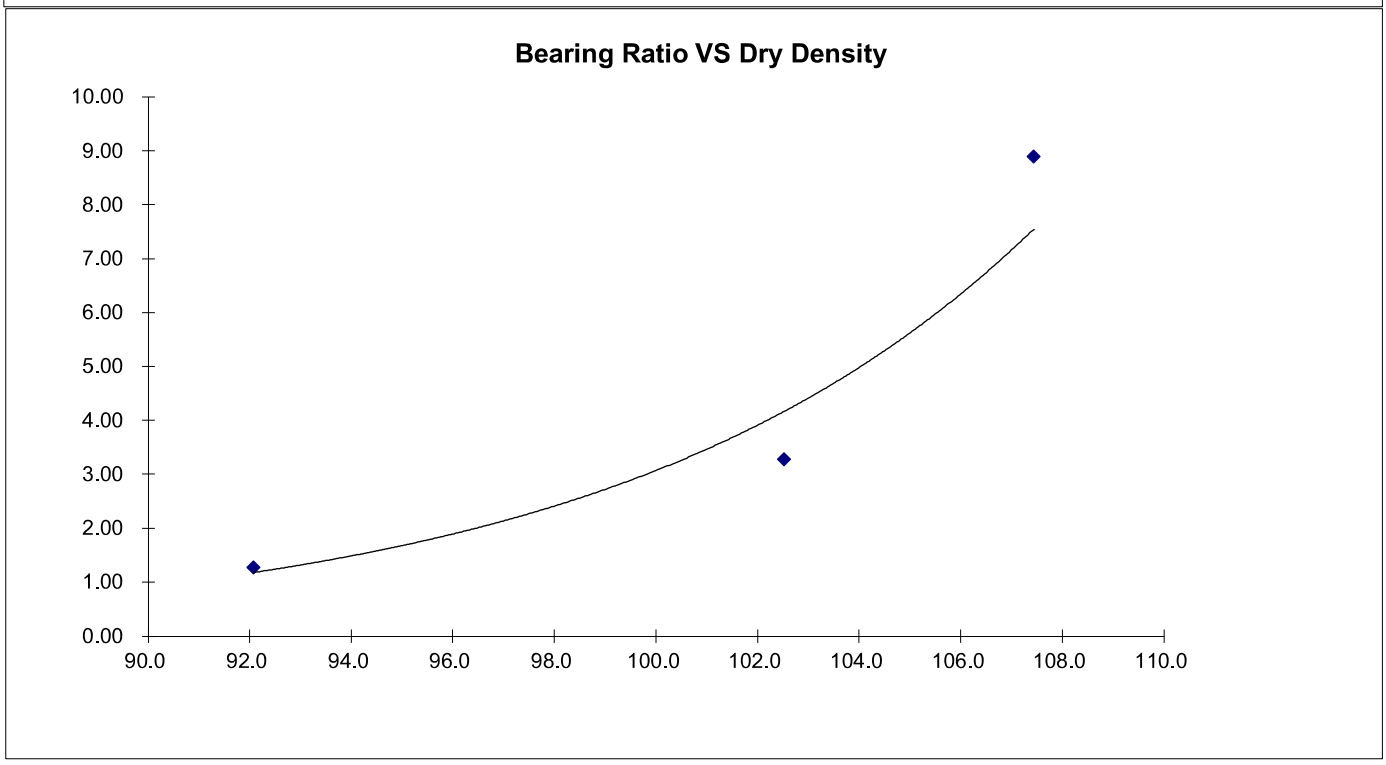
JOB NO. 241421

FIG. B-20

SAMPLE LOCATION TB-1 @ 0-3'

SOIL DESCRIPTION FILL, CLAY, SANDY, BROWN
SOIL TYPE 1





ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

FLYING HORSE NORTH, FILING NO. 5
FLYING HORSE NORTH, LLC

JOB NO. 241421

FIG. B-21

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

PROJECT DATA

Project Location: Flying Horse North, Filing No. 5

Job Number: 241421

DESIGN DATA

Equivalent (18-kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	36,500
Design CBR	CBR =	4.3
Standard Deviation	S_o =	0.45
Loss in Serviceability	Δpsi =	2.5
Reliability	Reliability =	75
Reliability (z-statistic)	Z_R =	-0.67
Soil Resilient Modulus	M_R =	6,450 psi

Required Structural Number (SN): → SN = 1.88

DESIGN EQUATIONS

Resilient Modulus

If using CBR: $M_R = (CBR) \times 1{,}500$

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

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 - HMA

C_2 = Strength Coefficient - CTS

D_1 = Depth of HMA (inches)

D_2 = Depth of CTS (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	CTS	C_2 = 0.11	8.0 inches	0.880	
			SN* =	2.640	1.88

Pavement SN > Required SN, Design is Acceptable

FIG. C-1

FLEXIBLE PAVEMENT DESIGN

PROJECT DATA

Project Location: Flying Horse North, Filing No. 5

Job Number: 241421

DESIGN DATA

Equivalent (18-kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	36,500
Design CBR	CBR =	4.3
Standard Deviation	S_o =	0.45
Loss in Serviceability	Δpsi =	2.5
Reliability	Reliability =	75
Reliability (z-statistic)	Z_R =	-0.67
Soil Resilient Modulus	M_R =	6,450 psi

Required Structural Number (SN): → SN = 1.88

DESIGN EQUATIONS

Resilient Modulus

If using CBR: $M_R = (CBR) \times 1{,}500$

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

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 - HMA

C_2 = Strength Coefficient - ABC

D_1 = Depth of HMA (inches)

D_2 = Depth of ABC (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	4.0 inches	0.440	
			SN* =	2.200	1.88

Pavement SN > Required SN, Design is Acceptable

FIG. C-2