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PAVEMENT DESIGN REPORT
LATIGO TRAILS FILING NO. 9
EL PASO COUNTY, COLORADO

Prepared for:
RDMA, LLC
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Attn: Akeem Seriki/Glenn Kunkel

June 13, 2024
Revised: September 23, 2024

Respectfully Submitted,

ENTECH ENGINEERING, INC.

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El Paso County Department of Public Works

Entech Job No. 231802

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1 Introduction

Entech Engineering, Inc. (Entech) completed a subsurface exploration program and a pavement design for roadways within the Latigo Trails Filing No. 9. This report describes the subsurface exploration program conducted for the proposed roadway improvements and provides a pavement section alternative and construction recommendations. Entech participated in this project as a subconsultant to RDMA, LLC. The contents of this report, including the pavement design recommendations, are subject to the limitations and assumptions presented in Section 7. This report supersedes all previous versions of this report.

2 Project Description

Latigo Trails Filing No. 9 is located east of Curtis Road and south of Judge Orr Road in eastern El Paso County, Colorado (Figure 1). The proposed roadway construction includes portions of Conestoga Trail South, Buffalo River Trail, and the Horse Canyon Trail cul-de-sac. The extent of our investigation is shown in Figure 2. The topography of the site consists of gently rolling hills and valleys with rough-graded roads and utilities installed. Surrounding properties include vacant land or land being developed for residential lots. Vegetation was absent along the roadways due to recent site grading.

3 Subsurface Explorations and Laboratory Testing

3.1 Subsurface Exploration Program

Subsurface conditions at the project site were explored by ten test borings, designated TB-1 through TB-10, drilled on April 23, 2024. 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 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 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 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 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.

One-dimensional swell/collapse testing (ASTM D4546) was performed on a select sample to determine the expansive or compressive characteristics of the soil. For pavement design, a modified proctor (ASTM D1557) and 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.

4 Subgrade Conditions

Four primary soil types and two bedrock types 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 roadway generally consisted of medium dense to dense silty to clayey sand fill (Soil Type 1), medium dense clayey sand fill (Soil Type 2), native dense silty sand to sand with silt (Soil Type 3), and native dense clayey sand (Soil Type 4). Sandstone bedrock, which classified as very dense silty sand to sand with silt (Soil Type 5) and (Soil Type 6), was also encountered. Water soluble sulfate tests indicated that the soils exhibit a negligible potential for sulfate attack. Laboratory test results are presented in Appendix B and are

summarized in Table B-1. Soil Types and corresponding AASHTO soil classifications are listed as follows:

- Soil Type 1: A-1-b and A-2-4 (Design Soil Type)
- Soil Type 2: A-6
- Soil Type 3: A-1-b
- Soil Type 4: A-2-6
- Soil Type 5: A-1-b

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 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 a representative sample of the Type 1 silty sand fill subgrade from TB-1 to determine the support characteristic of the subgrade soils for the roadway section. Soil Type 1 was selected as the representative design subgrade material based on materials encountered during our subsurface exploration program and subsequent laboratory testing. Isolated areas with cohesive materials (A-6) should be removed and replaced as discussed in Section 6.1.1. 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 – Silty Sand Fill
CBR at 95%	56.53
Design CBR	10
Liquid Limit	NV
Plasticity Index	NP
Percent Passing 200	31.9
AASHTO Classification	A-2-4
Unified Soils Classification	SM

5.2 Swell Mitigation

El Paso County requires swell mitigation for soils with swell testing results greater than 2% under a 150 pounds per square foot (psf) surcharge. Based on the classifications, mitigation for expansive soils will not be required on this site.

5.3 Traffic Loading

Traffic data was referenced from the Traffic Impact Study "Latigo Preserve Filing, No. 9 PCD File No. SF-21-36". The roadways classify as rural local based on the current development plans. The *El Paso County Engineering Criteria Manual* provides default 18-kip equivalent single axle loadings (ESAL) based on the street classifications (ECM Section D.3.3, Table D-2). For design, a default ESAL value of 36,500 was used for the local low-volume residential designations.

5.4 Pavement Design

The pavement section was determined utilizing the *El Paso County Engineering Criteria Manual*, the CBR testing, and the default ESAL value. Design parameters used in the pavement analysis are presented in Exhibit 2.

Exhibit 2: Pavement Design Parameters

Design Parameter	Value
Reliability	80%
Standard Deviation	0.45
Serviceability Loss (Δ psi)	2.5
Design CBR	10
Resilient Modulus	15,000 psi
Structural Coefficients	
Hot Bituminous Pavement	0.44
Aggregate Base Course	0.11

The recommended hot mix asphalt (HMA) over aggregate base course (ABC) composite pavement section for the roadways at Latigo Trails Filing No. 9 is provided in Exhibit 3. The pavement design calculations are presented in Appendix C.

Exhibit 3: Recommended Pavement Section

Pavement Area	Design ESAL	Alternative [1]
Conestoga Trail South, Buffalo River Trail, and Horse Canyon Trail	36,500	1. 4.0 inches HMA over 4.0 inches ABC

ABC = Aggregate Base Course; ESAL = equivalent single axle loads; HMA = Hot Mix Asphalt

Notes:

1. Pavement alternative meets the minimum HMA and ABC thickness required per *El Paso County Pavement Design Manual*.

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, if any, should be removed by stripping, with the depth to be field determined.

6.1.1 Subgrade Preparation

To provide uniform subgrade support and mitigate any potentially expansive soils, we recommend overexcavating 12 inches of the roadway subgrade, scarifying an additional 6 inches, moisture conditioning the scarified subgrade to within +/-2% of its optimum moisture content, and compacting it to 95% of the Modified Proctor Maximum Dry Density (ASTM D1557). The overexcavated subgrade soils can then be replaced in 6-inch compacted lifts to the same specifications as described above. Any cohesive materials (AASHTO A-6) encountered during subgrade preparation should be removed and replaced with granular fill (Section 6.1.2.

The final moisture-treated subgrade surface 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 Fill Placement and Compaction

Granular fill placed as part of the pavement subgrade shall consist of non-expansive, 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 10. All granular fill placed within the pavement subgrade should be compacted to a minimum of 95% of its maximum Modified Proctor Dry Density (ASTM D1557) 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.

6.2 Aggregate Base Course

ABC materials shall conform to the *El Paso County Engineering Criteria Manual*, Section D.5.5.I and Table D-6 Aggregate Base Course Materials. ABC materials should be compacted to a minimum of 95% of their maximum Modified Proctor Dry Density (ASTM D1557) at +/-2% of optimum moisture content.

6.3 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 or Type II cement is recommended for all concrete on this site. To further avoid concrete degradation during construction, it is recommended that concrete not be placed on frozen or wet ground.

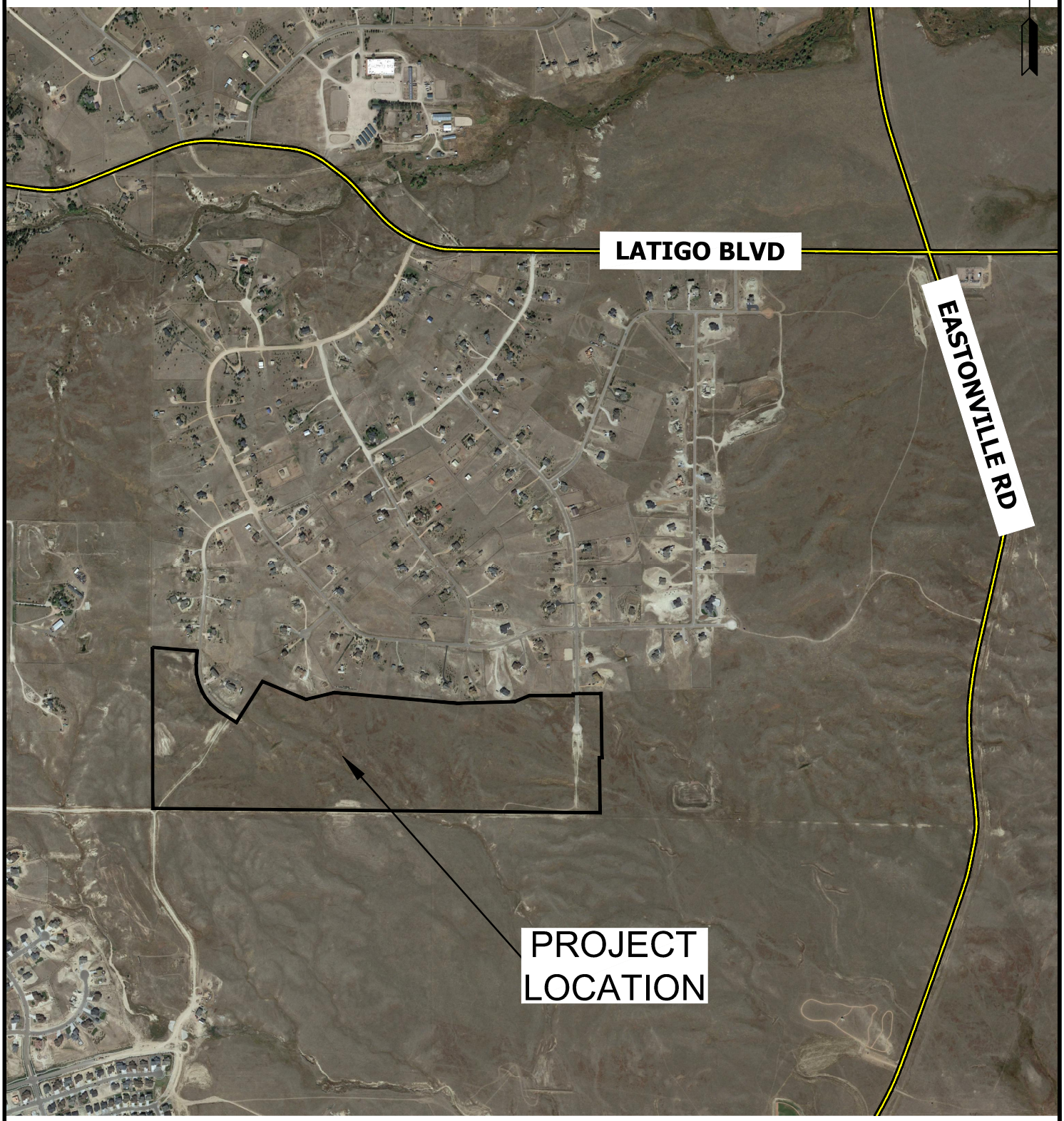
6.4 Construction Observation

Subgrade preparation for pavement structures 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 RDMA with application to the paving of the Latigo Trails Filing No. 9 project in east 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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VICINITY MAP

LATIGO TRAILS FILING No. 9
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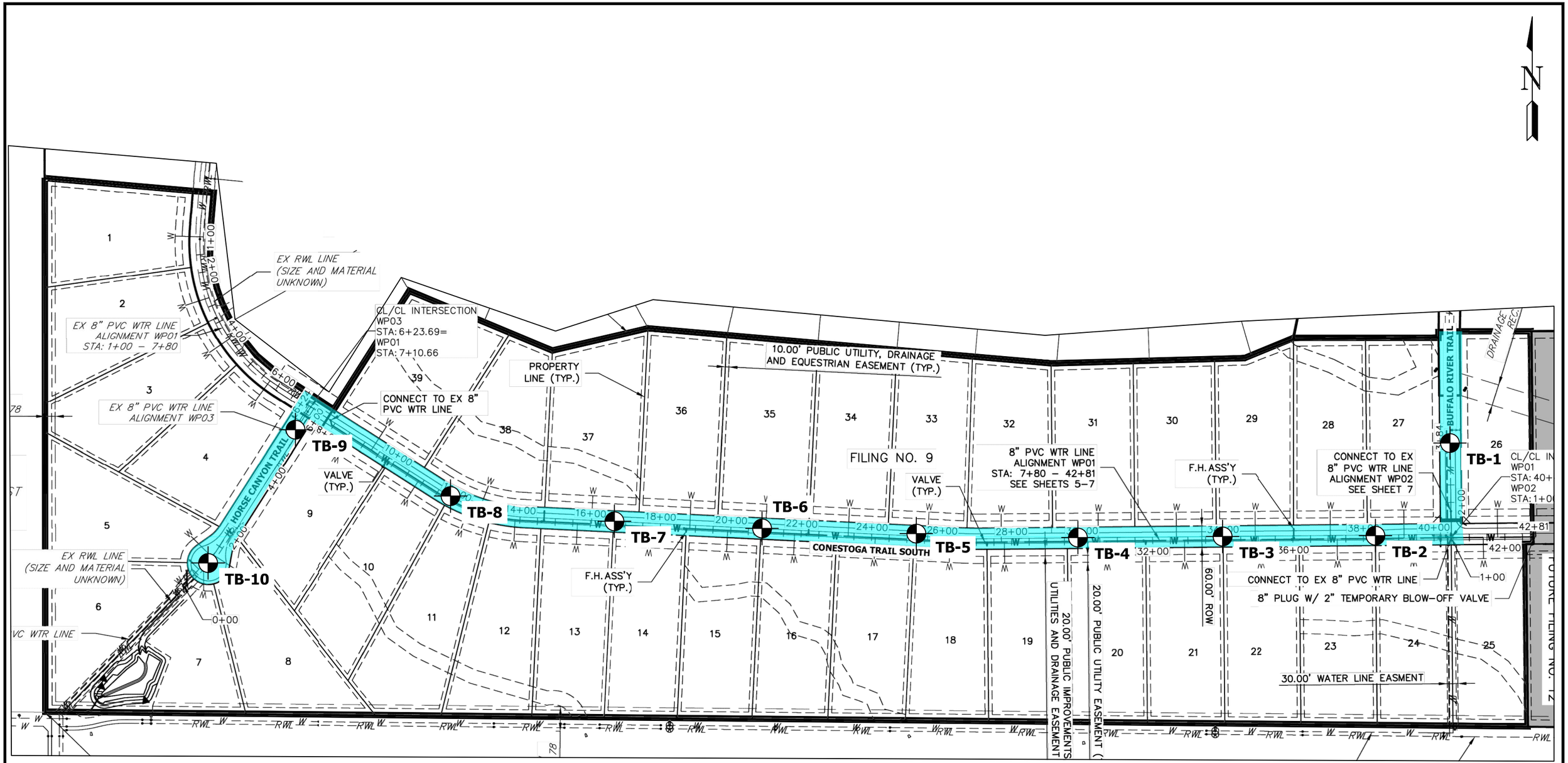
FIG. 1



CONESTOGA TRAIL SOUTH, BUFFALO RIVER TRAIL, HORSE CANYON TRAIL
Roadway Classification: Local Rural Residential
Design 18-kip ESAL = 36,500
Soil Type 1 (AASHTO A-2-4)
Pavement Section: 4" HMA over 4" ABC

TB- APPROXIMATE TEST BORING LOCATION AND NUMBER

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SITE AND EXPLORATION PLAN

LATIGO TRAILS FILING No. 9
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JOB NO. 231802

FIG. 2

APPENDIX A: Test Boring Logs

TABLE A-1

DEPTH TO BEDROCK

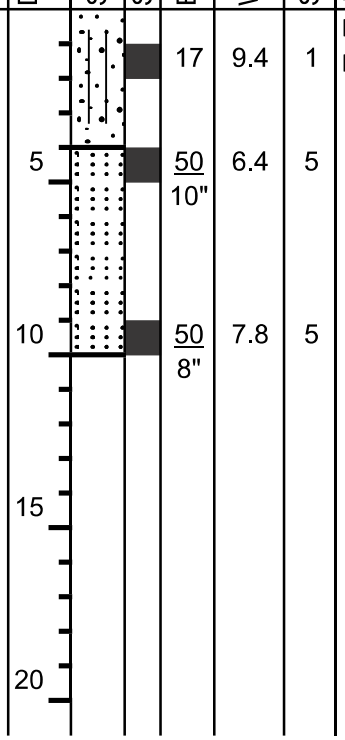
TEST BORING	DEPTH TO BEDROCK (ft.)
1	4
2	>5
3	3
4	SURFACE
5	SURFACE
6	SURFACE
7	SURFACE
8	SURFACE
9	4
10	4

TEST BORING 1
DATE DRILLED 4/23/2024

REMARKS

DRY TO 10', 4/23/24

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-4', SAND, SILTY, BROWN, MEDIUM DENSE, MOIST			17	9.4	1
SANDSTONE, VERY WEAK, BROWN, MODERATELY WEATHERED (SAND, SILTY, VERY DENSE, MOIST)			50/10"	6.4	5
			50/8"	7.8	5

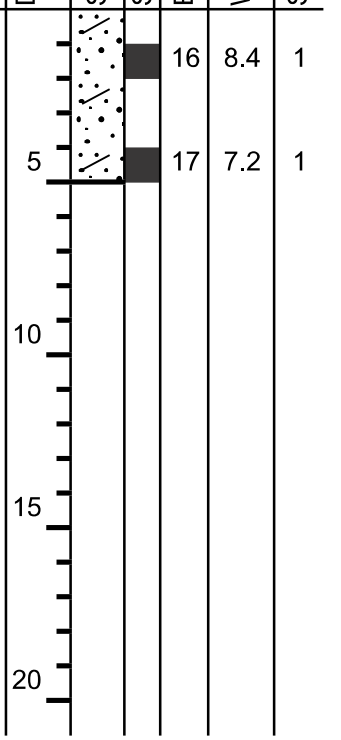


TEST BORING 2
DATE DRILLED 4/23/2024

REMARKS

DRY TO 5', 4/23/24

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-5', SAND, CLAYEY, BROWN, MEDIUM DENSE, MOIST			16	8.4	1
			17	7.2	1



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TEST BORING LOGS

LATIGO TRAILS, FILING NO. 9
RDMA

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FIG. A-1

TEST BORING 3
DATE DRILLED 4/23/2024

REMARKS

DRY TO 5', 4/23/24

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			31	3.9	1
					3
5			50/10"	9.3	6
10					
15					
20					

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

SAND, SILTY, BROWN

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

TEST BORING 4
DATE DRILLED 4/23/2024

REMARKS

DRY TO 10', 4/23/24

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			50/11"	5.6	5
5			50/9"	8.4	5
10			50/4"	8.5	5
15					
20					

SANDSTONE, EXTREMELY WEAK, TAN, HIGHLY WEATHERED (SAND, WITH SILT, VERY DENSE, MOIST)

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TEST BORING LOGS

LATIGO TRAILS, FILING NO. 9
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FIG. A-2

TEST BORING 5
DATE DRILLED 4/23/2024

REMARKS

DRY TO 5', 4/23/24

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			50/11"	7.2	5
5			50/9"	7.2	5
10					
15					
20					

SANDSTONE, EXTREMELY WEAK, TAN, HIGHLY WEATHERED (SAND, WITH SILT to SAND, CLAYEY, VERY DENSE, MOIST)

TEST BORING 6
DATE DRILLED 4/23/2024

REMARKS

DRY TO 5', 4/23/24

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			50/11"	6.5	5
5			50/9"	12.8	5
10					
15					
20					

SANDSTONE, EXTREMELY WEAK, TAN, HIGHLY WEATHERED (SAND, WITH SILT, VERY DENSE, MOIST)

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TEST BORING LOGS

LATIGO TRAILS, FILING NO. 9
RDMA

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FIG. A-3

TEST BORING 7
DATE DRILLED 4/23/2024

REMARKS

DRY TO 10', 4/23/24

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			50/6"	4.1	5
5			50/6"	5.5	5
10			50/6"	9.8	6
15					
20					

SANDSTONE, EXTREMELY WEAK, TAN, HIGHLY WEATHERED (SAND, WITH SILT, VERY DENSE, MOIST)

SANDSTONE, VERY WEAK, TAN, MODERATELY WEATHERED (SAND, CLAYEY, VERY DENSE, MOIST)

TEST BORING 8
DATE DRILLED 4/23/2024

REMARKS

DRY TO 5', 4/23/24

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			41	8.9	6
5			50/11"	8.2	6
10					
15					
20					

SANDSTONE, EXTREMELY WEAK, OLIVE, HIGHLY WEATHERED (SAND, CLAYEY, DENSE to VERY DENSE, MOIST)

ENTECH ENGINEERING, INC.

TEST BORING LOGS

LATIGO TRAILS, FILING NO. 9
RDMA

JOB NO. 231802

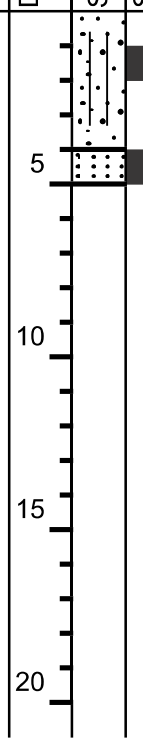
FIG. A-4

TEST BORING 9
DATE DRILLED 4/23/2024

REMARKS

DRY TO 5', 4/23/24

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
SAND, WITH SILT, BROWN, MEDIUM DENSE, MOIST			24	3.6	3
SANDSTONE, VERY WEAK, LIGHT BROWN, MODERATELY WEATHERED (SAND, SILTY, VERY DENSE, MOIST)			50/9"	9.8	5

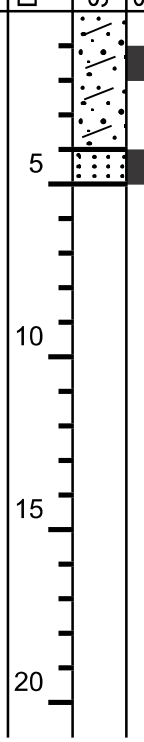


TEST BORING 10
DATE DRILLED 4/23/2024

REMARKS

DRY TO 5', 4/23/24

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-4', SAND, CLAYEY, BROWN, MEDIUM DENSE, MOIST			10	9.9	2
SANDSTONE, EXTREMELY WEAK, LIGHT BROWN, MODERATELY WEATHERED (SAND, CLAYEY, DENSE, MOIST)			37	7.7	6



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TEST BORING LOGS

LATIGO TRAILS, FILING NO. 9
RDMA

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FIG. A-5

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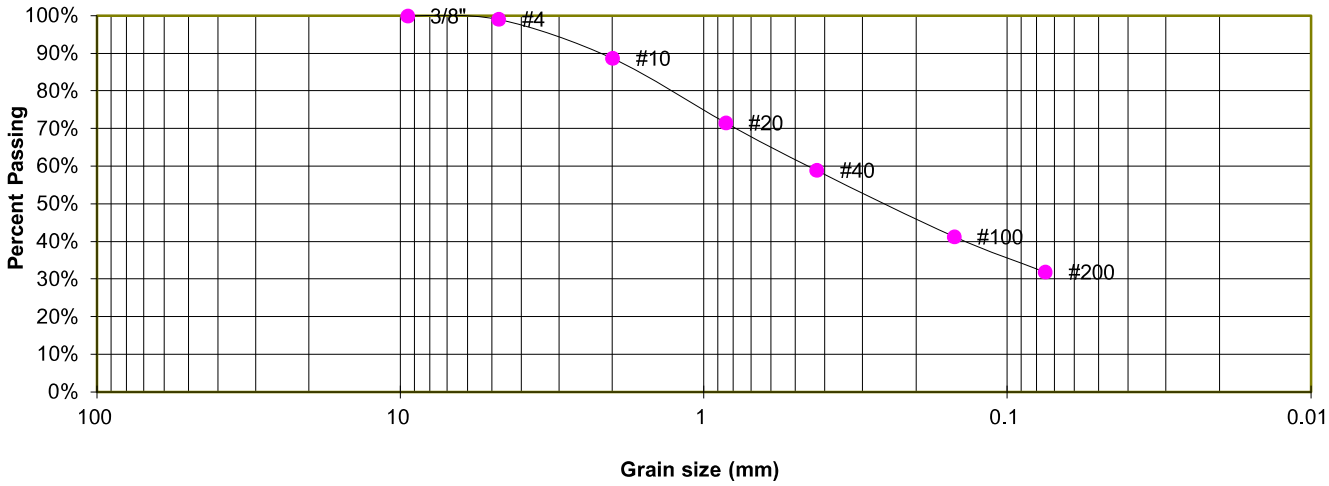
TABLE B-1
SUMMARY OF LABORATORY TEST RESULTS

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	SULFATE (WT %)	SWELL/ COLLAPSE (%)	AASHTO CLASS.	USCS	SOIL DESCRIPTION
1, CBR	1	0-3	6.8		31.9	NV	NP	NP			A-2-4	SM	FILL, SAND, SILTY
1	1	1-2	9.1		23.1	28	22	6			A-1-b	SM	FILL, SAND, SILTY
1	2	1-2	8.9		20.6	30	20	10	<0.01		A-2-4	SC	FILL, SAND, CLAYEY
1	3	1-2	4.1		19.3	28	24	4			A-1-b	SM	FILL, SAND, CLAYEY
2	10	1-2	10.3		40.0	37	23	14	<0.01		A-6	SC	FILL, SAND, CLAYEY
3	9	1-2	3.7		8.4	NV	NP	NP			A-1-b	SW-SM	SAND, WITH SILT
3	8	1-2	10.2		8.8	NV	NP	NP	<0.01		A-1-b	SW-SM	SAND, WITH SILT
4	10	5	8.0		37.4	24	15	9			A-2-6	SC	SAND, CLAYEY
5	4	1-2	6.8		7.6	NV	NP	NP			A-1-b	SW-SM	SANDSTONE (SAND, WITH SILT)
5	5	1-2	7.0		11.6	NV	NP	NP			A-1-b	SW-SM	SANDSTONE (SAND, WITH SILT)
5	6	1-2	6.5		7.6	NV	NP	NP			A-1-b	SW-SM	SANDSTONE (SAND, WITH SILT)
5	7	1-2	4.1		8.2	NV	NP	NP			A-1-b	SW-SM	SANDSTONE (SAND, WITH SILT)
5	1	10	8.9		15.0	31	23	8			A-1-b	SM	SANDSTONE (SAND, SILTY)
5	9	5	9.4		15.7	NV	NP	NP			A-1-b	SM	SANDSTONE (SAND, SILTY)
6	3	5	10.7		31.1	28	19	9	<0.01		A-2-4	SC	SANDSTONE (SAND, CLAYEY)
6	8	5	7.8		13.1	41	21	20			A-2-6	SC	SANDSTONE (SAND, CLAYEY)
6	7	10	14.8	85.6	35.2				<0.01	-2.8		SC	SANDSTONE (SAND, CLAYEY)

Project: Latigo Trails, Filing No. 9
Client: RDMA
Job No: 231802

APPENDIX B: Laboratory Test Results

TEST BORING	1	SOIL DESCRIPTION	FILL, SAND, SILTY
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	99.1%
10	88.7%
20	71.6%
40	58.9%
100	41.3%
200	31.9%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

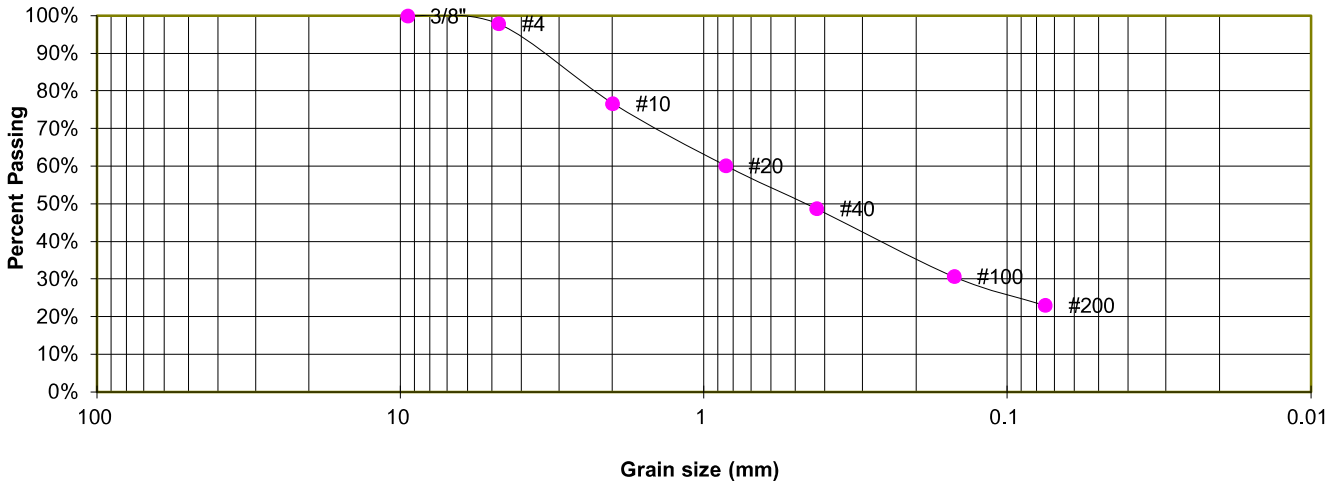
LABORATORY TEST RESULTS

LATIGO TRAILS, FILING NO. 9
RDMA

JOB NO. 231802

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	97.9%
10	76.7%
20	60.2%
40	48.7%
100	30.7%
200	23.1%

ATTERBERG LIMITS

Plastic Limit	22
Liquid Limit	28
Plastic Index	6

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

LATIGO TRAILS, FILING NO. 9
RDMA

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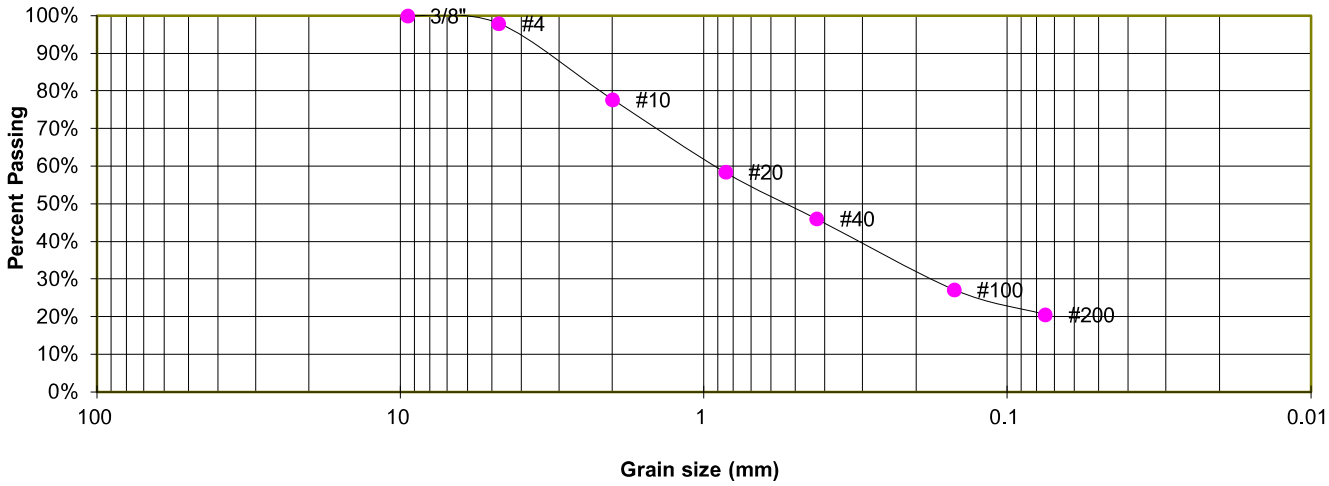
FIG. B-2

TEST BORING	2	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	98.0%
10	77.7%
20	58.5%
40	46.0%
100	27.2%
200	20.6%

ATTERBERG LIMITS

Plastic Limit	20
Liquid Limit	30
Plastic Index	10

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

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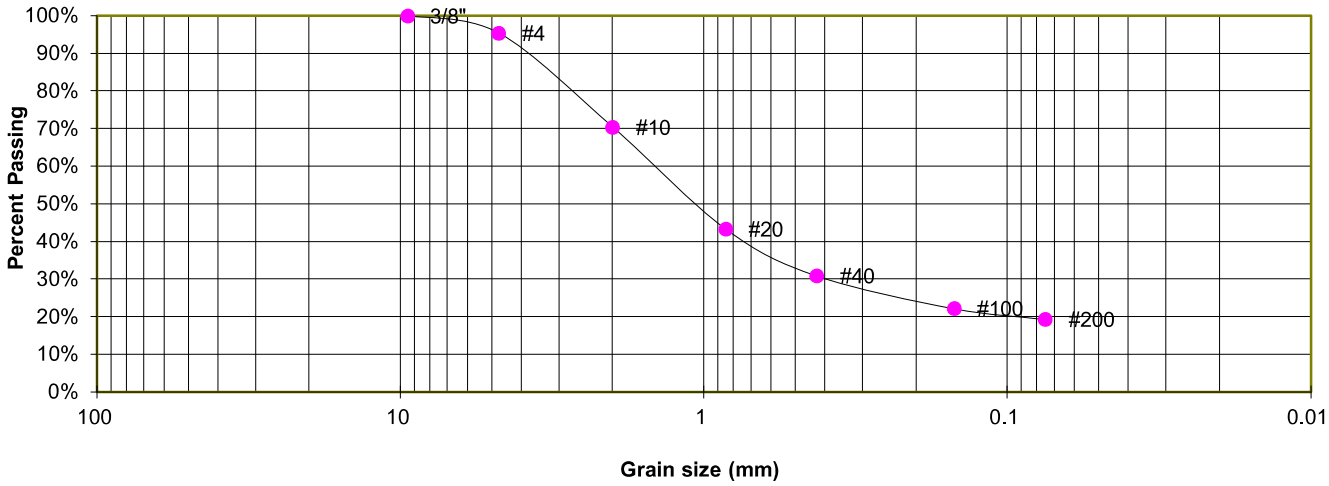
FIG. B-3

TEST BORING	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	95.4%
10	70.4%
20	43.3%
40	30.9%
100	22.2%
200	19.3%

ATTERBERG LIMITS

Plastic Limit	24
Liquid Limit	28
Plastic Index	4

SOIL CLASSIFICATION

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

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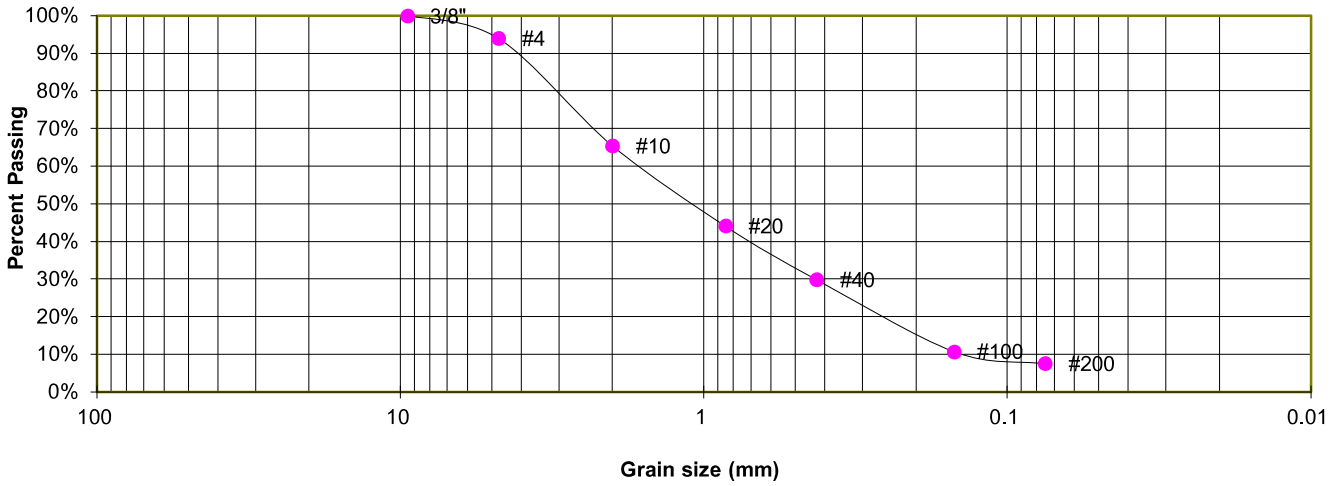
FIG. B-4

TEST BORING	4	SOIL DESCRIPTION	SANDSTONE (SAND, WITH SILT)
DEPTH (FT)	1-2	SOIL TYPE	5



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.0%
10	65.4%
20	44.1%
40	29.9%
100	10.8%
200	7.6%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

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

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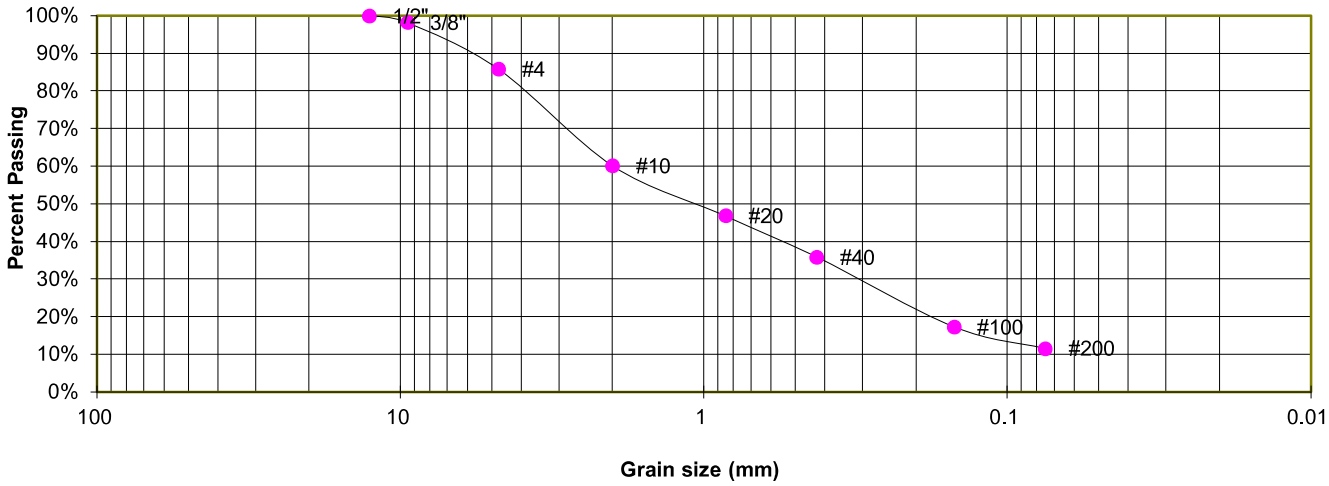
FIG. B-5

TEST BORING	5	SOIL DESCRIPTION	SANDSTONE (SAND, WITH SILT)
DEPTH (FT)	1-2	SOIL TYPE	5



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	98.2%
4	85.8%
10	60.2%
20	46.9%
40	35.9%
100	17.4%
200	11.6%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

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

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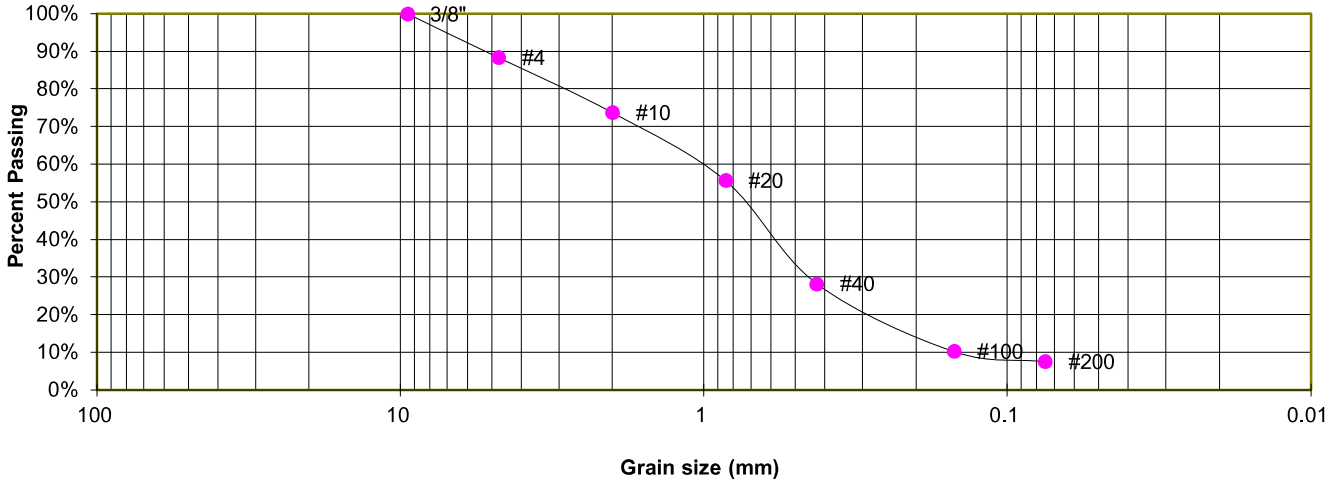
FIG. B-6

TEST BORING	6	SOIL DESCRIPTION	SANDSTONE (SAND, WITH SILT)
DEPTH (FT)	1-2	SOIL TYPE	5



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	88.4%
10	73.7%
20	55.7%
40	28.3%
100	10.3%
200	7.6%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

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

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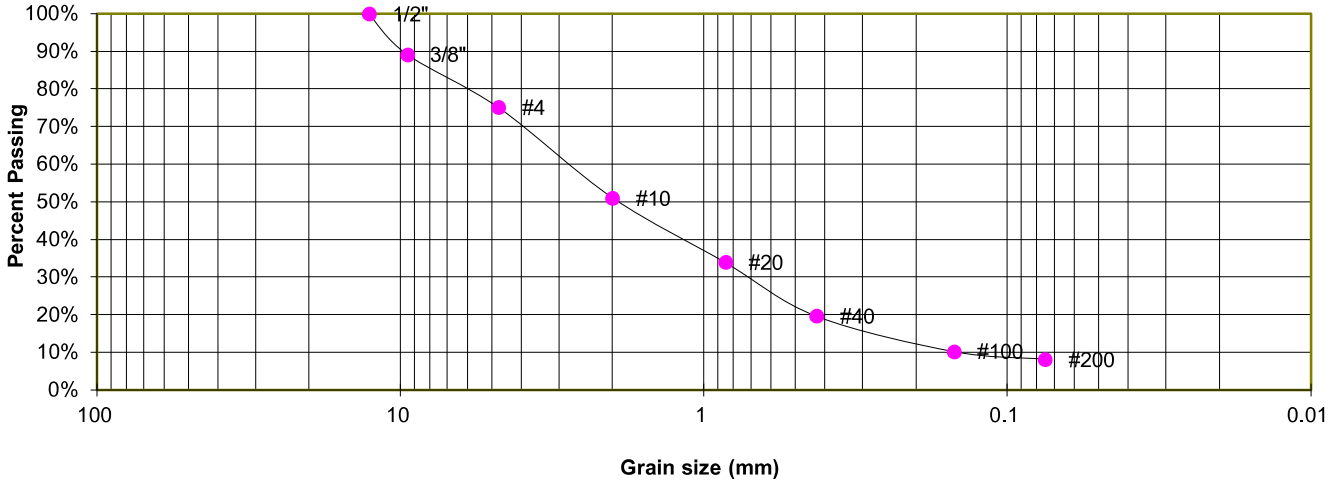
FIG. B-7

TEST BORING	7	SOIL DESCRIPTION	SANDSTONE (SAND, WITH SILT)
DEPTH (FT)	1-2	SOIL TYPE	5



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	89.2%
4	75.1%
10	51.0%
20	33.9%
40	19.6%
100	10.3%
200	8.2%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

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

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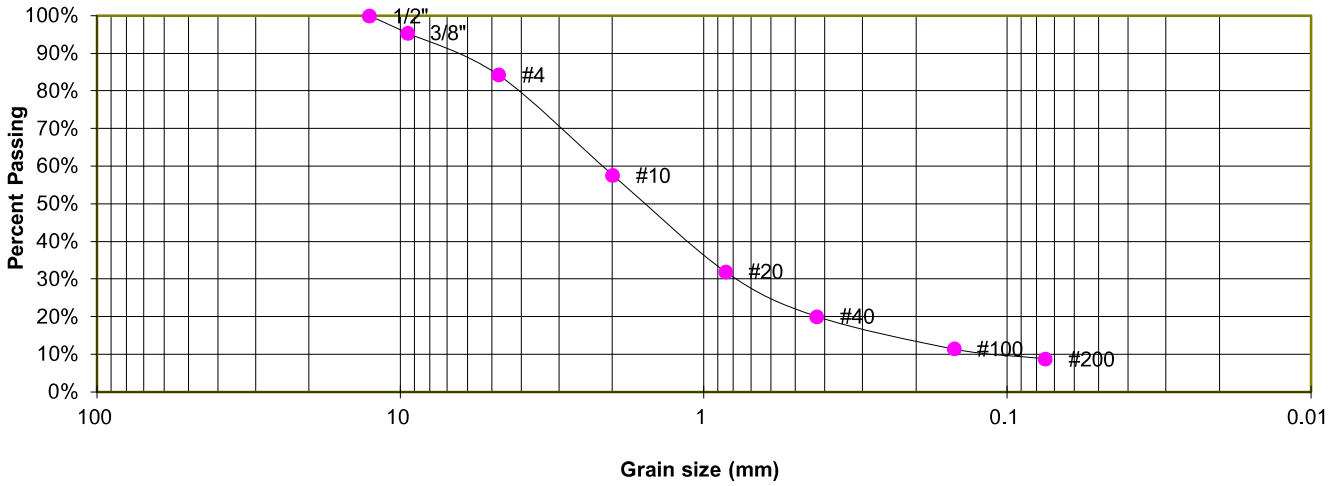
FIG. B-8

TEST BORING	8	SOIL DESCRIPTION	SAND, WITH SILT
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"	95.5%
4	84.2%
10	57.7%
20	32.0%
40	20.1%
100	11.5%
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
AASHTO GROUP INDEX: 0

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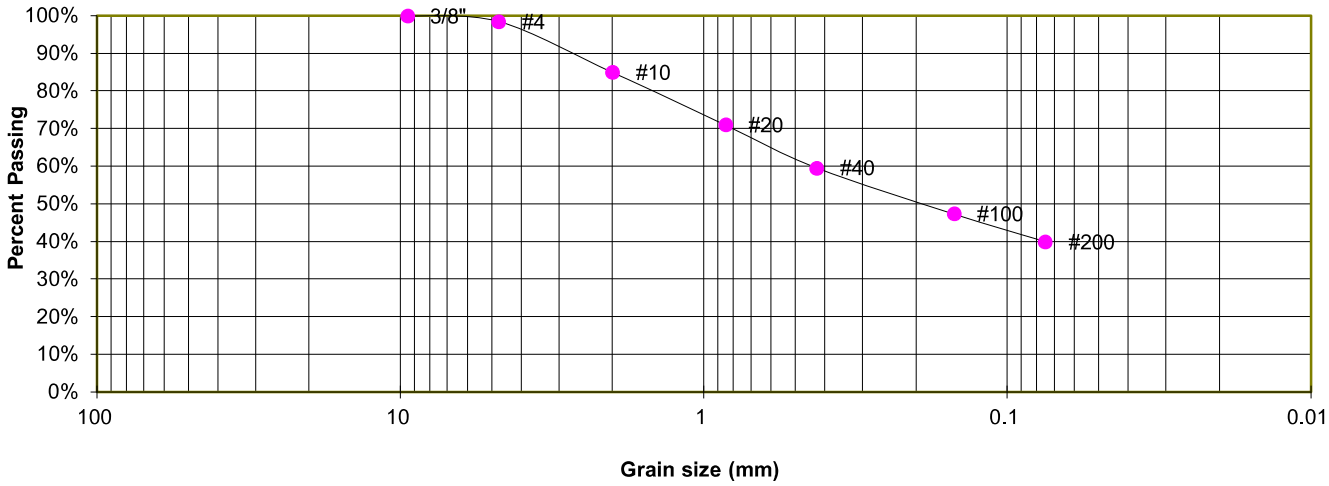
FIG. B-9

TEST BORING	10	SOIL DESCRIPTION	FILL, SAND, CLAYEY
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"	100.0%
4	98.5%
10	85.0%
20	71.0%
40	59.6%
100	47.4%
200	40.0%

ATTERBERG LIMITS

Plastic Limit	23
Liquid Limit	37
Plastic Index	14

SOIL CLASSIFICATION

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

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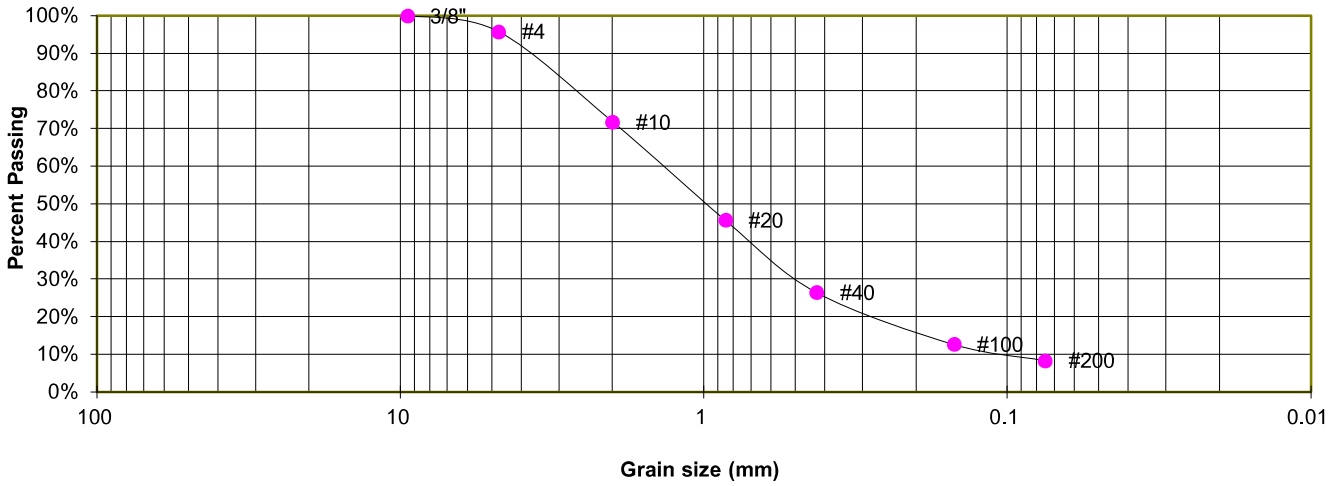
FIG. B-11

TEST BORING	9	SOIL DESCRIPTION	SAND, WITH SILT
DEPTH (FT)	1-2	SOIL TYPE	3



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.8%
10	71.8%
20	45.7%
40	26.4%
100	12.7%
200	8.4%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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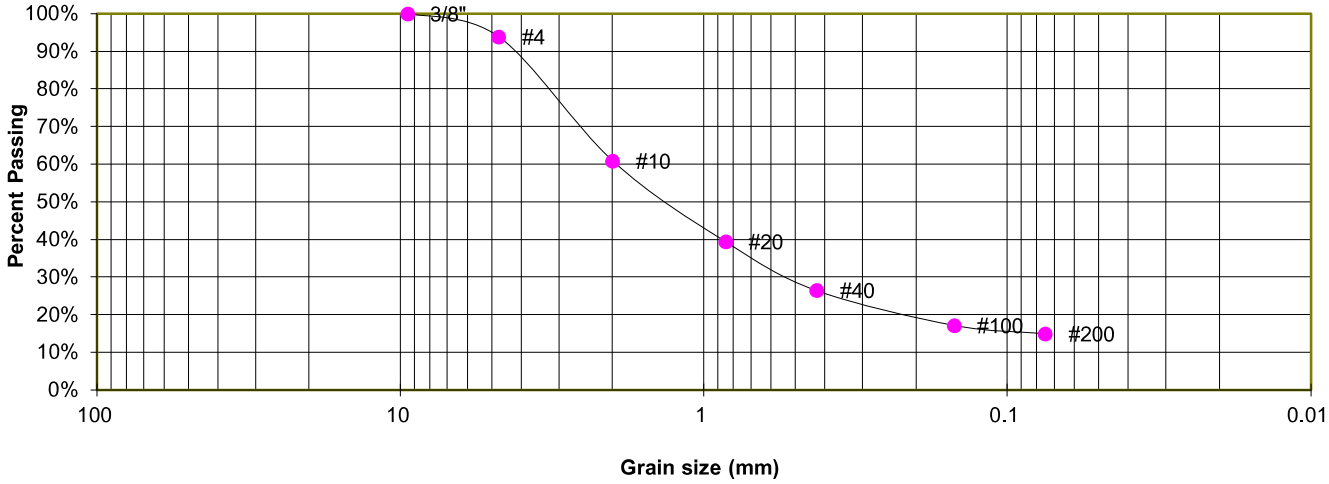
FIG. B-10

TEST BORING	1	SOIL DESCRIPTION	SANDSTONE (SAND, SILTY)
DEPTH (FT)	10	SOIL TYPE	5



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.9%
10	60.9%
20	39.4%
40	26.5%
100	17.2%
200	15.0%

ATTERBERG LIMITS

Plastic Limit	23
Liquid Limit	31
Plastic Index	8

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

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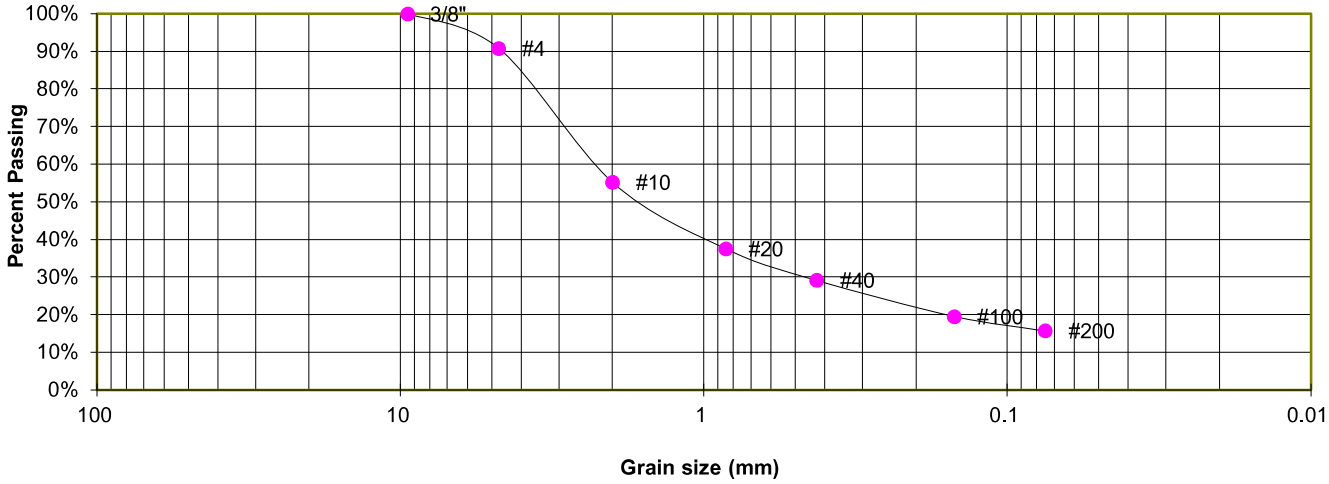
FIG. B-12

TEST BORING	9	SOIL DESCRIPTION	SANDSTONE (SAND, SILTY)
DEPTH (FT)	5	SOIL TYPE	5



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	90.8%
10	55.2%
20	37.6%
40	29.2%
100	19.6%
200	15.7%

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.

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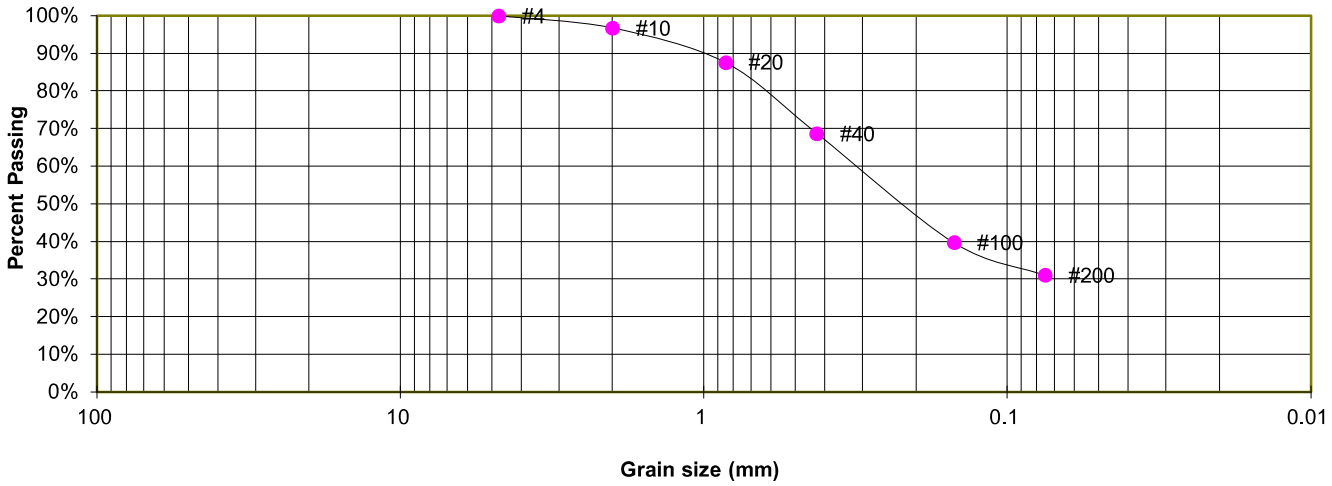
FIG. B-13

TEST BORING	3	SOIL DESCRIPTION	SANDSTONE (SAND, CLAYEY)
DEPTH (FT)	5	SOIL TYPE	6



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	96.8%
20	87.6%
40	68.7%
100	39.7%
200	31.1%

ATTERBERG LIMITS

Plastic Limit	19
Liquid Limit	28
Plastic Index	9

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

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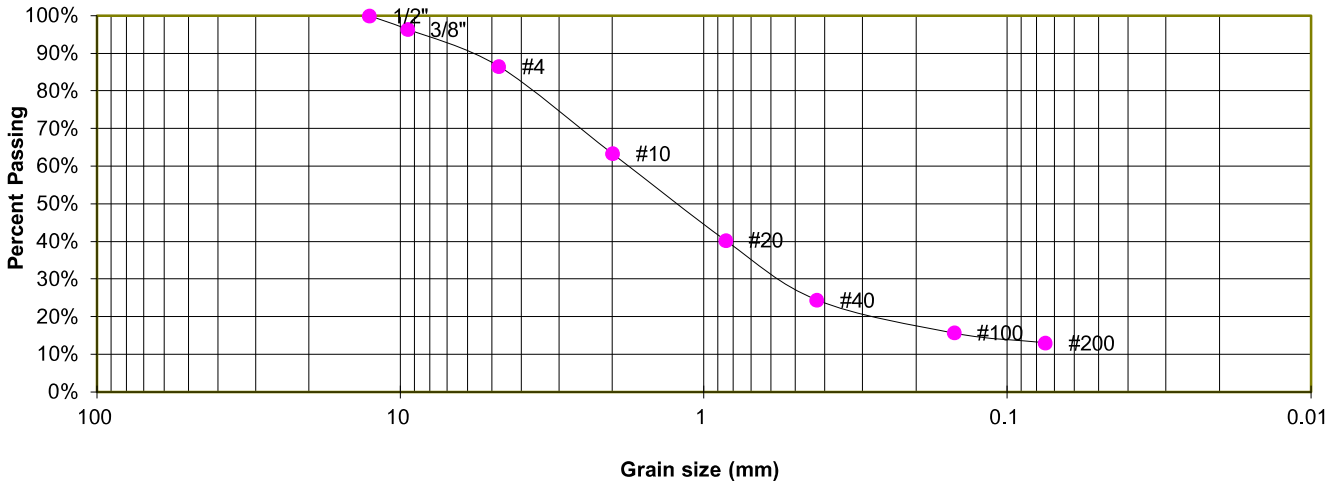
FIG. B-14

TEST BORING	8	SOIL DESCRIPTION	SANDSTONE (SAND, CLAYEY)
DEPTH (FT)	5	SOIL TYPE	6



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	96.4%
4	86.6%
10	63.3%
20	40.4%
40	24.5%
100	15.8%
200	13.1%

ATTERBERG LIMITS

Plastic Limit	21
Liquid Limit	41
Plastic Index	20

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SC
AASHTO CLASSIFICATION:	A-2-6
AASHTO GROUP INDEX:	0

ENTECH ENGINEERING, INC.

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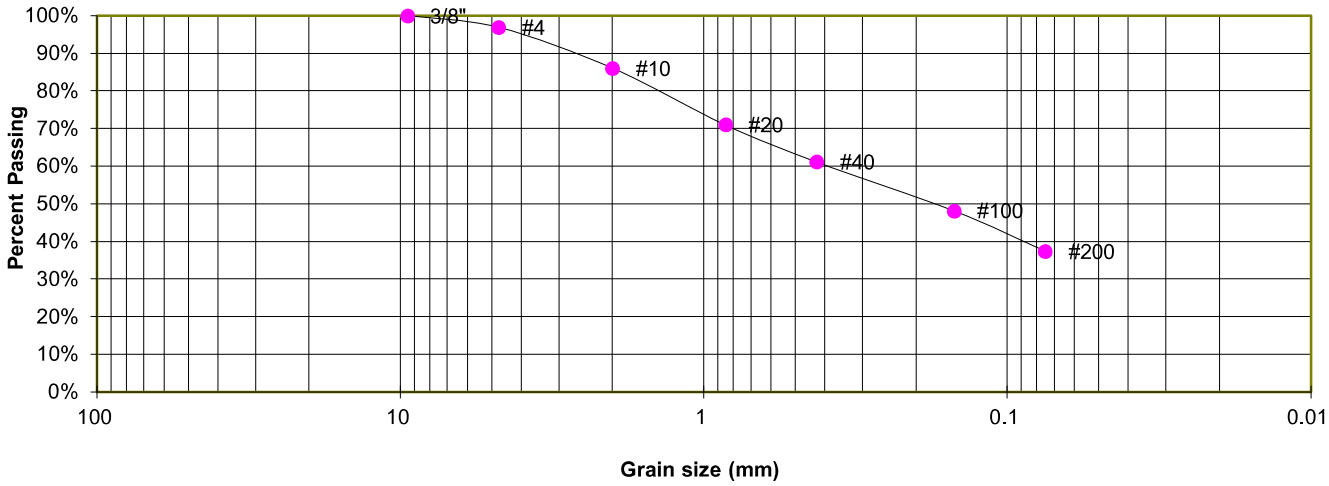
FIG. B-15

TEST BORING	10	SOIL DESCRIPTION	SAND, CLAYEY
DEPTH (FT)	5	SOIL TYPE	4



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.9%
10	86.1%
20	71.0%
40	61.2%
100	48.2%
200	37.4%

ATTERBERG LIMITS

Plastic Limit	15
Liquid Limit	24
Plastic Index	9

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SC
AASHTO CLASSIFICATION:	A-2-6
AASHTO GROUP INDEX:	0

ENTECH ENGINEERING, INC.

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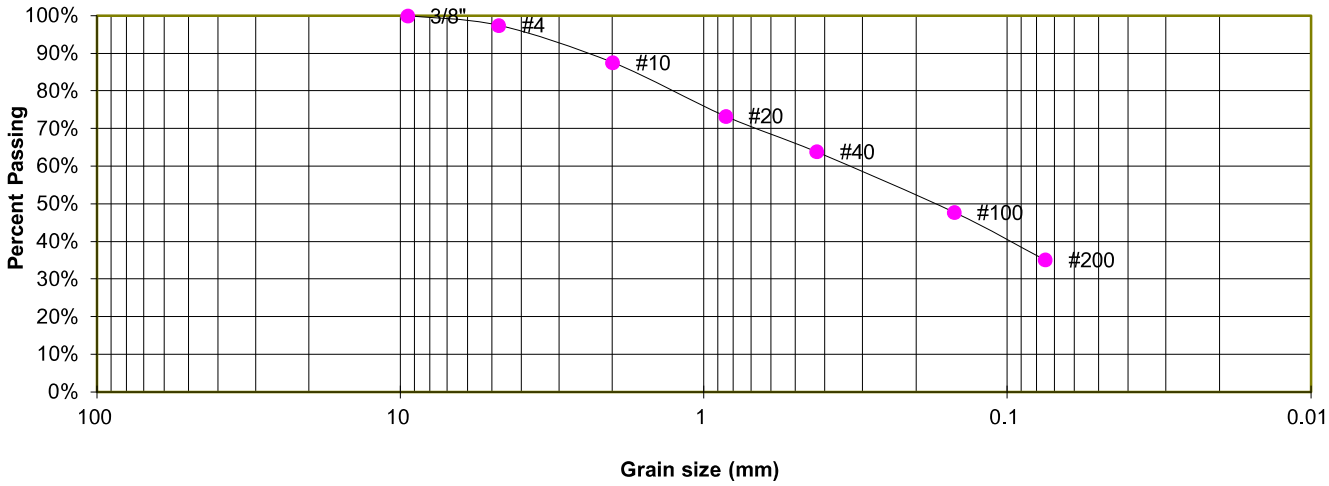
FIG. B-16

TEST BORING	7	SOIL DESCRIPTION	SANDSTONE (SAND, CLAYEY)
DEPTH (FT)	10	SOIL TYPE	6



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.5%
10	87.6%
20	73.3%
40	63.9%
100	47.8%
200	35.2%

SOIL CLASSIFICATION

USCS CLASSIFICATION: SC
AASHTO CLASSIFICATION:
AASHTO GROUP INDEX:

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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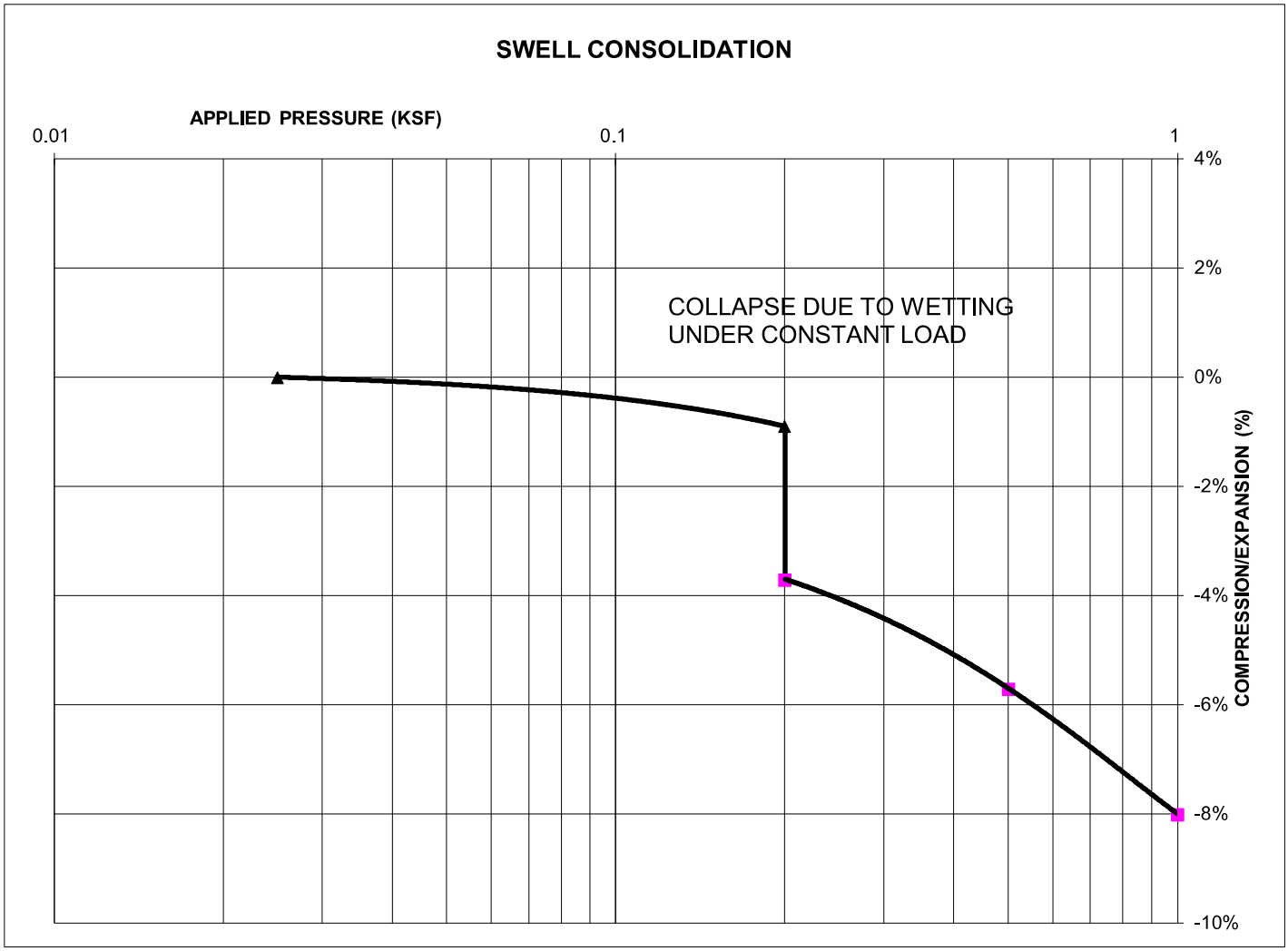
FIG. B-17

TEST BORING	7	SOIL DESCRIPTION	SANDSTONE (SAND, CLAYEY)
DEPTH (FT)	10	SOIL TYPE	6



SWELL/COLLAPSE TEST RESULTS

NATURAL UNIT DRY WEIGHT (PCF):	86
NATURAL MOISTURE CONTENT:	14.8%
SWELL/COLLAPSE (%):	-2.8%

ENTECH ENGINEERING, INC.

SWELL TEST RESULTS

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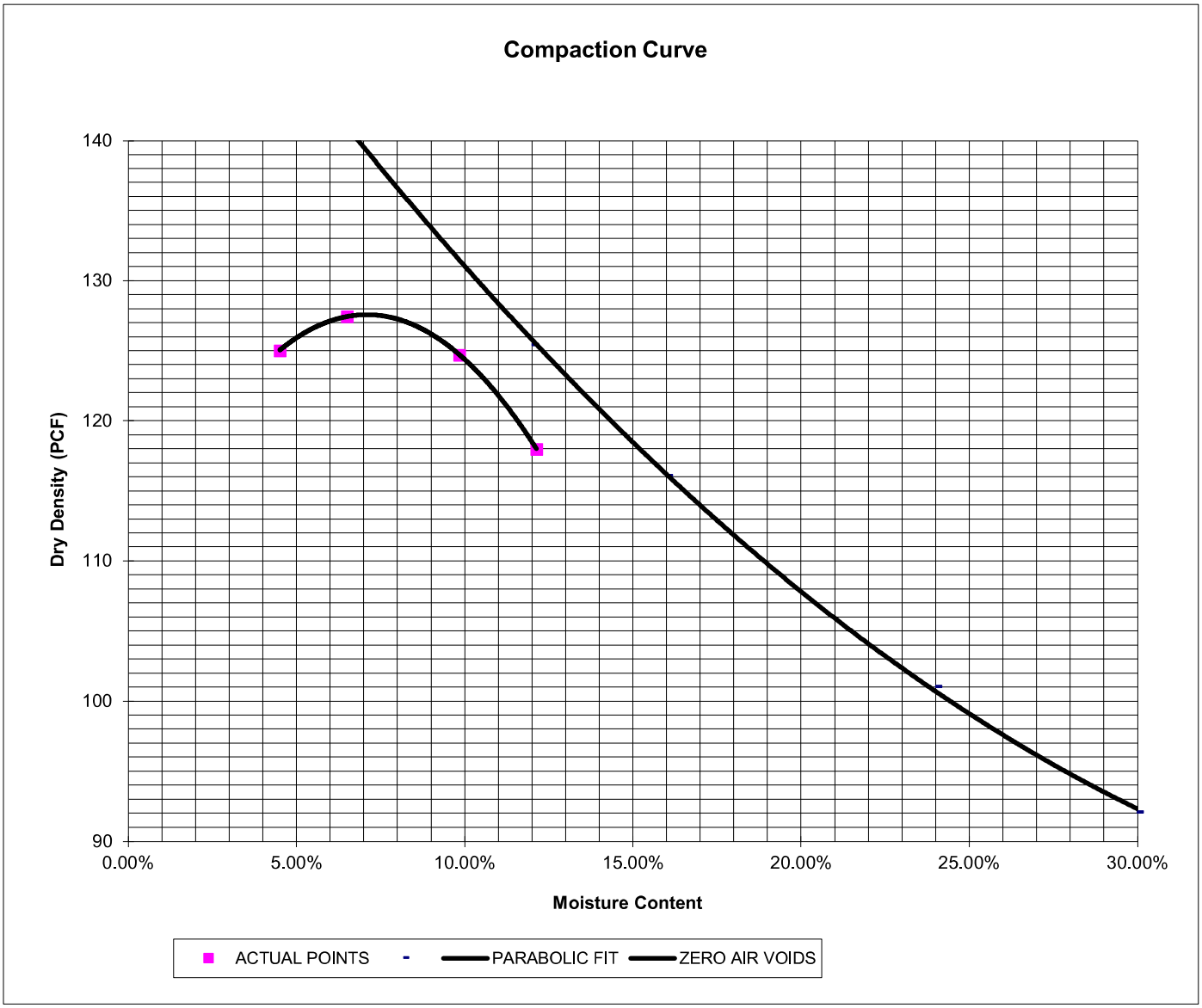
FIG. B-18

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

PROCTOR DATA

IDENTIFICATION:	SM
PROCTOR TEST #:	1
TEST BY:	DK
TEST DESIGNATION:	ASTM-1557-A
MAXIMUM DRY DENSITY (PCF):	127.6
OPTIMUM MOISTURE:	7.1



ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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FIG. B-19

SAMPLE LOCATION TB-1 @ 0-3' | SOIL DESCRIPTION FILL, SAND, SILTY, 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	437	146.03	746	249.29	1095	365.91
0.050	723	241.60	1440	481.20	2020	675.02
0.075	881	294.40	1855	619.88	2826	944.36
0.100	992	331.49	2166	723.81	3588	1198.99
0.125	1062	354.89	2410	805.34	4150	1386.80
0.150	1125	375.94	2600	868.84	4653	1554.88
0.175	1186	396.32	2768	924.98	5195	1736.00
0.200	1239	414.03	2916	974.43	5740	1918.12
0.300	1427	476.86	3482	1163.57	6000	2005.01
0.400	1565	522.97	3813	1274.18		
0.500	1713	572.43	4182	1397.49		

MOISTURE AND DENSITY DATA

	Mold # 1	Mold # 2	Mold # 3
Can #	350	351	352
Wt. Can	7.99	7.97	8.12
Wt. Can+Wet	239.14	232.82	196.74
Wt. Can+Dry	210.97	209.51	179.94
Wt. H20	28.17	23.31	16.8
Wt. Dry Soil	202.98	201.54	171.82
Moisture Content	13.88%	11.57%	9.78%
Wet Density (PCF)	126.0	132.5	138.6
Dry Density (PCF)	117.6	123.7	129.4
% Compaction	92%	97%	101%
CBR	33.15	72.38	119.90

PROCTOR DATA

Maximum Dry Density (pcf)	127.6
Optimum Moisture	7.1
90% of Max. Dry Density (pcf)	114.8
95% of Max. Dry Density (pcf)	121.2

CBR at 90% of Max. Density = 15.26	~ R VALUE 50
CBR at 95% of Max. Density = 56.53	~ R VALUE 76

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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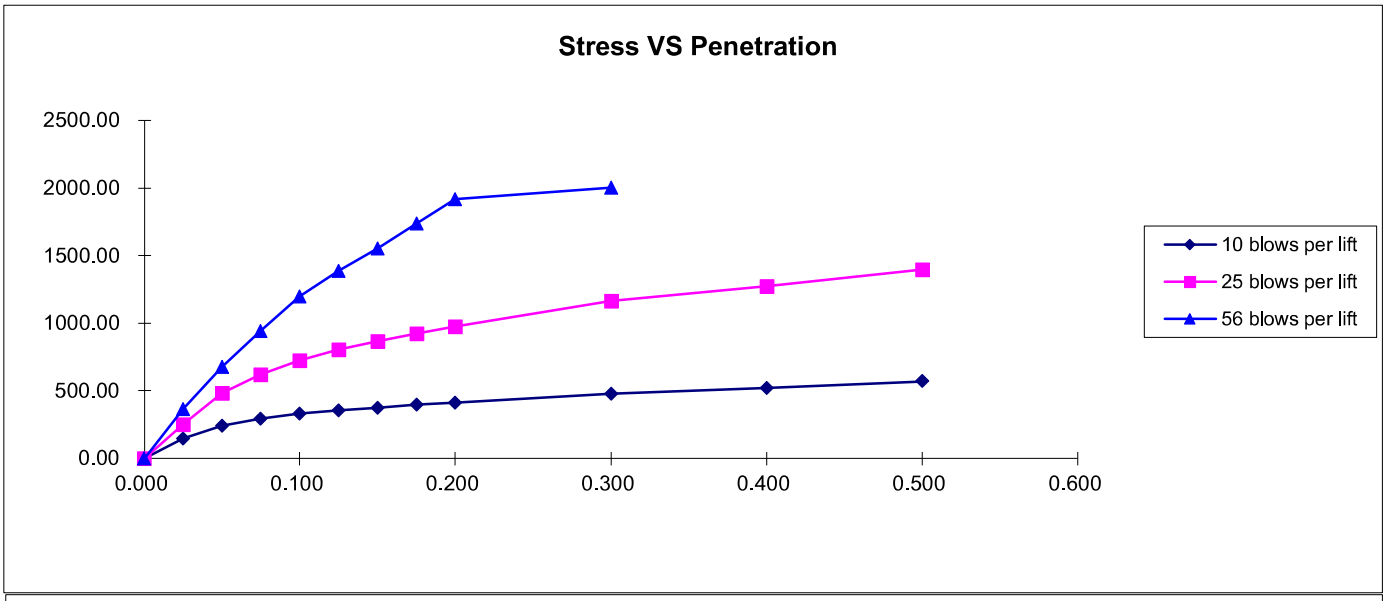
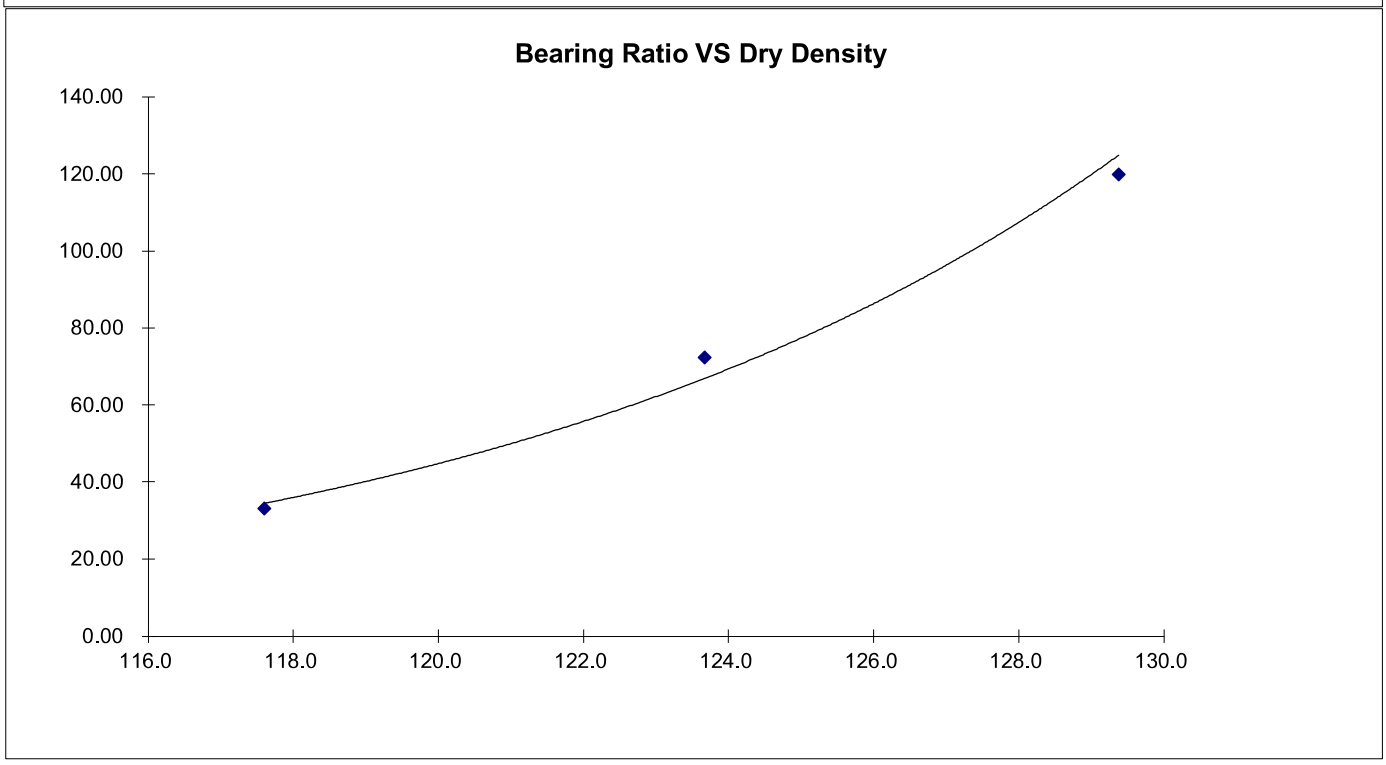
FIG. B-20

SAMPLE LOCATION TB-1 @ 0-3'

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





ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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FIG. B-21

ENTECH
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APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

PROJECT DATA

Project Location: Latigo Trails Filing No. 9 Local (low volume) Roadways

Job Number: 231802

DESIGN DATA

Equivalent (18-kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	36,500
Design CBR	CBR =	10
Standard Deviation	S_o =	0.44
Loss in Serviceability	Δpsi =	2.5
Reliability	Reliability =	80
Reliability (z-statistic)	Z_R =	-0.84
Soil Resilient Modulus	M_R =	15,000 psi

Required Structural Number (SN): → SN = 1.38

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		1.38

Pavement SN > Required SN, Design is Acceptable

FIG. C-1