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PAVEMENT DESIGN REPORT
ARROYA LANE
EL PASO COUNTY, COLORADO

PCD File No. SF2241

Prepared for:
TimberRidge Development Group, LLC
2138 Flying Horse Club Drive
Colorado Springs, CO 80921

Attn: Austin Lenz

December 30, 2024

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Lucas Morrison
Geotechnical Engineering Staff

Reviewed by:

COLORADO LICENSED PROFESSIONAL ENGINEER
JOSEPH C GOODE III
52381

Digitally signed by Joseph C Goode III
Date: 12/30/24

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

LJM:JCG/ed

Entech Job No. 241657

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1 Introduction

Entech Engineering, Inc. (Entech) completed this pavement design report for Arroya Lane within the Retreat at TimberRidge, Filing No. 3. 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 subconsultant to TimberRidge Development Group, 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 east of Vollmer Road and north of Aspen Valley Road within the Retreat at TimberRidge, Filing No. 3, in El Paso County, Colorado (Figure 1). The proposed improvements include paving Arroya Lane from the western extent at Volmer Road to the east approximately 2,080 feet where the proposed temporary turn around will be located. The extent of our investigation is shown in Figure 2.

At the time of our subsurface exploration program, the existing roadway was functioning as a gravel road and utilities had been installed. Surrounding properties are comprised of vacant land, land being developed for future residential lots, and an existing subdivision. Based on the development plans, the roadway is designated as a rural minor collector roadway.

3 Subsurface Explorations and Laboratory Testing

3.1 Subsurface Exploration Program

Subsurface conditions at the project site were explored by five test borings, designated TB-1 through TB-5, drilled on November 5 and November 12, 2024. The locations of the test borings are shown on the Site and Exploration Plan (Figure 2). Due to utility conflicts the borings were completed directly adjacent to existing roadway profile. 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.

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.

Strength testing was performed on two sets of soil/cement composite samples. Testing was performed on soil 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 5-day average strength value of the 2% mix was 292 psi and the 5-day strength of the 4% mix was 331 psi. A 2% mix is recommended based on the laboratory test results. A summary of the testing results is attached in Appendix B, Table B-2.

4 Subgrade Conditions

Two 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 loose clayey sand fill (Soil Type 1, AASHTO A-1-b, A-2-4, A-2-6) and native medium dense to dense slightly silty to silty sand and sand with silt (Soil Type 2, AASHTO A-1-b). Very weak sandstone bedrock, or very dense silty sand when classified as a soil (Soil Type 3, AASHTO A-1-b), was encountered in two of the test borings (TB-1 and TB-3) underlying Soil Types 1 and 2. Water soluble sulfate tests indicated that the soils exhibit a negligible potential for sulfate attack.

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 a representative sample of the Soil Type 2 native silty sand subgrade from TB-2 to determine the support characteristics of the subgrade soils. 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	2 – Silty Sand
CBR at 95%	21.9
Design CBR	10
Liquid Limit	NV
Plasticity Index	NP
Percent Passing 200	22.7
AASHTO Classification	A-1-b
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 subgrade soils classification mitigation for expansive soils will not be required on this site.

5.3 Traffic Loading

Traffic data is not available for the future Arroya Lane roadway in the Retreat at TimberRidge, Filing No. 3; however, the roadway is classified as a rural minor collector roadway based on current development plans. Refer to the Traffic Impact Study, *Retreat at TimberRidge Filing No. 3 Traffic Technical Memorandum SF2241, LSC Transportation Consultants* for additional information. 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 109,500 was used for the rural minor collector road designation.

5.4 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 2.

Exhibit 2: Pavement Design Parameters

Design Parameter	Value
Reliability	80%
Standard Deviation	0.45
Serviceability Loss (Δ psi)	2.0
Design CBR	10
Resilient Modulus	15,000 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 Arroya Lane are summarized in Exhibit 3. The pavement design calculations are presented in Appendix C.

Exhibit 3: Recommended Pavement Sections

Pavement Area	Design ESAL	Alternative [1]
Arroya Lane	109,500	1. 4.0 inches HMA over 6.0 inches ABC/RCB
		2. 4.0 inches HMA over 8.0 inches CTS [2]

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

Notes:

1. All pavement alternatives meet the minimum sections required per the *El Paso County Engineering Criteria Manual.*
2. 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, if any, should be removed by stripping, with the depth to be field determined.

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 Base

Prior to placement of cement stabilization, a preliminary proof roll should be completed 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.

Following the preliminary proof roll, the subgrade shall be stabilized by the addition of cement. The amount of cement applied shall be a minimum of 4% (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. The cement should be spread evenly on the subgrade surface and be thoroughly mixed into the subgrade such that a uniform blend of soil and cement is achieved to the CTS design depth. Densification of the cement-stabilized subgrade should be completed to obtain a compaction of at least 95% of the subgrade 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 I/II or 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. Testing reports will be provided to El Paso County as construction progresses.
- A minimum 7-day CTS compressive strength of 125 psi must be achieved.
- Soil strengths in excess of 275 psi will require microfracturing. Microfracturing will be completed using the Standard Method as defined by the *City of Colorado Springs Draft Standard Specification,* Section 305 – Chemically Treated Subgrade. Microfracturing will be performed with the same (or equivalent tonnage) steel drum vibratory roller used for

compaction of the CTS. A minimum of 12-ton roller shall be used. Three full passes with the roller operating at maximum amplitude and traveling at 2- 3 mph 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 10. 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*, Section 300 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 to severe exposure threat to concrete placed below the site grade.

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 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. Construction observation requirements as presented in the Use of CTS for Paving Season Memorandum should be followed.

7 Closure

The subsurface investigation, geotechnical evaluation, and recommendations presented in this report are intended for use by TimberRidge Development Group, LLC with application to the paving of Arroya Lane 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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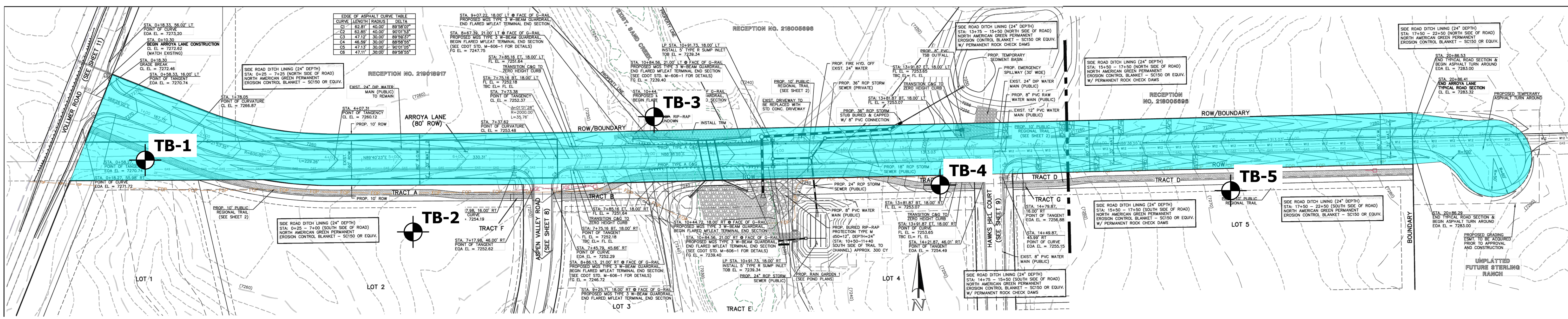
VICINITY MAP

ARROYA LANE
TIMBERRIDGE DEVELOPMENT, LLC

JOB NO.
241657

FIG. 1



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Arroya Lane

Rural Minor Collector

Design 18-KIP ESAL=109,500

Soil Type 2 (AASHTO A-1-B)

Pavement Section Alternatives:

1. 4" HMA over 6" ABC/RCB
2. 4" HMA over 8" CTS

TB- APPROXIMATE TEST BORING LOCATION AND NUMBER

SCALE: 0 50 100

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SITE AND EXPLORATION PLAN

ARROYA LANE
TIMBERRIDGE DEVELOPMENT, LLC

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FIG. 2

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APPENDIX A: Test Boring Logs

TEST BORING 1

DATE DRILLED 11/5/2024

REMARKS

DRY TO 5', 11/5/24

	Depth (ft)	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-1', SAND, CLAYEY, BROWN					1
SANDSTONE, VERY WEAK, BROWN, HIGHLY WEATHERED (SAND, SILTY, VERY DENSE, MOIST)		■	50/11"	12.5	3
	5	■	50/8"	7.9	3

Depth scale: 5, 10, 15, 20

TEST BORING 2

DATE DRILLED 11/12/2024

REMARKS

DRY TO 5', 11/12/24

	Depth (ft)	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-1', SAND, SILTY, BROWN					
SAND, SILTY, LIGHT BROWN, MEDIUM DENSE to DENSE, DRY to MOIST		■	14	1.5	2
	5	■	45	7.1	2

Depth scale: 5, 10, 15, 20

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TEST BORING LOGS

ARROYA LANE
TIMBERRIDGE DEVELOPMENT

JOB NO.
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FIG. A-1

TEST BORING 3
DATE DRILLED 11/12/2024
REMARKS
DRY TO 10', 11/12/24

Description	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
SAND, SILTY, TAN, DENSE, MOIST			■	40	7.4	2
SANDSTONE, VERY WEAK, BROWN to LIGHT BROWN, HIGHLY WEATHERED (SAND, SILTY, VERY DENSE, MOIST)	5		■	50/11"	7.9	3
	10		■	50/7"	6.9	3
	15					
	20					

TEST BORING 4
DATE DRILLED 11/12/2024
REMARKS
DRY TO 5', 11/12/24

Description	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-5', SAND, CLAYEY, DARK BROWN, MEDIUM DENSE to LOOSE, MOIST to DRY			■	17	3.5	1
	5		■	7	1.6	1
	10					
	15					
	20					

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TEST BORING LOGS

ARROYA LANE
TIMBERRIDGE DEVELOPMENT

JOB NO. 241657

FIG. A-2

TEST BORING 5
DATE DRILLED 11/12/2024
REMARKS

DRY TO 5', 11/12/24

Description	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
FILL 0-3', SAND, CLAYEY, BROWN, MEDIUM DENSE, MOIST				20	5.0	1
SAND, WITH SILT, LIGHT BROWN, MEDIUM DENSE, DRY	5			22	2.9	2
	10					
	15					
	20					

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TEST BORING LOGS

ARROYA LANE
TIMBERRIDGE DEVELOPMENT

JOB NO.
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FIG. A-3

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APPENDIX B: Laboratory Test Results

TABLE B-1
SUMMARY OF LABORATORY TEST RESULTS

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	SULFATE (WT %)	AASHTO CLASS. (GROUP INDEX)	USCS	SOIL DESCRIPTION
1	4	1-2	3.5	21.3	28	21	7	<0.01	A-1-b (0)	SC	FILL, SAND, CLAYEY
1	5	1-2	5.0	22.6	27	18	9		A-2-4 (0)	SC	FILL, SAND, CLAYEY
1	1	0-1	3.2	30.4	33	20	13		A-2-6 (0)	SC	FILL, SAND, CLAYEY
1	4	0-3	7.9	20.5	28	24	4		A-1-b (0)	SM	FILL, SAND, CLAYEY
2, CBR	2	0-3	1.6	22.7	NV	NP	NP		A-1-b (0)	SM	SAND, SILTY
2	2	1-2	1.5	3.8	NV	NP	NP	0.00	A-1-b (0)	SW	SAND, SLIGHTLY SILTY
2	3	1-2	7.4	17.2	NV	NP	NP		A-1-b (0)	SM	SAND, SILTY
2	5	5	2.9	7.5	NV	NP	NP		A-1-b (0)	SW-SM	SAND, WITH SILT
3	1	1-2	12.5	24.4	43	27	16	0.00	A-1-b (0)	SM	SANDSTONE (SAND, SILTY)
3	3	10	6.9	19.4	NV	NP	NP		A-1-b (0)	SM	SANDSTONE (SAND, SILTY)

TABLE B-2

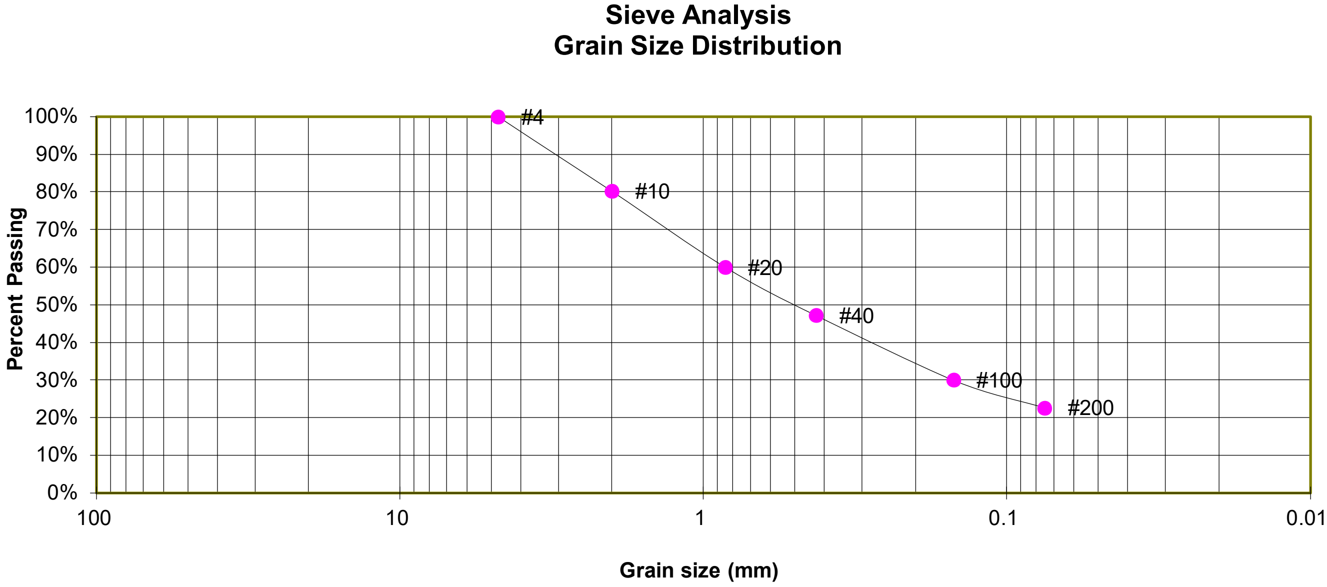
SUMMARY OF CTS TEST RESULTS

FIELD SAMPLE ID	SOIL ADDITIVE	ADDITIVE PERCENTAGE (%)	WATER CONTENT (%)	DENSITY (dry)	AGE (days)	STRENGTH (psi)
TB-2 @ 0-3'	TYPE IL CEMENT	2	7.6	132.4	5	292
				131.9		280
				132.9		305
					AVERAGE:	**292**
TB-2 @ 0-3'	TYPE IL CEMENT	4	7.6	133.1	5	323
				133.8		350
				133.2		321
					AVERAGE:	**331**

<u>Notes:</u>

1. CURING METHOD: 100° HUMIDIFIED OVEN

TEST BORING	2	SOIL DESCRIPTION	SAND, SILTY
DEPTH (FT)	0-3	SOIL TYPE	2, CBR



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	80.2%
20	60.1%
40	47.2%
100	30.1%
200	22.7%

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

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LABORATORY TEST RESULTS

ARROYA LANE
TIMBERRIDGE DEVELOPMENT

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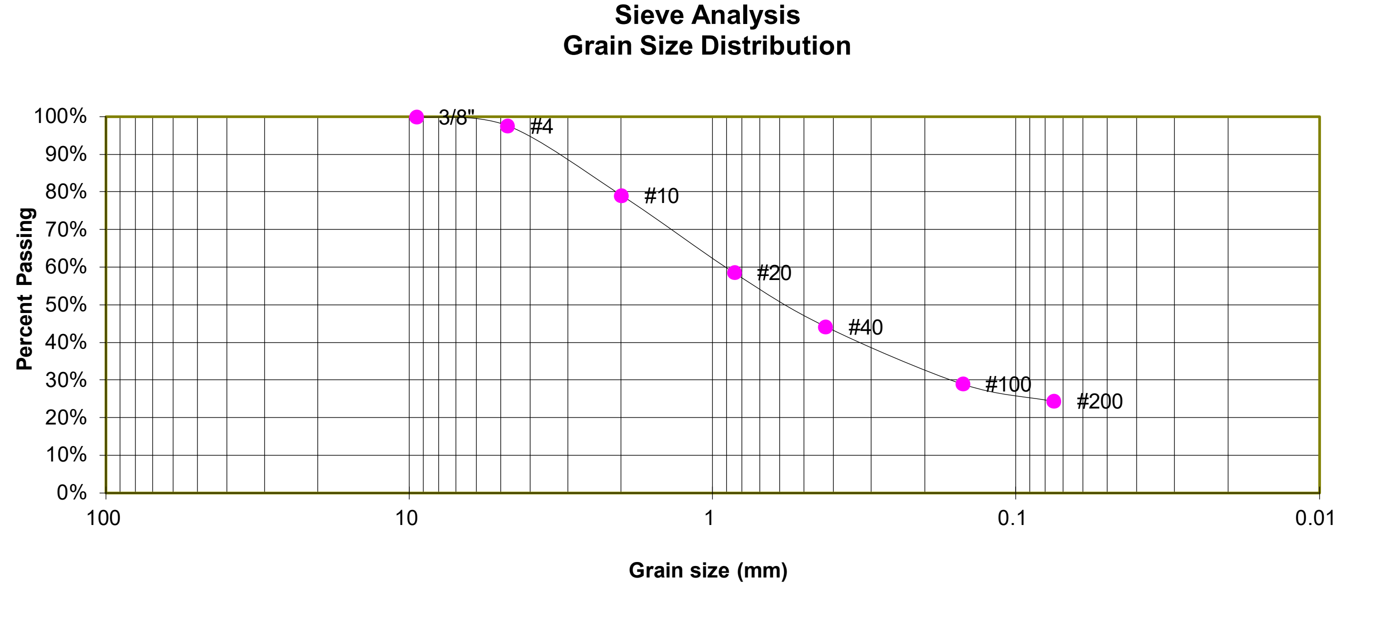
FIG. B-1

TEST BORING	1	SOIL DESCRIPTION	SANDSTONE (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"	
3/8"	100.0%
4	97.6%
10	79.1%
20	58.6%
40	44.2%
100	29.0%
200	24.4%

ATTERBERG LIMITS

Plastic Limit	27
Liquid Limit	43
Plastic Index	16

SOIL CLASSIFICATION

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

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LABORATORY TEST RESULTS

ARROYA LANE
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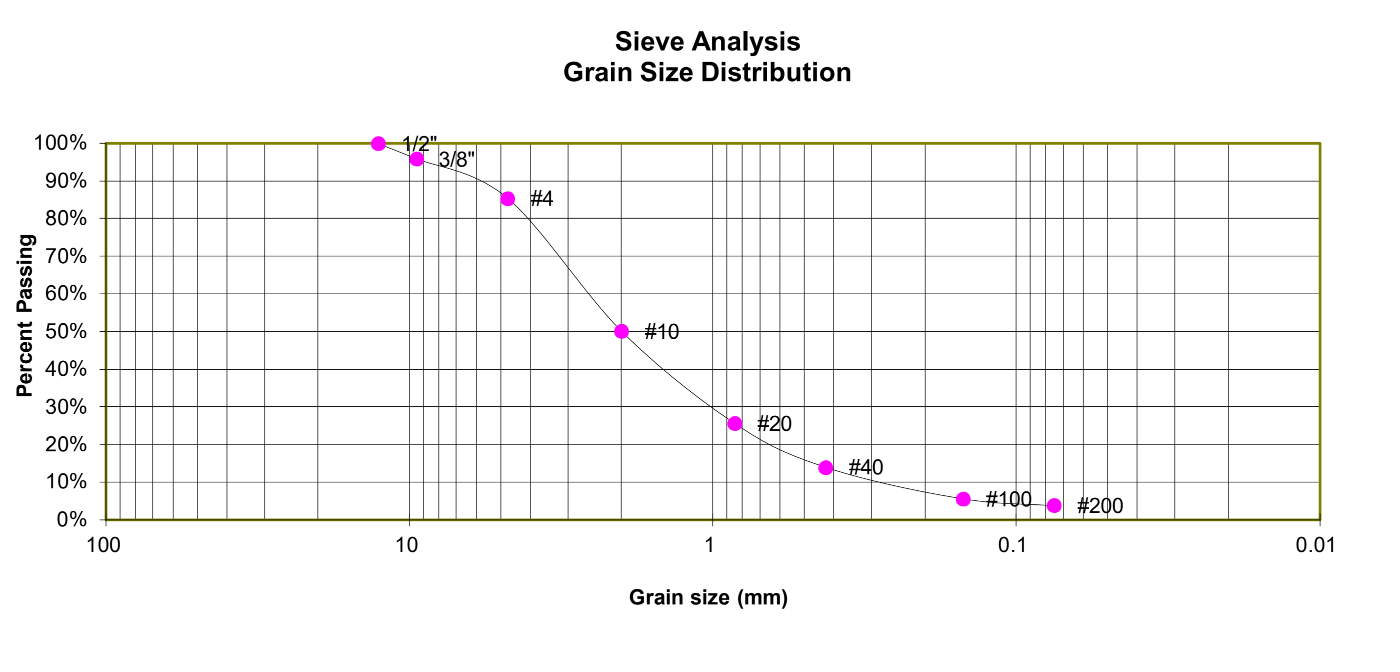
FIG. B-2

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



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	96.0%
4	85.4%
10	50.1%
20	25.7%
40	14.0%
100	5.6%
200	3.8%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

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

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LABORATORY TEST RESULTS

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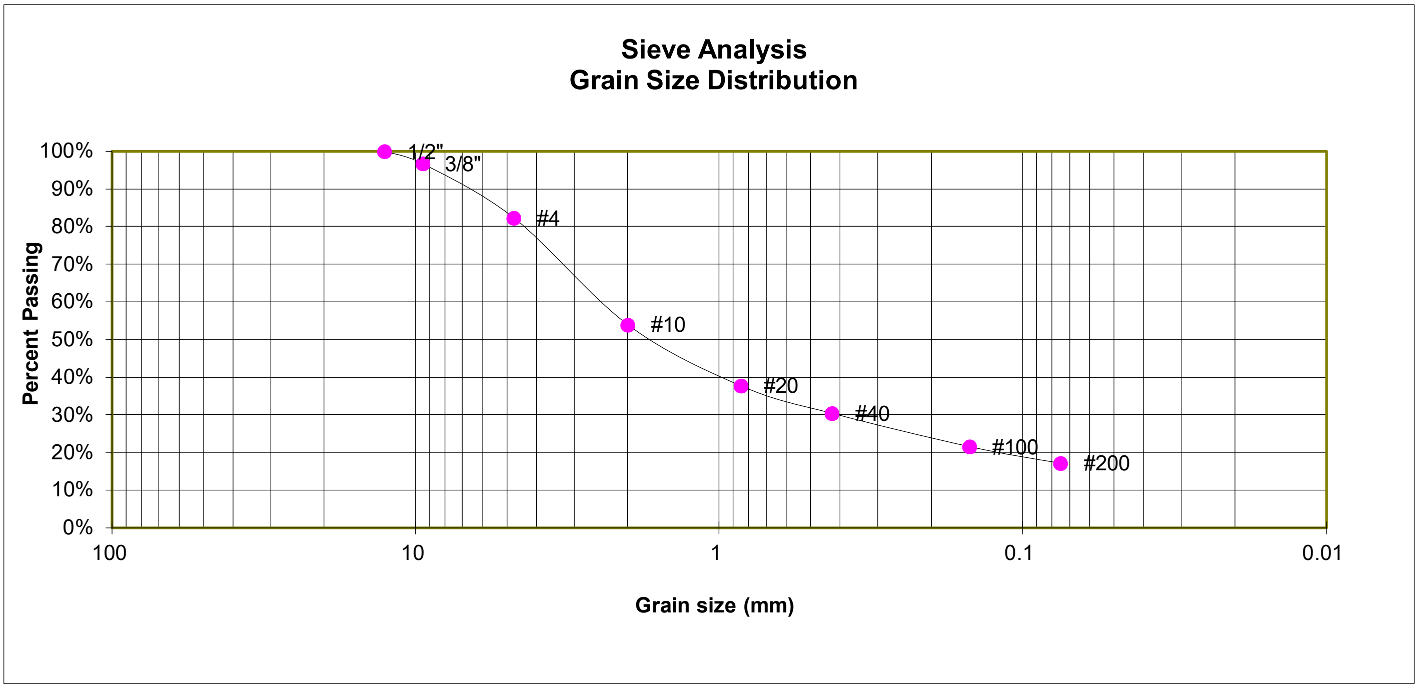
FIG. B-3

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



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	96.7%
4	82.3%
10	54.0%
20	37.8%
40	30.4%
100	21.6%
200	17.2%

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

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LABORATORY TEST RESULTS

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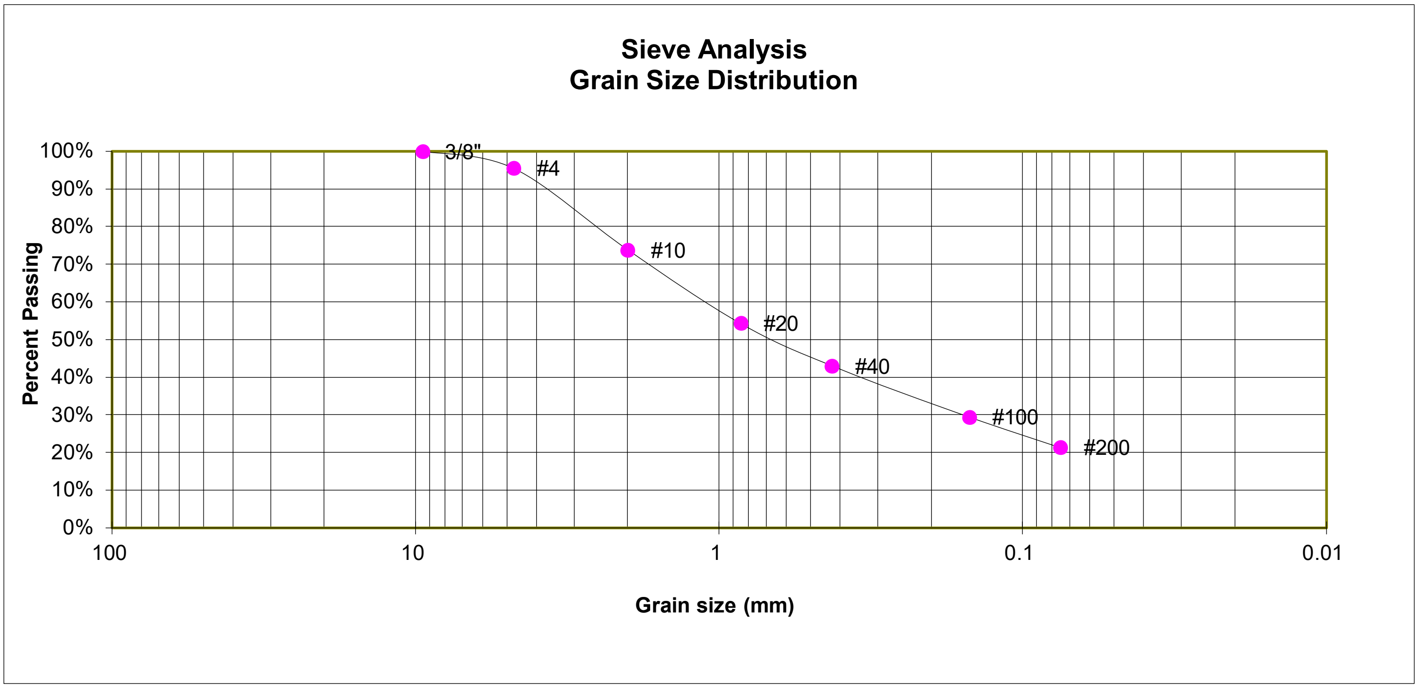
FIG. B-4

TEST BORING	4	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	95.5%
10	73.8%
20	54.3%
40	43.0%
100	29.5%
200	21.3%

ATTERBERG LIMITS

Plastic Limit	21
Liquid Limit	28
Plastic Index	7

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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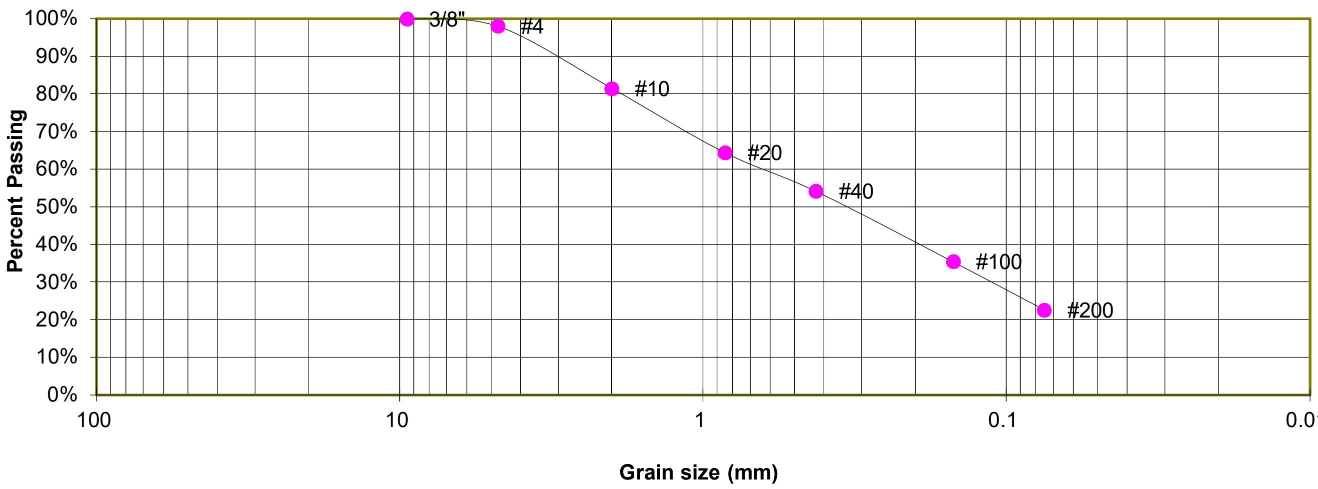
FIG. B-5

TEST BORING	5	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	81.5%
20	64.4%
40	54.2%
100	35.4%
200	22.6%

ATTERBERG LIMITS

Plastic Limit	18
Liquid Limit	27
Plastic Index	9

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

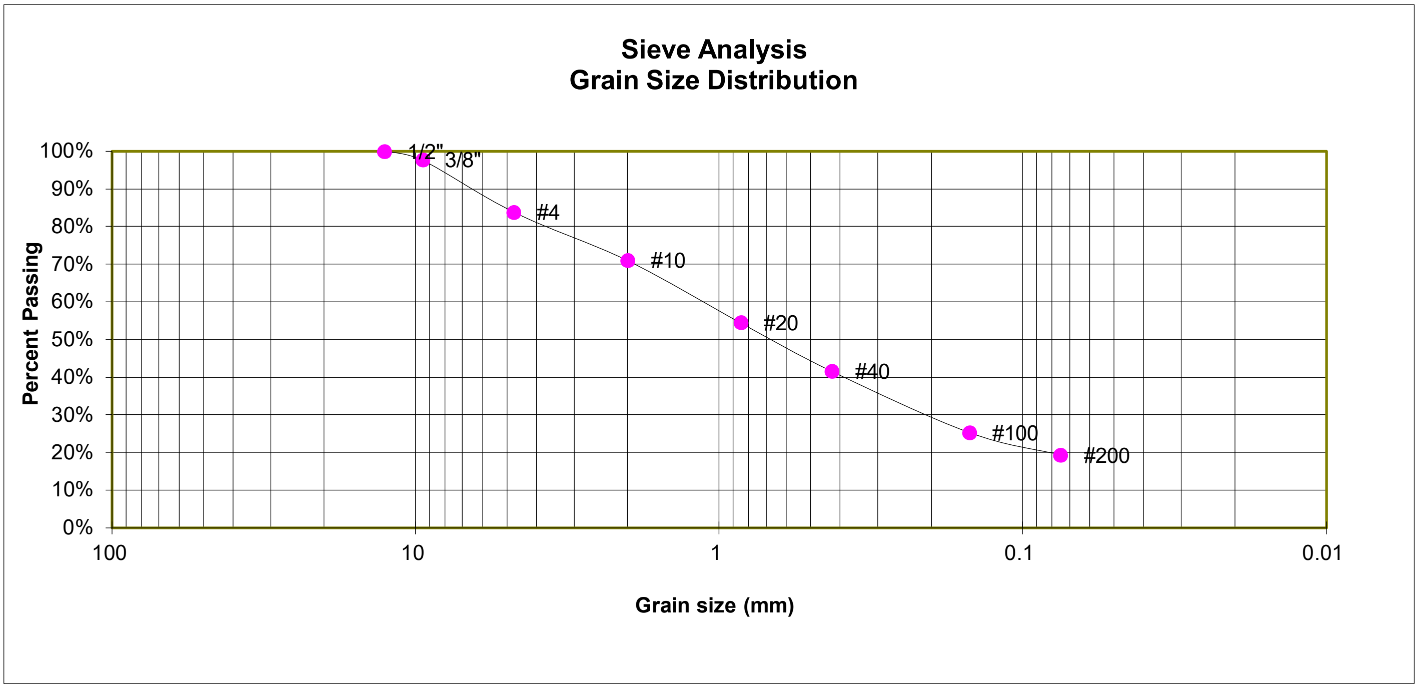
LABORATORY TEST RESULTS

ARROYA LANE
TIMBERRIDGE DEVELOPMENT

JOB NO.
241657

FIG. B-6

TEST BORING	3	SOIL DESCRIPTION	SANDSTONE (SAND, SILTY)
DEPTH (FT)	10	SOIL TYPE	3



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.7%
4	83.8%
10	71.0%
20	54.5%
40	41.6%
100	25.3%
200	19.4%

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

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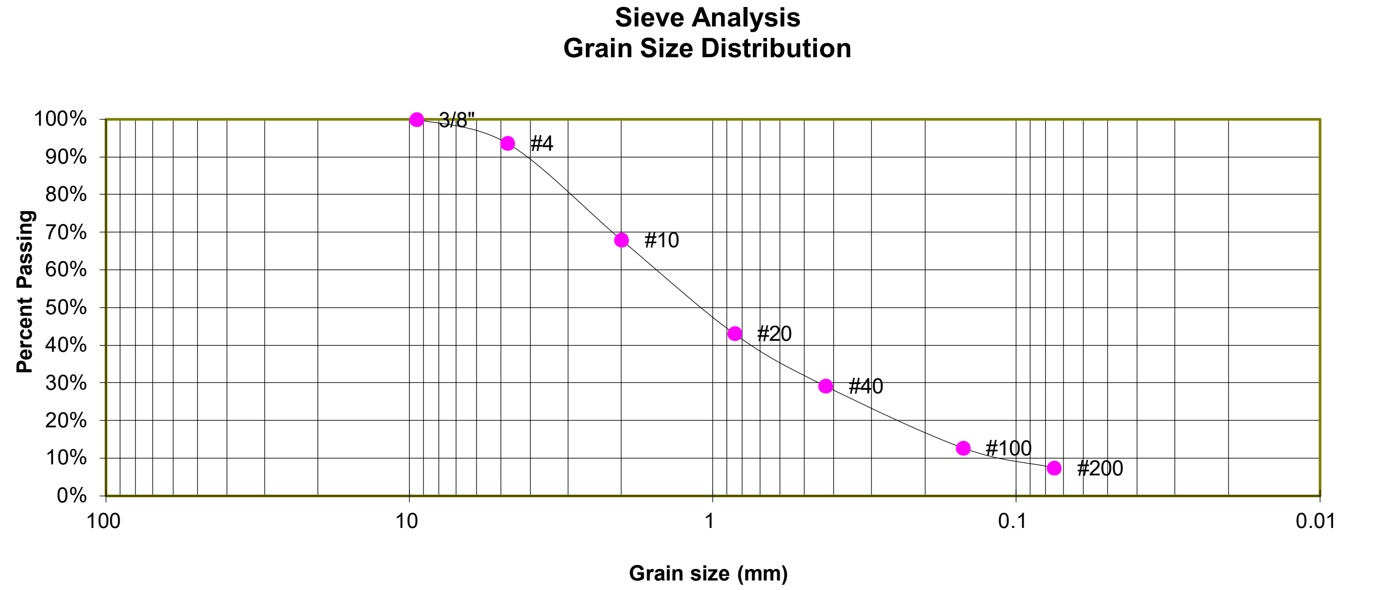
FIG. B-7

TEST BORING	5	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	93.6%
10	67.9%
20	43.1%
40	29.2%
100	12.7%
200	7.5%

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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JOB NO.
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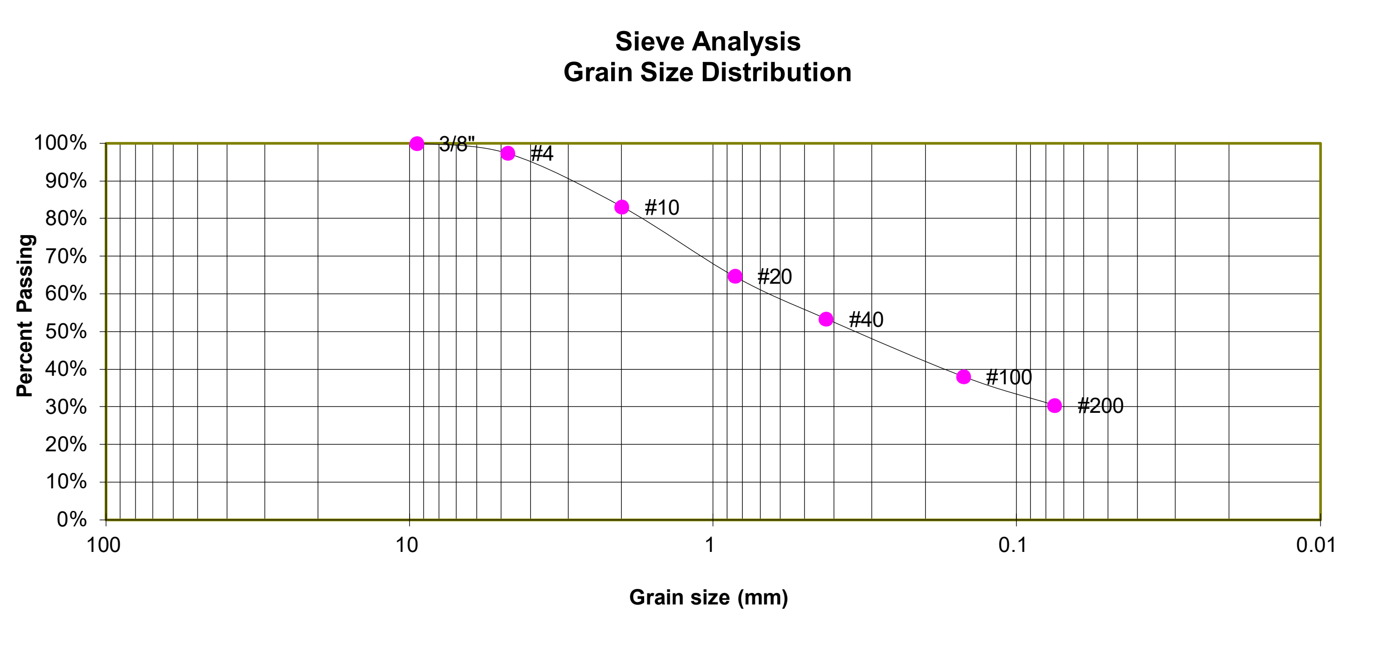
FIG. B-8

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



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.4%
10	83.2%
20	64.7%
40	53.4%
100	38.1%
200	30.4%

ATTERBERG LIMITS

Plastic Limit	20
Liquid Limit	33
Plastic Index	13

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

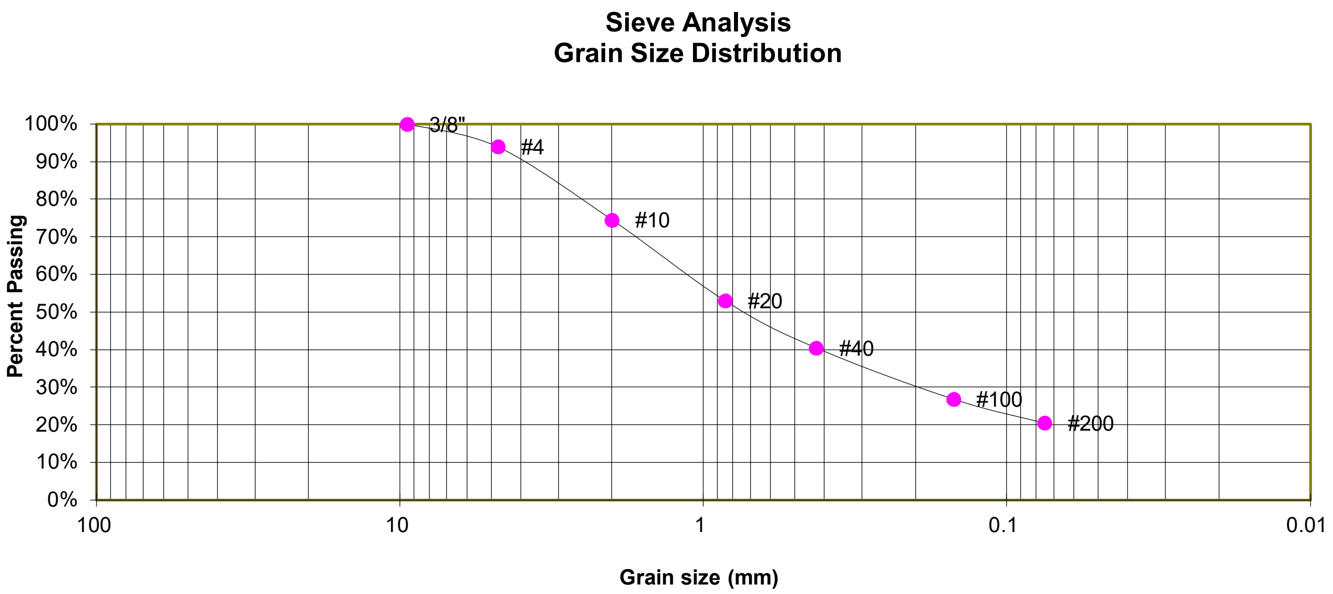
LABORATORY TEST RESULTS

ARROYA LANE
TIMBERRIDGE DEVELOPMENT

JOB NO. 241657

FIG. B-9

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



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.0%
10	74.5%
20	53.0%
40	40.5%
100	26.9%
200	20.5%

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

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

ARROYA LANE
TIMBERRIDGE DEVELOPMENT

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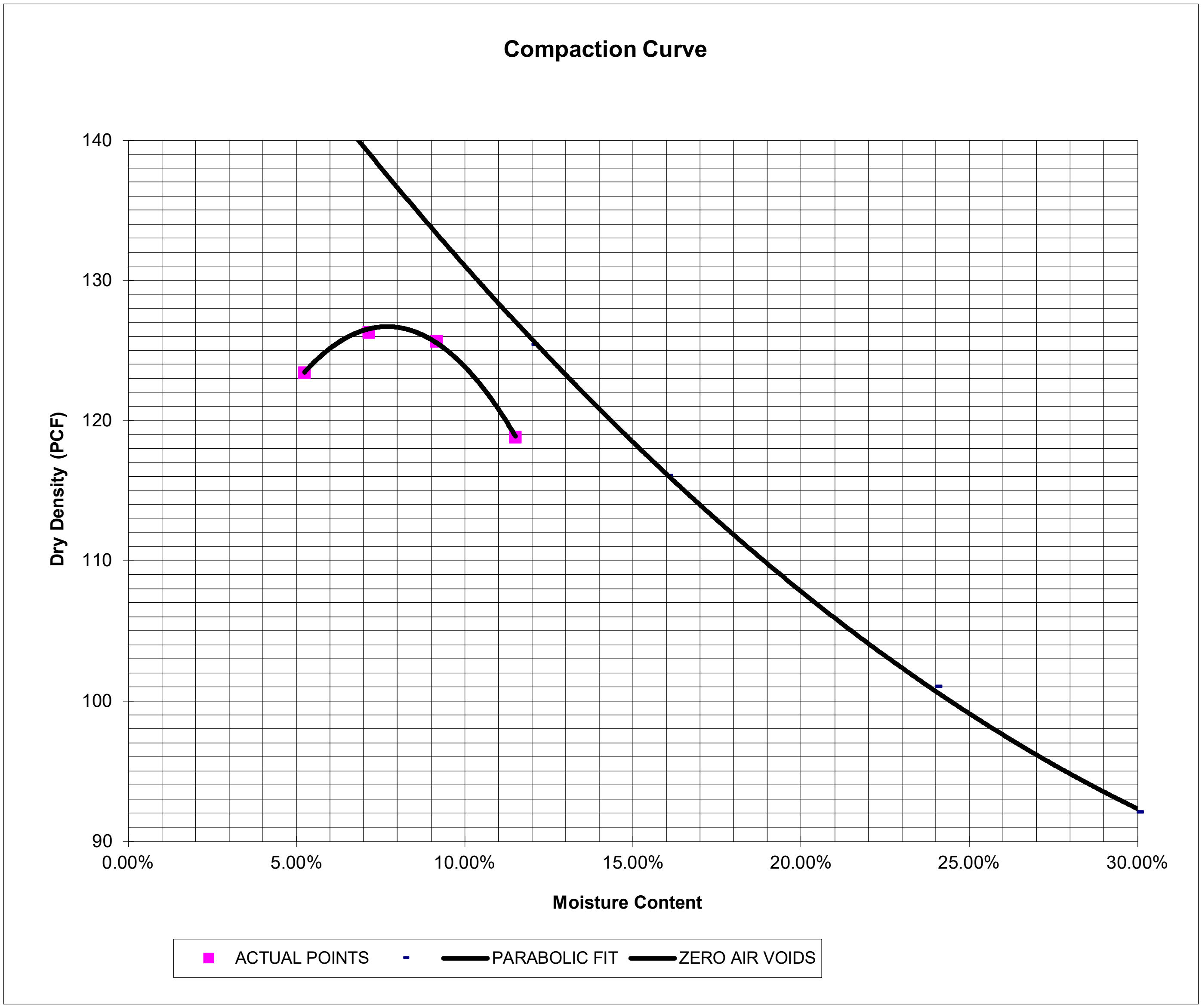
FIG. B-10

SAMPLE LOCATION TB-2 @ 0-3'	SOIL DESCRIPTION SAND, SILTY, BROWN SOIL TYPE 2

PROCTOR DATA

IDENTIFICATION:	SM
PROCTOR TEST #:	1
TEST BY:	PH
TEST DESIGNATION:	ASTM-1557-A
MAXIMUM DRY DENSITY (PCF):	126.8
OPTIMUM MOISTURE:	7.6



ENTECH ENGINEERING, INC.	**LABORATORY TEST RESULTS** ARROYA LANE TIMBERRIDGE DEVELOPMENT	JOB NO. 241657 **FIG. B-11**

SAMPLE LOCATION TB-2 @ 0-3'   SOIL DESCRIPTION SAND, SILTY, BROWN
SOIL TYPE 2

CBR TEST LOAD DATA

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

Penetration Depth (inches)	10 BLOWS Mold # 1 Load (lbs)	10 BLOWS Mold # 1 Stress (psi)	25 BLOWS Mold # 2 Load (lbs)	25 BLOWS Mold # 2 Stress (psi)	56 BLOWS Mold # 3 Load (lbs)	56 BLOWS Mold # 3 Stress (psi)
0.000	0	0.00	0	0.00	0	0.00
0.025	182	60.82	297	99.25	470	157.06
0.050	351	117.29	384	128.32	819	273.68
0.075	450	150.38	472	157.73	1065	355.89
0.100	503	168.09	668	223.22	1357	453.47
0.125	630	210.53	1061	354.55	1928	644.28
0.150	683	228.24	1524	509.27	2154	719.80
0.175	821	274.35	1893	632.58	2430	812.03
0.200	902	301.42	2332	779.28	2697	901.25
0.300	1254	419.05	3814	1274.52	4549	1520.13
0.400	1459	487.55	4510	1507.10	5900	1971.59
0.500	1623	542.35	5498	1837.25	6000	2005.01

MOISTURE AND DENSITY DATA

	Mold # 1	Mold # 2	Mold # 3
Can #	357	354	399
Wt. Can	8.08	8.27	8.43
Wt. Can+Wet	132.67	136.07	118.79
Wt. Can+Dry	120.49	123.44	108.66
Wt. H20	12.18	12.63	10.13
Wt. Dry Soil	112.41	115.17	100.23
Moisture Content	10.84%	10.97%	10.11%
Wet Density (PCF)	125.9	130.0	136.5
Dry Density (PCF)	117.0	120.8	126.9
% Compaction	92%	95%	100%
CBR	16.81	22.32	45.35

PROCTOR DATA

Maximum Dry Density (pcf)	126.8
Optimum Moisture	7.6
90% of Max. Dry Density (pcf)	114.1
95% of Max. Dry Density (pcf)	120.5

CBR at 90% of Max. Density = 12.6   ~ R VALUE 37
CBR at 95% of Max. Density = 21.9   ~ R VALUE 71

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

ARROYA LANE
TIMBERRIDGE DEVELOPMENT

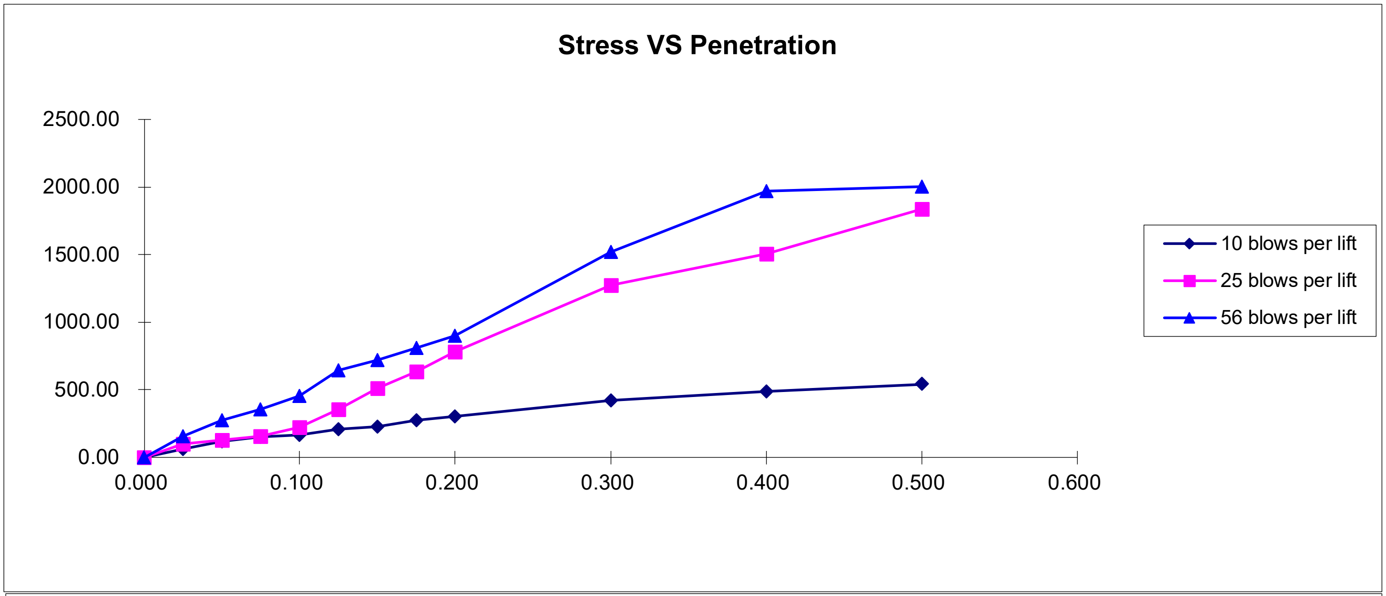
JOB NO. 241657

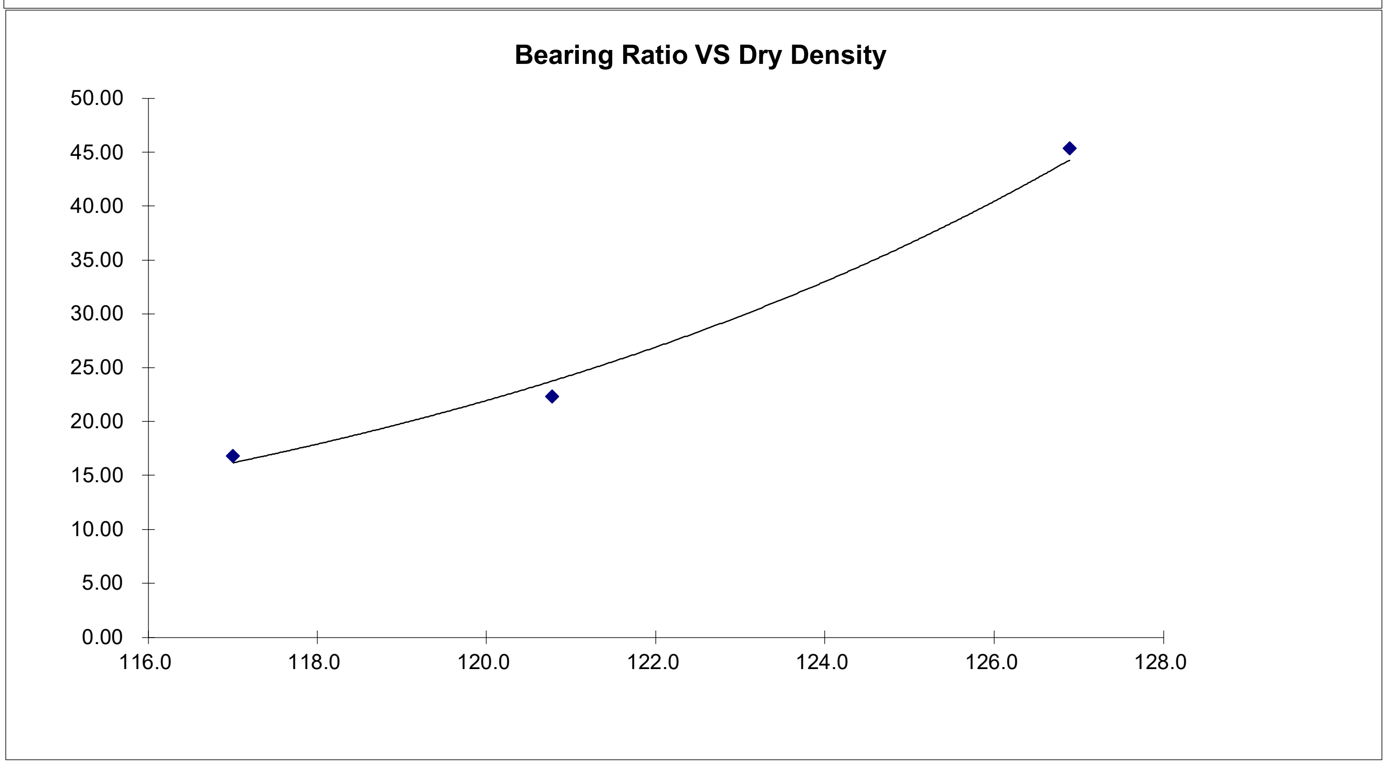
FIG. B-12

SAMPLE LOCATION TB-2 @ 0-3'

SOIL DESCRIPTION SAND, SILTY, BROWN

SOIL TYPE 2





ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

ARROYA LANE
TIMBERRIDGE DEVELOPMENT

JOB NO.
241657

FIG. B-13

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

PROJECT DATA

Project Location: Arroya Lane

Job Number: 241657

DESIGN DATA

Equivalent (18-kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	109,500
Design CBR	CBR =	10
Standard Deviation	S_o =	0.45
Loss in Serviceability	Δpsi =	2.0
Reliability	Reliability =	80
Reliability (z-statistic)	Z_R =	-0.84
Soil Resilient Modulus	M_R =	15,000 psi

Required Structural Number (SN): → SN = 1.69

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 $S_1 = [(\text{R-value} - 5) / 11.29] + 3$

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 - HMA

C_2 = Strength Coefficient - ABC/RCB

D_1 = Depth of HMA (inches)

D_2 = Depth of ABC/RCB (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/RCB	C_2 = 0.11	6.0 inches	0.660	
				SN* = 2.420	1.69

Pavement SN > Required SN, Design is Acceptable

FIG. C-1

ENTECH ENGINEERING, INC.

FLEXIBLE PAVEMENT DESIGN

PROJECT DATA

Project Location: Arroya Lane

Job Number: 241657

DESIGN DATA

Equivalent (18-kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	109,500
Design CBR	CBR =	10
Standard Deviation	S_o =	0.45
Loss in Serviceability	Δpsi =	2.0
Reliability	Reliability =	80
Reliability (z-statistic)	Z_R =	-0.84
Soil Resilient Modulus	M_R =	15,000 psi

Required Structural Number (SN): → SN = 1.69

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

$SN^* = C_1 D_1 + C_2 D_2$ 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	1.69

Pavement SN > Required SN, Design is Acceptable

FIG. C-2