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PAVEMENT DESIGN REPORT
VOLLMER ROAD NORTH
EL PASO COUNTY, COLORADO

Prepared for:
Classic Communities
2138 Flying Horse Club North
Colorado Springs, Colorado 80921

Attn: Austin Lenz

December 22, 2023

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Stuart Wood
Geologist

Reviewed by:

COLORADO LICENSED
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Date: 2023.12.22 16:19:00 -07'00'

Joseph C. Goode III, P.E.
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SW:JCG/

Entech Job No. 231519

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1 Introduction

Entech Engineering, Inc. (Entech) completed a subsurface exploration program, laboratory testing, and pavement design recommendations for a segment of Vollmer Road in northern El Paso County, Colorado. This report describes the subsurface exploration program conducted for the proposed roadway improvements and provides pavement section alternatives and construction recommendations. Entech participated in this project as a subconsultant to Classic Communities. The contents of this report, including the pavement design recommendations, are subject to the limitations and assumptions presented in Section 7.

2 Project and Site Description

The proposed improvements to Vollmer Road consist of approximately 1 mile of roadway widening and improvements from approximately 500 feet northeast of Glider Loop to Poco Road (Figure 1). Improvements will include widening of the existing roadway and a new pavement section. The extent of the improvements will include a 2-inch mill and overlay to tie in with the existing roadway.

The existing topography along Vollmer Road includes vacant pasture land and land being developed for future residential lots. The roadway is currently paved with asphalt and is without curbs and gutters. We understand that the proposed roadway surface will remain asphalt. Based on the development plans the improvements include two travel lanes in each direction, a striped median, and curb and gutter installation. Vollmer Road will be designated as an urban minor arterial.

3 Subsurface Explorations and Laboratory Testing

3.1 Subsurface Exploration Program

Subsurface conditions at the project site were explored by 11 test borings, designated TB-1 through TB-11, drilled on November 1, 2023. 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 open borehole 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 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 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 1/2. A compression strength of 160 pounds per square inch (psi) is recommended for cement-stabilized subgrade. The 5-day average strength value of the 2% mix was 206 psi. The 5-day average strength value of the 4% mix was 233 psi. A 4% 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 loose to dense silty to clayey sand fill and sand with silt or clay fill (Soil Type 1), native medium dense to dense silty sand to sand with silt (Soil Type 2). Very weak to extremely weak, moderately to highly weathered sandstone was encountered at depths of 4 to 7 feet bgs in five of the test borings. When classified as a soil, the sandstone classified as very dense, silty sand to sand with silt (Soil Type 3). The test borings were drilled through 3 to 7 inches of existing hot mix asphalt (HMA) and 1 to 3 inches of aggregate base course (ABC). Soil types and corresponding AASHTO soil classifications are listed as follows:

- Soil Type 1: A-2-4, A-1-b, A-2-6 and A-6
- Soil Type 2: A-2-4 and A-1-b
- Soil Type 3: A-1-b

Identify sample used for testing purposed here

Laboratory test results are presented in Appendix B and are 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. 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*.

5.1 Subgrade Conditions

California Bearing Ratio (CBR) testing was performed on a representative sample of the subgrade clayey sand fill (Soil Type 1) from TB-7 to determine the support characteristic 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
CBR at 95%	53.27
Design CBR	10
Liquid Limit	26
Plasticity Index	10
Percent Passing 200	27.5
AASHTO Classification	A-2-4
Unified Soils Classification	SC

5.2 Swell Mitigation

El Paso County recommendations require swell mitigation of expansive soils criteria for soils with swell testing results greater than 2% under a 150 pounds per square foot (psf) surcharge. Based on the granular nature of the site materials encountered, mitigation for expansive soils is not required. Localized areas of higher clay contents such as the A-6 material encountered in boring TB-11 may be encountered during subgrade preparation. Overexcavation of cohesive soils is recommended to provide proper subgrade support as discussed in Section 6.1.1.

5.3 Traffic Loading

Traffic data is not available for the Vollmer Road widening alignment; however, the roadway is classified as an urban minor arterial. *The El Paso County Engineering Criteria Manual* provides default 18-kip equivalent single axle loading (ESAL) based street classifications. For design, a default ESAL value of 1,971,000 was used for the urban minor arterial designation.

Include ECM reference section

5.4 Pavement Design

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

Include ECM reference section

Exhibit 2: Pavement Design Parameters

Design Parameter	Value
Reliability	85%
Standard Deviation	0.45
Serviceability Loss (Δ psi)	2.0
Design CBR	10.0
Resilient Modulus	15,000 psi
Structural Coefficients	
Hot Mix Asphalt	0.44
Cement Treated Subgrade	0.11

Pavement sections recommended for roads are summarized in Exhibit 3. The pavement design calculations are presented in Appendix C.

Exhibit 3: Recommended Pavement Sections

Pavement Area	Roadway Designation	Design ESAL	Alternative [1]
Vollmer Road (North)	Urban Minor Arterial	1,971,000	1. 5.0 inches HMA over 10.0 inches CTS
			2. 5.0 inches HMA over 8.0 inches ABC

ABC = Aggregate Base Course; CTS = cement-treated subgrade; ESAL = equivalent single axle loads; HMA = Hot Mix Asphalt

Notes:

1. All pavement alternatives meet the minimum sections required per *El Paso County Pavement Design Criteria*.

Include ECM reference section

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 Overexcavation

Where encountered, cohesive soils (AASHTO A-6, TB-11) should be removed to a depth 18 inches and replaced with granular fill (Section 6.1.4) to provide uniform subgrade support. The extent of any cohesive material overexcavation should be field determined.

6.1.2 Subgrade Preparation – Aggregate Base Course Alternatives

If pavement section alternatives are selected utilizing aggregate base course (ABC), the final subgrade surface should be scarified to a depth of 12 inches, moisture conditioned within +/-2% over the optimum water content, and recompacted to 95% of its maximum Modified Proctor dry density, ASTM D1557.

Any A-6 material identified during scarification should be removed to a depth of 18 inches and be replaced with granular fill as discussed in Section 6.1.1.

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.

6.1.3 Cement-treated Subgrade

For pavement section alternatives utilizing cement-treated subgrade (CTS), the subgrade shall be stabilized prior to placement of the asphalt by the addition of cement to a depth of 10 inches. 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 Test (ASTM D1557) for granular soils or by the Standard Proctor Test (ASTM D698) for cohesive soils. The cement should be spread evenly on the subgrade surface and be thoroughly mixed into the subgrade over a 10-inch depth, as specified, such that a uniform blend of soil and cement is achieved. Prior to application or mixing of the cement, the upper 10 inches of subgrade should be thoroughly moisture conditioned to the soil's optimum water content or as much as 2% more than the optimum water content as necessary to provide a compactable soil condition. 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 Test (ASTM D1557) or by the Standard Proctor Test (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 a qualified geotechnical engineer. The geotechnical engineer should complete in-situ compaction tests and construct representative compacted specimens of the treated subgrade material for subsequent laboratory quality assurance testing.

Pending the results of the field density testing, microfracturing of the stabilized subgrade may be required. Soil strengths in excess of 275 psi require microfracturing.

6.1.4 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 Standard Specifications Manual*, Table D-6, Aggregate Base Course Materials. ABC materials should be compacted to a minimum of 95% of its 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 II or 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 foundation excavation prior to the placement of concrete. If standing water is present in the foundation excavation, it should be removed by ditching to sumps and pumping the water away from the foundation area prior to concrete placement. 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.

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 Classic Communities with application to the Vollmer Road North paving project in El Paso County, Colorado. In conducting the subsurface exploration program, 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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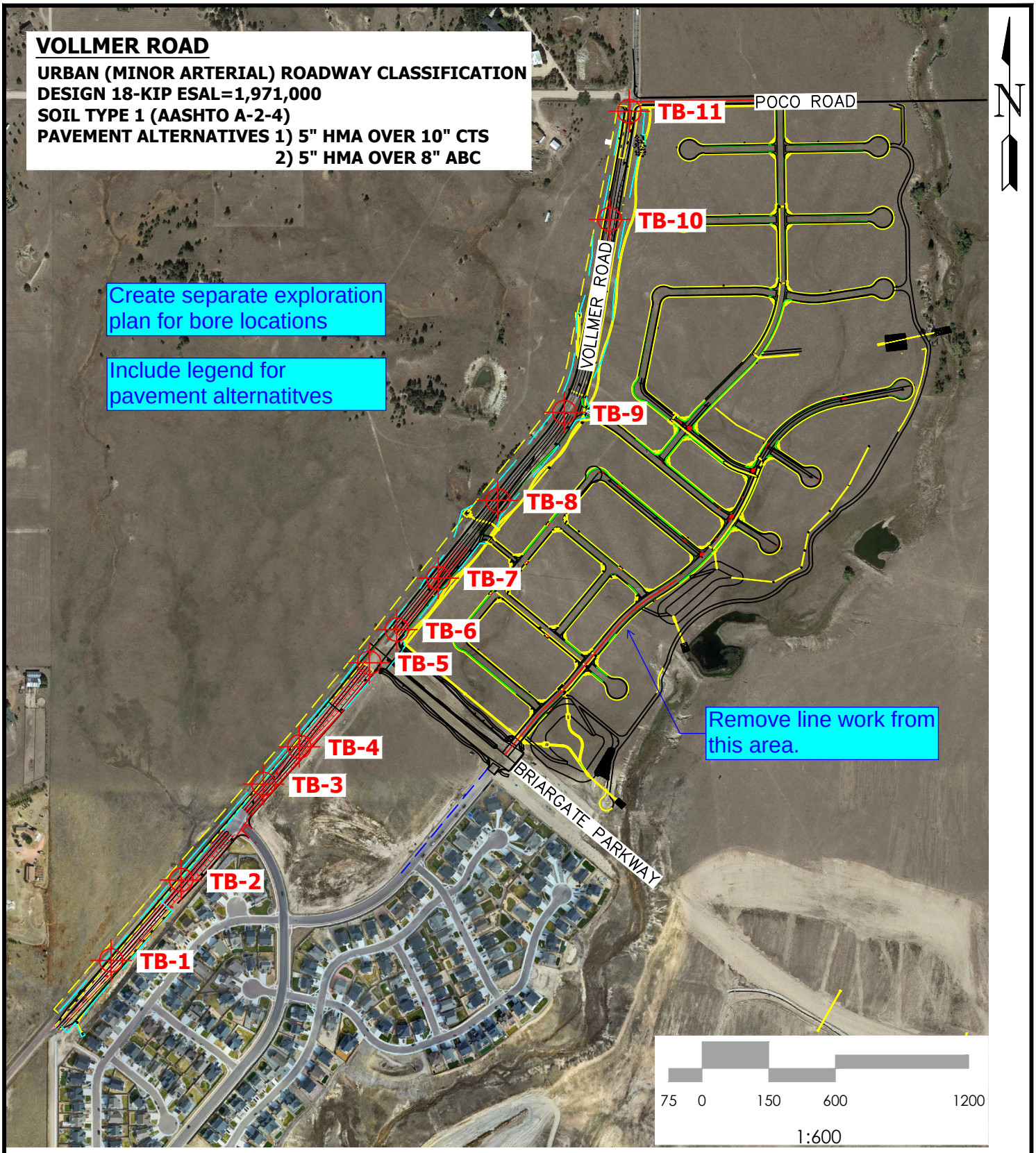
VICINITY MAP

VOLLMER ROAD NORTH
CLASSIC COMMUNITIES

JOB NO.
231519

FIG. 1



TB- APPROXIMATE TEST BORING LOCATION AND NUMBER

ENTECH ENGINEERING, INC.

SITE AND EXPLORATION PLAN

VOLLMER ROAD NORTH
CLASSIC COMMUNITIES

JOB NO. 231519

FIG. 2

APPENDIX A: Test Boring Logs

TEST BORING 1
DATE DRILLED 11/1/2023

REMARKS

DRY TO 10', 11/1/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			21	4.3	1
5			11	5.9	1
10			50/6"	6.8	3
15					
20					

3" ASPHALT, 2" BASE COURSE
FILL 0-6', SAND, WITH SILT, BROWN, MEDIUM DENSE, MOIST

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

TEST BORING 2
DATE DRILLED 11/1/2023

REMARKS

DRY TO 5', 11/1/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			15	6.0	1
5			8	7.8	1
10					
15					
20					

3" ASPHALT, 2" BASE COURSE
FILL 0-5', SAND, WITH SILT TO SILTY, BROWN, MEDIUM DENSE to LOOSE, MOIST

ENTECH ENGINEERING, INC.

TEST BORING LOGS

VOLLMER ROAD NORTH
CLASSIC COMMUNITIES

JOB NO. 231519

FIG. A-1

TEST BORING 3
DATE DRILLED 11/1/2023

REMARKS

DRY TO 5', 11/1/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			31	8.6	1
5			7	8.0	1
10					
15					
20					

5" ASPHALT, 1" BASE COURSE
FILL 0-5', SAND, SILTY, BROWN, DENSE to LOOSE, MOIST

TEST BORING 4
DATE DRILLED 11/1/2023

REMARKS

DRY TO 10', 11/1/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			25	9.4	1
5			10	10.8	2
10			50/8"	11.7	3
15					
20					

5" ASPHALT, 2" BASE COURSE
FILL 0-4', SAND, SILTY, BROWN, MEDIUM DENSE, MOIST

SAND, SILTY, GRAY, MEDIUM DENSE, MOIST

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

ENTECH ENGINEERING, INC.

TEST BORING LOGS

VOLLMER ROAD NORTH
CLASSIC COMMUNITIES

JOB NO. 231519

FIG. A-2

TEST BORING 5
DATE DRILLED 11/1/2023

REMARKS

DRY TO 5', 11/1/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			36	7.6	1
5			16	11.4	1
10					
15					
20					

7" ASPHALT, 1" BASE COURSE

FILL 0-5', SAND, SILTY TO CLAYEY, BROWN, DENSE to MEDIUM DENSE, MOIST

TEST BORING 6
DATE DRILLED 11/1/2023

REMARKS

DRY TO 5', 11/1/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			23	12.4	1
5			50/11"	11.1	3
10					
15					
20					

6" ASPHALT, 1" ROAD BASE

FILL 0-4', SAND, SILTY, BROWN, MEDIUM DENSE, MOIST

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

ENTECH ENGINEERING, INC.

TEST BORING LOGS

VOLLMER ROAD NORTH
CLASSIC COMMUNITIES

JOB NO. 231519

FIG. A-3

TEST BORING 7
DATE DRILLED 11/1/2023

REMARKS

DRY TO 10', 11/1/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
6" ASPHALT, 3" BASE COURSE					
FILL 0-6', SAND, WITH SILT TO CLAY, MEDIUM DENSE, MOIST			19	6.0	1
5			15	11.5	1
SANDSTONE, VERY WEAK, TAN, MODERATELY WEATHERED (SAND, WITH SILT, VERY DENSE,			50/7"	13.1	3
10					
15					
20					

TEST BORING 8
DATE DRILLED 11/1/2023

REMARKS

DRY TO 5', 11/1/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
6" ASPHALT, 3" BASE COURSE					
FILL 0-5', SAND, WITH SILT, BROWN, MEDIUM DENSE, MOIST			23	5.2	1
5			18	4.3	1
10					
15					
20					

ENTECH ENGINEERING, INC.

TEST BORING LOGS

VOLLMER ROAD NORTH
CLASSIC COMMUNITIES

JOB NO. 231519

FIG. A-4

TEST BORING 9
DATE DRILLED 11/1/2023

REMARKS

DRY TO 5', 11/1/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			11	12.8	1
5			27	7.9	2
10					
15					
20					

6" ASPHALT, 3" BASE COURSE
FILL 0-4', SAND, SILTY, BROWN, MEDIUM DENSE, MOIST

SAND, SILTY, TAN, MEDIUM DENSE, MOIST

TEST BORING 10
DATE DRILLED 11/1/2023

REMARKS

DRY TO 10', 11/1/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			13	10.2	1
5			44	6.4	2
10			50/7"	9.8	3
15					
20					

6" ASPHALT, 3" BASE COURSE
FILL 0-4', SAND, CLAYEY, BROWN, MEDIUM DENSE, MOIST

SAND, WITH SILT, TAN, DENSE, MOIST

SANDSTONE, VERY WEAK, TAN, MODERATELY WEATHERED
(SAND, WITH SILT, VERY DENSE,

ENTECH ENGINEERING, INC.

TEST BORING LOGS

VOLLMER ROAD NORTH
CLASSIC COMMUNITIES

JOB NO. 231519

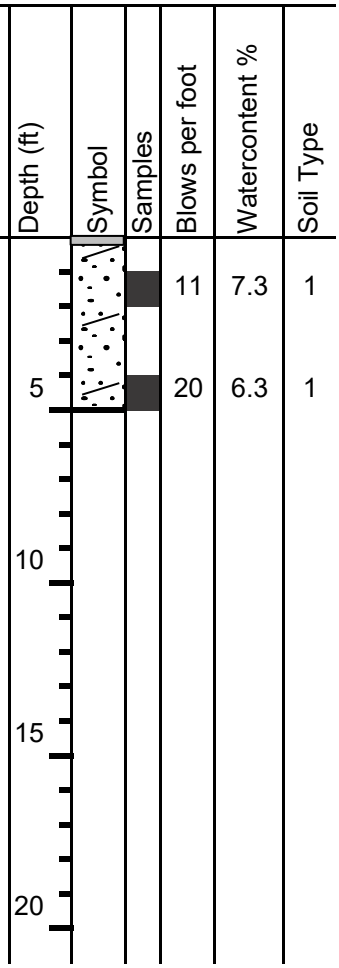
FIG. A-5

TEST BORING 11

DATE DRILLED 11/1/2023

REMARKS

DRY TO 5', 11/1/23



ENTECH ENGINEERING, INC.

TEST BORING LOGS

VOLLMER ROAD NORTH
CLASSIC COMMUNITIES

JOB NO. 231519

FIG. A-6

APPENDIX B: Laboratory Test Results

Add moisture content to table results

ENTECH ENGINEERING, INC.

TABLE B-1
SUMMARY OF LABORATORY TEST RESULTS

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	SULFATE (WT %)	AASHTO CLASS.	USCS	SOIL DESCRIPTION
1, CBR	7	0-3	27.5	26	16	10		A-2-4	SC	FILL, SAND, CLAYEY
1	1	1-2	10.7	NV	NP	NP		A-1-b	SM	FILL, SAND, WITH SILT
1	2	1-2	11.6	NV	NP	NP		A-1-b	SM	FILL, SAND, WITH SILT
1	3	1-2	29.3	NV	NP	NP	<0.01	A-2-4	SM	FILL, SAND, SILTY
1	4	1-2	30.4	NV	NP	NP		A-2-4	SM	FILL, SAND, SILTY
1	5	1-2	14.0	NV	NP	NP		A-1-b	SM	FILL, SAND, SILTY
1	6	1-2	30.2	NV	NP	NP	<0.01	A-2-4	SM	FILL, SAND, SILTY
1	7	1-2	9.3					A-2-6	SC	FILL, SAND, WITH CLAY
1	8	1-2	11.7	NV	NP	NP		A-1-b	SW-SM	FILL, SAND, WITH SILT
1	9	1-2	29.9	NV	NP	NP		A-2-4	SM	FILL, SAND, SILTY
1	10	1-2	31.9	29	21	8	<0.01	A-2-4	SC	FILL, SAND, CLAYEY
1	11	1-2	36.7	35	21	14		A-6	SC	FILL, SAND, CLAYEY
1	1	0-3	24.5					A-2-4	SM	FILL, SAND, SILTY
2	9	5	29.2	NV	NP	NP		A-2-4	SM	SAND, SILTY
2	10	5	9.3	NV	NP	NP		A-1-b	SW-SM	SAND, WITH SILT
3	1	10	10.3	NV	NP	NP	<0.01	A-1-b	SW-SM	SANDSTONE (SAND, WITH SILT)
3	4	10	10.0	NV	NP	NP		A-1-b	SW-SM	SANDSTONE (SAND, WITH SILT)
3	6	5	12.3	NV	NP	NP	<0.01	A-1-b	SM	SANDSTONE (SAND, SILTY)
3	7	10	9.5	NV	NP	NP	<0.01	A-1-b	SW-SM	SANDSTONE (SAND, WITH SILT)
3	10	10	9.7	NV	NP	NP	<0.01	A-1-b	SW-SM	SANDSTONE (SAND, WITH SILT)

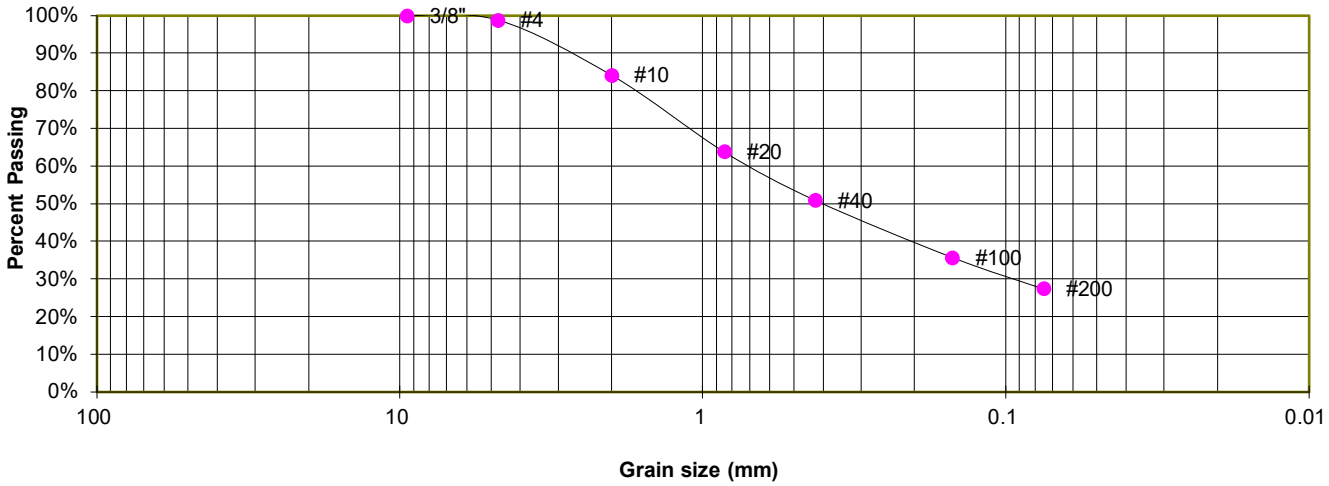
Project: Vollmer Road North
Client: Classic Communities
Job No: 231519

TABLE B-2
SUMMARY OF CTS TEST RESULTS

FIELD SAMPLE ID	SAND, SILTY
SOIL ADDITIVE	TYPE I/II CEMENT
CURING METHOD	100° HUMIDIFIED OVEN

ADDITIVE %	***WATER %***	***DENSITY (dry)***	***AGE (days)***	***STRENGTH (psi)***
2	7.0	122.9	5	197
2	7.0	122.7	5	207
2	7.0	122.6	5	214
			AVERAGE:	**206**
4	7.0	122.8	5	231
4	7.0	122.5	5	226
4	7.0	122.6	5	242
			AVERAGE:	**233**

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



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.8%
10	84.2%
20	63.8%
40	50.9%
100	35.7%
200	27.5%

ATTERBERG LIMITS

Plastic Limit	16
Liquid Limit	26
Plastic Index	10

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

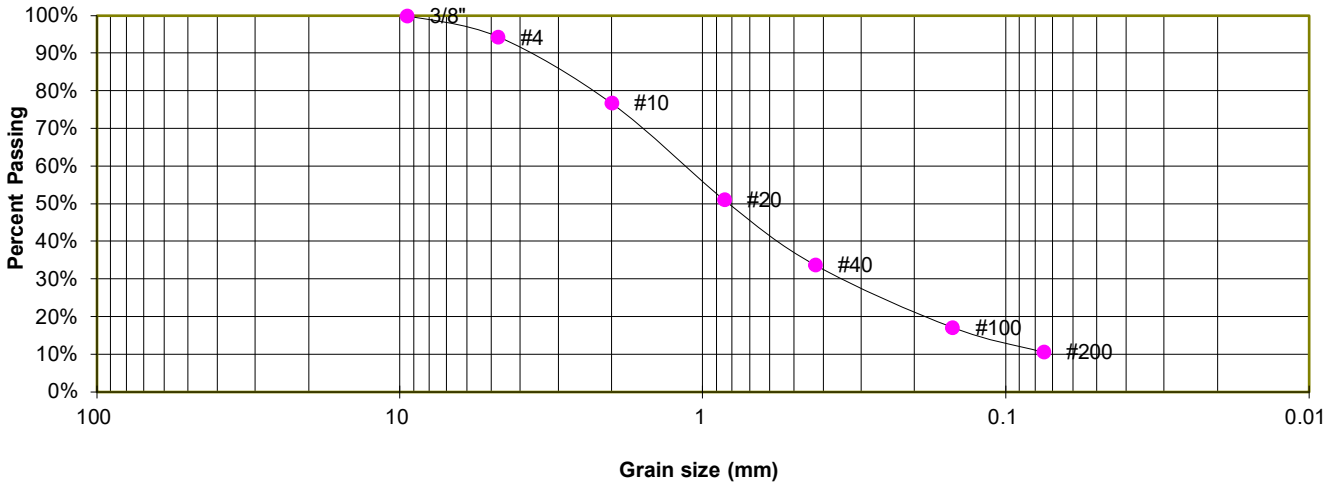
LABORATORY TEST RESULTS

VOLLMER ROAD NORTH
CLASSIC COMMUNITIES

JOB NO. 231519

FIG. B-1

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



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.4%
10	76.7%
20	51.1%
40	33.7%
100	17.2%
200	10.7%

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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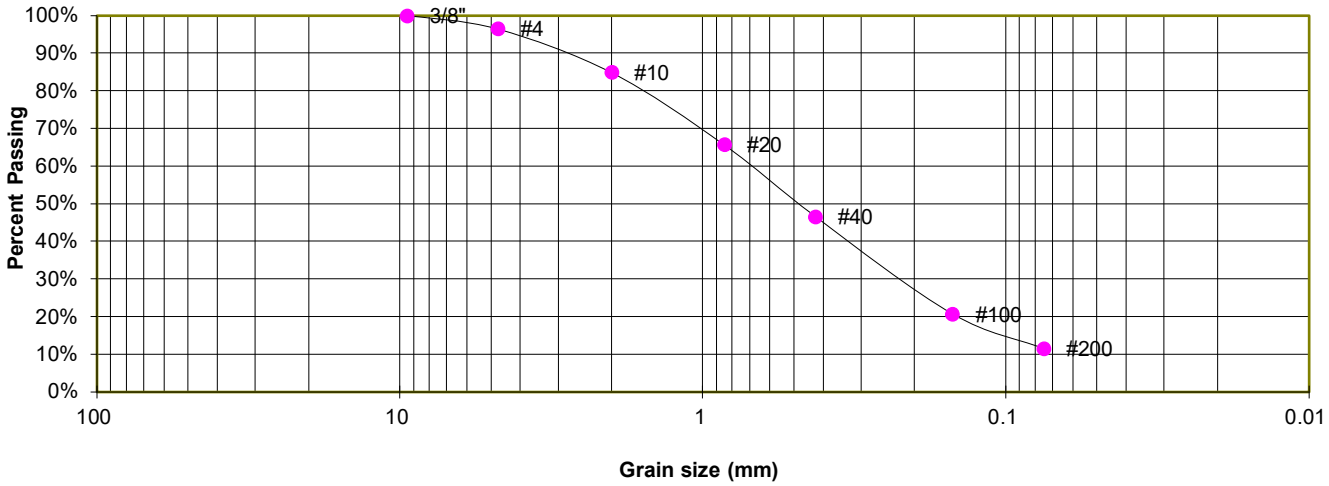
FIG. B-2

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



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.5%
10	84.9%
20	65.7%
40	46.5%
100	20.7%
200	11.6%

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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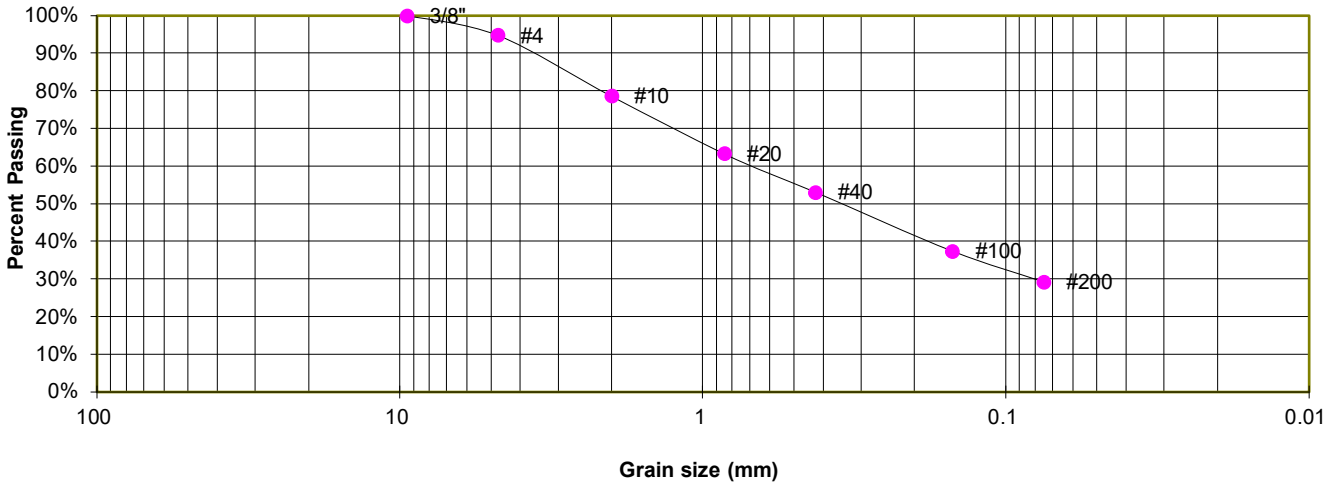
FIG. B-3

TEST BORING	3	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	94.8%
10	78.6%
20	63.4%
40	53.1%
100	37.4%
200	29.3%

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

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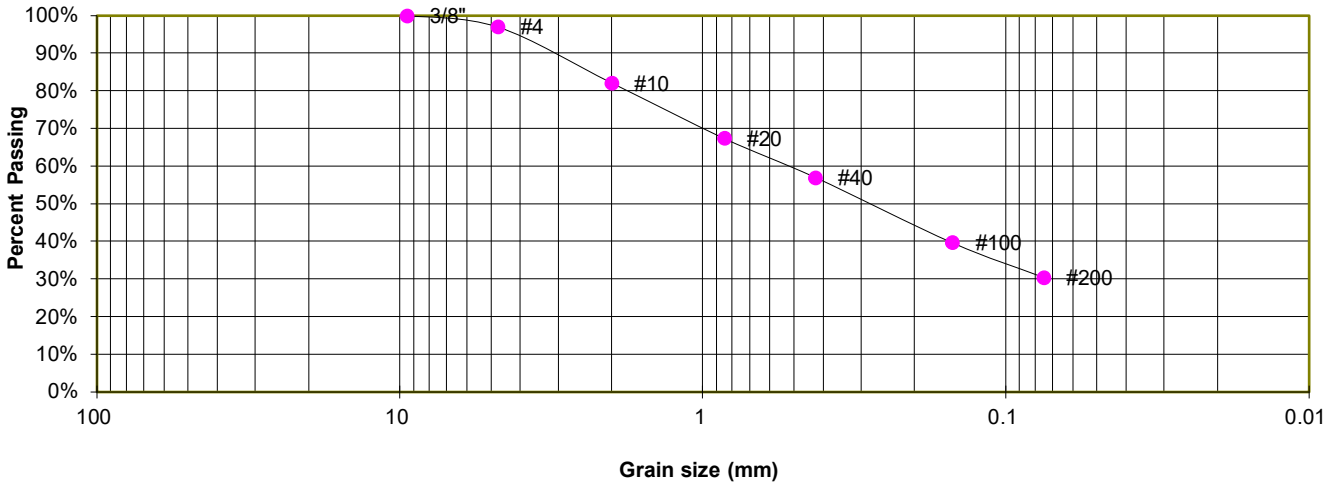
FIG. B-4

TEST BORING	4	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	97.0%
10	82.1%
20	67.4%
40	57.0%
100	39.7%
200	30.4%

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

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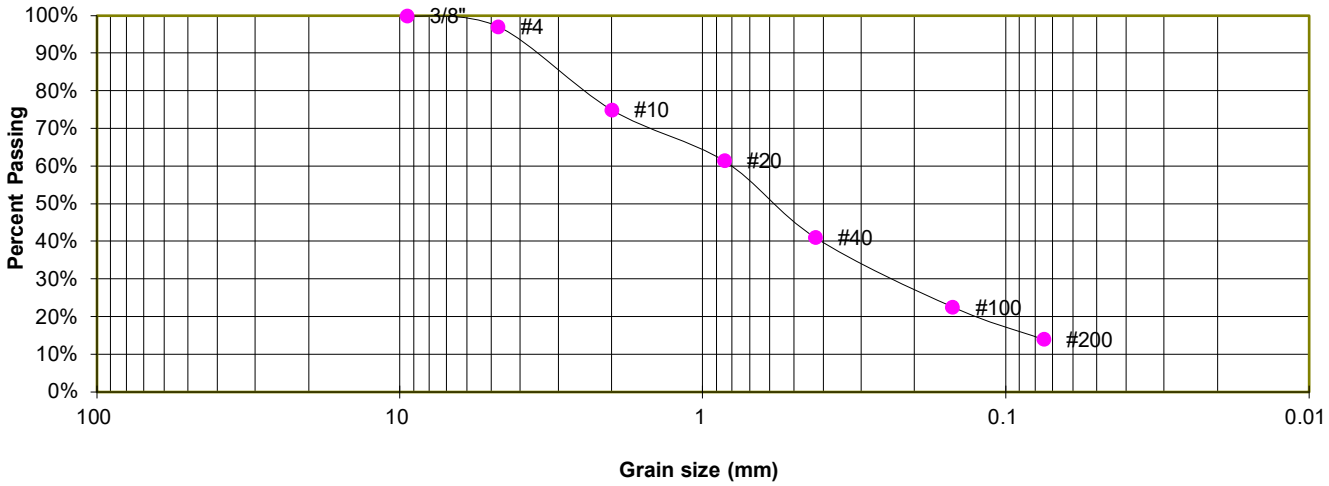
FIG. B-5

TEST BORING	5	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	97.1%
10	75.0%
20	61.4%
40	41.0%
100	22.6%
200	14.0%

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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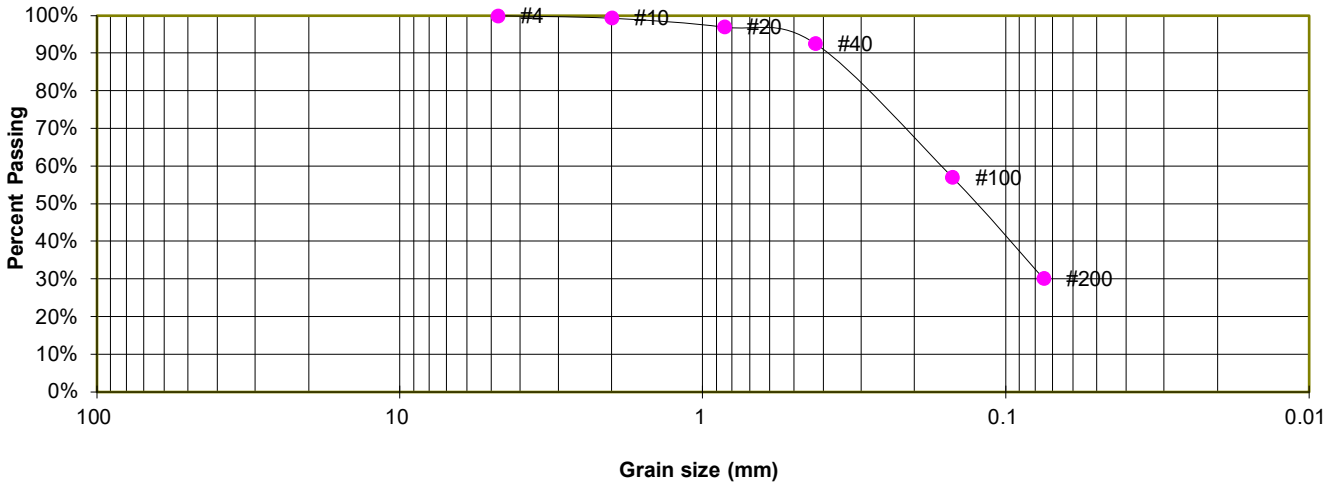
FIG. B-6

TEST BORING	6	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"	
4	100.0%
10	99.3%
20	97.0%
40	92.6%
100	57.0%
200	30.2%

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

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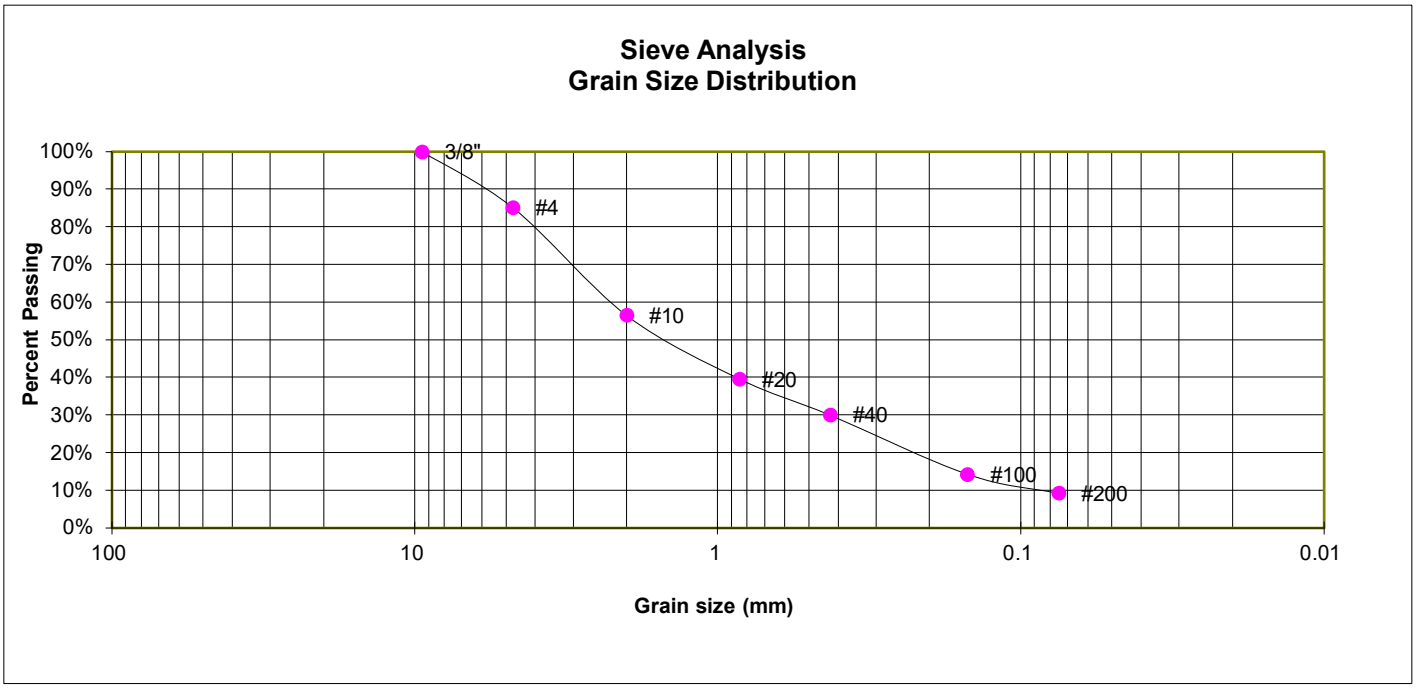
FIG. B-7

TEST BORING	7	SOIL DESCRIPTION	FILL, SAND, WITH CLAY
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	85.1%
10	56.5%
20	39.6%
40	30.0%
100	14.2%
200	9.3%

SOIL CLASSIFICATION

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

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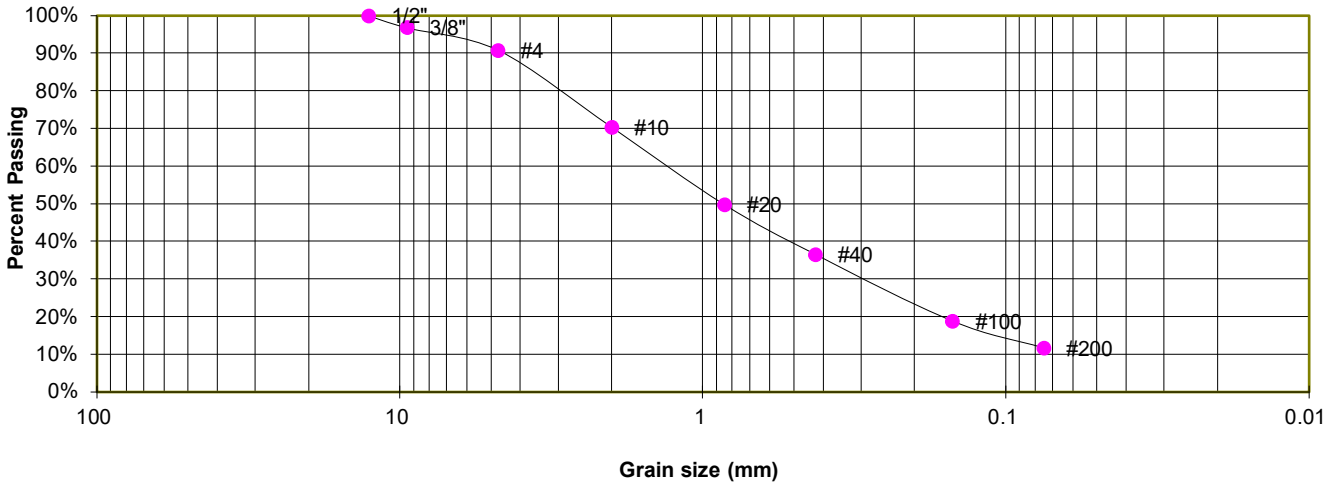
FIG. B-8

TEST BORING	8	SOIL DESCRIPTION	FILL, SAND, WITH SILT
DEPTH (FT)	1-2	SOIL TYPE	1



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	96.8%
4	90.7%
10	70.4%
20	49.8%
40	36.6%
100	18.9%
200	11.7%

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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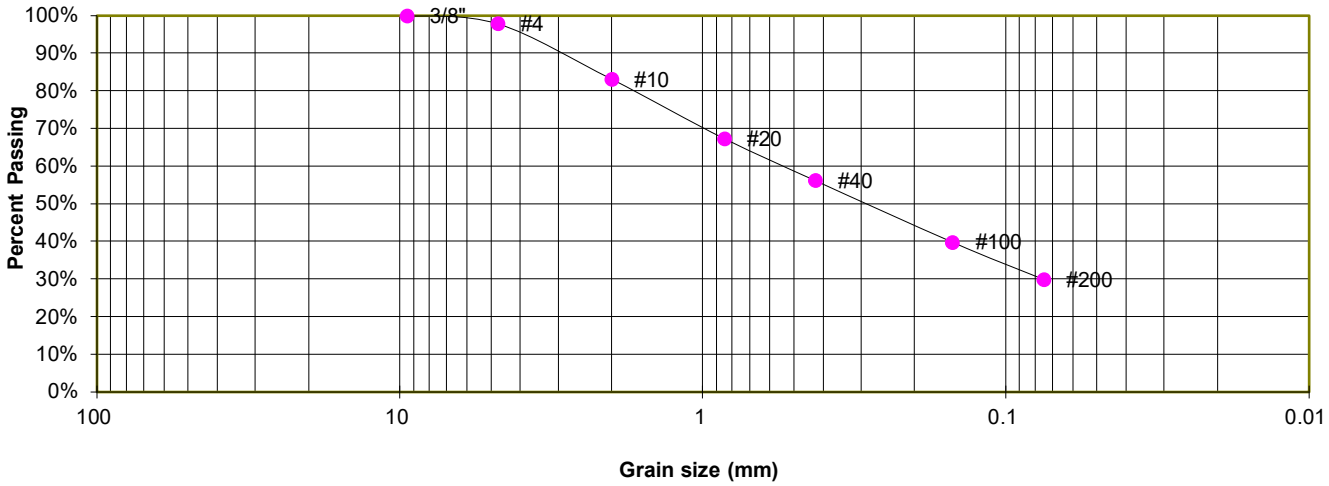
FIG. B-9

TEST BORING	9	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	83.1%
20	67.4%
40	56.2%
100	39.8%
200	29.9%

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

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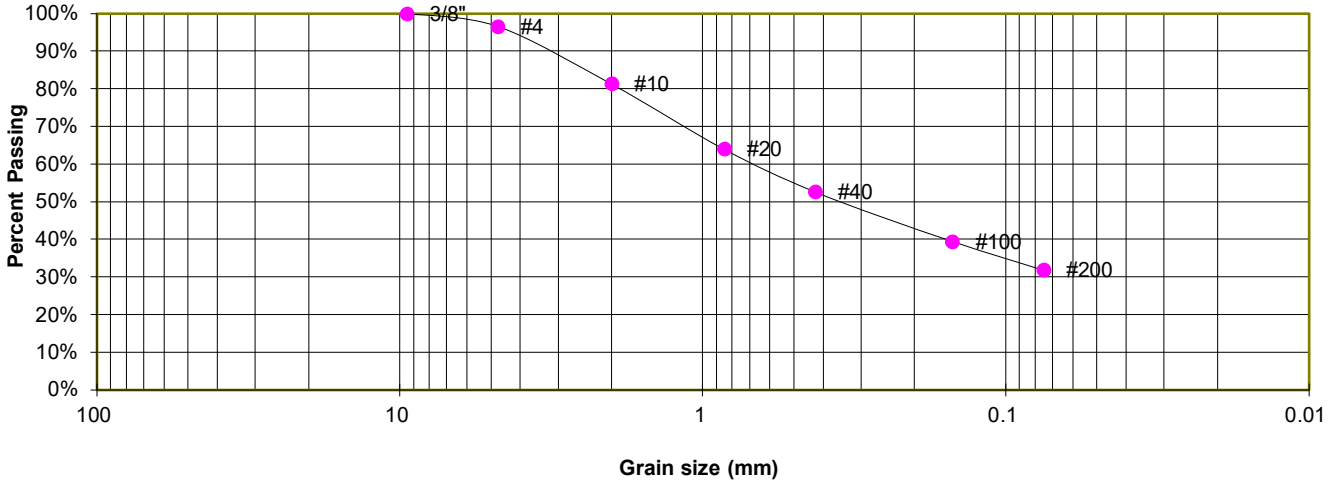
FIG. B-10

TEST BORING 10	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	96.5%
10	81.4%
20	64.0%
40	52.7%
100	39.5%
200	31.9%

ATTERBERG LIMITS

Plastic Limit	21
Liquid Limit	29
Plastic Index	8

SOIL CLASSIFICATION

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

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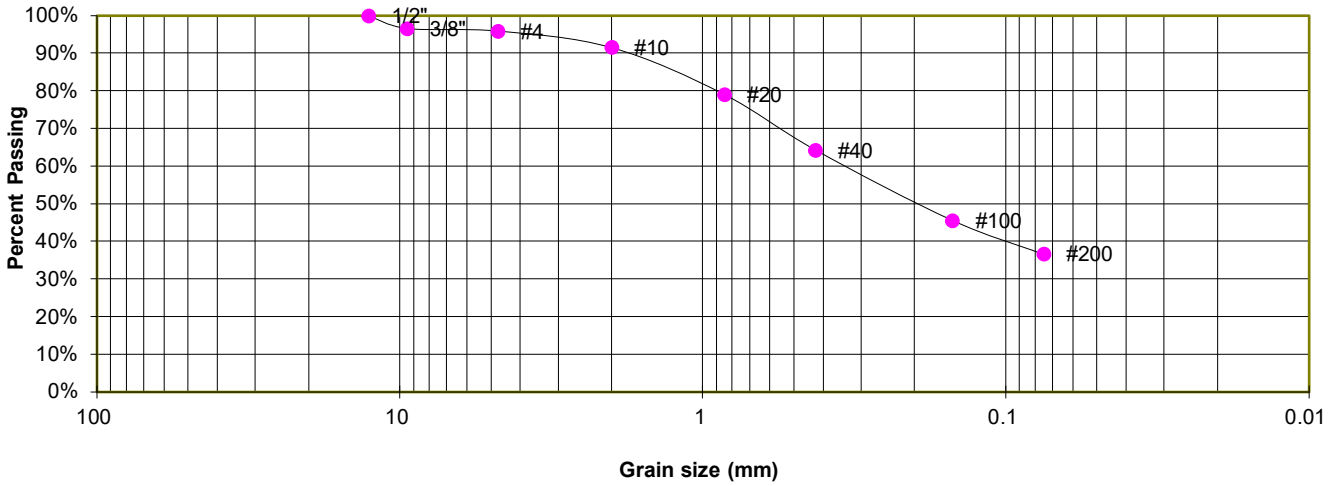
FIG. B-11

TEST BORING 11	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"	100.0%
3/8"	96.6%
4	95.9%
10	91.6%
20	79.1%
40	64.3%
100	45.6%
200	36.7%

ATTERBERG LIMITS

Plastic Limit	21
Liquid Limit	35
Plastic Index	14

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SC
AASHTO CLASSIFICATION:	A-6
AASHTO GROUP INDEX:	1

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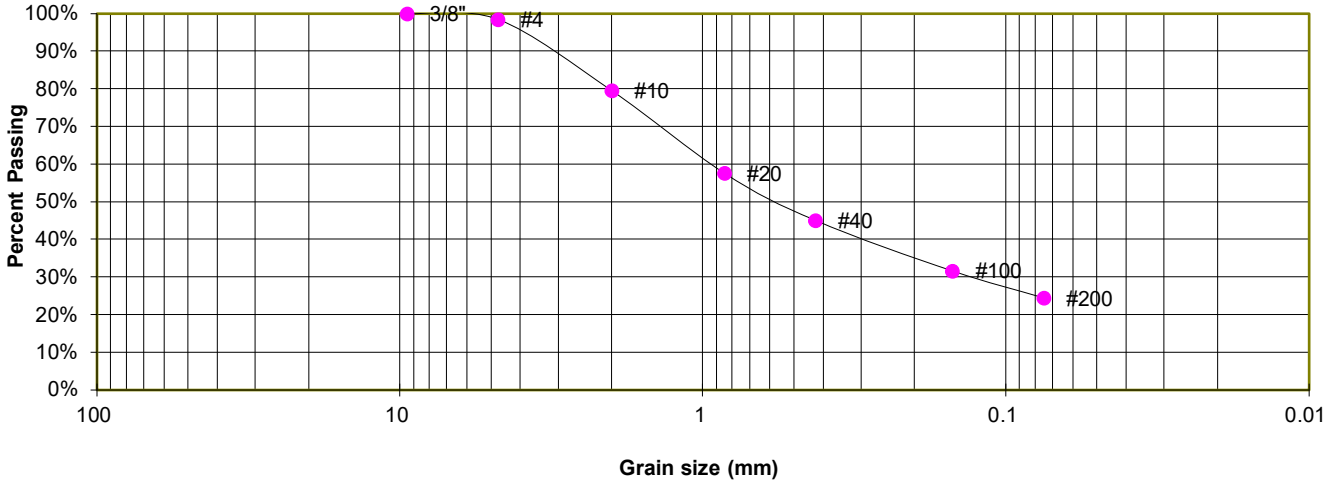
FIG. B-12

TEST BORING	1	SOIL DESCRIPTION	FILL, SAND, SILTY
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	98.4%
10	79.6%
20	57.7%
40	45.0%
100	31.7%
200	24.5%

SOIL CLASSIFICATION

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

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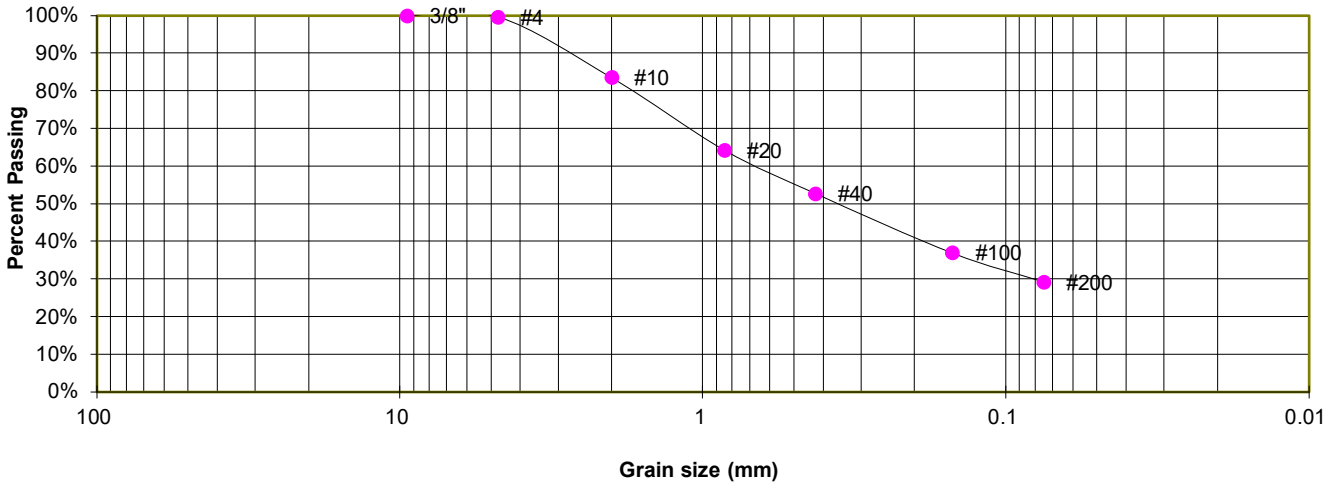
FIG. B-13

TEST BORING	9	SOIL DESCRIPTION	SAND, SILTY
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	99.6%
10	83.6%
20	64.3%
40	52.7%
100	37.0%
200	29.2%

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

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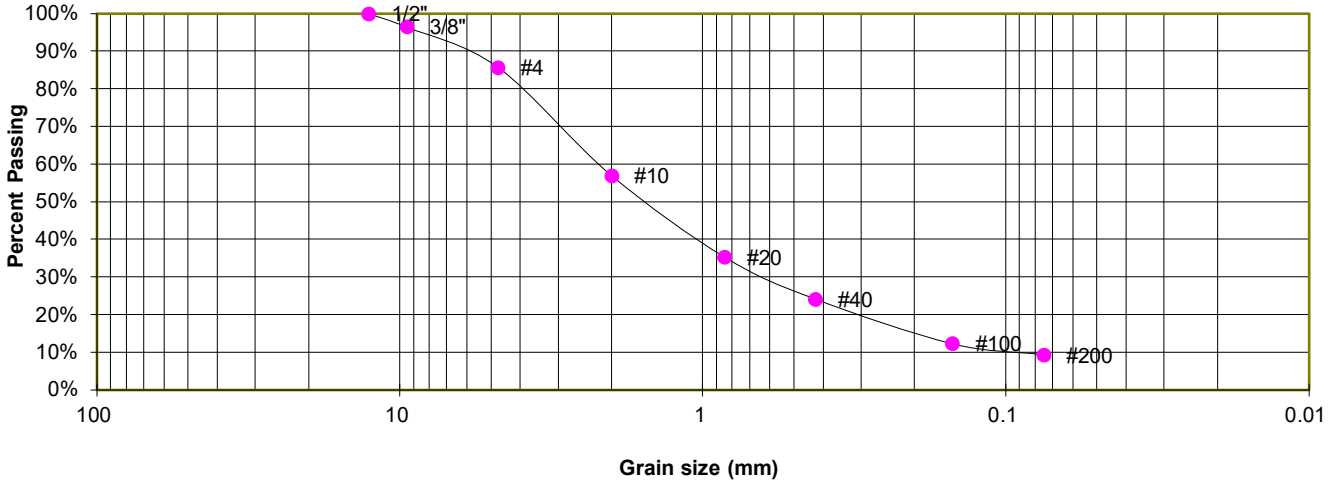
FIG. B-14

TEST BORING	10	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"	100.0%
3/8"	96.5%
4	85.7%
10	57.0%
20	35.4%
40	24.1%
100	12.4%
200	9.3%

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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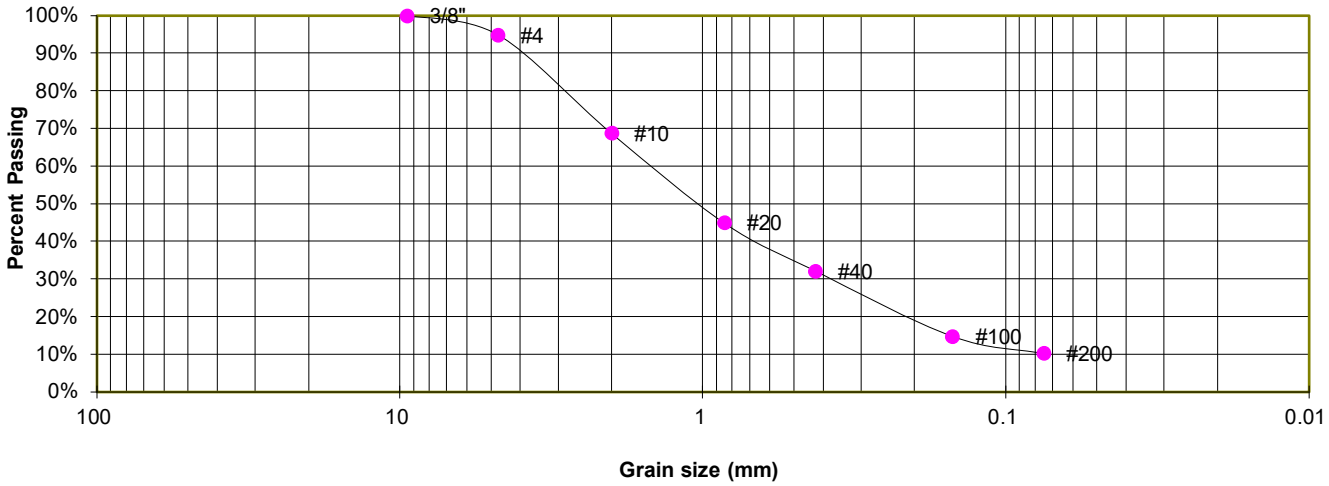
FIG. B-15

TEST BORING	1	SOIL DESCRIPTION	SANDSTONE (SAND, WITH SILT)
DEPTH (FT)	10	SOIL TYPE	3



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.8%
10	68.8%
20	44.9%
40	32.1%
100	14.8%
200	10.3%

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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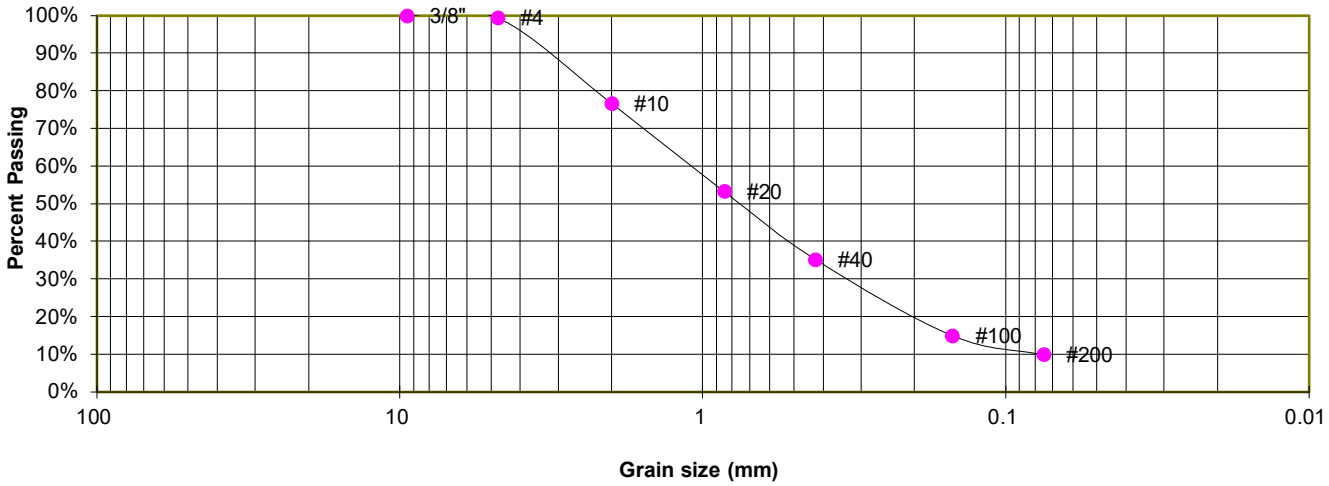
FIG. B-16

TEST BORING	4	SOIL DESCRIPTION	SANDSTONE (SAND, WITH SILT)
DEPTH (FT)	10	SOIL TYPE	3



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.4%
10	76.6%
20	53.3%
40	35.2%
100	14.9%
200	10.0%

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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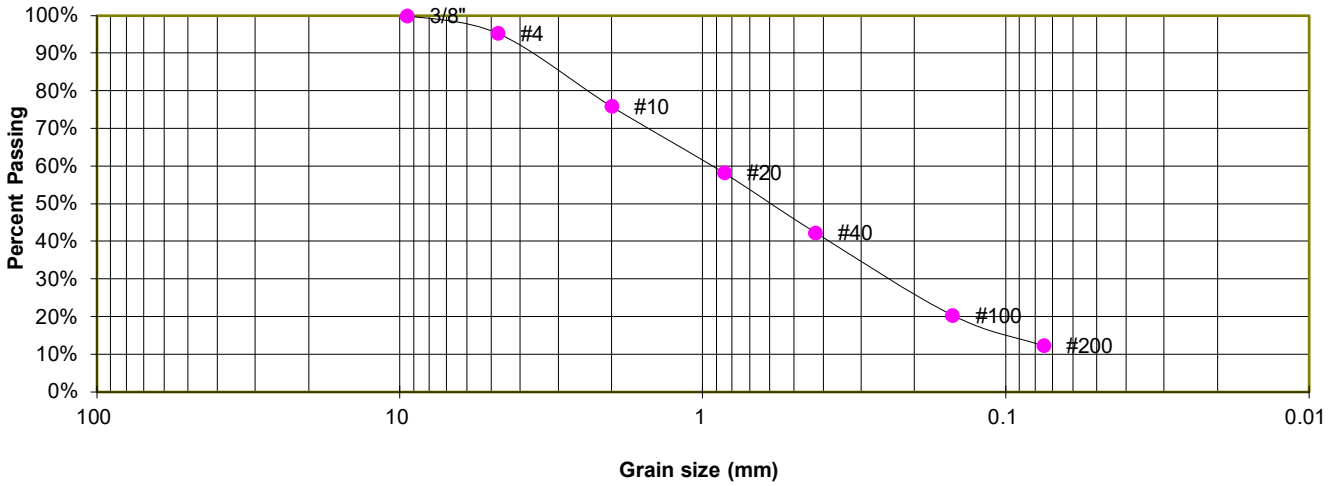
FIG. B-17

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



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.3%
10	75.9%
20	58.3%
40	42.4%
100	20.4%
200	12.3%

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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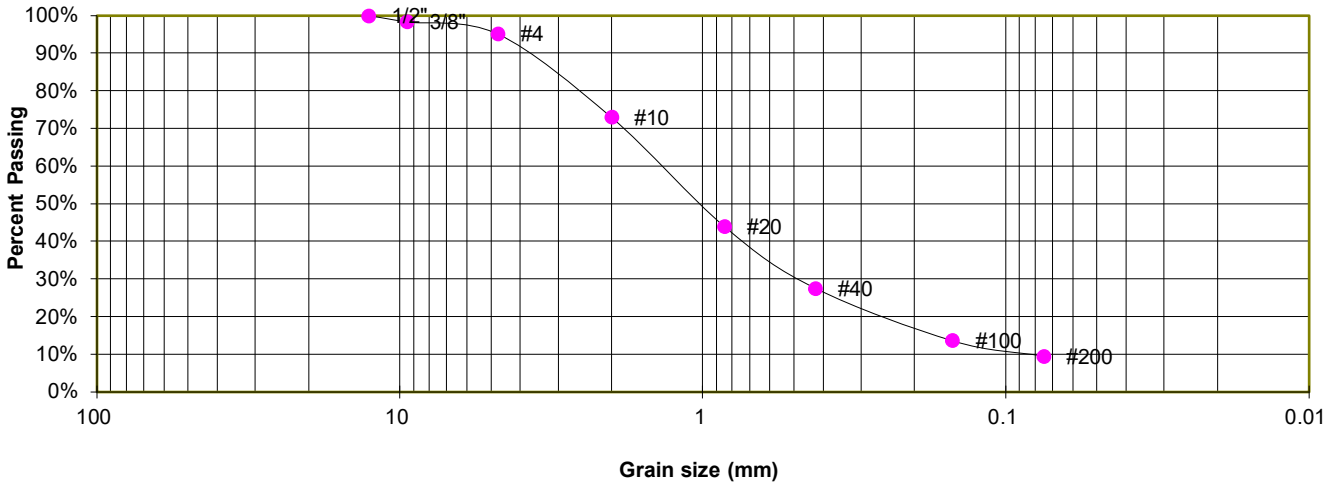
FIG. B-18

TEST BORING	7	SOIL DESCRIPTION	SANDSTONE (SAND, WITH SILT)
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"	98.4%
4	95.1%
10	73.0%
20	44.0%
40	27.5%
100	13.7%
200	9.5%

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

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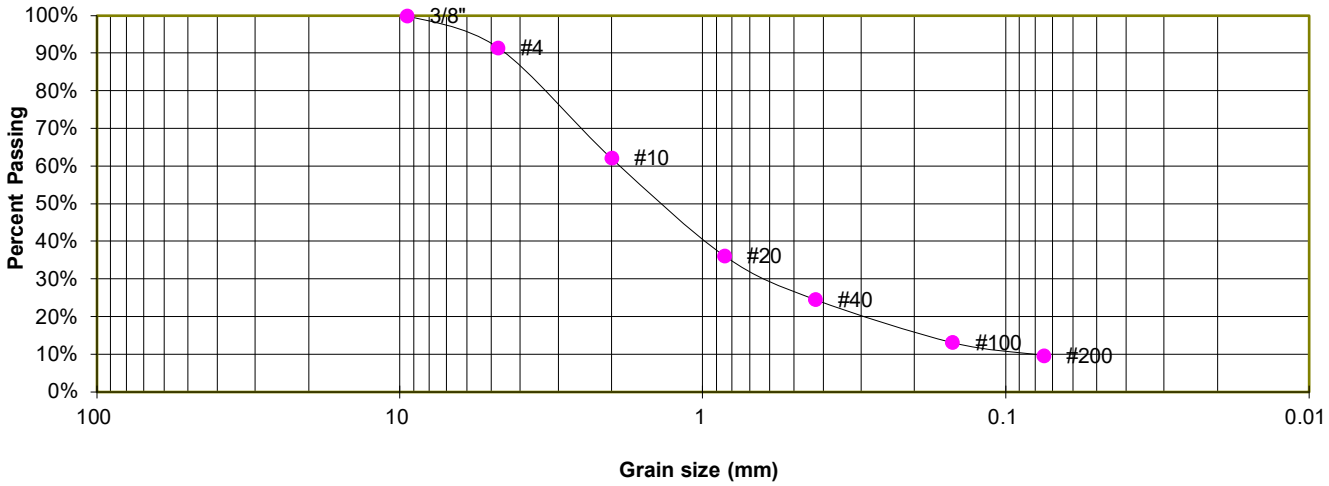
FIG. B-19

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



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	91.5%
10	62.2%
20	36.2%
40	24.6%
100	13.2%
200	9.7%

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-20

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):	129.1
OPTIMUM MOISTURE:	7

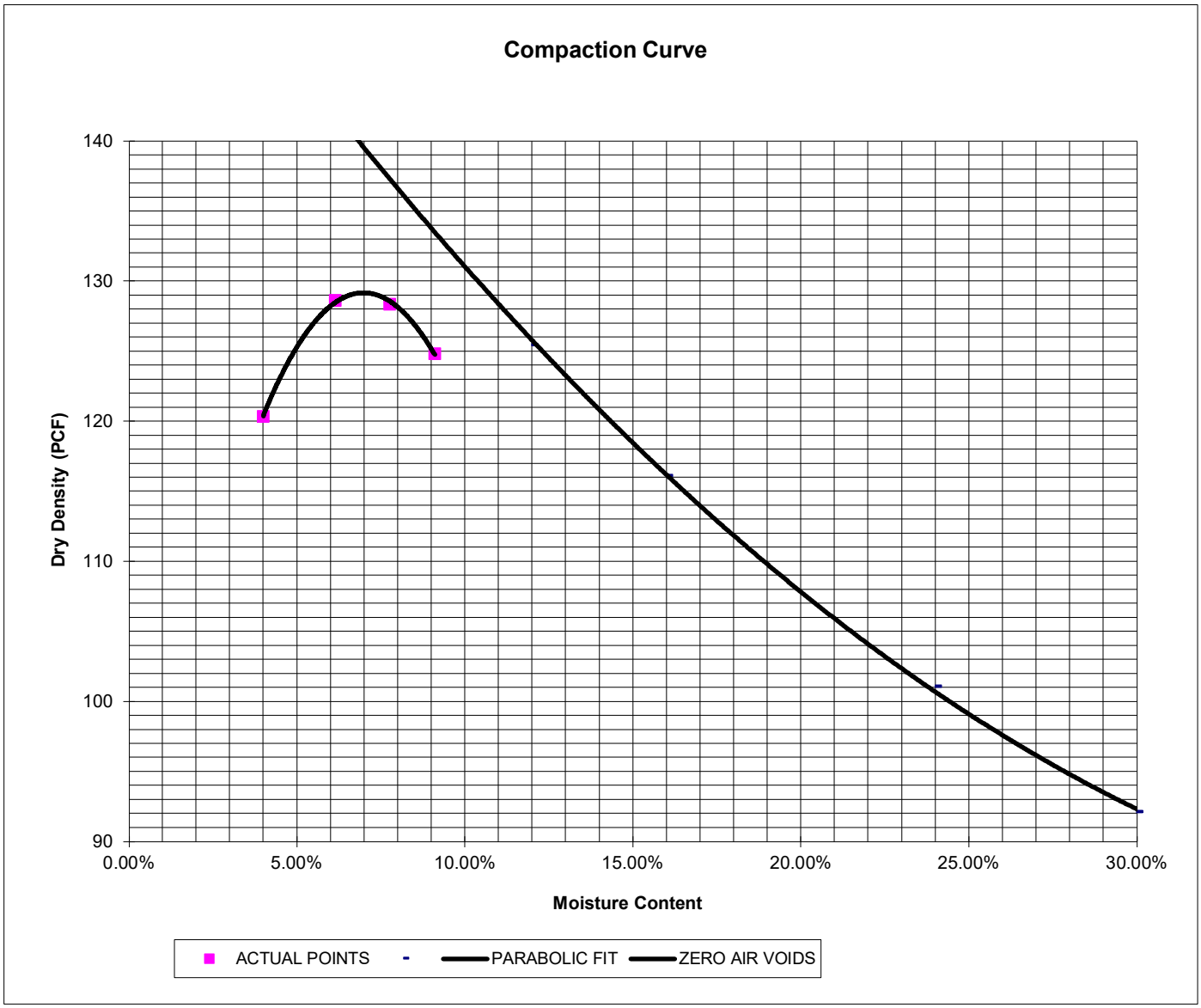

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FIG. B-21

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	151	50.46	208	69.51	306	102.26
0.050	309	103.26	450	150.38	796	266.00
0.075	490	163.74	723	241.60	1389	464.16
0.100	681	227.57	1051	351.21	2133	712.78
0.125	851	284.38	1329	444.11	2682	896.24
0.150	1006	336.17	1578	527.32	3310	1106.10
0.175	1137	379.95	1811	605.18	3620	1209.69
0.200	1251	418.04	2048	684.38	4190	1400.16
0.300	1703	569.09	2998	1001.83	5230	1747.70
0.400	1881	628.57	3506	1171.59	6000	2005.01
0.500	2053	686.05	3989	1333.00		

MOISTURE AND DENSITY DATA

	Mold # 1	Mold # 2	Mold # 3
Can #	341	117	352
Wt. Can	7.39	9.52	6.98
Wt. Can+Wet	176.67	231.7	235.23
Wt. Can+Dry	158.2	210.95	216.49
Wt. H20	18.47	20.75	18.74
Wt. Dry Soil	150.81	201.43	209.51
Moisture Content	12.25%	10.30%	8.94%
Wet Density (PCF)	123.7	127.8	134.6
Dry Density (PCF)	115.6	119.5	125.8
% Compaction	90%	93%	97%
CBR	22.76	35.12	71.28

PROCTOR DATA

Maximum Dry Density (pcf)	129.1
Optimum Moisture	7
90% of Max. Dry Density (pcf)	116.2
95% of Max. Dry Density (pcf)	122.6

CBR at 90% of Max. Density = 24.56	~ R VALUE 71
CBR at 95% of Max. Density = 53.27	~ R VALUE 76

ENTECH ENGINEERING, INC.

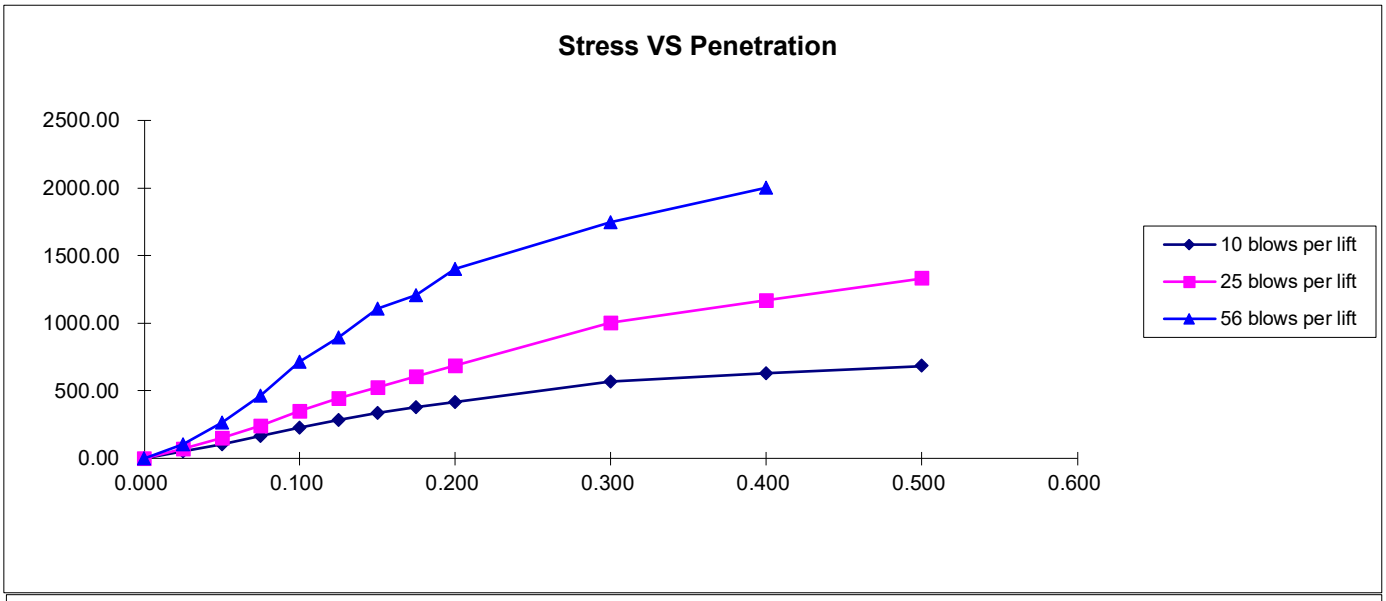
LABORATORY TEST RESULTS

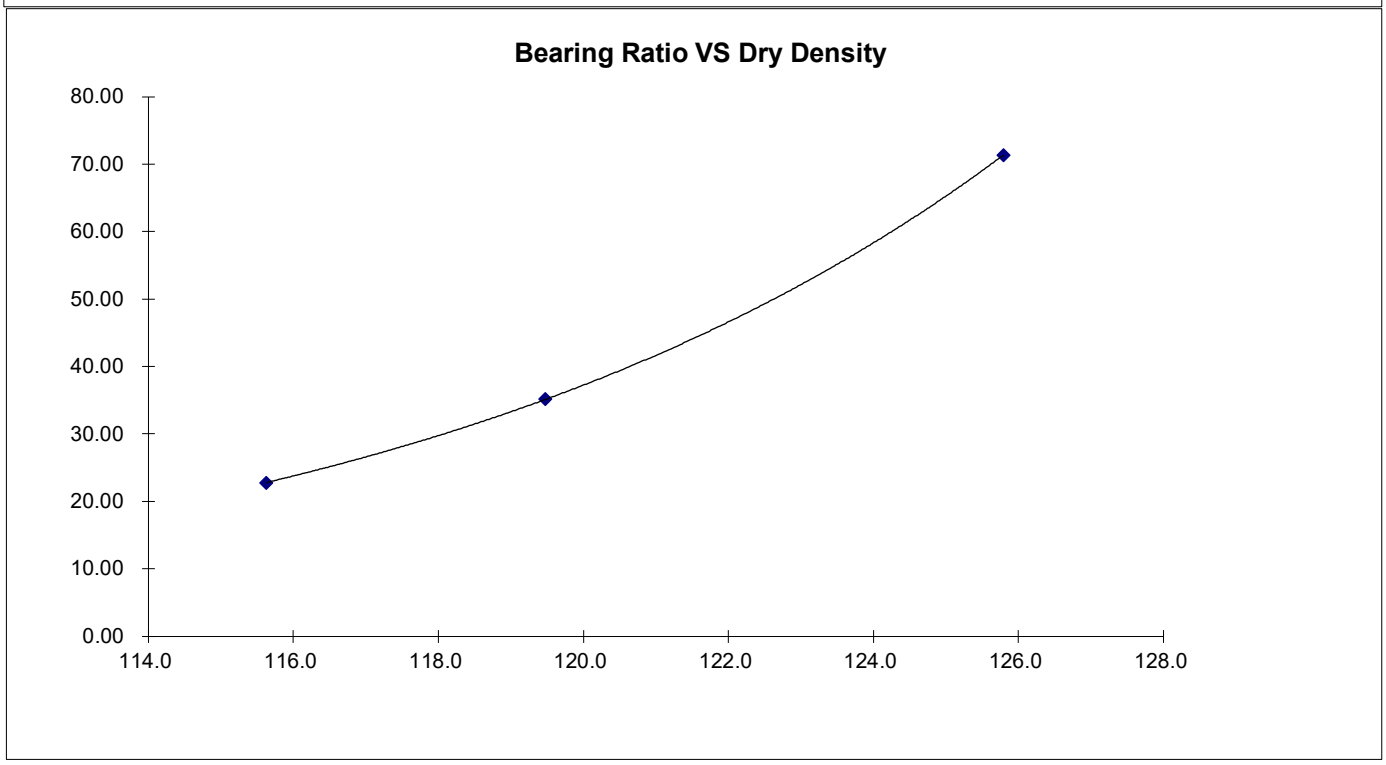
VOLLMER ROAD NORTH
CLASSIC COMMUNITIES

JOB NO. 231519

FIG. B-22

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





ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

VOLLMER ROAD NORTH
CLASSIC COMMUNITIES

JOB NO. 231519

FIG. B-23

APPENDIX C: Pavement Design Calculations

State program used to create the pavement design

ENTECH ENGINEERING, INC.

FLEXIBLE PAVEMENT DESIGN

PROJECT DATA

Project Locatior Vollmer Road North

Job Number: 231519

DESIGN DATA

Equivalent (18-kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	1,971,000	
Design CBR	CBR =	10	
Standard Deviation	S_o =	0.45	
Loss in Serviceability	Δpsi =	2.0	
Reliability	Reliability =	85	
Reliability (z-statistic)	Z_R =	-1.04	
Soil Resilient Modulus	M_R =	15,000	psi

Required Structural Number (SN): → SN = 2.80

DESIGN EQUATIONS

Resilient Modulus

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

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

Required Structural Number

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

Pavement Section Thickness

$SN^* = C_1D_1 + C_2D_2$ where:

C_1 = Strength Coefficient - HMA

C_2 = Strength Coefficient - ABC

D_1 = Depth of HMA (inches)

D_2 = Depth of ABC (inches)

RECOMMENED THICKNESSES

Layer	Material	Coefficient	Thickness (D^*_i)	SN^*_i	SN
1	HMA	C_1 = 0.44	5.0 inches	2.200	-
2	ABC	C_2 = 0.11	8.0 inches	0.880	
			SN* =	3.080	2.80

Pavement SN > Required SN, Design is Acceptable

FIG. C-1

State program used to create the pavement design

FLEXIBLE PAVEMENT DESIGN

PROJECT DATA

Project Locatior Sterling Ranch Road

Vollmer Road North

Job Number: 231661

231519

DESIGN DATA

Equivalent (18-kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	1,971,000
Design CBR	CBR =	10
Standard Deviation	S_o =	0.45
Loss in Serviceability	Δpsi =	2.0
Reliability	Reliability =	85
Reliability (z-statistic)	Z_R =	-1.04
Soil Resilient Modulus	M_R =	15,000 psi

Required Structural Number (SN): → SN = 2.80

DESIGN EQUATIONS

Resilient Modulus

If using CBR:

M_R = (CBR) x 1,500

If using R-Value:

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

Required Structural Number

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

Pavement Section Thickness

$SN^* = C_1D_1 + C_2D_2$ where:

C_1 = Strength Coefficient - HMA

C_2 = Strength Coefficient - CTS

D_1 = Depth of HMA (inches)

D_2 = Depth of CTS (inches)

RECOMMENED THICKNESSES

Layer	Material	Coefficient	Thickness (D^*_i)	SN^*_i	SN
1	HMA	C_1 = 0.44	5.0 inches	2.200	-
2	CTS	C_2 = 0.11	10.0 inches	1.100	
			SN* =	3.300	2.80

Pavement SN > Required SN, Design is Acceptable

FIG. C-2