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SUBSURFACE SOIL INVESTIGATION
LOTS 1-3, BENT GRASS EAST COMMERCIAL, FILING NO. 3
EL PASO COUNTY, COLORADO

Prepared for:
Copestone General Contractors
555 Amelia Street, Suite 100
Colorado Springs, CO 80915

Attn: Nathan Derwick

November 8, 2023

Respectfully Submitted,

ENTECH ENGINEERING, INC.

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Geotechnical Engineering Staff

Reviewed by:

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1 Introduction

Entech Engineering Inc. (Entech) completed a subsurface investigation for two proposed commercial buildings with parking lots and associated site improvements located on Lots 1-3 of the Bent Grass East Commercial property, Filing No. 3 in El Paso County, Colorado. This report describes the subsurface investigation conducted for the planned structure and provides recommendations for foundation design, pavement sections, and construction. Our services were completed for Copestone General Contractors (Copestone) in accordance with our subsurface soil investigation service agreement dated September 13, 2023. The contents of this report, including the geotechnical evaluation and recommendations, are subject to the limitations and assumptions presented in Section 9.

2 Project and Site Description

The project will consist of the construction of two commercial buildings with parking lots and other associated site improvements on Lots 1-3 of Bent Grass East Commercial in El Paso County near Falcon, Colorado. The location of the project site is shown on the Vicinity Map (Figure 1). At the time of drilling, the property was comprised of vacant lots that were recently graded. Vegetation consisted of sparse weeds, and the topography of the site is relatively flat. Building loads are expected to be light to moderate.

3 Previous Investigation

The site was previously investigated by Entech Engineering, Inc., with the results presented in the *Preliminary Subsurface Soil Investigation,* dated June 6, 2017, Entech Job No. 170651. Subsurface soils information from the report was used in preparing this Subsurface Soil Investigation. Four test borings were drilled on May 24, 2017 across the site in the proposed building locations. Based on the updated plans provided by Copestone, two of the test borings from the previous exploration program were determined to be located within the proposed building footprints. The locations of the test borings are indicated on the Development Plan, the Site and Exploration Plan (Figure 2). Laboratory testing was also performed on some of the soils to classify and determine the soils engineering characteristics. Laboratory tests included grain-size analysis, ASTM D-422, and Atterberg Limits, ASTM D-4318. The Test Boring Logs and Summary of Laboratory Testing Results are included in Appendix D. The locations of these test borings are indicated on

4 Subsurface Explorations and Laboratory Testing

4.1 Subsurface Exploration Program

Subsurface conditions at the project site were explored by six test borings, designated TB-1 through TB-6, drilled on September 21, 2023. The locations of the test borings are shown on the Site and Exploration Plan (Figure 2). TB-1 through TB-3 were drilled to depths of 20 feet below the existing ground surface (bgs) in the approximate footprints of the buildings. TB-4 through TB-6 were drilled to depths of 10 feet bgs in the parking and drive areas for pavement recommendations. The drilling was performed using a truck-mounted, continuous flight auger-drilling 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 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 and bedrock types and the actual stratigraphic transitions may be more gradual or variable with location.

4.2 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.

Swell/Consolidation testing (ASTM D4546) was performed on select samples 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 on a bulk sample of the parking lot subgrade. 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 on Table B-1.

5 Subsurface Conditions

Two 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.

5.1 Soil and Bedrock

Subsurface conditions for the proposed project site consisted of medium dense silty sand fill (Soil Type 1), medium dense to dense native silty to clayey sand (Soil Type 2). Sandstone bedrock, or very dense silty to clayey sand when classified as a soil (Soil Type 3), was encountered in 5 of the test borings at 8 to 11 feet bgs and extended to the termination of the borings at 10 to 20 feet bgs. Siltstone bedrock, or hard sandy silt when classified as a soil (Soil Type 4), was encountered in TB-4 at a depth of 9 feet and extended to the termination of the boring at 10 feet bgs. Soil types and corresponding AASHTO soil classifications are listed as follows:

- Soil Type 1: A-1-b and A-2-4
- Soil Type 2: A-2-4 and A-2-6
- Soil Type 3: A-2-4 and A-4 (sandstone)
- Soil Type 4: A-7-6 (siltstone)

Swell/Consolidation testing on a sample of the clayey sandstone and siltstone resulted in volume changes of 2.7% and 2.1%, respectively. The results indicate a moderate to high expansion potential. The sand fill is anticipated to exhibit a low expansion potential.

5.2 Groundwater

Groundwater was encountered during our subsurface investigation in 4 of the 6 test borings at depths ranging from 3 to 14 feet bgs. Groundwater is expected to affect shallow foundations or paving operations on the site. Recommendations regarding shallow groundwater are provided in Section 8.1.2. It should be noted that groundwater levels could change due to seasonal variations, changes in land runoff characteristics, and future development of nearby areas.

6 Geotechnical Evaluation and Recommendations

The following discussion is based on the subsurface conditions encountered in the borings drilled for the two commercial buildings to be constructed. If subsurface conditions different from those described herein are encountered during construction, or if the project elements change from those described, Entech should be notified so that the evaluation and recommendations presented can be reviewed and revised if necessary.

As discussed in Section 2, we understand that the site will be developed with two commercial buildings and the paving of parking lots and access drives. The proposed buildings are expected to have shallow foundations with slab on grade floors. Anticipated subsurface conditions will consist of native or recompacted medium dense to dense silty sand.

6.1 Shallow Foundations

A spread footing (16")/stemwall foundation system is anticipated for this site. Subgrades should be prepared as discussed in Section 8.1.1. A maximum allowable bearing pressure of 2,400 pounds per square foot (psf) is recommended for the medium dense to dense silty sand or recompacted sand fill. Actual bearing capacities will be verified at the time of the individual open excavation observations (Section 8.9). Exterior footings should extend a minimum of 30 inches below the adjacent exterior site grade for frost protection.

Foundation walls should be designed to resist lateral pressures generated by the soils on this site. An equivalent hydrostatic fluid pressure (in the active state) of 40 pcf is recommended for the on-site sand soils. It should be noted that this value applies to level backfill conditions. If sloping backfill conditions exist, pressures will increase substantially depending on the conditions adjacent to the walls. Surcharge loading should also be considered in wall designs. Equivalent fluid pressures for sloping conditions should be determined on an individual basis.

6.2 On-Grade Floor Slabs

On-grade floor slabs for the planned structures should be supported on compacted site sands prepared in accordance with Section 8.1.1. Any loose soils or uncontrolled fill encountered will require removal according to Section 8.1.1.

Grade-supported floor slabs should be separated from other building structural components and utility penetrations to allow for possible future vertical movement. Interior partition walls should be

constructed in such a manner so as not to transfer slab movement into the overlying floor(s) and/or roof members, should slab movement occur. Control joints in grade-supported slabs are recommended at 10- to 15-foot perpendicular spacings to control cracking. If slab movement cannot be tolerated, a structural floor system should be used.

6.3 Seismic Site Classification

Based on the subsurface conditions encountered at the site and in accordance with Section 1613 of the 2015 International Building Code (IBC), the site meets the conditions of a Site Class D.

6.4 Surface and Subsurface Drainage

Positive surface drainage is recommended around the building's perimeter to minimize infiltration of surface water into the supporting foundation soils. A minimum ground surface slope of 5% in the first 10 feet adjacent to exterior foundation walls is recommended for unpaved areas. For paved areas and other impervious surfaces, a minimum slope of 2% is adequate. All roof drains and gutter downspouts should be extended to discharge well beyond the building's foundation backfill zone or be connected to a storm sewer system.

To help minimize infiltration of water into the foundation zone, vegetative plantings placed close to foundation walls should be limited to those species having low watering requirements and irrigated grass should not be located within 5 feet of the foundation. Sprinklers should not discharge water within 5 feet of foundations. Irrigation near foundations should be limited to the minimum amount sufficient to maintain vegetation. Application of more irrigation water than necessary can increase the potential for slab and foundation movement.

Perimeter drains are recommended for usable space below grade. A typical perimeter drain detail is shown in Figure 3. It is our opinion that a subsurface perimeter drain is not required for this site provided that the floor slab is located above the exterior grade, positive surface grading away from the foundation is maintained, the interior and exterior backfill is properly compacted, and irrigation adjacent to the foundation is minimized.

7 Pavement Design Recommendations

7.1 Pavement Subgrade Conditions

Three test borings (TB-4, TB-5, and TB-6) were drilled to depths of approximately 10 feet below the existing subgrade in the proposed parking lot and access road areas. Subsurface conditions

for the proposed parking lot and access road consisted of medium dense silty sand fill overlying native medium dense silty sand.

California Bearing Ratio (CBR) testing was performed on a representative sample of the subgrade silty sand fill (Soil Type 1) from TB-4 to determine the support characteristics of the subgrade soils for the parking lot and access road. The results of the CBR testing are presented in Appendix B and summarized in Exhibit 1.

Exhibit 1: Pavement Subgrade Laboratory Summary

Design Parameter	Value
Soil Type	1 – Silty Sand Fill
CBR at 95%	15.38
Design CBR	10
Liquid Limit	NV
Plasticity Index	NP
Percent Passing 200	24.5
AASHTO Classification	A-2-4
Group Index	0
Unified Soils Classification	SM

7.2 Swell Mitigation

El Paso County requires swell mitigation of expansive soils criteria for roadway subgrade with swell testing results greater than 2% under a 150 pounds per square foot (psf) surcharge. Given the classification of the soils, mitigation for expansive soils is not required on this site.

7.3 Traffic Loading

Traffic data is not available for the parking lot and access road. Based on the Colorado Asphalt Pavement Association, Guideline for the Design and Construction of Asphalt Parking Lots in Colorado (2006) an 18-kip equivalent single axle loading (ESAL) of 100,000 is appropriate for moderate traffic level which includes passenger cars and light trucks.

7.4 Pavement Design Recommendations

Pavement sections were determined for asphalt and aggregate base course composite sections. The pavement sections were determined utilizing the El Paso County Engineering Criteria Manual, the CBR testing, and assumed design ESAL. 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 Mix Asphalt	0.44
Aggregate Base Course	0.11

The recommended pavement section for the parking areas and access road are summarized in Exhibit 3. The pavement design calculations are presented in Appendix C.

Exhibit 3: Recommended Pavement Sections

Pavement Area	Design ESAL	Alternative
Parking Areas and Drive Lanes	100,000	4.0 inches HMA over 4.0 inches ABC

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

8 Construction Recommendations

8.1 Earthwork Recommendations for Structures

8.1.1 Subgrade Preparation

The foundations and on-grade floor slabs may be placed on undisturbed, nonexpansive native silty sand or recompacted granular fill. Pockets of loose soil may be encountered during subgrade preparation and will require overexcavation to suitable dense and unyielding underlying soils. After reaching suitable subgrades, the material should be scarified to an additional 12 inches. The scarified material and overexcavated site soils can then be moisture conditioned and recompacted in place (Section 8.1.4).

All soil beneath the foundation and slabs should be free of organics, debris, and cobbles larger than 3 inches in diameter.

Prior to site earthwork, any ponded water should be drained and surface runoff should be directed away from earthwork areas. If water is allowed to sit, pond, or infiltrate into the foundation subgrade, it will likely create unstable subgrade conditions.

8.1.2 Shallow Groundwater

If shallow groundwater is encountered during subgrade preparation, we recommend overexcavating 6 to 12 inches below the base of foundation elements, pushing 2 to 4-inch shot rock into the subgrade for stabilization, as required, followed by a layer of Mirafi 600x geotextile (or equivalent). The stabilization should extend a minimum of 2 feet beyond footings. We then recommend placing compacted granular fill in accordance with Section 8.1.3 and 8.1.4. After placement of backfill the subgrade should be proofrolled and evaluated to ensure that subgrade is not pumping. Based on the groundwater conditions encountered at the time of excavation, dewatering methods may be required, this could include diversion ditches, pumping, or capillary drains.

8.1.3 Granular Fill

Granular fill placed beneath foundation components and floor slabs shall consist of non-expansive, granular soil, free of organic matter, unsuitable materials, debris, and cobbles greater than 3-inches in diameter. On-site granular soils may be used as granular fill. Entech should approve any imported granular or structural fill to be used within the foundation area prior to delivery to the site.

8.1.4 Fill Placement and Compaction

All granular fill placed within the foundation area should be compacted to a minimum of 95% of the soils maximum dry density as determined by the Modified Proctor Test ASTM D1557 at +/- 2% of the optimum water content. Fill material should be placed in horizontal lifts such that each finished lift has a compacted thickness of 6 inches or less as determined by ASTM D1557. Mechanical methods can be used for placement and compaction of fill; however, heavy equipment should be kept at a distance from foundation walls and below slab infrastructure to avoid overstressing. No water flooding techniques of any type should be used for compaction or placement of foundation or floor slab fill material.

Fill placement and compaction beneath and around foundations should be observed and tested by Entech during construction. Density tests should be performed frequently to verify compaction with the first density test performed at the overexcavated subgrade elevation and with additional testing once each 12 to 18 inches of granular fill has been placed.

8.2 Pavements

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.

8.2.1 Roadway Subgrade Preparation

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.

The final subgrade surface should be scarified to a depth of 12 inches, moisture conditioned within +/-2% of the optimum water content and recompacted to 95% of its maximum Modified Proctor dry density, ASTM D1557. 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.

Shallow groundwater was encountered on-site. Areas of the parking lot and access drives may require stabilization utilizing shotrock and/or geotextile fabric or removal and replacement as discussed above.

8.2.2 Aggregate Base Course

ABC materials shall conform to the El Paso County Standard Specifications, 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.

8.3 Excavation Potential

Excavation of the upper granular soils should be feasible with rubber-tired equipment.

8.4 Excavation Stability

Excavation sidewalls must be properly sloped, benched, and/or otherwise supported in order to maintain stable conditions. All excavation openings and work completed therein shall conform to OSHA Standards as put forward in CFR 29, Part 1926.650-652, (Subpart P).

8.5 Utility Trench Backfill

Trench backfill placement should be performed in accordance with El Paso County specifications. All excavation and excavation shoring/bracing should be performed in accordance with OSHA guidelines.

Fill placement and compaction in utility trenches should be observed and tested by Entech during construction. Fill should be placed in horizontal lifts having a compacted thickness of 6 inches or less and at a water content conducive to adequate compaction, within +/-2% of optimum water content. No water flooding techniques of any type should be used for compaction or placement of utility trench fill.

8.6 General Backfill

Any areas to receive general grading fill should have all topsoil, organic material, and debris removed. Fill must be properly benched into existing slopes in order to be adequately compacted. The fill receiving surface should be scarified to a depth of 12 inches and moisture conditioned to +/-2% of the optimum water content, and compacted to a minimum of 95% of the ASTM D1557 maximum dry density before the addition of new fill. Fill should be placed in thin lifts not to exceed 6 inches in thickness after compaction while maintaining at least 95% of the ASTM D1557 maximum dry density. Fill material should be free of vegetation and other unsuitable material and shall not contain cobbles or fragments greater than 3 inches. Topsoil and strippings should be segregated from all other fill sources on the site. Fill placement and compaction beneath and around foundations, in utility trenches, or beneath roadways or other structural features of the project should be observed and tested by Entech during construction.

8.7 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 placed below surface grade. The test results indicated less than 0.01% to 0.0% 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 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.

8.8 Winter Construction

In the event construction of the planned facility occurs during winter, foundations and subgrades should be protected from freezing conditions. Concrete should not be placed on frozen soil and once concrete has been placed, it should not be allowed to freeze. Similarly, once exposed, the foundation subgrade should not be allowed to freeze. During site grading and subgrade preparation, care should be taken to eliminate burial of snow, ice, or frozen material within the planned construction area.

8.9 Foundation Excavation and Construction Observation

Subgrade preparation for building foundations should be observed by Entech prior to construction of the footings and floor slabs 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 foundation area prior to concrete placement or backfilling. Entech should make final recommendations for overexcavation, if required, and foundation drainage at the time of excavation observation, if necessary.

In addition, Entech should observe and document placement and compaction of utility bedding and trench backfill.

9 Closure

The subsurface investigation, geotechnical evaluation, and recommendations presented in this report are intended for use by Copestone General Contractors with application to the planned commercial buildings and associated site improvements at the Bent Grass East Commercial Site, Filing No. 3, located 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 which 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.

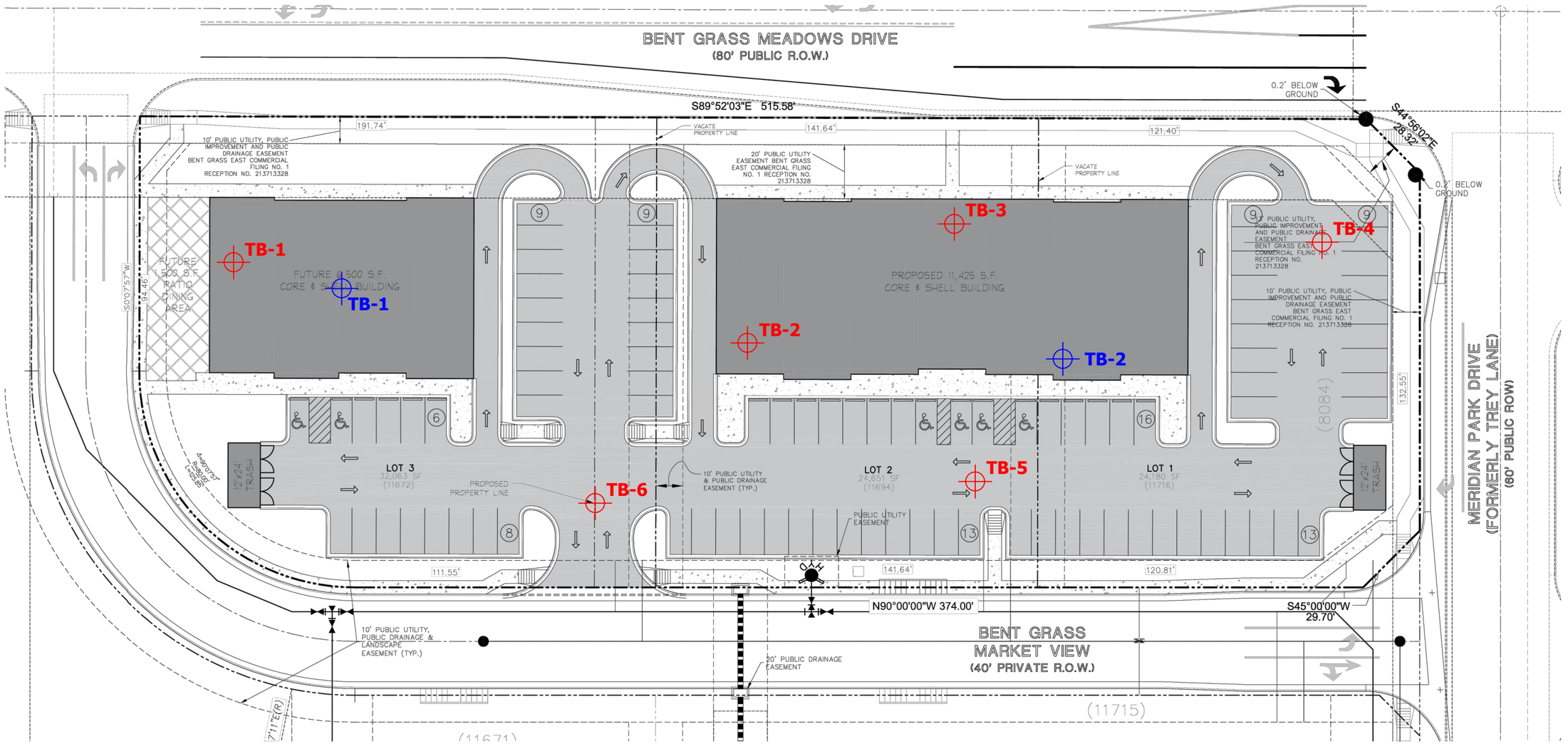
ENTECH ENGINEERING, INC.

VICINITY MAP

BENT GRASS, FILING NO. 3
COPESTONE GENERAL CONTRACTORS

JOB NO. 231508

FIG. 1



TB- APPROXIMATE TEST BORING LOCATION AND NUMBER FROM PREVIOUS REPORT DATED JUNE 6, 2017 ENTECH JOB (170651)

TB- APPROXIMATE TEST BORING LOCATION AND NUMBER (231508)

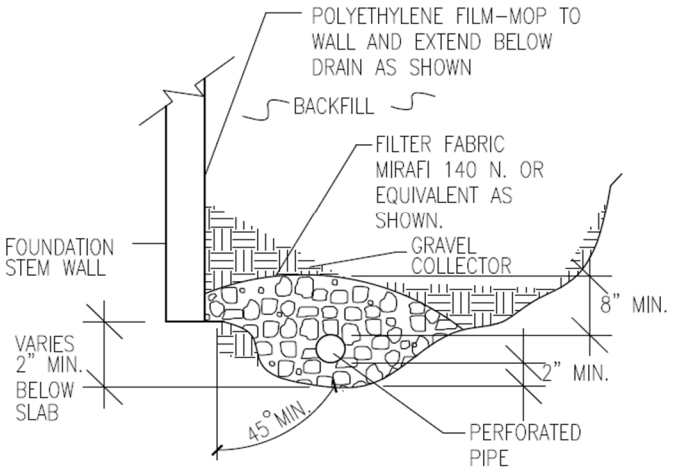
ENTECH ENGINEERING, INC.

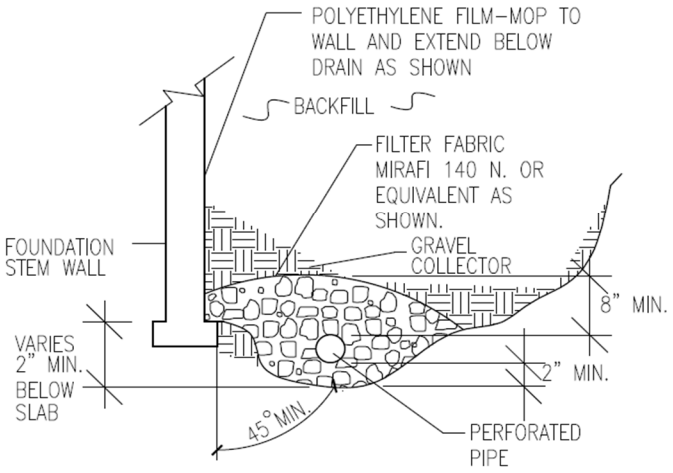
SITE AND EXPLORATION PLAN

BENT GRASS, FILING NO. 3
COPESTONE GENERAL CONTRACTORS

JOB NO. 231508

FIG. 2





NOTES:

–GRAVEL SIZE IS RELATED TO DIAMETER OF PIPE PERFORATIONS–85% GRAVEL GREATER THAN 2x PERFORATION DIAMETER.

–PIPE DIAMETER DEPENDS UPON EXPECTED SEEPAGE. 4–INCH DIAMETER IS MOST OFTEN USED.

–ALL PIPE SHALL BE PERFORATED PLASTIC. THE DISCHARGE PORTION OF THE PIPE SHOULD BE NON–PERFORATED PIPE.

–FLEXIBLE PIPE MAY BE USED UP TO 8 FEET IN DEPTH, IF SUCH PIPE IS DESIGNED TO WITHSTAND THE PRESSURES. RIGID PLASTIC PIPE WOULD OTHERWISE BE REQUIRED.

–MINIMUM GRADE FOR DRAIN PIPE TO BE 1% OR 3 INCHES OF FALL IN 25 FEET.

–DRAIN TO BE PROVIDED WITH A FREE GRAVITY OUTFALL, IF POSSIBLE. A SUMP AND PUMP MAY BE USED IF GRAVITY OUT FALL IS NOT AVAILABLE.

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PERIMETER DRAIN DETAIL

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FIG. 3

APPENDIX A: Test Boring Logs

TABLE A-1

DEPTH TO GROUNDWATER & BEDROCK

TEST BORING	DEPTH TO GROUNDWATER (ft.)	DEPTH TO BEDROCK (ft.)
1	7	11
2	14	9
3	>20	8
4	>10	8
5	3	9
6	>10	9

TEST BORING 1
DATE DRILLED 9/21/2023

REMARKS

WATER @ 7', 9/26/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			15	7.9	1
5			20	8.4	2
10			44	10.3	2
15			50/6"	11.4	3
20			50/11"	14.9	3

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

SAND, SILTY, OLIVE, MEDIUM DENSE to DENSE, MOIST

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

TEST BORING 2
DATE DRILLED 9/21/2023

REMARKS

WATER @ 14', 9/26/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			14	3.2	2
5			37	7.7	2
10			50/10"	14.1	3
15			50	15.4	3
20			50/6"	12.1	3

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

SANDSTONE, VERY WEAK, GRAY to OLIVE, HIGHLY WEATHERED (SAND, CLAYEY, VERY DENSE,

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TEST BORING LOGS

BENT GRASS, FILING NO. 3
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FIG. A-1

TEST BORING 3
DATE DRILLED 9/21/2023

REMARKS

WATER @ 9.5', 9/26/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			14	3.2	1	FILL 0-3', SAND, SILTY, DARK BROWN, MEDIUM DENSE, MOIST
5			33	7.2	2	SAND, SILTY, OLIVE, DENSE, MOIST
10			50/8"	11.1	3	SANDSTONE, VERY WEAK, OLIVE to GRAY, HIGHLY WEATHERED (SAND, SILTY, VERY DENSE, ▼
15			50/6"	10.7	3	
20			50/8"	15.2	3	

TEST BORING 4
DATE DRILLED 9/21/2023

REMARKS

DRY TO 8.5', 9/26/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			15	5.7	1	FILL 0-3', SAND, SILTY, DARK BROWN, MEDIUM DENSE, MOIST
5			19	5.0	2	SAND, SILTY, BROWN, MEDIUM DENSE, MOIST
10			50/10"	16.0	4	SILTSTONE, VERY WEAK, OLIVE, HIGHLY WEATHERED (SILT, SANDY, HARD, MOIST)
15						
20						

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TEST BORING LOGS

BENT GRASS, FILING NO. 3
COPESTONE GENERAL CONTRACTORS

JOB NO. 231508

FIG. A-2

TEST BORING 5
DATE DRILLED 9/21/2023

REMARKS

WATER @ 3', 9/26/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			11	6.9		FILL 0-3', SAND, SILTY, DARK BROWN, MEDIUM DENSE, MOIST
5			27	11.5		SAND, CLAYEY, OLIVE, MEDIUM DENSE, MOIST
10			50/11"	13.3		SANDSTONE, VERY WEAK, OLIVE, HIGHLY WEATHERED (SAND, CLAYEY, VERY DENSE, MOIST)
15						
20						

TEST BORING 6
DATE DRILLED 9/21/2023

REMARKS

DRY TO 10', 9/26/23

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			9	7.6		FILL 0-3', SAND, SILTY, DARK BROWN, MEDIUM DENSE, MOIST
5			26	11.5		SAND, CLAYEY, OLIVE, MEDIUM DENSE, MOIST
10			50/11"	12.9		SANDSTONE, VERY WEAK, OLIVE, HIGHLY WEATHERED (SAND, CLAYEY, VERY DENSE, MOIST)
15						
20						

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TEST BORING LOGS

BENT GRASS, FILING NO. 3
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JOB NO. 231508

FIG. A-3

APPENDIX B: Laboratory Test Results

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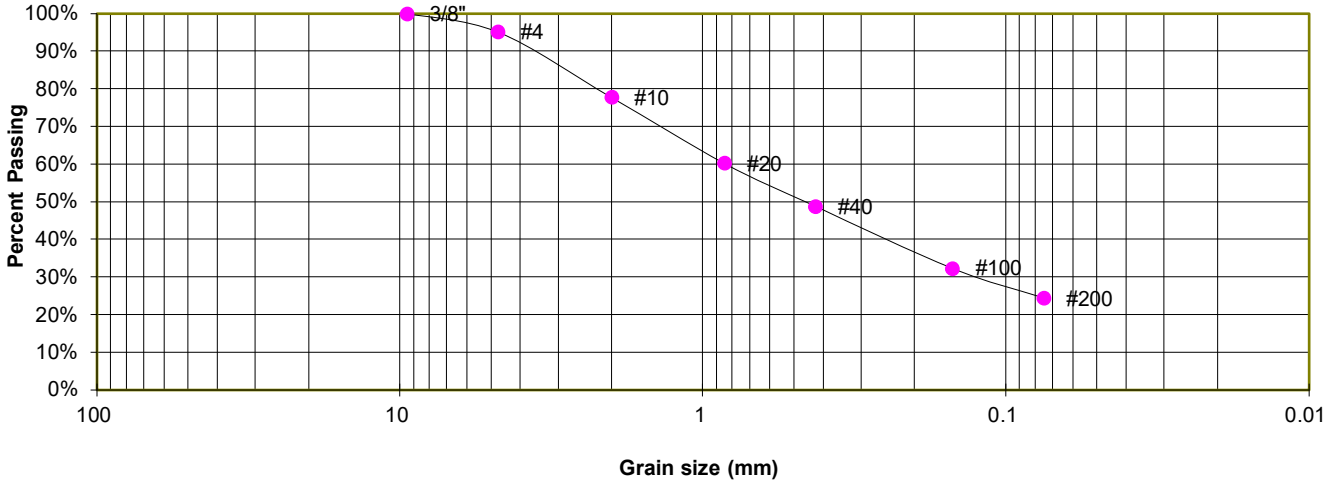
TABLE B-1
SUMMARY OF LABORATORY TEST RESULTS

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX	SULFATE (WT %)	AASHTO CLASS.	SWELL/ CONSOL (%)	USCS	SOIL DESCRIPTION
1, CBR	4	0-3			24.5	NV	NP	NP		A-2-4		SM	FILL, SAND, SILTY
1	1	2-3			28.0	NV	NP	NP	<0.01	A-2-4		SM	FILL, SAND, SILTY
1	4	1-2			17.8	NV	NP	NP		A-1-b		SM	FILL, SAND, SILTY
1	5	1-2			16.5	NV	NP	NP	<0.01	A-1-b		SM	FILL, SAND, SILTY
1	6	1-2			12.3	NV	NP	NP		A-2-4		SM	FILL, SAND, SILTY
1	5	0-3			27.7							SM	FILL, SAND, SILTY
2	2	5			17.3	NV	NP	NP	<0.01	A-2-4		SM	SAND, SILTY
2	5	5			27.9	34	20	14	0.00	A-2-6		SC	SAND, CLAYEY
3	1	15			25.5	NV	NP	NP	<0.01	A-2-4		SM	SANDSTONE (SAND, SILTY)
3	3	15			39.3	NV	NP	NP	0.00	A-4		SM	SANDSTONE (SAND, SILTY)
3	6	10	13.6	116.4	45.0						2.7	SC	SANDSTONE (SAND, CLAYEY)
4	4	10	16.4	112.3	63.4	42	28	14	<0.01	A-7-6	2.1	ML	SILTSTONE (SILT, SANDY)

TEST BORING	4	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	95.1%
10	77.8%
20	60.3%
40	48.8%
100	32.3%
200	24.5%

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

BENT GRASS, FILING NO. 3
COPESTONE GENERAL CONTRACTORS

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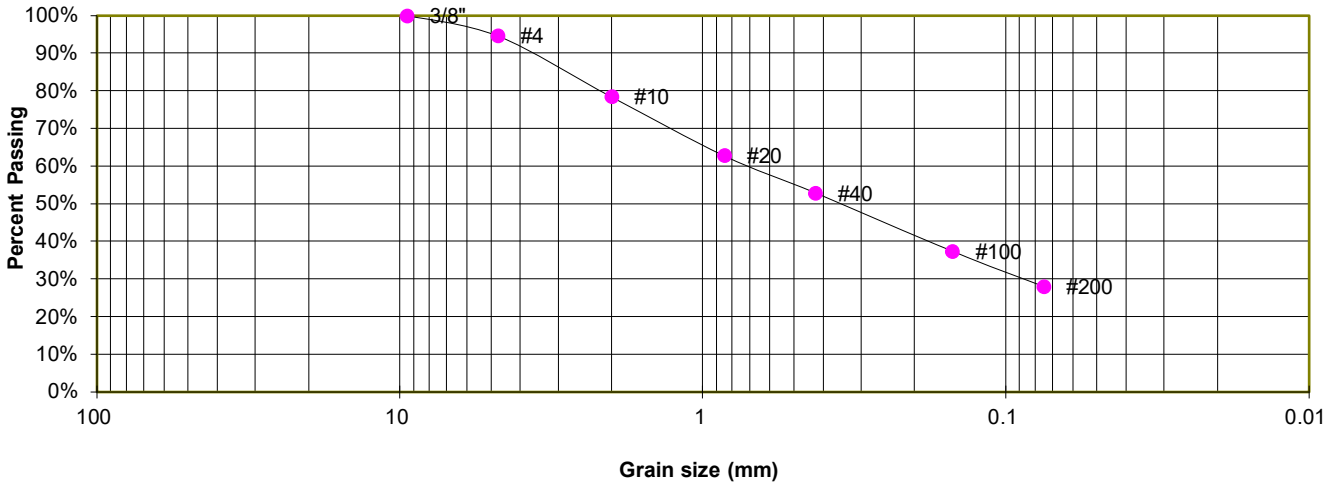
FIG. B-1

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



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.6%
10	78.5%
20	62.8%
40	52.8%
100	37.4%
200	28.0%

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

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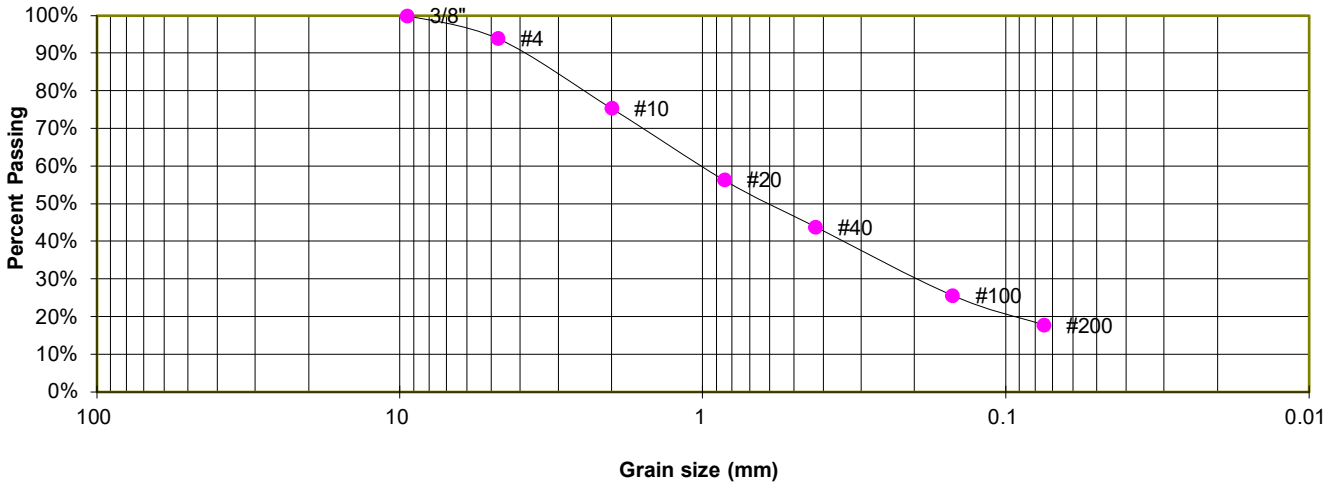
FIG. B-2

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	93.9%
10	75.4%
20	56.4%
40	43.9%
100	25.7%
200	17.8%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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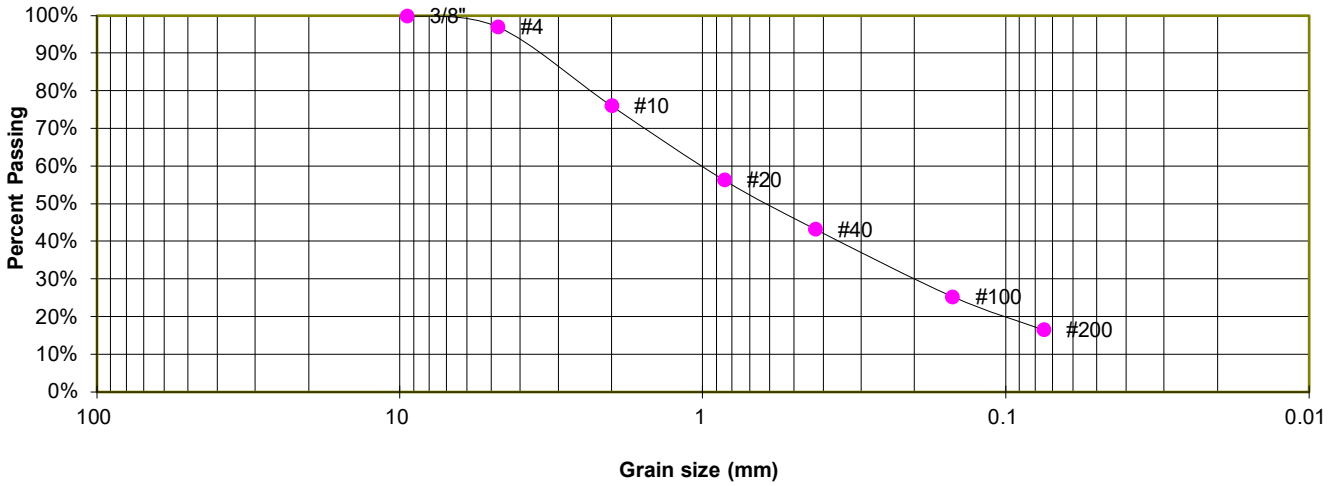
FIG. B-3

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	97.0%
10	76.1%
20	56.3%
40	43.3%
100	25.4%
200	16.5%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

BENT GRASS, FILING NO. 3
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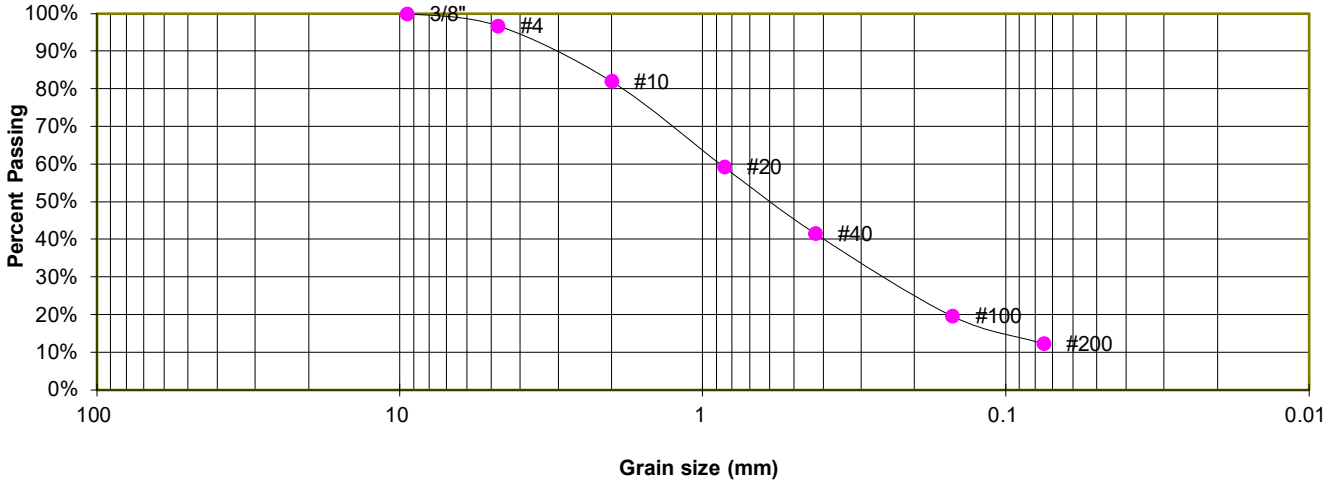
FIG. B-4

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"	100.0%
4	96.8%
10	82.1%
20	59.2%
40	41.5%
100	19.6%
200	12.3%

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

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

BENT GRASS, FILING NO. 3
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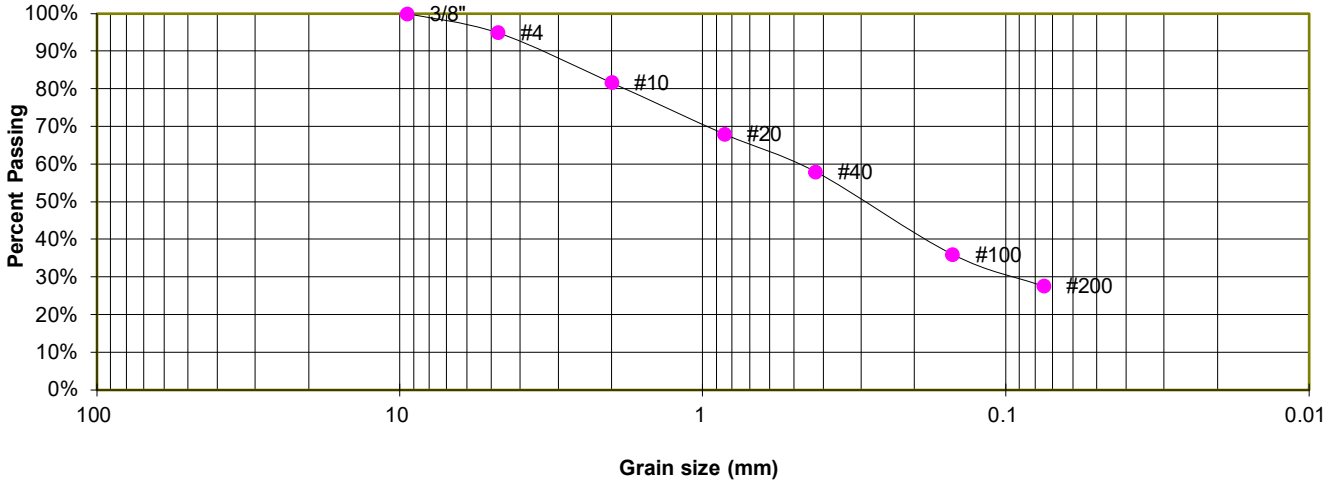
FIG. B-5

TEST BORING	5	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	94.9%
10	81.7%
20	68.0%
40	58.0%
100	36.0%
200	27.7%

SOIL CLASSIFICATION

USCS CLASSIFICATION: SM
AASHTO CLASSIFICATION:
AASHTO GROUP INDEX:

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

BENT GRASS, FILING NO. 3
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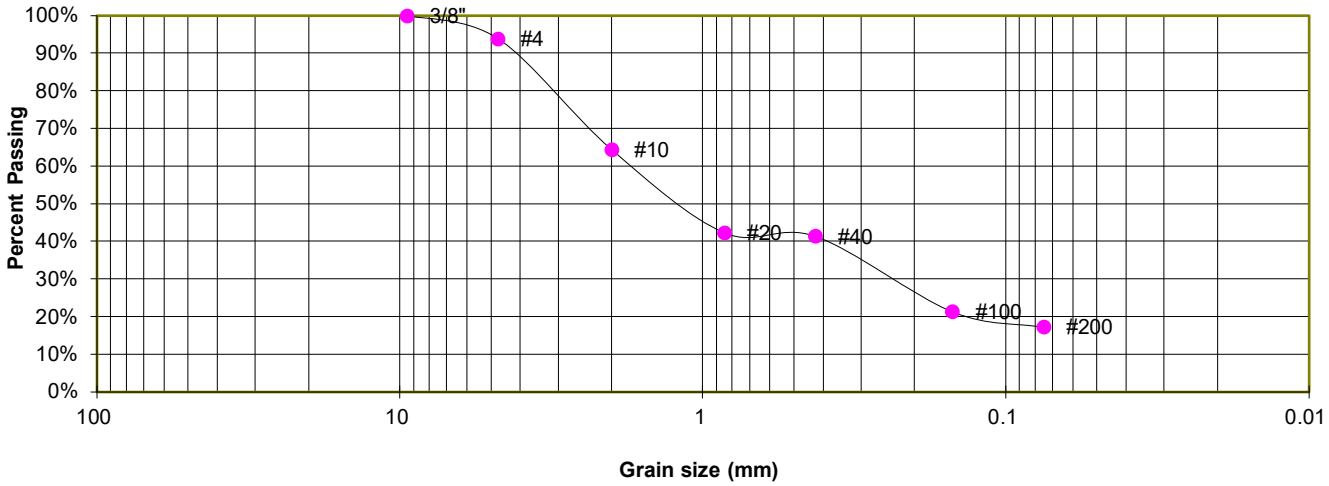
FIG. B-6

TEST BORING	2	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	93.9%
10	64.4%
20	42.3%
40	41.4%
100	21.4%
200	17.3%

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

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

BENT GRASS, FILING NO. 3
COPESTONE GENERAL CONTRACTORS

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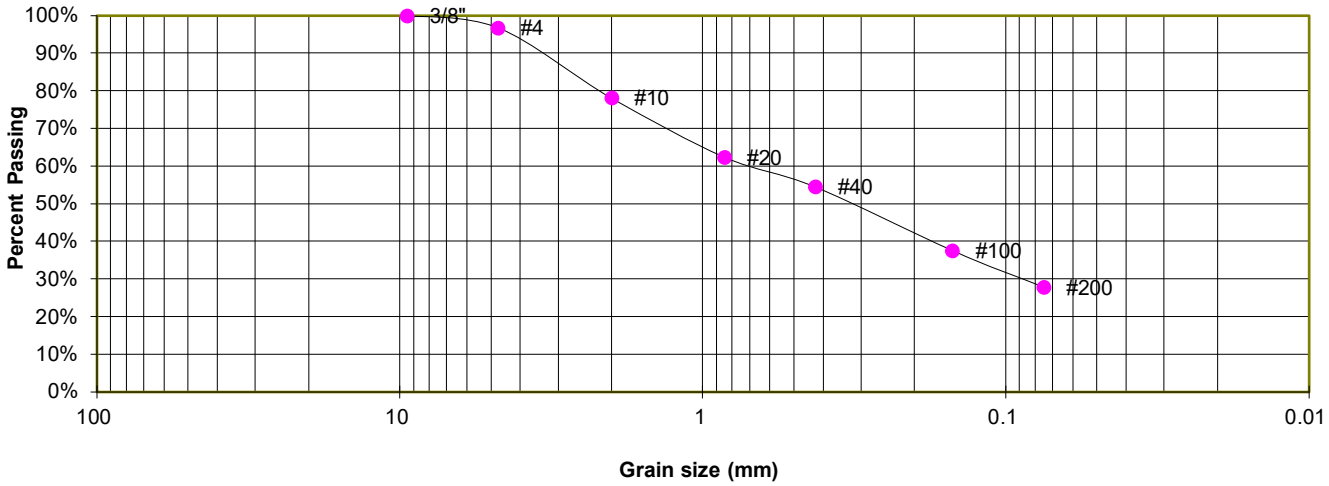
FIG. B-7

TEST BORING	5	SOIL DESCRIPTION	SAND, CLAYEY
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	96.8%
10	78.2%
20	62.4%
40	54.5%
100	37.5%
200	27.9%

ATTERBERG LIMITS

Plastic Limit	20
Liquid Limit	34
Plastic Index	14

SOIL CLASSIFICATION

USCS CLASSIFICATION:	SC
AASHTO CLASSIFICATION:	A-2-6
AASHTO GROUP INDEX:	1

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

BENT GRASS, FILING NO. 3
COPESTONE GENERAL CONTRACTORS

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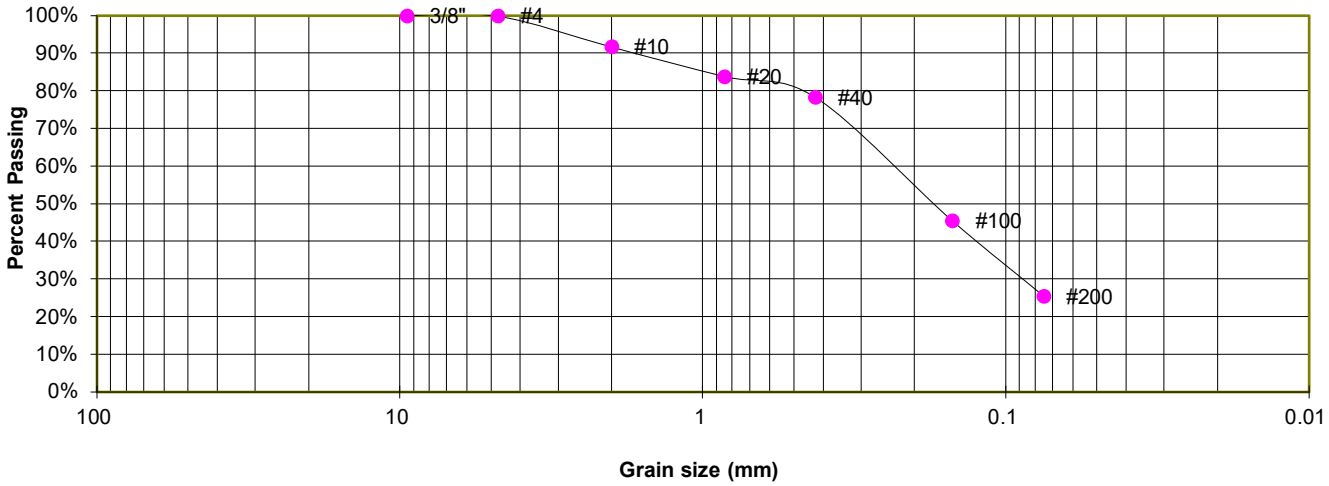
FIG. B-8

TEST BORING	1	SOIL DESCRIPTION	SANDSTONE (SAND, SILTY)
DEPTH (FT)	15	SOIL TYPE	3



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.9%
10	91.7%
20	83.9%
40	78.3%
100	45.5%
200	25.5%

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

BENT GRASS, FILING NO. 3
COPESTONE GENERAL CONTRACTORS

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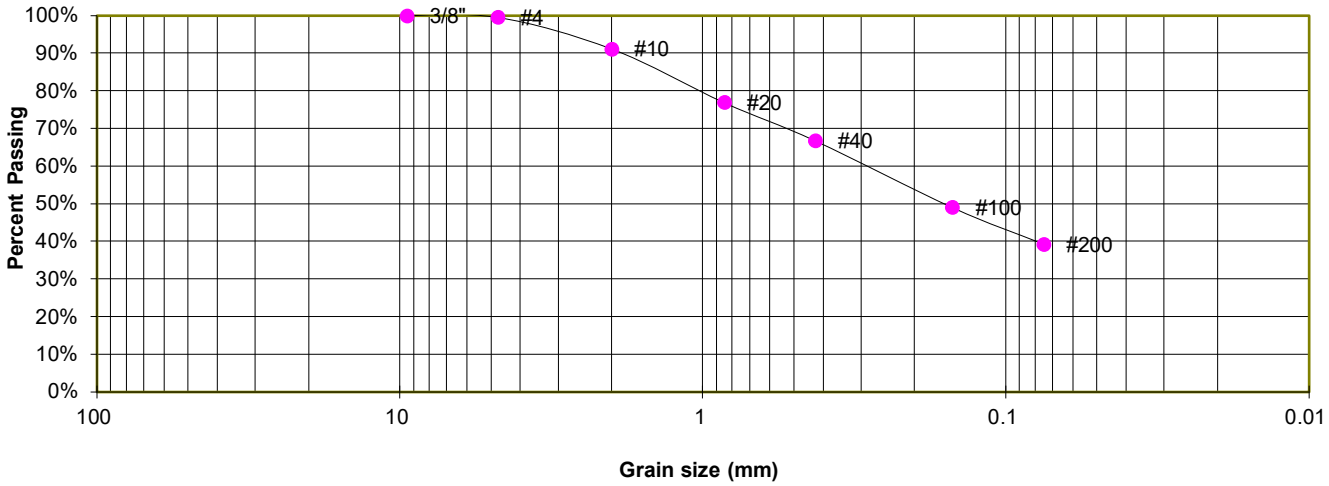
FIG. B-9

TEST BORING	3	SOIL DESCRIPTION	SANDSTONE (SAND, SILTY)
DEPTH (FT)	15	SOIL TYPE	3



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.5%
10	91.2%
20	76.9%
40	66.7%
100	49.0%
200	39.3%

ATTERBERG LIMITS

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

SOIL CLASSIFICATION

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

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

BENT GRASS, FILING NO. 3
COPESTONE GENERAL CONTRACTORS

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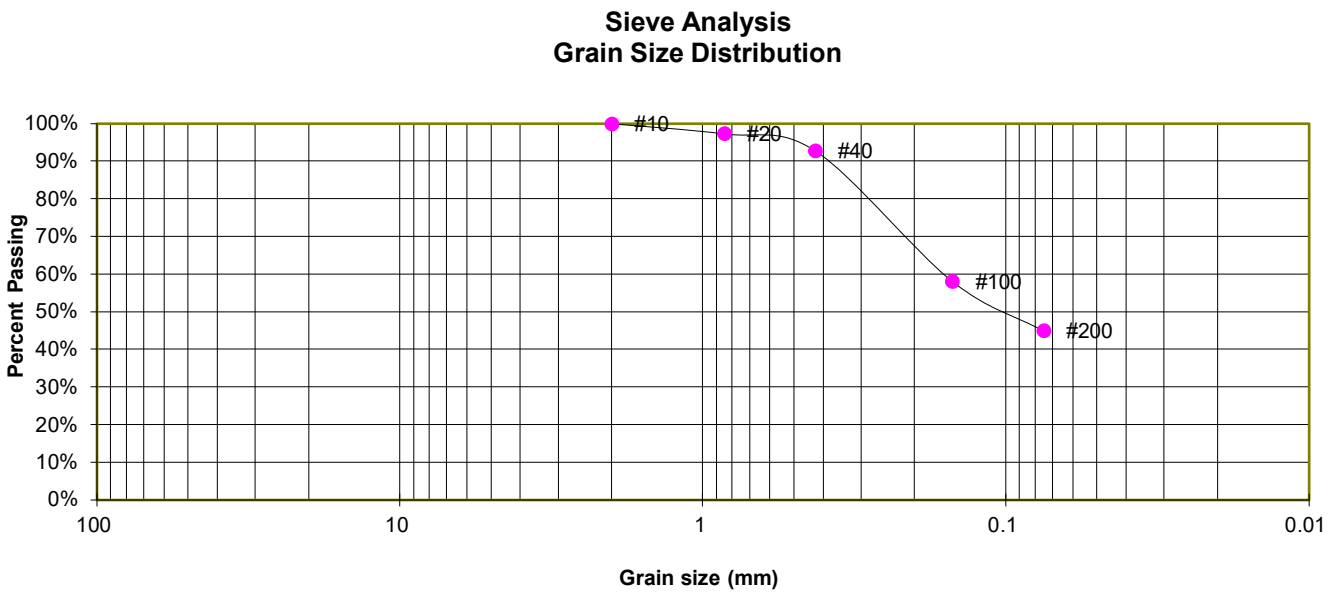
FIG. B-10

TEST BORING	6	SOIL DESCRIPTION	SANDSTONE (SAND, CLAYEY)
DEPTH (FT)	10	SOIL TYPE	3



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	97.3%
40	92.8%
100	58.1%
200	45.0%

SOIL CLASSIFICATION

USCS CLASSIFICATION: SC
AASHTO CLASSIFICATION:
AASHTO GROUP INDEX:

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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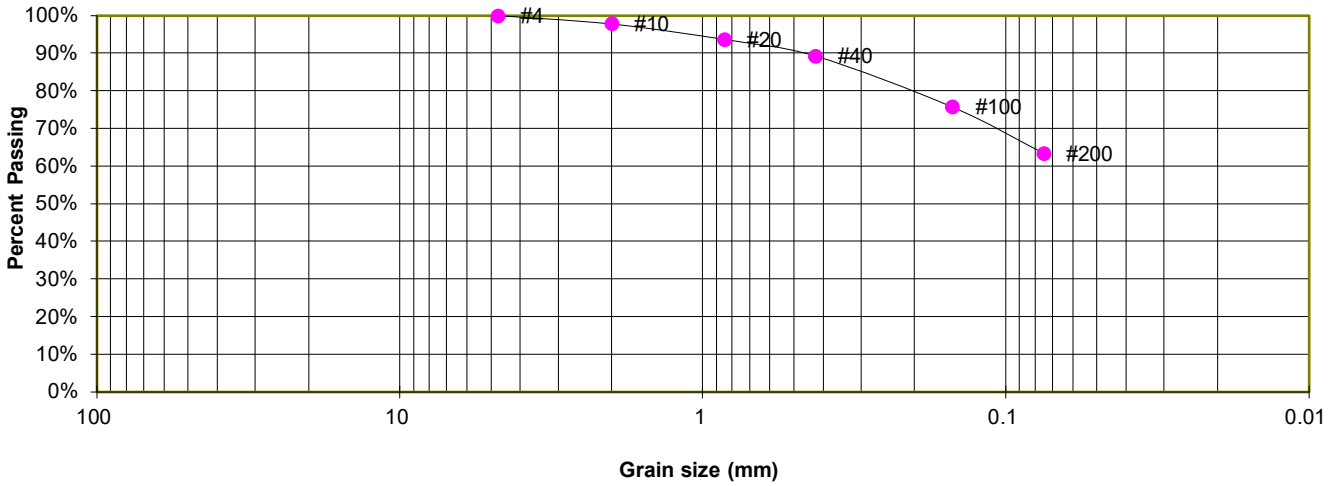
FIG. B-11

TEST BORING	4	SOIL DESCRIPTION	SILTSTONE (SILT, SANDY)
DEPTH (FT)	10	SOIL TYPE	4



GRAIN SIZE ANALYSIS

U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	97.8%
20	93.7%
40	89.3%
100	75.8%
200	63.4%

ATTERBERG LIMITS

Plastic Limit	28
Liquid Limit	42
Plastic Index	14

SOIL CLASSIFICATION

USCS CLASSIFICATION:	ML
AASHTO CLASSIFICATION:	A-7-6
AASHTO GROUP INDEX:	8

ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

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COPESTONE GENERAL CONTRACTORS

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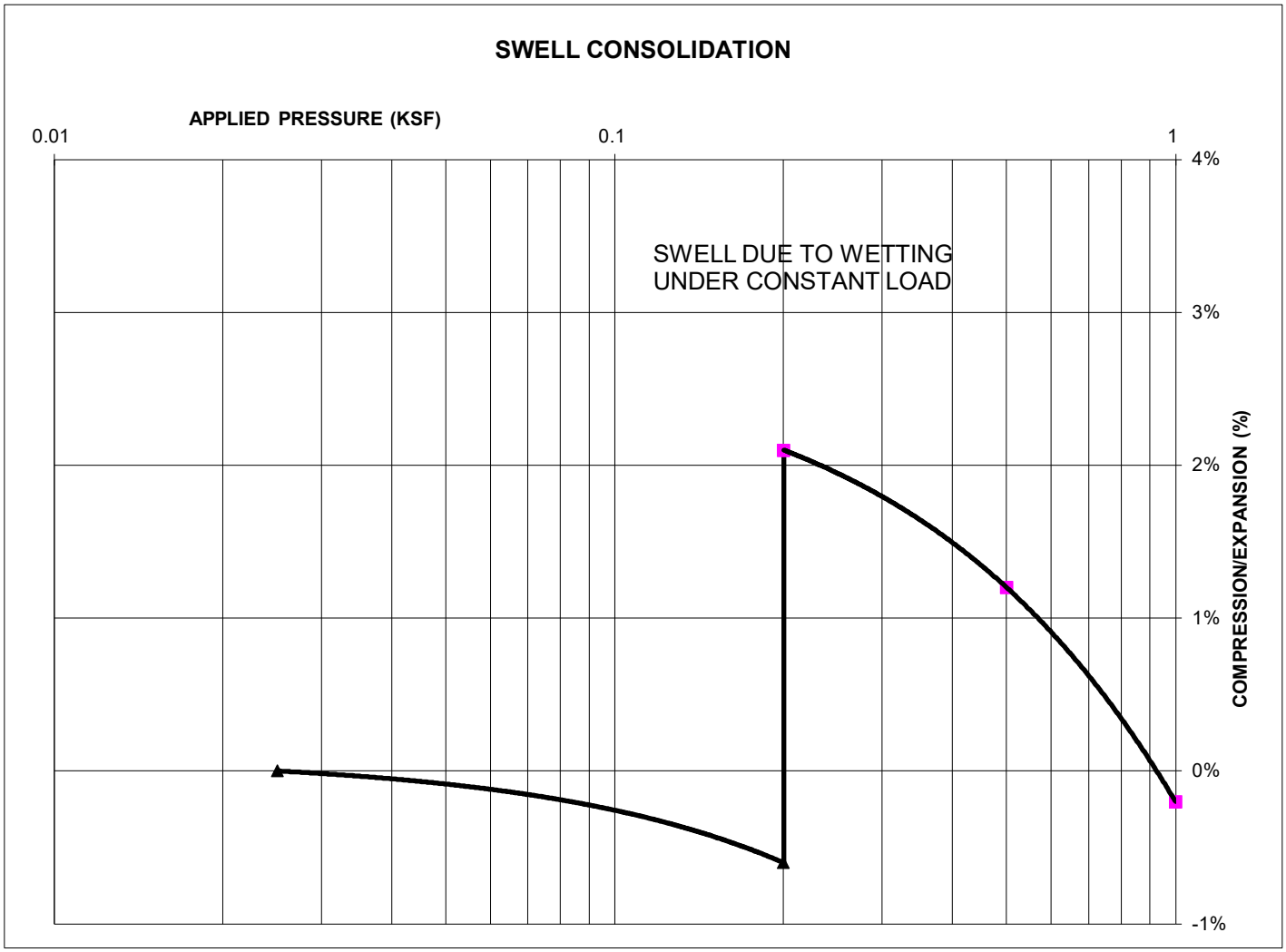
FIG. B-12

TEST BORING	6	SOIL DESCRIPTION	SANDSTONE (SAND, CLAYEY)
DEPTH (FT)	10	SOIL TYPE	4



SWELL/CONSOLIDATION TEST RESULTS

NATURAL UNIT DRY WEIGHT (PCF):	116
NATURAL MOISTURE CONTENT:	13.6%
SWELL/CONSOLIDATION (%):	2.7%

ENTECH ENGINEERING, INC.

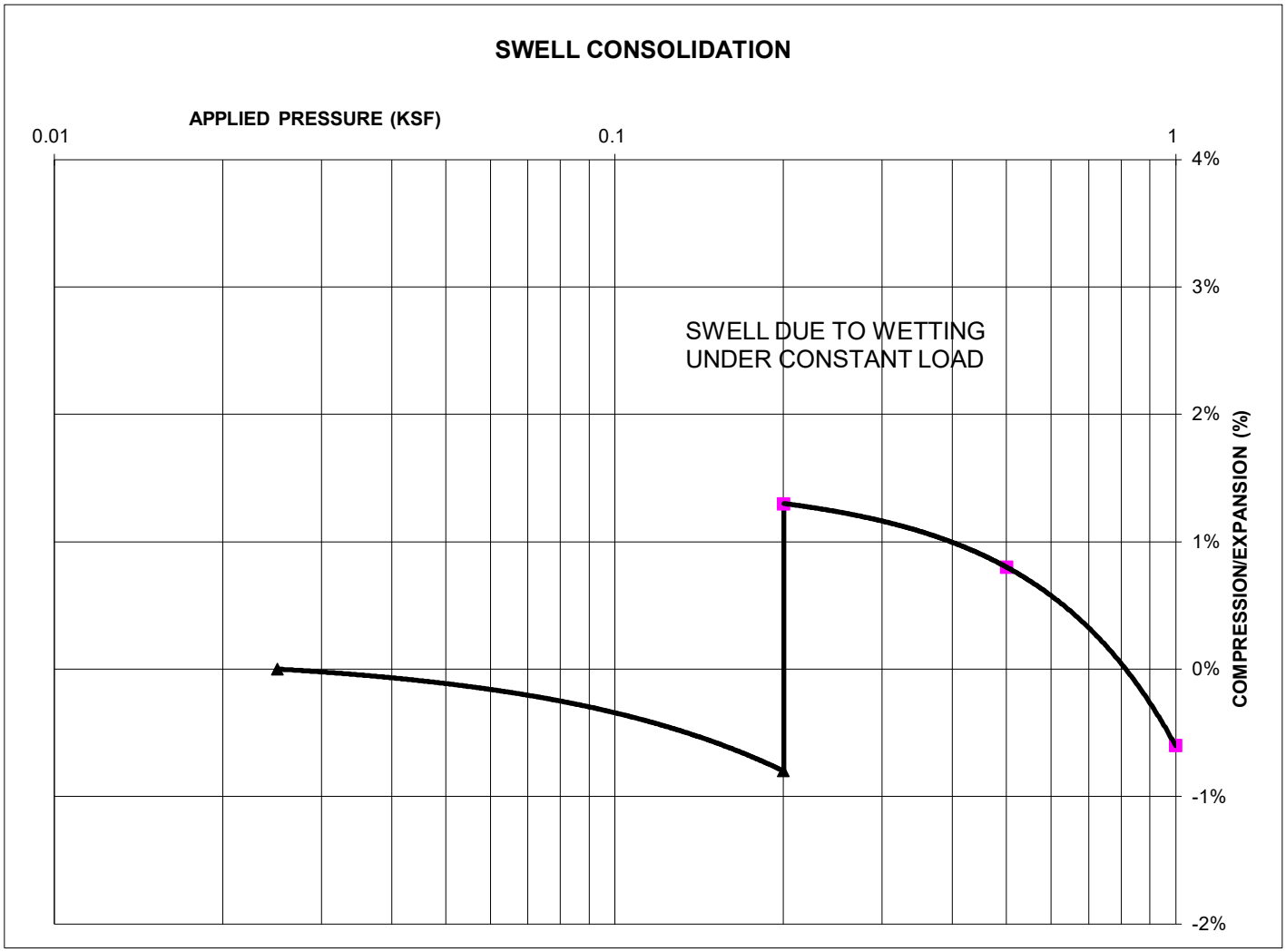
SWELL/CONSOLIDATION TEST RESULTS

BENT GRASS, FILING NO. 3
COPESTONE GENERAL CONTRACTORS

JOB NO. 231508

FIG. B-13

TEST BORING	4	SOIL DESCRIPTION	SILTSTONE (SILT, SANDY)
DEPTH (FT)	10	SOIL TYPE	3



SWELL/CONSOLIDATION TEST RESULTS

NATURAL UNIT DRY WEIGHT (PCF): 112
NATURAL MOISTURE CONTENT: 16.4%
SWELL/CONSOLIDATION (%): 2.1%

ENTECH ENGINEERING, INC.

SWELL/CONSOLIDATION TEST RESULTS

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COPESTONE GENERAL CONTRACTORS

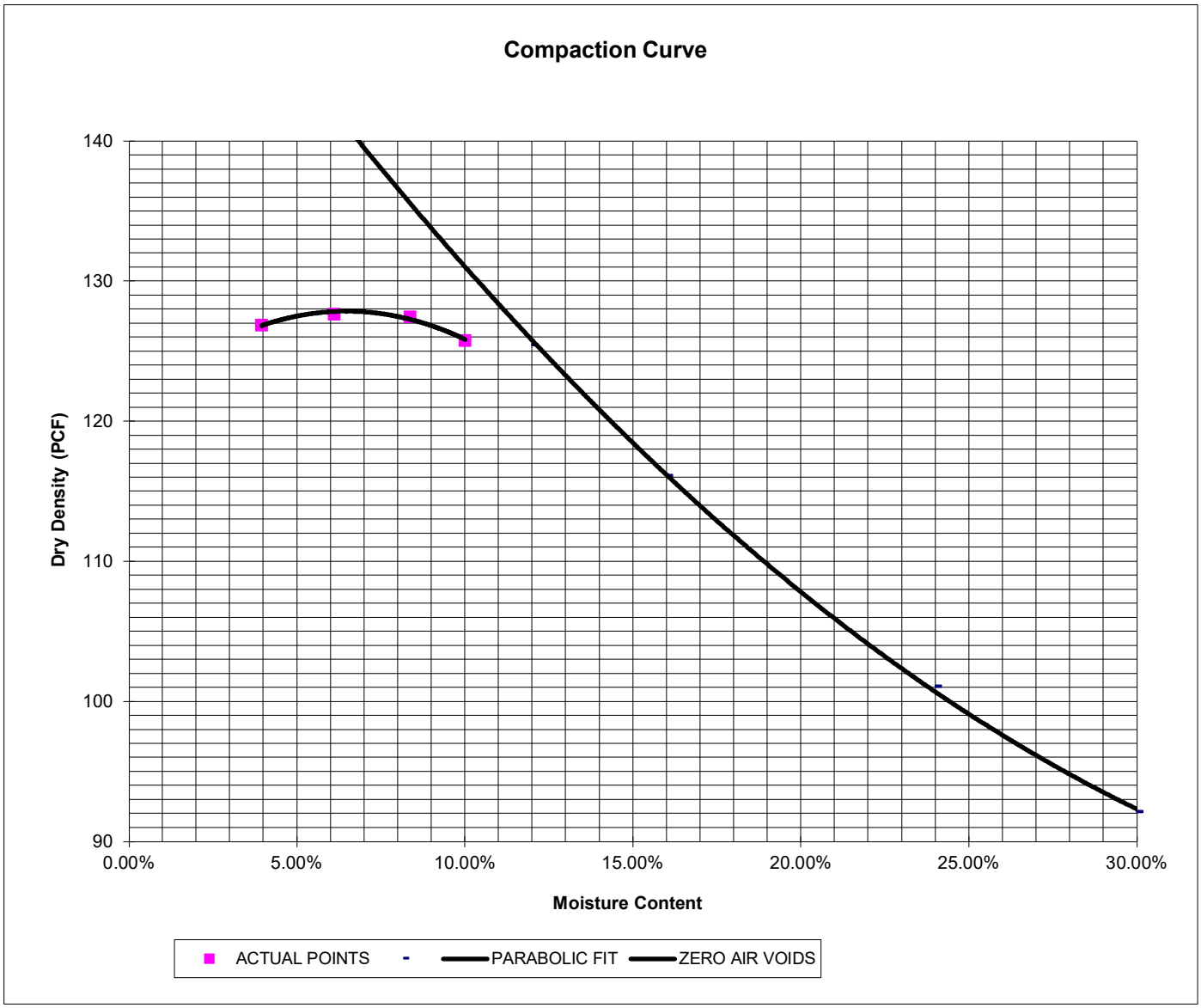
JOB NO. 231508

FIG. B-14

SAMPLE LOCATION TB-4 @ 0-3'	SOIL DESCRIPTION SAND, SILTY, BROWN
	SOIL TYPE 1

PROCTOR DATA

IDENTIFICATION:	SM
PROCTOR TEST #:	1
TEST BY:	BL
TEST DESIGNATION:	ASTM-1557-A
MAXIMUM DRY DENSITY (PCF):	127.9
OPTIMUM MOISTURE:	6.7



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LABORATORY TEST RESULTS

BENT GRASS, FILING NO. 3
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FIG. B-15

SAMPLE LOCATION TB-4 @ 0-3'	SOIL DESCRIPTION SAND, SILTY, BROWN
DEPTH (FT) 0	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	96	32.08	269	89.89	305	101.92
0.050	113	37.76	347	115.96	375	125.31
0.075	121	40.43	387	129.32	412	137.68
0.100	129	43.11	403	134.67	462	154.39
0.125	141	47.12	510	170.43	558	186.47
0.150	156	52.13	556	185.80	698	233.25
0.175	169	56.47	616	205.85	799	267.00
0.200	184	61.49	671	224.23	877	293.07
0.300	214	71.51	867	289.72	1248	417.04
0.400	257	85.88	1040	347.53	1523	508.94
0.500	305	101.92	1238	413.70	1844	616.21

MOISTURE AND DENSITY DATA

	Mold # 1	Mold # 2	Mold # 3
Can #	341	342	343
Wt. Can	8.5	8.69	8.58
Wt. Can+Wet	258.26	263.34	234.21
Wt. Can+Dry	226.65	234.12	209.11
Wt. H20	31.61	29.22	25.1
Wt. Dry Soil	218.15	225.43	200.53
Moisture Content	14.49%	12.96%	12.52%
Wet Density (PCF)	118.9	126.5	129.7
Dry Density (PCF)	111.4	118.5	121.6
% Compaction	87%	93%	95%
CBR	4.31	13.47	15.44

PROCTOR DATA

Maximum Dry Density (pcf)	127.9
Optimum Moisture	6.7
90% of Max. Dry Density (pcf)	115.1
95% of Max. Dry Density (pcf)	121.5

CBR at 90% of Max. Density = 9.06	~ R VALUE 26
CBR at 95% of Max. Density = 15.38	~ R VALUE 50

ENTECH ENGINEERING, INC.

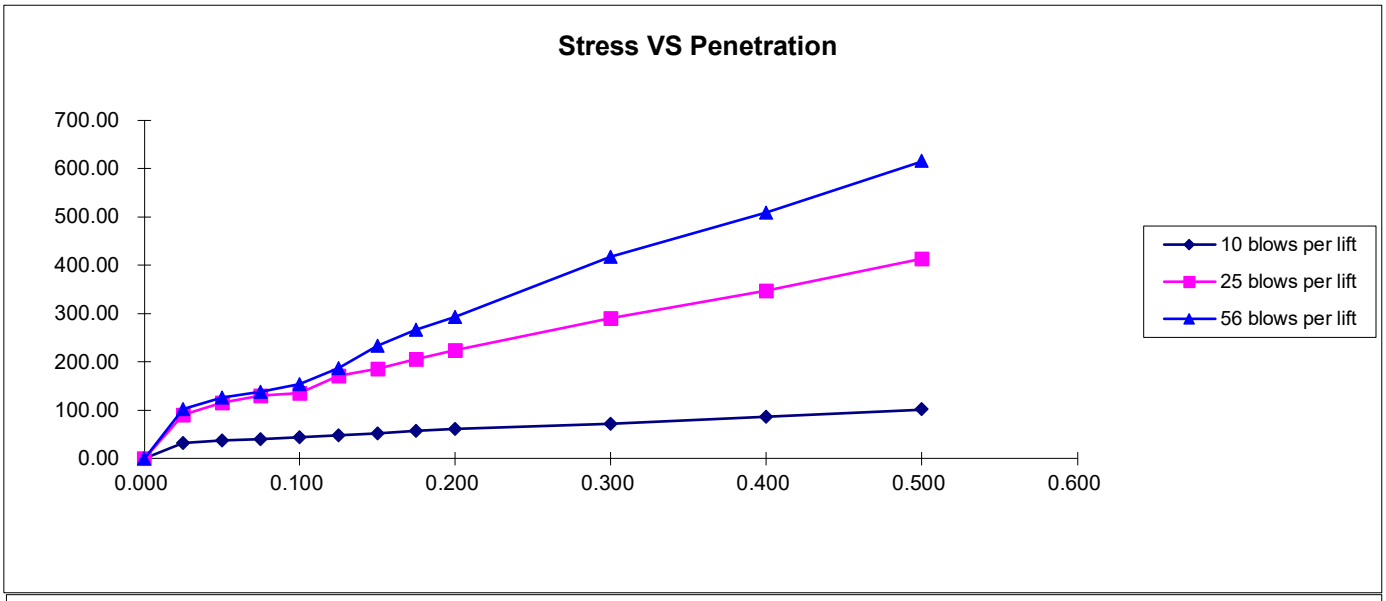
LABORATORY TEST RESULTS

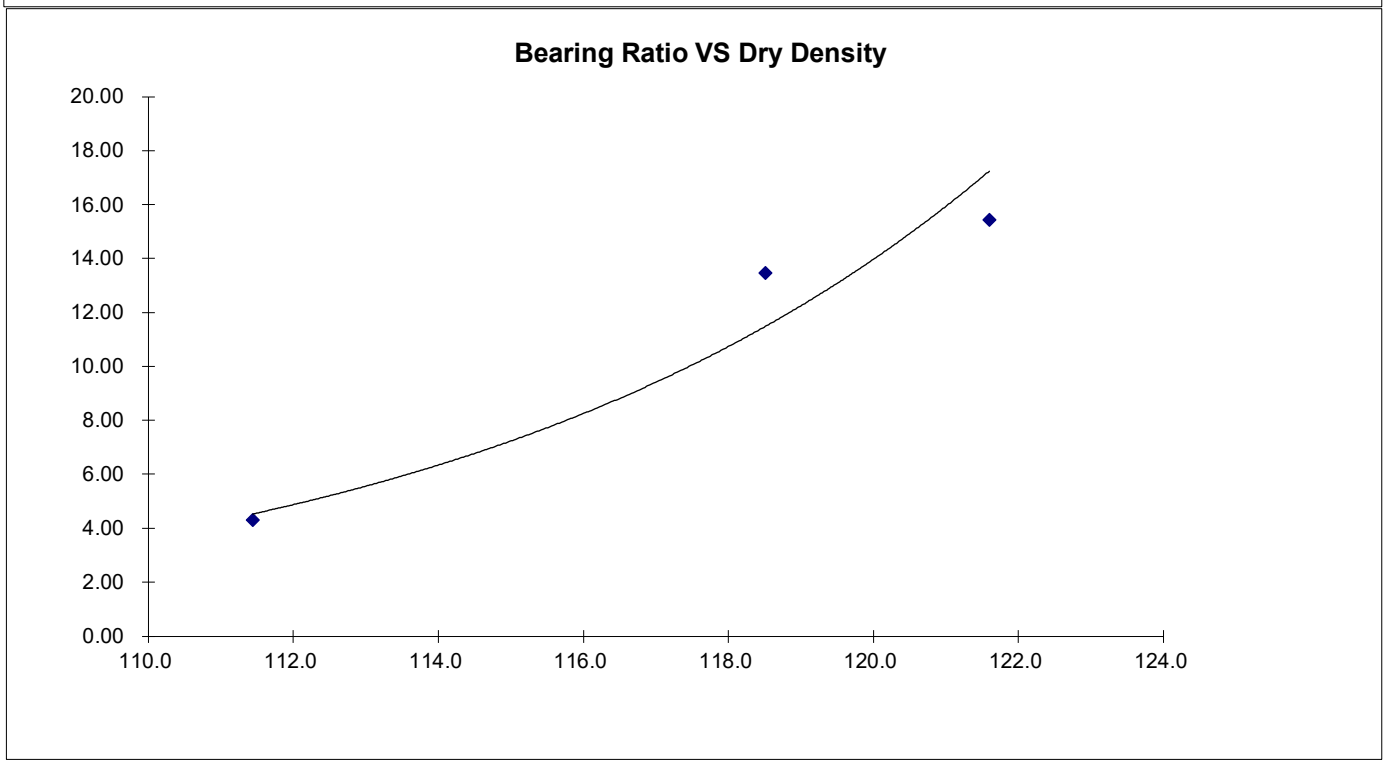
BENT GRASS, FILING NO. 3
COPESTONE GENERAL CONTRACTORS

JOB NO. 231508

FIG. B-16

SAMPLE LOCATION TB-4 @ 0-3'	SOIL DESCRIPTION SAND, SILTY, BROWN
DEPTH (FT) 0	SOIL TYPE 0





ENTECH ENGINEERING, INC.

LABORATORY TEST RESULTS

BENT GRASS, FILING NO. 3
COPESTONE GENERAL CONTRACTORS

JOB NO. 231508

FIG. B-17

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

PROJECT DATA

Project Location: BENT GRASS EAST COMMERCIAL FILING NO. 3

Job Number: 231508

DESIGN DATA

Equivalent (18-kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	100,000
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 = 1.66

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	4.0 inches	1.760	-
2	ABC	C_2 = 0.11	4.0 inches	0.440	
			SN* =	2.200	1.66

Pavement SN > Required SN, Design is Acceptable

FIG. C-1

APPENDIX D: Previous Explorations

APPENDIX D: Previous Explorations

Exhibit 1: Test Boring Logs from Preliminary Subsurface Soil Investigation by Entech Engineering, Inc. dated June 6, 2017, Entech Job No. 170651.

TEST BORING NO. 1
DATE DRILLED 5/24/2017
Job # 170651

REMARKS

WATER @ 12.5', 5/25/17

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			20	13.0	1
5			44	9.2	1
10			50/7"	9.0	2
15			50/8"	10.8	2
20			50/7"	11.7	2

SAND, CLAYEY, FINE TO COARSE GRAINED, GRAY BROWN, MEDIUM DENSE TO DENSE, MOIST

SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST TO WET

TEST BORING NO. 2
DATE DRILLED 5/24/2017
CLIENT LAND FIRST, INC.
LOCATION BENT GRASS COMM., F-2

REMARKS

WATER @ 6', 5/25/17

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			8	10.3	1
5			27	10.7	1
10			50/11"	15.2	2
15			50/6"	9.3	2
20			50/6"	17.4	2

SAND, CLAYEY, FINE TO COARSE GRAINED, GRAY BROWN, LOOSE TO MEDIUM DENSE, MOIST

SANDSTONE, VERY SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST TO WET

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN	DATE	CHECKED	DATE
		LLL	6/5/17

JOB NO 170651
FIG NO A- 1

TEST BORING NO. 3
DATE DRILLED 5/24/2017
Job # 170651

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
WATER @ 5', 5/25/17						
SAND, CLAYEY, FINE TO COARSE GRAINED, GRAY BROWN, MEDIUM DENSE TO DENSE, MOIST				22	10.8	1
	5			43	11.8	1
SANDSTONE, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST TO WET CLAYSTONE LENSES	10			50/8"	11.2	2
	15			50/8"	11.2	2
	20			50/4"	11.3	2

TEST BORING NO. 4
DATE DRILLED 5/24/2017
CLIENT LAND FIRST, INC.
LOCATION BENT GRASS COMM., F-2

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
WATER @ 8', 5/25/17						
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				15	7.0	1
SAND, CLAYEY, FINE TO COARSE GRAINED, GRAY BROWN, DENSE, MOIST	5			39	9.1	1
SANDSTONE, VERY CLAYEY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST TO WET CLAYSTONE LENSES	10			50/11"	12.7	2
	15			50/6"	7.2	2
	20			50/6"	11.9	2

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN	DATE	CHECKED	DATE

JOB NO 170651
FIG NO A- 2