



**ENTECH**  
ENGINEERING, INC.

505 ELKTON DRIVE  
COLORADO SPRINGS, CO 80907  
PHONE (719) 531-5599  
FAX (719) 531-5238

October 15, 2020

Land First, Inc.  
1378 Promontory Bluff View  
Colorado Springs, CO 80921

Attn: Ron Waldthausen

Re: Soil, Geology and Geologic Hazard Evaluation  
Bentgrass Commercial, Filing 2B  
Bent Grass Meadows Drive  
El Paso County, Colorado

Dear Mr. Waldthausen:

#### **GENERAL SITE CONDITIONS AND PROJECT DESCRIPTION**

The site is located in a portion of the SE $\frac{1}{4}$  of the NE $\frac{1}{4}$  of Section 1, Township 13 South, Range 65 West of the 6<sup>th</sup> Principal Meridian in El Paso County, Colorado. The site is located southwest of Bent Grass Meadows Drive and Meridian Road in El Paso County, Colorado. The location of the site is shown on the Vicinity Map, Figure 1.

The topography of the site is gradually sloping to the southeast. No drainages were observed on the site. The site boundaries are indicated on the USGS Map, Figure 2. Previous land uses have included undeveloped and agricultural grazing land. The site is currently vacant and vegetation consist of primarily field grasses and weeds. Site photographs, taken September 29, 2020, are included in Appendix A.

The site consists of a 5.05-acre parcel. Proposed development will consist of seven new commercial buildings, parking areas, and associated site improvements. The buildings will be serviced by municipal water and sewer. The Development Plan is presented in Figure 3.

#### **LAND USE AND ENGINEERING GEOLOGY**

This site was found to be suitable for the proposed development, which will consist of seven new commercial buildings, parking areas, and associated site improvements. Areas were encountered where the geologic conditions will impose some constraints on development and land use. These include areas of artificial fill, and loose soils. Additionally, shallow groundwater may be encountered on the site. Based on the proposed development plan, it appears that these areas will have some impacts on the development. These conditions will be discussed in greater detail in the report.

In general, it is our opinion that the development can be achieved if the observed geologic conditions on site are either avoided or properly mitigated. All recommendations are subject to the limitations discussed in the report.

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## SCOPE OF THE REPORT

The scope of the report will include the following:

- A general geologic analysis utilizing published geologic data. Detailed site-specific mapping will be conducted to obtain general information in respect to major geographic and geologic features, geologic descriptions and their effects on the development of the property.

## PREVIOUS INVESTIGATIONS

The site was previously investigated by Entech Engineering, Inc., with the results presented in the *Preliminary Subsurface Soil Investigation*, dated June 6, 2017 (Reference 1, Appendix B). Subsurface soils information from the report was used in preparing this Soil, Geology, and Geologic Hazard Evaluation. Four test borings were drilled across the site in the proposed building locations. The locations of the test borings are indicated on the Development Plan, Figure 3. 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. Test Boring Logs and Summary of Laboratory Testing Results are included in Appendix B.

The site was also investigated as a part of a Geologic Hazard/Land Use Investigation for the entire 201-acre Bent Grass Development by Entech Engineering, Inc., revised September 28, 2006 (Reference 2). Information from these reports was used in evaluating the site.

## FIELD INVESTIGATION

Our field investigation consisted of the preparation of a geologic map of bedrock features and significant surficial deposits. The Natural Resource Conservation Service (NRCS), previously the Soil Conservation Service (SCS) survey was also reviewed to evaluate the site. The position of mappable units within the subject site are shown on the Geologic Map. Our mapping procedures involved both field reconnaissance and measurements, and aerial photo reconnaissance and interpretation. The same mapping procedures have also been utilized to produce the Geology/Engineering Geology Map which identified pertinent geologic conditions affecting development. The field mapping was performed by personnel of Entech Engineering, Inc. on September 29, 2020.

## SOIL AND GEOLOGIC CONDITIONS

### Soil Survey

The Natural Resource Conservation Service (NRCS) (Reference 3, Figure 3), previously the Soil Conservation Service (Reference 4) has mapped one soil type on the site. Complete descriptions of the soils are presented in Appendix C. In general, the soils consist of gravelly sandy loam, and very gravelly loamy sand. The soils are described as follows:

<u>Type</u>	<u>Description</u>
19	Columbine Gravelly Sandy Loam, 0-3% Slopes

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The soils have been described to have rapid permeabilities. The soils are described as well suited for use as homesites. Possible hazards with soils erosion are present on the site. The erosion potential can be controlled with vegetation. The soils have been described to have moderate erosion hazards (Reference 2).

### Soils

One soil type and one bedrock type were encountered in the test borings drilled for the preliminary subsurface soil investigation (Reference 1, Appendix B): Type 1: clayey to slightly silty sand (SC, SM-SW), and Type 2: weathered to formational slightly silty to very silty, and clayey to very clayey sandstone (SM, SM-SW, SC). Bedrock was encountered at 9 feet bgs in all of the test borings which were drilled to 20 feet. Each soil and bedrock type were classified in accordance with the Unified Soil Classification System (USCS) using the laboratory testing results and the observations made during drilling.

Soil Type 1 is a clayey to slightly silty sand (SC, SM-SW). The sand was encountered in all of the test borings at depths ranging from existing ground surface to 9 feet. SPT Testing conducted on the sand resulted in N-values ranging from 8 to 44 bpf indicating loose to dense states. Moisture content and grain size analysis indicated moisture contents of 7 to 13 percent and 7 to 37 percent of the soil particles passing the No. 200 Sieve. Atterberg Limits Testing on the sand resulted in a liquid limit of 30 and plastic index of 16. A Swell/Consolidation test on a sample of clayey sand resulted in a volume change of 0.0 percent indicating a low potential for expansion.

Soil Type 2 is a slightly silty to very silty and clayey to very clayey sandstone (SM, SM-SW, SC). The sandstone was encountered in all of the test borings at 9 feet bgs and extended to the termination of the borings (20 feet). SPT Testing conducted on the sandstone resulted in N-values of greater than 50 bpf, indicating very dense states. Moisture content and grain size analysis indicated moisture contents of 7 to 17 percent and 21 to 42 percent of the soil particles passing the No. 200 Sieve. Atterberg Limits Testing resulted in the sandstone being non-plastic.

### Groundwater

Groundwater was encountered in all of the test borings at depths ranging from 5 to 12.5 feet bgs (Reference 1, Appendix B). The borings were drilled to 20 feet. Interceptor drains or underslab drains may be necessary where foundations encroach the groundwater table. Groundwater may affect the construction of shallow foundations proposed for this site and deeper excavations for utilities, depending on site grading and depths of excavation. Unstable conditions should be expected where excavations approach the groundwater level. Stabilization using shot rock or geo grids may be necessary. It should be noted that fluctuation in groundwater levels could change due to seasonal variations, changes in land runoff characteristics and future development of nearby areas. Isolated sand layers within the soil profile can carry water in the subsurface. Contractors should be cognizant of the potential for the occurrence of subsurface water during construction.

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## Geology

Approximately 15 miles west of the site is a major structural feature known as the Rampart Range Fault. This fault marks the boundary between the Great Plains Physiographic Province and the Southern Rocky Mountain Province. The site exists within a large structural feature known as the Denver Basin. Bedrock in the area is typically gently dipping in a northerly direction. The bedrock underlying the site consists of the Dawson Formation of Cretaceous Age. The Dawson Formation typically consists of coarse-grained arkosic sandstone with interbedded layers siltstone or claystone. Overlying the Dawson Formation are deposits of man-made fill soils and soils associated with water-deposited alluvial sands.

The geology of the site was evaluated using the *Geologic Map of the Falcon Quadrangle*, by Morgan and White in 2012, (Reference 5, Figure 5). The Geology for the site is presented in Figure 6. Two mappable units were identified on this site which, are described as follows:

- Qaf**            **Artificial Fill of Late Holocene Age:** These are man-made fill deposits associated with fill piles and erosion berms observed on the site. Areas of fill other than those mapped may be encountered.
- Qa<sub>3</sub>**           **Alluvium Three of Late Pleistocene Age:** These materials consist of lower stream terrace deposits. Alluvium Three typically consists of silty to clayey gravelly sands. This deposit is usually highly stratified and may contain lenses of silt, clay or cobbles. This unit correlates with the Broadway Alluvium in the Denver area.

The soils listed above were mapped from site-specific mapping, the *Geologic Map of the Falcon Quadrangle* distributed by the Colorado Geologic Survey in 2012 (Reference 5, Figure 5), and the *Geologic Map of the Pueblo 1° x 2° Quadrangle*, distributed by the US Geological Survey in 1978 (Reference 6). The test borings used in evaluating the site are included in Appendix B. The Geology Map prepared for the site is presented in Figure 6.

## **ENGINEERING GEOLOGIC HAZARDS**

Mapping has been performed on this site to identify areas where various geologic conditions exist of which developers should be cognizant during the planning, design and construction stages should new construction be proposed. The engineering geologic hazards identified on this site include artificial fill, and loose soils. Additionally, shallow groundwater may be encountered at variable depths across the site. These hazards and recommended mitigation techniques are discussed as follows:

### Artificial Fill

Fill associated with an existing fill stockpile and erosion berms were observed in the eastern portion of the site.

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Mitigation: It is anticipated that the fill piles, and the erosions berms will be removed during site grading. Areas of fill other than those encountered may be encountered. The fill piles are considered uncontrolled. Any uncontrolled fill encountered beneath foundations should be removed and recompactd at a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557.

#### Loose Soils

Loose to dense soils were encountered in borings drilled on site (Reference 1, Appendix B). Loose soils encountered beneath the foundation or floor slabs will require mitigation.

Mitigation: Should loose soils be encountered beneath the foundations or floor slabs; mitigation will be necessary. Overexcavation and recompaction at a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 is a suitable mitigation, which is common in the area. An overexcavation depth of 2 to 3 feet is anticipated.

#### Floodplain Areas

The site does not lie within a floodplain according to the FIRM Map, No. 08041CO553G (Reference 9, Figure 7). Any site grading considered should be modified to direct surface flows around the structures or roads, or carried off-site so as to not produce any areas of ponded water. Specific drainage studies and exact floodplain locations are beyond the scope of this report.

#### Groundwater

Groundwater was encountered in all of the test borings at depths ranging from 5 to 12.5 feet bgs (Reference 1, Appendix B). The borings were drilled to 20 feet. Perched groundwater tables exist due to permeable terrace alluvium overlying less permeable lenses in the Dawson Formation. Coarse grained sand lenses can carry water perched on impermeable clay lenses, claystone or sandstone. Perimeter drains, interceptor drains, or underslab drains may be necessary where foundations on encroach the groundwater table. Typical drain details are presented in Figures 8 through 10.

Groundwater may affect the construction of shallow foundations in some areas of this site and deeper excavations for utilities, depending on site grading and depths of excavation. Unstable conditions should be expected where excavations approach the groundwater level. Stabilization using shot rock or geo grids may be necessary. It should be noted that fluctuation in groundwater levels could change due to seasonal variations, changes in land runoff characteristics and future development of nearby areas. Isolated sand layers within the soil profile can carry water in the subsurface. Contractors should be cognizant of the potential for the occurrence of subsurface water features during construction.

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## **RELEVANCE OF GEOLOGIC CONDITIONS TO LAND USE PLANNING**

The proposed development will consist of seven new commercial buildings, parking areas, and associated site improvements. The existing geologic and engineering geologic conditions will impose constraints on development and construction. The geologic conditions on the site include artificial fill, shallow groundwater, and loose soils, which can be satisfactorily mitigated through proper engineering design and construction practices.

The upper granular soils in the borings drilled on the site were encountered at loose to medium dense states. Loose or collapsible soils, if encountered beneath foundation or floor slabs, will require recompaction. Expansive layers may also be encountered in the soil on this site. Expansive soils, if encountered, will require special foundation design. These soils will not prohibit development. Overexcavation and replacement with non-expansive soils at a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557 is a suitable mitigation, which is common in the area. Floor slabs on expansive soils should be expected to experience movement.

Fill exists on this site that is associated with a fill pile and erosion berms. Areas of fill, other than those mapped, may be encountered. All fill piles and debris within building areas should be completely removed prior to construction. Any uncontrolled fill encountered beneath new foundations and floor slabs will require removal and recompaction at a minimum of 95% of its maximum Modified Proctor Dry Density, ASTM D-1557.

Groundwater was encountered in all of the test borings at depths ranging from 5 to 12.5 feet (Reference 2, Appendix B). Areas where groundwater was shallow may affect the construction of foundations proposed for this site. Grading which requires cuts is not recommended. Groundwater may affect deeper excavations for utilities. Unstable conditions should be expected where excavations approach the groundwater level. Stabilization using shot rock or geo grids may be necessary. Specific drainage studies and exact floodplain locations are beyond the scope of this report.

In summary, the recompacted granular soils will likely provide suitable support for shallow foundations. The geologic conditions encountered on site can be mitigated with proper engineering and construction practices. Specific recommendations have been made in the Subsurface Soil Investigation (Reference 1).

## **ECONOMIC MINERAL RESOURCES**

Some of the sandy materials on-site could be considered a low-grade sand resource. According to the *El Paso County Aggregate Resource Evaluation Map* (Reference 10), the area is mapped as upland deposits. According to the *Atlas of Sand, Gravel and Quarry Aggregate Resources, Colorado Front Range Counties* distributed by the Colorado Geological Survey (Reference 11), areas of the site are mapped as A3 – Alluvial fan: sand resource. According to the *Evaluation of Mineral and Mineral Fuel Potential* (Reference 12), the area of the site has

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been mapped as "Little or no potential" for industrial minerals. Generally, the Dawson formation does not contain significant industrial mineral resources. The sands associated with the eolian and alluvial deposits may be considered a sand resource. Considering the silty to clayey nature of much of these materials and abundance of similar materials through the region, they would be considered to have little significance as an economic resource.

According to *the Evaluation of Mineral and Mineral Fuel Potential of El Paso County State Mineral Lands* (Reference 12), the site is mapped within the Denver Basin Coal Region. However, the area of the site has been mapped as "Poor" for coal resources. No active or inactive mines have been mapped in the area of the site. The *El Paso County Aggregate Resource Map* (Reference 11) has mapped coal resources in the Falcon area approximately ½ mile south of the site; however, the coal resources are estimated at 1,500 feet below the surface (Reference 9). At this depth, mining the coal would not be economical at this time. No metallic mineral resources have been mapped on the site (Reference 12).

The site has been mapped as "Fair" for oil and gas resources (Reference 12). No oil or gas fields have been discovered in the area of the site. A well was drilled nearly 3 miles southeast of the site to 8,263 feet deep in 1955. No oil or gas was reported and it was plugged. The sedimentary rocks in the area may lack the geologic structure for trapping oil or gas; therefore, it would not be considered a significant resource.

## **CLOSURE**

It should be pointed out that because of the nature of data obtained by random sampling of such variable nonhomogeneous materials as soil and rock, it is important that we be informed of any differences observed between surface and subsurface conditions encountered in construction and those assumed in the body of this report. Any new construction considered on this site will require additional investigation. Construction and design personnel should be made familiar with the contents of this report. Specific construction and foundation recommendations will be provided when investigations are completed at each building site prior to new construction.

This report has been prepared for Land First, Inc. for application to the proposed development in accordance with generally accepted geologic, soil and engineering practices. No other warranty expresses or implied is made.

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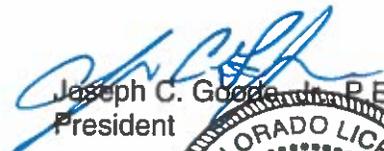
We trust that this report has provided you with all the information that you required. Should you have any questions or require additional information, please do not hesitate to contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Reviewed by:

  
Logan L. Langford, P.G.  
Geologist

  
Joseph C. Goode, P.E.  
President



  
Kristen A. Andrew-Hoeser, P.G.  
Senior Geologist

LLL

Encl.

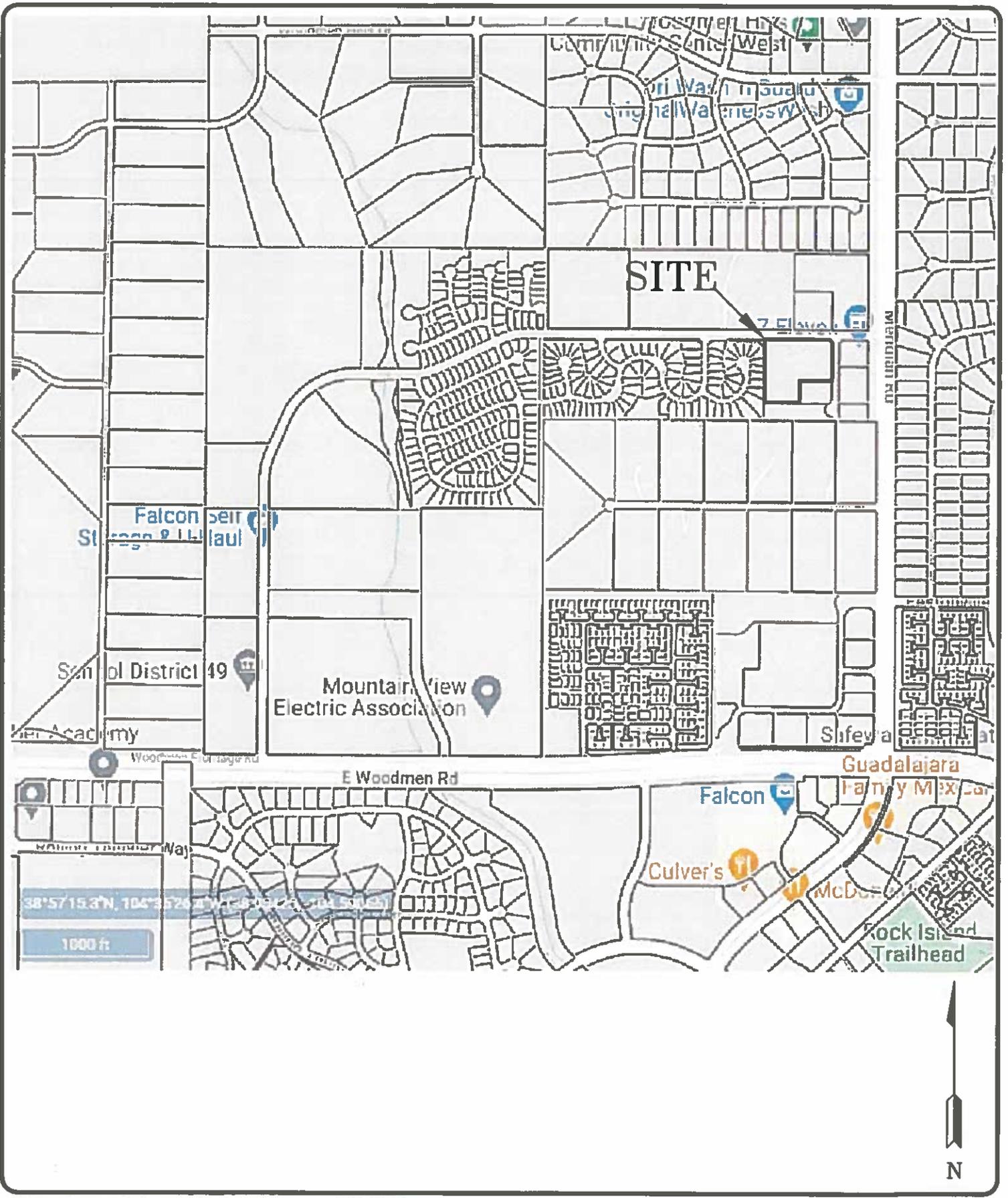
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El Paso County, Colorado

## BIBLIOGRAPHY

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## FIGURES



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VICINITY MAP  
 BENTGRASS COMMERCIAL, FILING NO 2B  
 BENT GRASS MEADOWS DRIVE  
 EL PASO COUNTY, CO.  
 FOR: LAND FIRST, INC.

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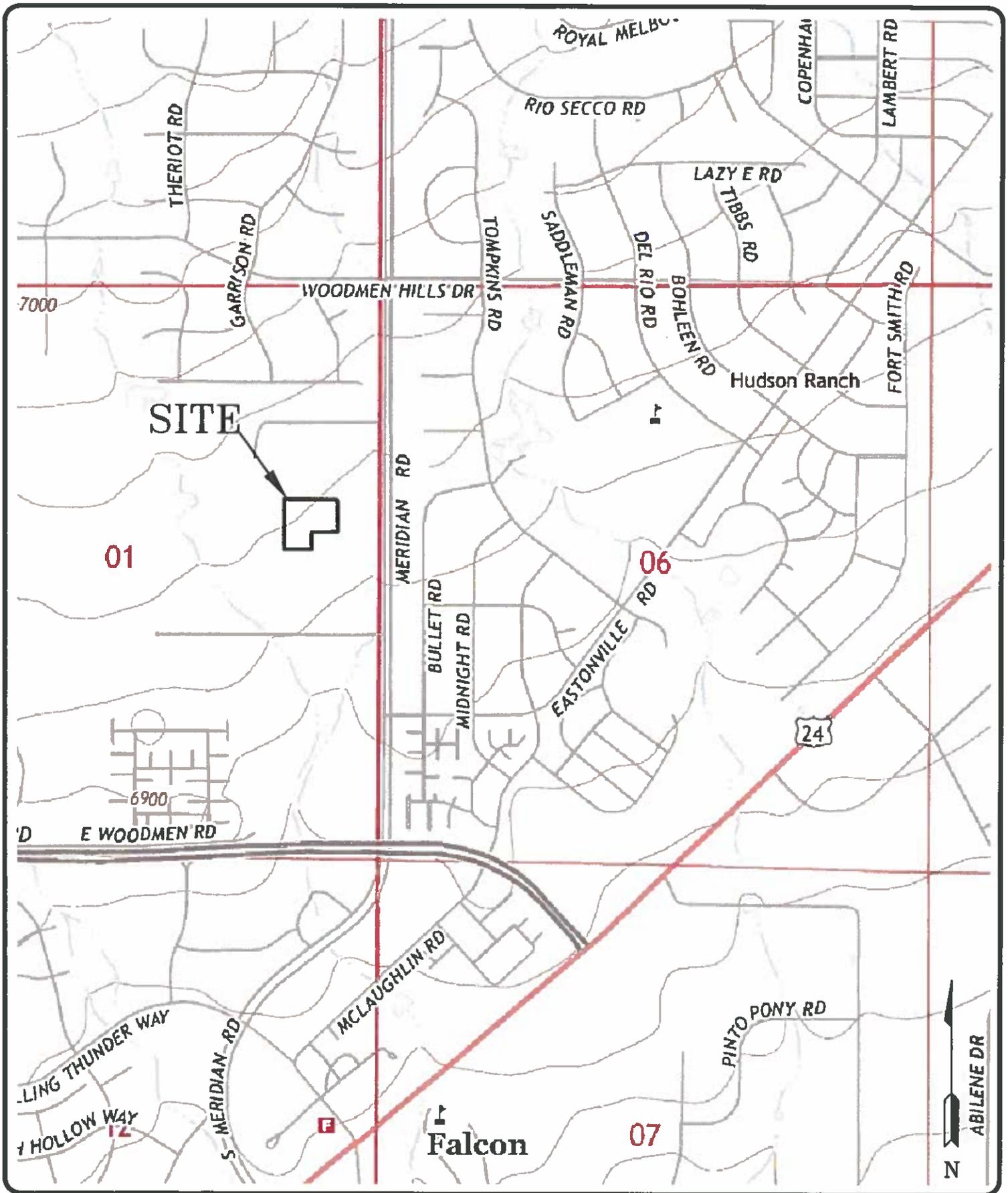
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FIG NO.:  
**1**



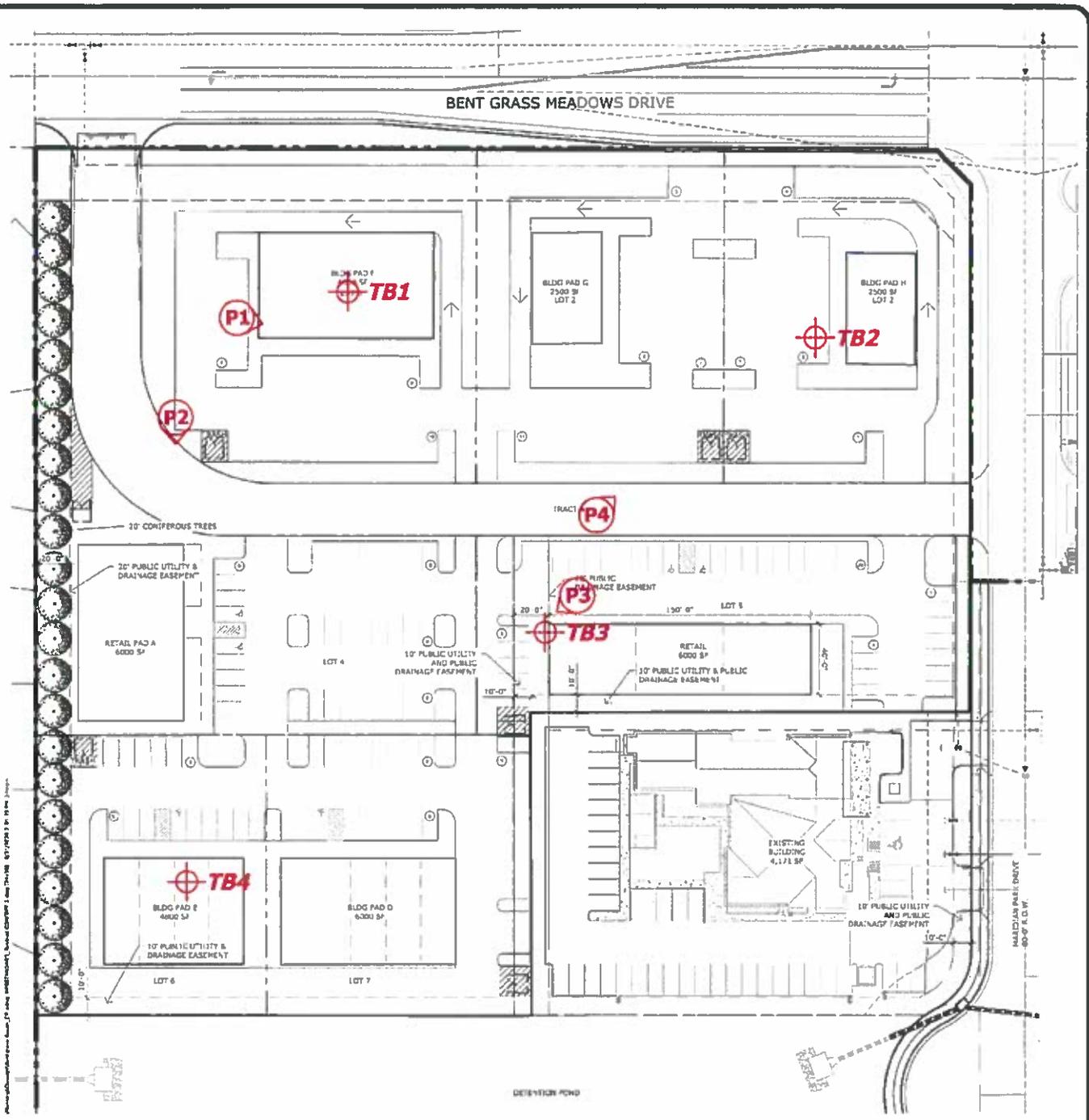

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USGS TOPOGRAPHY MAP  
BENTGRASS COMMERCIAL, FILING NO 2B  
BENT GRASS MEADOWS DRIVE  
EL PASO COUNTY, CO.  
FOR: LAND FIRST, INC.

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FIG NO.:  
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- ⊕ TB- approximate test boring location and number
- Ⓟ - approximate location and number of photograph

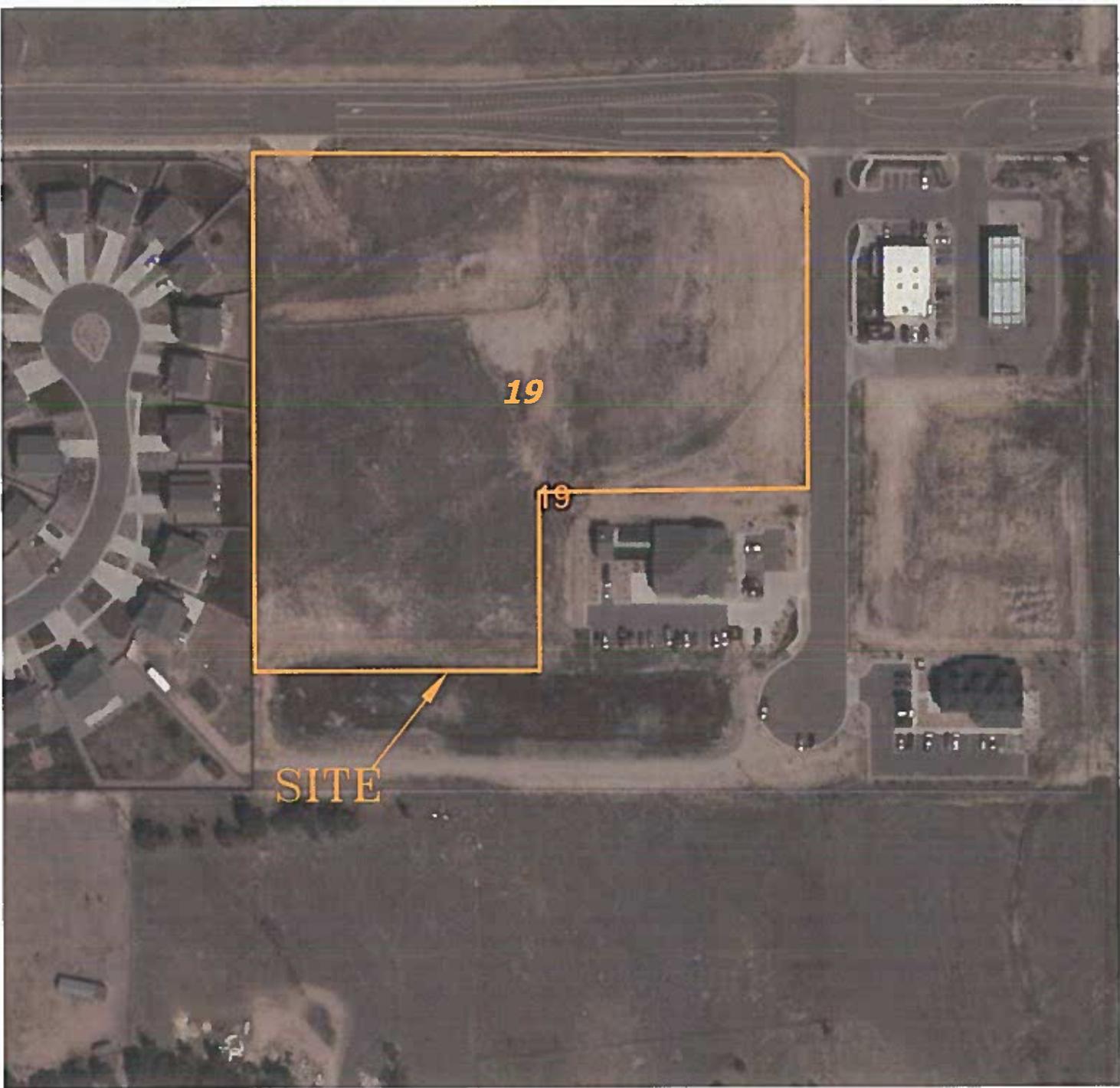


**ENTECH**  
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**SITE PLAN**  
**BENTGRASS COMMERCIAL, FILING NO 2B**  
**BENT GRASS MEADOWS DRIVE**  
**EL PASO COUNTY, CO.**  
**FOR: LAND FIRST, INC.**

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**3**



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SOIL SURVEY MAP  
BENTGRASS COMMERCIAL, FILING NO 2B  
BENT GRASS MEADOWS DRIVE  
EL PASO COUNTY, CO.  
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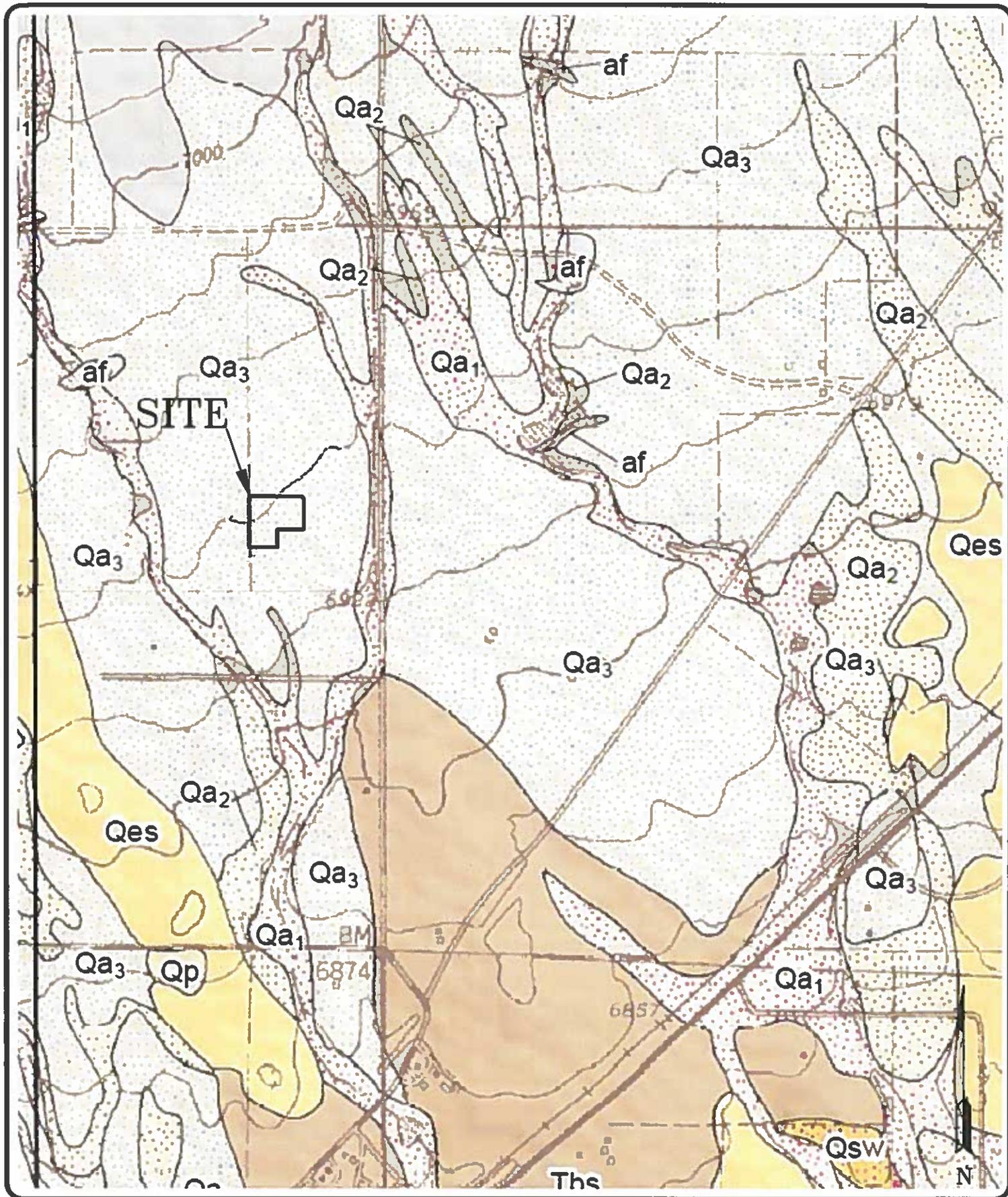
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FIG NO.:  
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FALCON QUADRANGLE GEOLOGY MAP  
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 BENT GRASS MEADOWS DRIVE  
 EL PASO COUNTY, CO.  
 FOR: LAND FIRST, INC.

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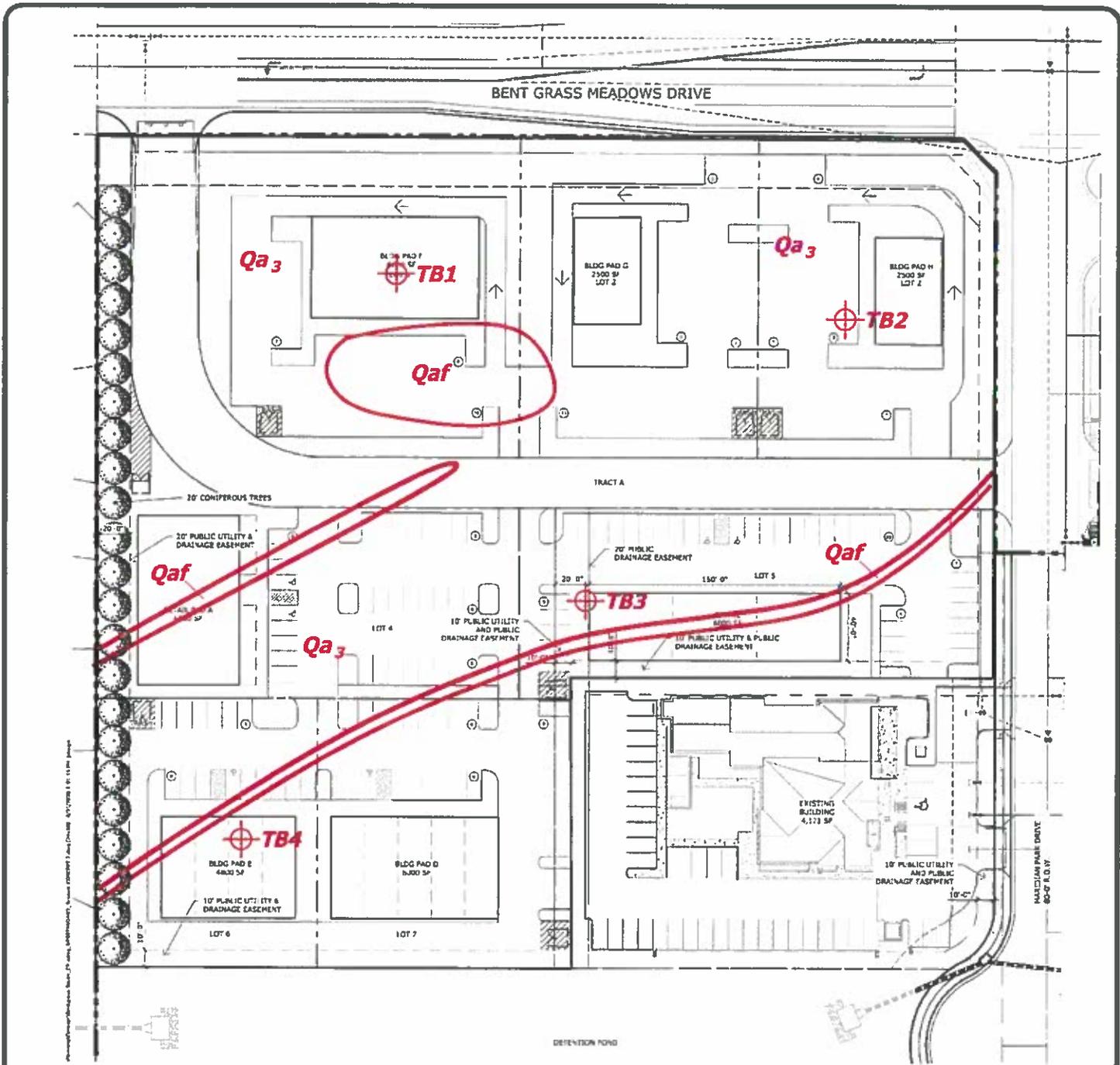
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FIG NO.:  
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**Legend:**

- Qaf - Artificial Fill Deposits of Holocene Age:**  
man-made fill deposits associated a fill stockpile and erosion berms
- Qa<sub>3</sub> - Alluvium Three of Late Pleistocene Age:**  
stream terrace deposited sands



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**ENGINEERING GEOLOGY/ GEOLOGY MAP**  
**BENTGRASS COMMERCIAL, FILING NO 2B**  
**BENT GRASS MEADOWS DRIVE**  
**EL PASO COUNTY, CO.**  
**FOR: LAND FIRST, INC.**

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FIG NO:  
**6**



<b>PIN</b>	Approximate location based on user input and does not represent an authoritative property location	<b>SPECIAL FLOOD HAZARD AREAS</b>	Without Base Flood Elevation (BFE) Zone A, X, AH With BFE or Depth Regulatory Floodway Zone A2, A3, A4, A5, AF	<b>OTHER FEATURES</b>	Cross Sections with 1% Annual Chance Water Surface Elevation Coastal transect Base Flood Elevation Line (BFE) Limit of Study Jurisdiction Boundary Coastal Transect Baseline Profile Baseline Hydrographic Feature
<b>MAP PANELS</b>	selected floodmap boundary Digital Data Available No Digital Data Available Unmapped	<b>OTHER AREAS OF FLOOD HAZARD</b>	0.2% Annual Chance Flood Hazard. Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile. Zone 2 Future Conditions 1% Annual Chance Flood Hazard. Zone X Area with Reduced Flood Risk due to Levees. See Notes. Zone 2 Area with Flood Risk due to Levees. Zone 2	<b>GENERAL STRUCTURES</b>	Channel, Culvert, or Storm Sewer Levee, Dike, or Floodwall
<b>OTHER AREAS</b>	Area of Minimal Flood Hazard Zone X Effective Levees Area of Undetermined Flood Hazard Zone 2 On-behind Protected Area Coastal Barrier Resource System Area				



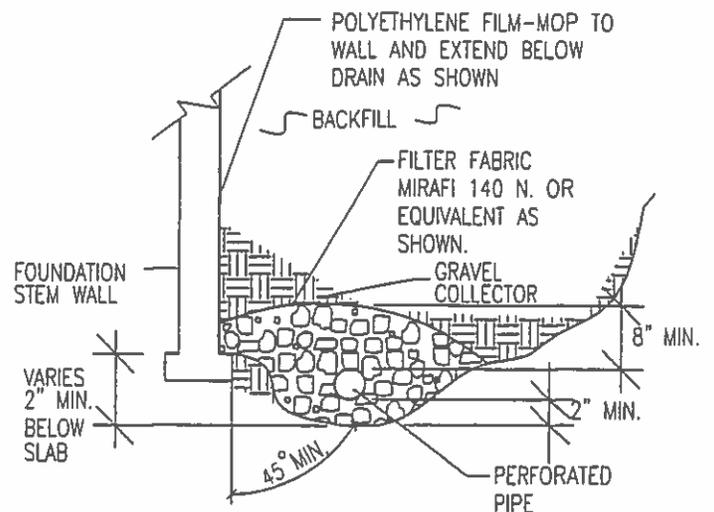
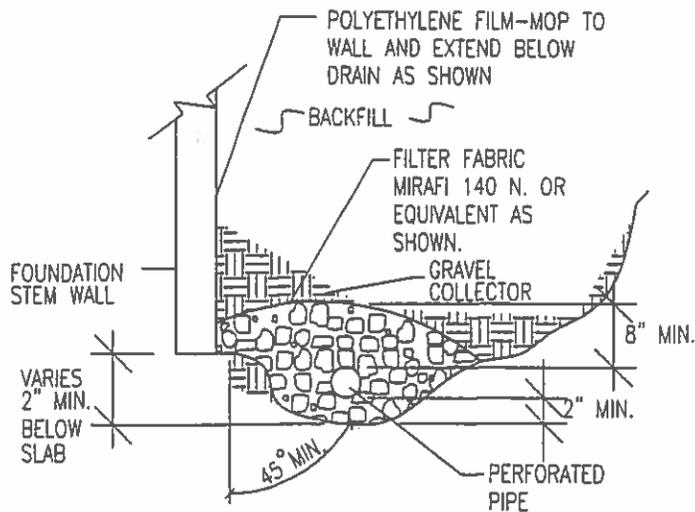
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**FEMA FLOODPLAIN MAP**  
**BENTGRASS COMMERCIAL, FILING NO 2B**  
**BENT GRASS MEADOWS DRIVE**  
**EL PASO COUNTY, CO.**  
**FOR: LAND FIRST, INC.**

<b>DRAWN:</b> LLL	<b>DATE:</b> 10/5/20	<b>CHECKED:</b>	<b>DATE:</b>
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**JOB NO.:**  
202118

**FIG NO.:**  
7



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.

A:\11e\_Detail\Bach\Drain\Exterior Perimeter drain.dwg, 9/12/2006 8:42:19 AM, 0.25:12



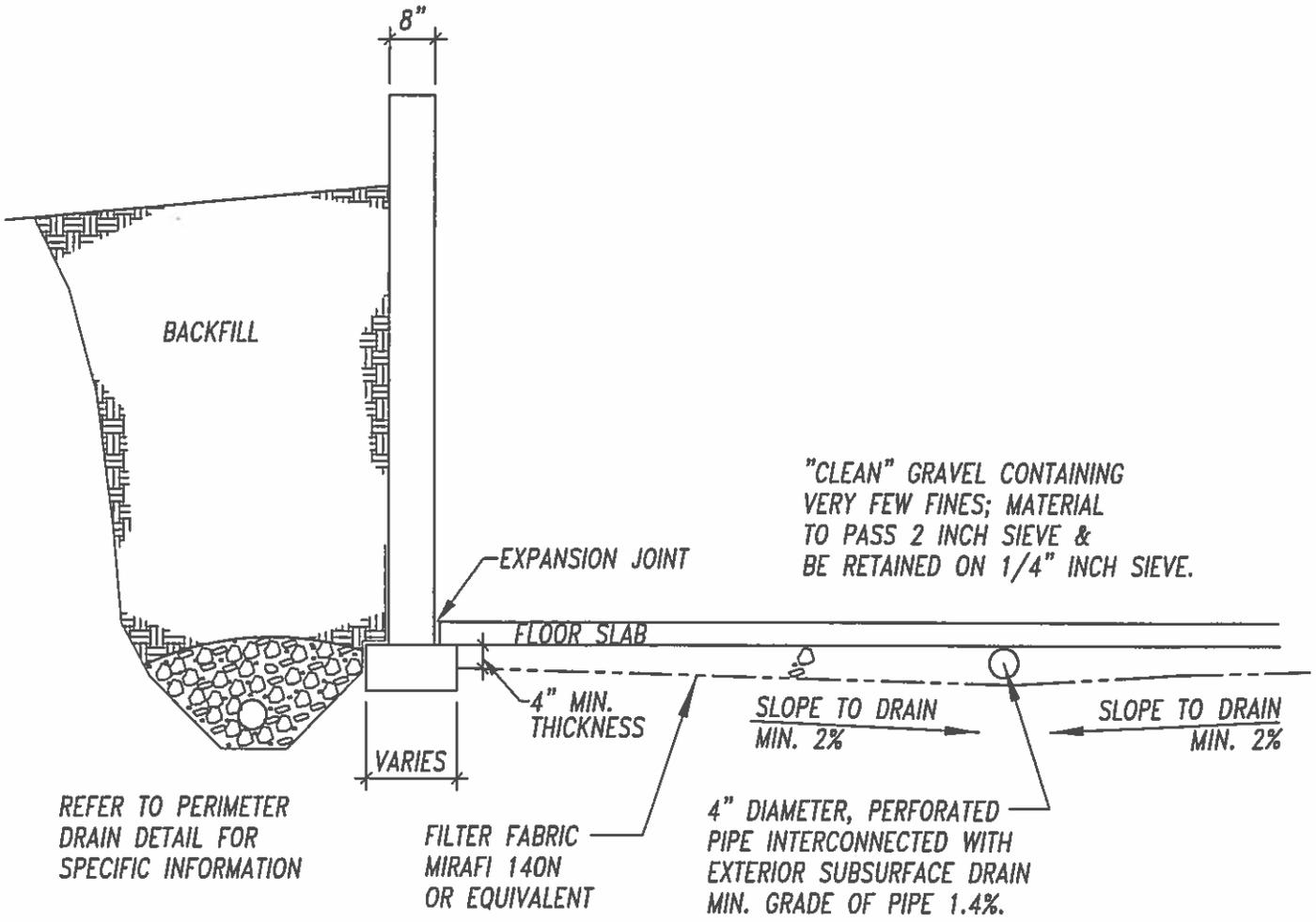
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*EXTERIOR PERIMETER DRAIN DETAIL*

<i>DRAWN:</i> M. VAN KAMPEN	<i>DATE:</i>	<i>DESIGNED:</i>	<i>CHECKED:</i> W
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*JOB NO.:*  
202118  
*FIG NO.:*  
8





4:11a Detail Book\Drawings\UNDERSLAB CAPILLARY BREAK DRAIN.dwg (rev.1) 6/17/2007 12:11:55 PM  
 1/4"



**ENTECH**  
**ENGINEERING, INC.**  
 505 ELKTON DRIVE  
 COLORADO SPRINGS, CO. 80907 (719) 531-5599

TYP. UNDERSLAB DRAINAGE  
 LAYER (CAPILLARY BREAK)

DRAWN:

DATE:

DESIGNED:

CHECKED:

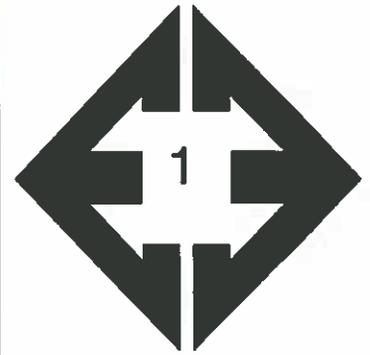
JOB NO.:

202118

FIG NO.:

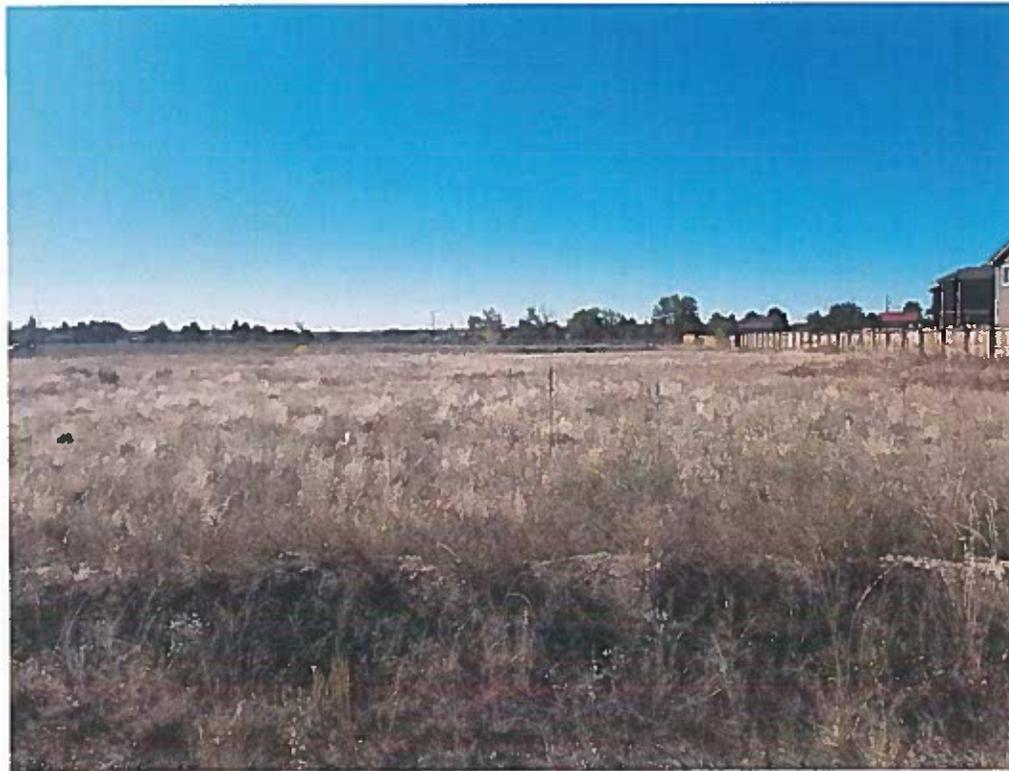
10

## **APPENDIX A: Site Photographs**



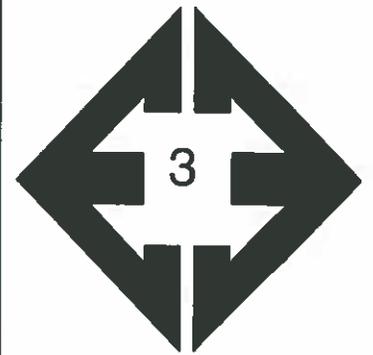
**Looking east from the northwest corner of the site.**

September 29, 2020



**Looking south from the northwestern portion of the site.**

September 29, 2020



**Looking southwest  
from the central  
portion of the site.**

September 29, 2020



**Looking northeast  
from the central  
portion of the site.**

September 29, 2020

**APPENDIX B: Entech Engineering, Inc. Preliminary Subsurface  
Soil Investigation, Entech Job No. 170651**

June 6, 2017



**ENTECH**  
ENGINEERING, INC.

505 ELKTON DRIVE  
COLORADO SPRINGS, CO 80907  
PHONE (719) 531-5599  
FAX (719) 531-5238

Land First, Inc.  
1378 Promontory Bluff View  
Colorado Springs, Colorado 80921

Attn: Ron Waldthausen

Re: Preliminary Subsurface Soil Investigation  
Bent Grass East Commercial Filing 2 – Tract B  
El Paso County, Colorado

Dear Mr. Waldthausen:

As requested, Entech Engineering, Inc. (Entech) performed a Preliminary Subsurface Soil Investigation for the eight additional commercial lots planned for construction of the Bent Grass East Commercial Filing 2 Tract B, located in El Paso County, Colorado.

The site is located southwest of Bent Grass Meadows Drive and Meridian Park Drive, approximately one mile north of Falcon, Colorado. The approximate location of the site is indicated on the vicinity map, Figure 1.

#### SITE CONDITIONS

At the time of drilling the site was undeveloped. The site is comprised of eight new commercial lots. Vegetation consists of field grasses and weeds. The topography was relatively flat to very gently sloping to the south-southeast. There is a small fill pile in the area of Lot 3. It is anticipated the fill pile will be removed during site grading for development. A detention pond was located along the southern side of the parcel, and water was observed standing at the time of our site visit.

#### FIELD EXPLORATIONS AND LABORATORY TESTING

Subsurface conditions at the site were explored by drilling four test borings at the locations shown on the Site Plan/ Test Boring Location Map Figure 2. The borings were advanced to a depth of 20 feet below ground surface (bgs) using a truck mounted, continuous flight auger-drilling rig supplied and operated by Entech. Representative soil and rock samples were recovered from each of the borings at approximate 5-foot depth increments using 2 inch O.D. split barrel and California samplers and following Standard Penetration Test (SPT) procedures. Boring logs describing the subsurface conditions encountered in each of the borings are included Appendix A.

Laboratory testing was completed on selected soil samples recovered from the borings for classification. The water content testing results and soil types (by number) are included on the boring logs with respect to sample depth. Table 1 presents a summary of the laboratory testing and the Unified Soil Classification System (USCS) designations for each of the soils encountered in the borings. The laboratory testing results are presented in Appendix B.

## SOIL, ROCK AND GROUNDWATER

Two primary soil types were encountered in the borings

<u>Type No.</u>	<u>Description</u>	<u>USCS Designation</u>
1	Clayey to Slightly Silty Sand	SC, SM-SW
2	Slightly Silty to Very Silty and Clayey to Very Clayey Sandstone	SM, SM-SW, SC

Soil Type 1 is a clayey to slightly silty sand (SC, SM-SW). The sand was encountered in all of the test borings at depths ranging from existing ground surface to 9 feet. SPT Testing conducted on the sand resulted in N-values ranging from 8 to 44 bpf indicating loose to dense states. Moisture content and grain size analysis indicated moisture contents of 7 to 13 percent and 7 to 37 percent of the soil particles passing the No. 200 Sieve. Atterberg Limits Testing on the sand resulted in a liquid limit of 30 and plastic index of 16. A Swell/Consolidation test on a sample of clayey sand resulted in a volume change of 0.0 percent indicating a low potential for expansion.

Soil Type 2 is a slightly silty to very silty and clayey to very clayey sandstone (SM, SM-SW, SC). The sandstone was encountered in all of the test borings at 9 feet bgs and extended to the termination of the borings (20 feet). SPT Testing conducted on the sandstone resulted in N-values of greater than 50 bpf, indicating very dense states. Moisture content and grain size analysis indicated moisture contents of 7 to 17 percent and 21 to 42 percent of the soil particles passing the No. 200 Sieve. Atterberg Limits Testing resulted in the sandstone being non-plastic.

Groundwater was encountered in all of the test borings at depths ranging from 5 to 12.5 feet bgs. The borings were drilled to 20 feet. Interceptor drains or underslab drains may be necessary where foundations encroach the groundwater table. Unstable conditions should be expected where excavations approach the groundwater level. In areas of shallow water the foundation excavations should be kept as shallow as possible so as to maintain a minimum separation of 3 feet between the bottom of the footings and the groundwater table. Stabilization using geo-grids or shot rock may be necessary. It should be noted that groundwater levels, other than those observed at the time of the subsurface investigation, could change due to seasonal variations, changes in land runoff characteristics and future development of nearby areas.

Soil descriptions are included on the enclosed drill logs in Appendix A. Laboratory results are summarized in Table 1 and included in Appendix B. Classifications shown on the logs are based on the visual classification of the samples at the depths indicated. The soil types may vary between samples and locations tested. Also, stratification lines shown on logs represent the approximate boundary between soil types and the actual transition may be gradual and vary with location.

### **PRELIMINARY GEOTECHNICAL EVALUATION**

*The following evaluation of subsurface conditions and foundation related recommendations are based on the conditions encountered in the test borings at this site and the locations shown and should be considered preliminary. The evaluation and recommendations are meant for planning purposes only and should be verified through additional subsurface investigations and testing at each building location.*

Commercial buildings along with associated site improvements are proposed for this site. Shallow spread footing/stemwall foundation are anticipated for the project. Four test borings were drilled at locations shown in Figure 2. Subsurface Soil conditions encountered in the test borings consisted of loose to dense native sand overlying sandstone. Bedrock was encountered at depths of 9 feet. The sand was encountered at loose to dense states. Subgrade preparation for shallow foundations may include moisture conditioning and recompaction of the soils below footing grade. On-site granular materials may be used as structural fill as approved. The medium dense to dense granular materials will provide good support for shallow foundations. Loose soils encountered beneath foundation will require removal and recompaction.

Shallow groundwater was encountered in Test Bgs 2 and 3 (5 and 6 feet). Foundation excavation in these areas may encounter unstable conditions as the groundwater level is approached. Stabilization with rock or geogrid may be required. Foundation excavation in these areas should be kept as shallow as possible.

The upper soils have low expansion potential. Expansive claystone is commonly encountered in the area. Expansive soils encountered at foundation grade will require removal and replacement with non-expansive compacted structural fill. The need for and extent of removal/recompaction or overexcavation will be determined during the excavation observations on each lot. Overexcavation is not anticipated for slab on grade structures with shallow foundations.

An allowable bearing capacity of 2400 psf is anticipated for the on-site medium dense to dense sands, recompacted site soils, or imported structural fill. An allowable bearing capacity of 3500 psf is recommended for undisturbed sandstone. Shallow foundations should have a minimum 30-inch frost protection. An equivalent fluid pressure (in the active state) of 45 pcf is recommended for the site.

On-grade floor slabs for the planned structures can be supported on medium dense to dense native sands. Loose soils will require recompaction. Expansive soils, if encountered below slabs, will require removal and replacement with non-expansive fill.

Subsurface perimeter drains are not required for slab on grade structures with shallow foundations provided that the slabs are above exterior grade. Subsurface perimeter drains are recommended for useable space located below grade and around the entire structure if expansive soils are encountered. A typical drain detail is attached in Figure No. 3.

Land First, Inc.  
Preliminary Subsurface Soil Investigation  
Bent Grass East Commercial Filing 2 – Tract B  
El Paso County, Colorado  
Page Four

Additional subsurface soils investigation is recommended when building locations and grades are determined to provide final foundation recommendations. The individual open foundation excavations should also be observed prior to construction of the foundation in order to verify that no anomalies are present, that materials at the proper design bearing capacity have been encountered, no unsuitable fill soils are present, and that no soft or loose spots or debris are present in the foundation area. Final drainage recommendations should also be determined at the time of the excavation observation.

**CLOSURE**

The borings were located to provide preliminary geotechnical information; variations in site subsurface conditions not indicated on the boring logs should be anticipated. Additional subsurface investigation and testing is recommended to further evaluate the site.

This report has been prepared for Land First, Inc. The preliminary subsurface investigation conducted for this report was performed in accordance with generally accepted soil and foundation engineering practices and principles consistent with the level of care and skill, ordinarily exercised by members of the geotechnical profession practicing in the same general locality at the same general time. No other warranty expressed or implied is made.

We trust that this report has provided you with the information you requested. If you have any questions or need additional information, please do not hesitate to contact us.

Respectfully Submitted,

ENTECH ENGINEERING, INC.



Logan L. Langford  
Geologist

LLL/rm

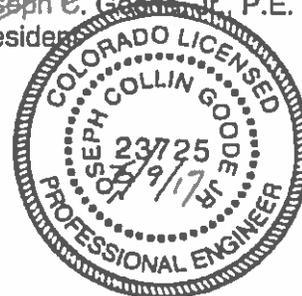
Encl.

Entech Job No. 170651  
AAprojects/2017/170651 pssi

Reviewed by:



Joseph E. Gooden, Jr., P.E.  
President



**TABLE**

**TABLE 1**  
**SUMMARY OF LABORATORY TEST RESULTS**

CLIENT LAND FIRST, INC.  
 PROJECT BENT GRASS COMM., F-2  
 JOB NO. 170651

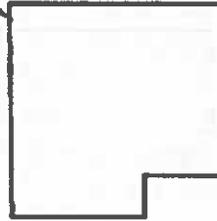
SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	FHA SWELL (PSF)	SWELL/CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	1	2-3			17.4	30	16				SC	SAND, CLAYEY
1	2	5	10.3	123.4	36.7					0.0	SC	SAND, CLAYEY
1	4	2-3			7.0						SM-SW	SAND, SLIGHTLY SILTY
2	2	10			41.8	NV	NP				SM	SANDSTONE, VERY SILTY
2	3	15			21.1						SM	SANDSTONE, SILTY
2	4	20			41.1						SC	SANDSTONE, VERY CLAYEY

## FIGURES

SITE

Avenue

Meridian Rd



Owl Pl

Meridian Rd

Bullet Rd

Eastonville Rd

Quandary Grove

E Woodmen Rd

Rd



**ENTECH**  
ENGINEERING, INC.

395 ELKTON DRIVE  
COLORADO SPRINGS, CO 80917 (719) 531-0399

VICINITY MAP  
BENTGRASS EAST COMMERCIAL FILING 2 -  
TRACT B  
EL PASO COUNTY, COLORADO  
FOR: LAND FIRST, INC.

DRAWN:  
LLL

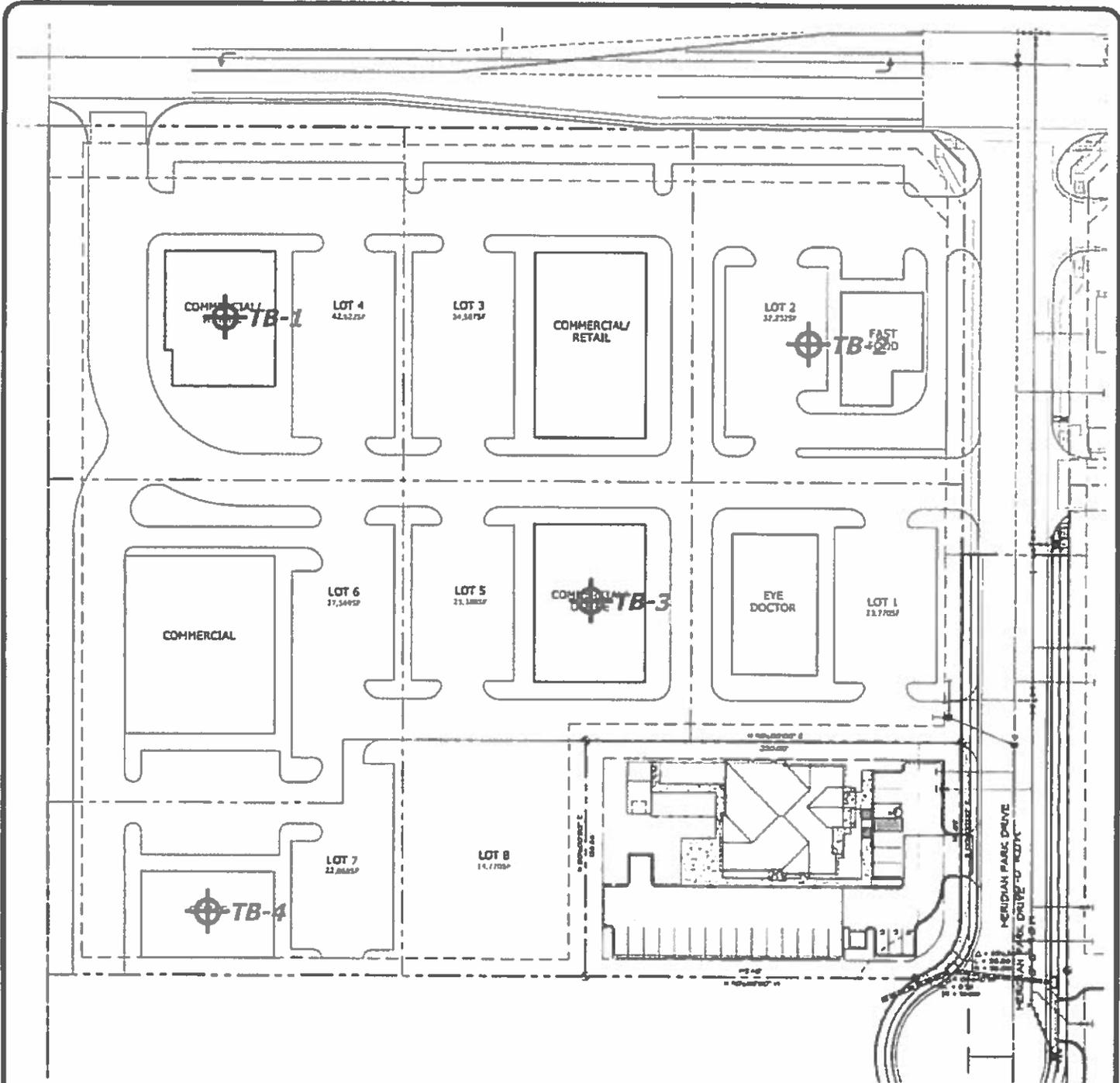
DATE:  
6/7/17

CHECKED:

DATE:

JOB NO.:  
170651

FIG NO.:  
1



⊕ TB- APPROXIMATE TEST BORING LOCATION AND NUMBER

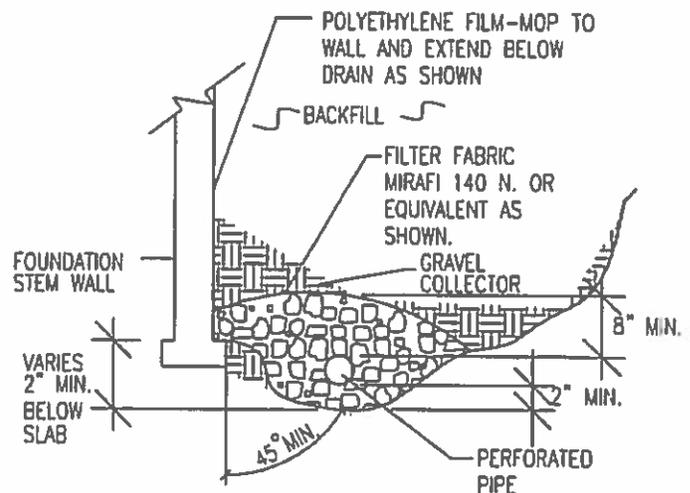
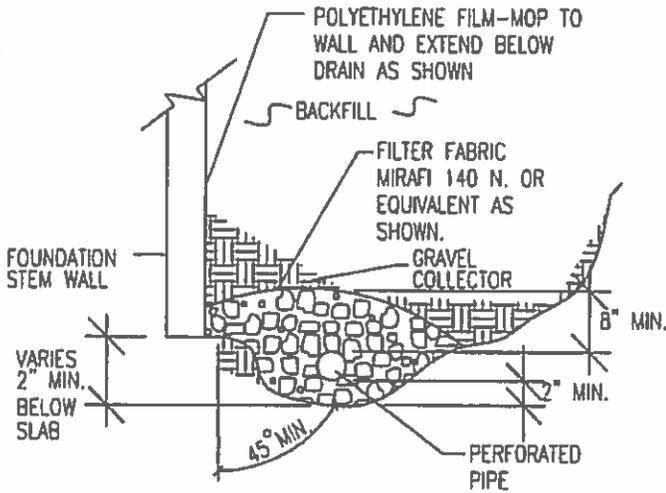


**ENTECH**  
ENGINEERING, INC.  
575 ELKTON DRIVE  
COLORADO SPRINGS, CO 80907 (719) 531-3299

SITE PLAN/TEST BORING LOCATION MAP  
BENTGRASS EAST COMMERCIAL FILING 2 - TRACT B  
EL PASO COUNTY, COLORADO  
FOR: LAND FIRST, INC.

DRAWN: LLL	DATE: 6/7/17	CHECKED:	DATE:
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JOB NO:  
170651  
  
FIG NO:  
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.



**ENTECH**  
**ENGINEERING, INC.**  
 380 ELKTON DRIVE  
 COLORADO SPRINGS, CO. 80907 (719) 531-3399

*PERIMETER DRAIN DETAIL*

DRAWN:

DATE:

DESIGNED:

DS

CHECKED:

LLL

JOB NO.:

170051

FIG NO.:

3

## **APPENDIX A: Test Boring Logs**

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

TEST BORING NO. 2  
 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	REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
WATER @ 12.5', 5/25/17							WATER @ 6', 5/25/17						
SAND, CLAYEY, FINE TO COARSE GRAINED, GRAY BROWN, MEDIUM DENSE TO DENSE, MOIST	5			20	13.0	1	SAND, CLAYEY, FINE TO COARSE GRAINED, GRAY BROWN, LOOSE TO MEDIUM DENSE, MOIST	5			8	10.3	1
	5			44	9.2	1		5			27	10.7	1
	10			50	9.0	2	SANDSTONE, VERY SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST TO WET	10			50	15.2	2
	10			7"				10			11"		
	15			50	10.8	2		15			50	9.3	2
	15			8"				15			6"		
	20			50	11.7	2		20			50	17.4	2
	20			7"				20			6"		



**ENTECH**  
**ENGINEERING, INC.**

505 ELKTON DRIVE  
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN	DATE	CHECKED: LLL	DATE 6/5/17
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JOB NO.  
170651

FIG NO.  
A-1

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

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

REMARKS

WATER @ 5', 5/25/17  
 SAND, CLAYEY, FINE TO  
 COARSE GRAINED, GRAY  
 BROWN, MEDIUM DENSE TO  
 DENSE, MOIST

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			22	10.8	1
5			43	11.8	1
10			50	11.2	2
			8"		
15			50	11.2	2
			8"		
20			50	11.3	2
			4"		

REMARKS

WATER @ 8', 5/25/17  
 SAND, SLIGHTLY SILTY, FINE  
 TO COARSE GRAINED, TAN,  
 MEDIUM DENSE, MOIST  
 SAND, CLAYEY, FINE TO  
 COARSE GRAINED, GRAY  
 BROWN, DENSE, MOIST

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

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
5			15	7.0	1
5			39	9.1	1
10			50	12.7	2
			11"		
15			50	7.2	2
			6"		
20			50	11.9	2
			6"		



**ENTECH**  
 ENGINEERING, INC.

505 ELKTON DRIVE  
 COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN

DATE

CHECKED

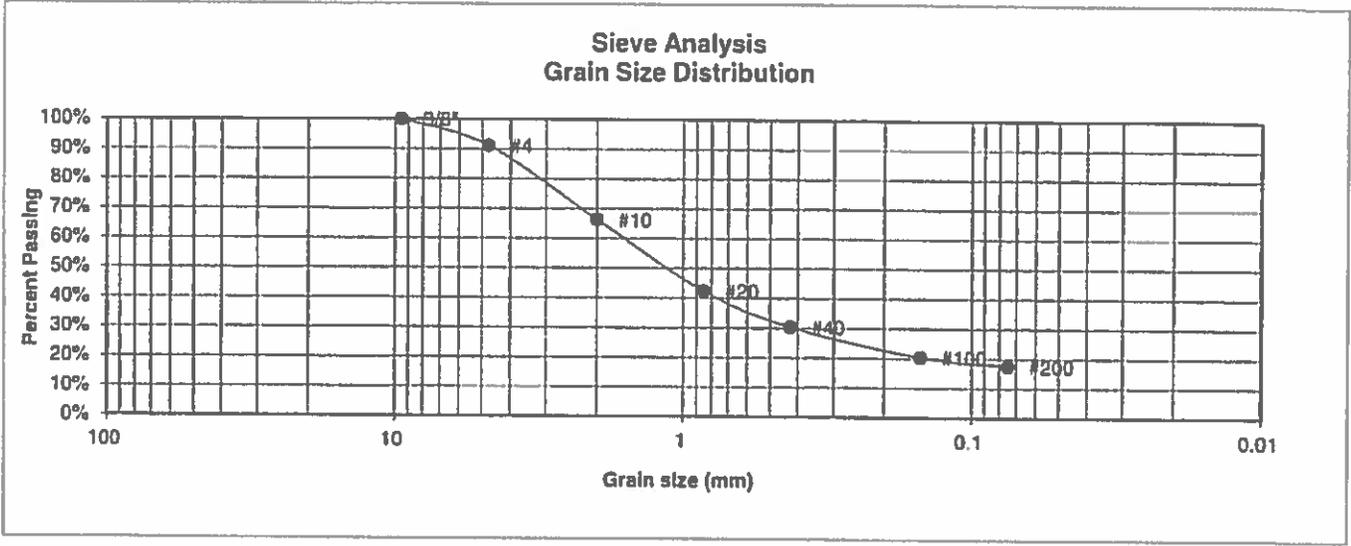
DATE

JOB NO.  
 170651

FIG NO.  
 A-2

## **APPENDIX B: Laboratory Test Results**

<b>UNIFIED CLASSIFICATION</b>	SC	<b>CLIENT</b>	LAND FIRST, INC.
<b>SOIL TYPE #</b>	1	<b>PROJECT</b>	BENT GRASS COMM., F-2
<b>TEST BORING #</b>	1	<b>JOB NO.</b>	170651
<b>DEPTH (FT)</b>	2-3	<b>TEST BY</b>	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	91.2%
10	66.3%
20	42.4%
40	30.4%
100	20.3%
200	17.4%

Atterberg Limits	
Plastic Limit	14
Liquid Limit	30
Plastic Index	16

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psi)	



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

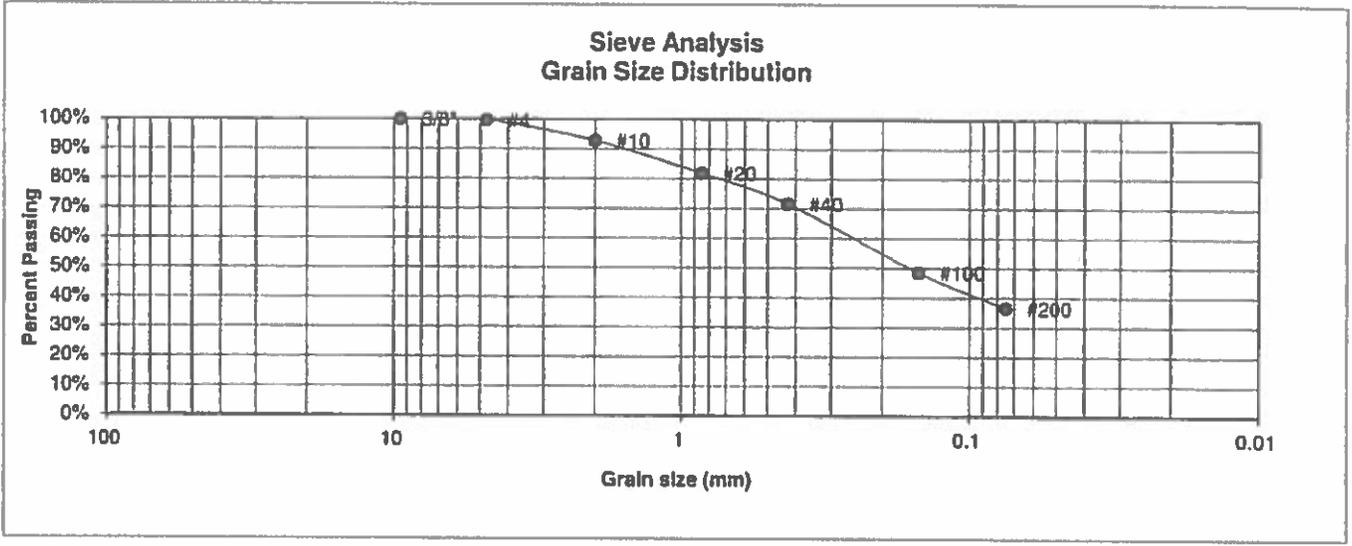
**LABORATORY TEST  
RESULTS**

DRAWN	DATE	CHECKED	DATE
		LLL	6/5/17

JOB NO:  
170651

FIG NO:  
B-1

<b>UNIFIED CLASSIFICATION</b>	SC	<b>CLIENT</b>	LAND FIRST, INC.
<b>SOIL TYPE #</b>	1	<b>PROJECT</b>	BENT GRASS COMM., F-2
<b>TEST BORING #</b>	2	<b>JOB NO.</b>	170651
<b>DEPTH (FT)</b>	5	<b>TEST BY</b>	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.6%
10	92.8%
20	81.9%
40	71.6%
100	48.6%
200	36.7%

**Atterberg Limits**  
 Plastic Limit  
 Liquid Limit  
 Plastic Index

**Swell**  
 Moisture at start  
 Moisture at finish  
 Moisture increase  
 Initial dry density (pcf)  
 Swell (psf)



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

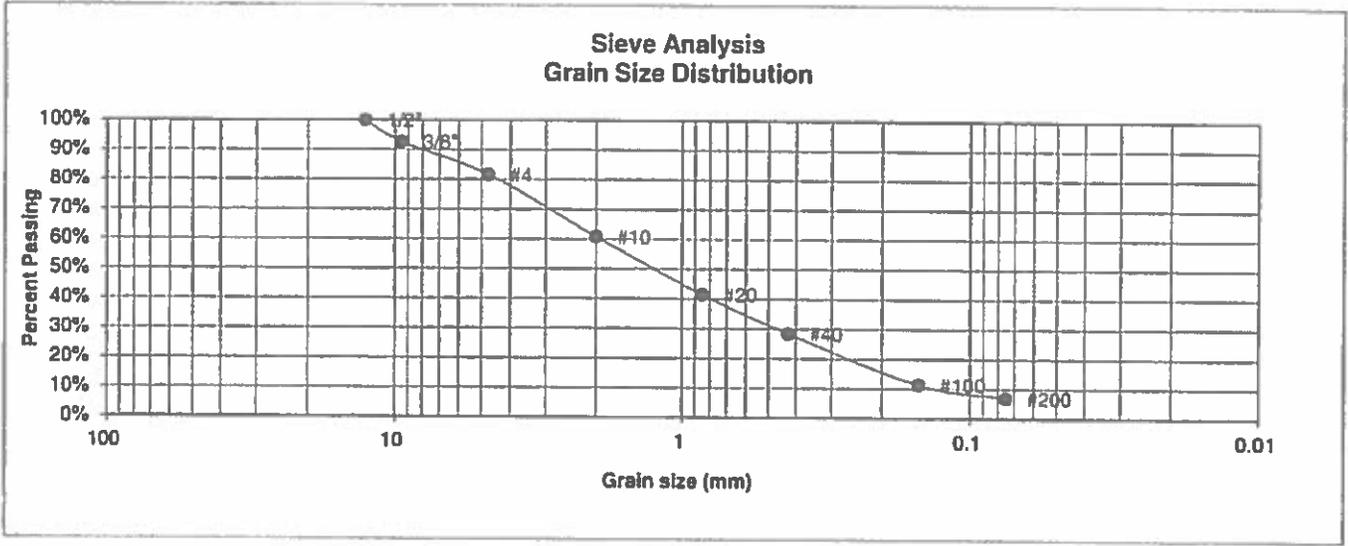
**LABORATORY TEST  
RESULTS**

DRAWN	DATE	CHECKED LLL	DATE 4/5/17
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JOB NO  
170651

FIG NO  
R-2

<b>UNIFIED CLASSIFICATION</b>	SM-SW	<b>CLIENT</b>	LAND FIRST, INC.
<b>SOIL TYPE #</b>	1	<b>PROJECT</b>	BENT GRASS COMM., F-2
<b>TEST BORING #</b>	4	<b>JOB NO.</b>	170651
<b>DEPTH (FT)</b>	2-3	<b>TEST BY</b>	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	92.7%
4	81.7%
10	60.9%
20	41.5%
40	28.4%
100	11.4%
200	7.0%

**Atterberg Limits**  
 Plastic Limit  
 Liquid Limit  
 Plastic Index

**Swell**  
 Moisture at start  
 Moisture at finish  
 Moisture increase  
 Initial dry density (pcf)  
 Swell (psi)



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

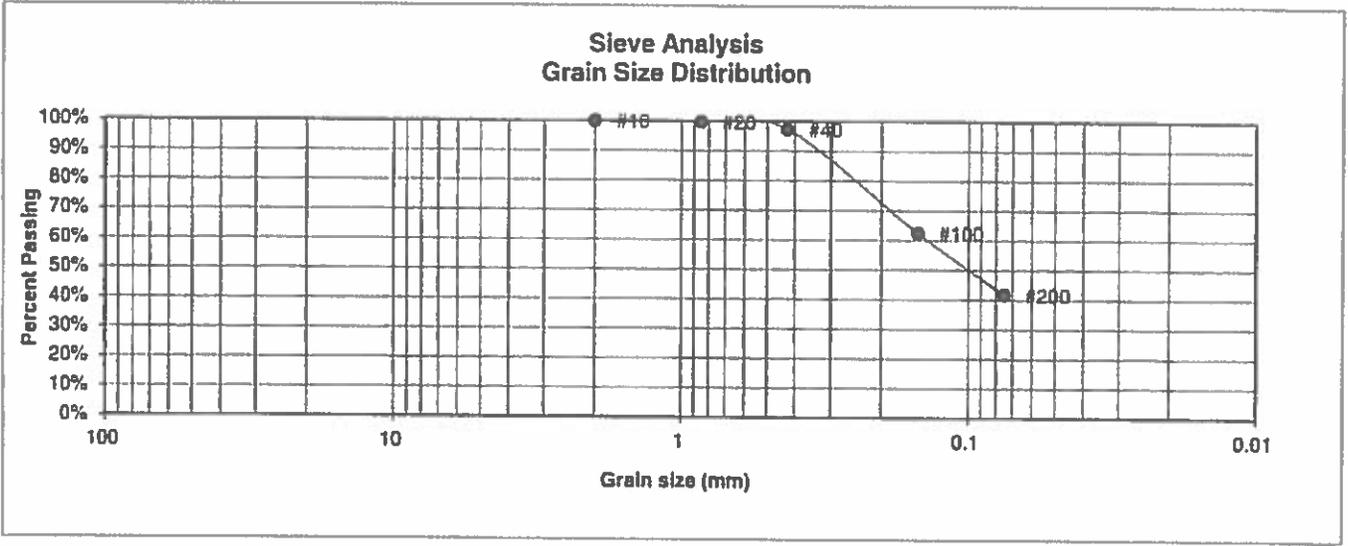
**LABORATORY TEST RESULTS**

DRAWN:	DATE:	CHECKED:	DATE:
		LLL	6/5/17

JOB NO  
170651

FIG NO  
B-3

<b>UNIFIED CLASSIFICATION</b>	SM	<b>CLIENT</b>	LAND FIRST, INC.
<b>SOIL TYPE #</b>	2	<b>PROJECT</b>	BENT GRASS COMM., F-2
<b>TEST BORING #</b>	2	<b>JOB NO.</b>	170651
<b>DEPTH (FT)</b>	10	<b>TEST BY</b>	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	99.7%
40	97.3%
100	62.5%
200	41.8%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP
Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	



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

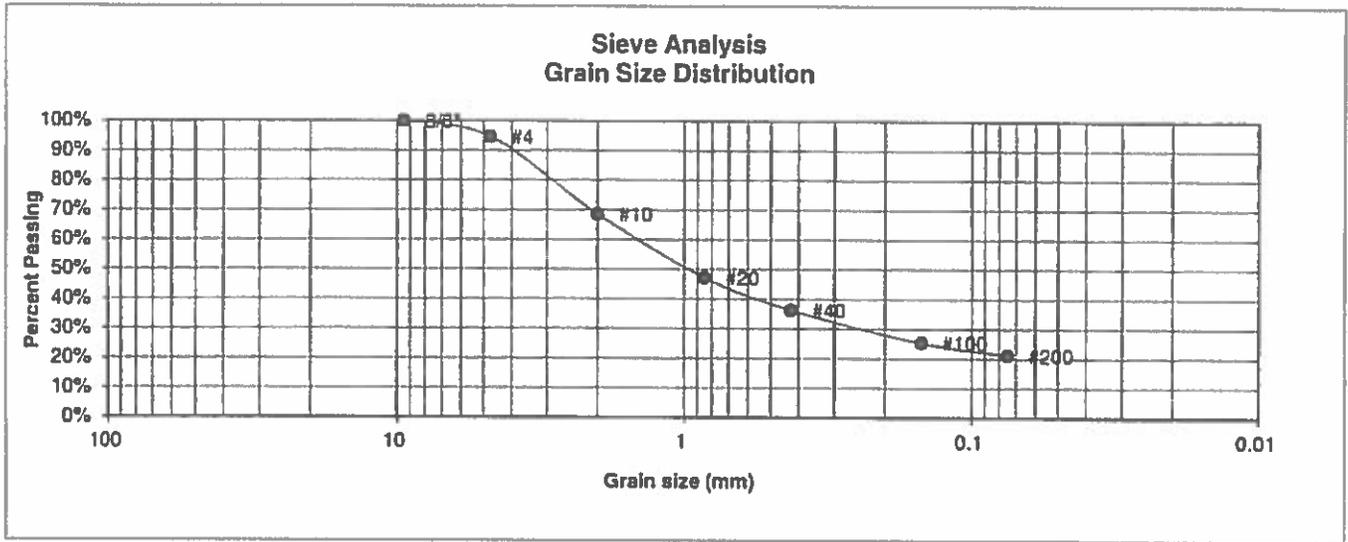
**LABORATORY TEST RESULTS**

DRAWN:	DATE:	CHECKED LLL	DATE 6/5/17
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JOB NO  
170651

FIG NO  
B-4

<b>UNIFIED CLASSIFICATION</b>	SM	<b>CLIENT</b>	LAND FIRST, INC.
<b>SOIL TYPE #</b>	2	<b>PROJECT</b>	BENT GRASS COMM., F-2
<b>TEST BORING #</b>	3	<b>JOB NO.</b>	170651
<b>DEPTH (FT)</b>	15	<b>TEST BY</b>	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.7%
10	68.6%
20	47.3%
40	36.3%
100	25.4%
200	21.1%

**Atterberg  
Limits**  
Plastic Limit  
Liquid Limit  
Plastic Index

**Swell**  
Moisture at start  
Moisture at finish  
Moisture increase  
Initial dry density (pcf)  
Swell (psf)



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

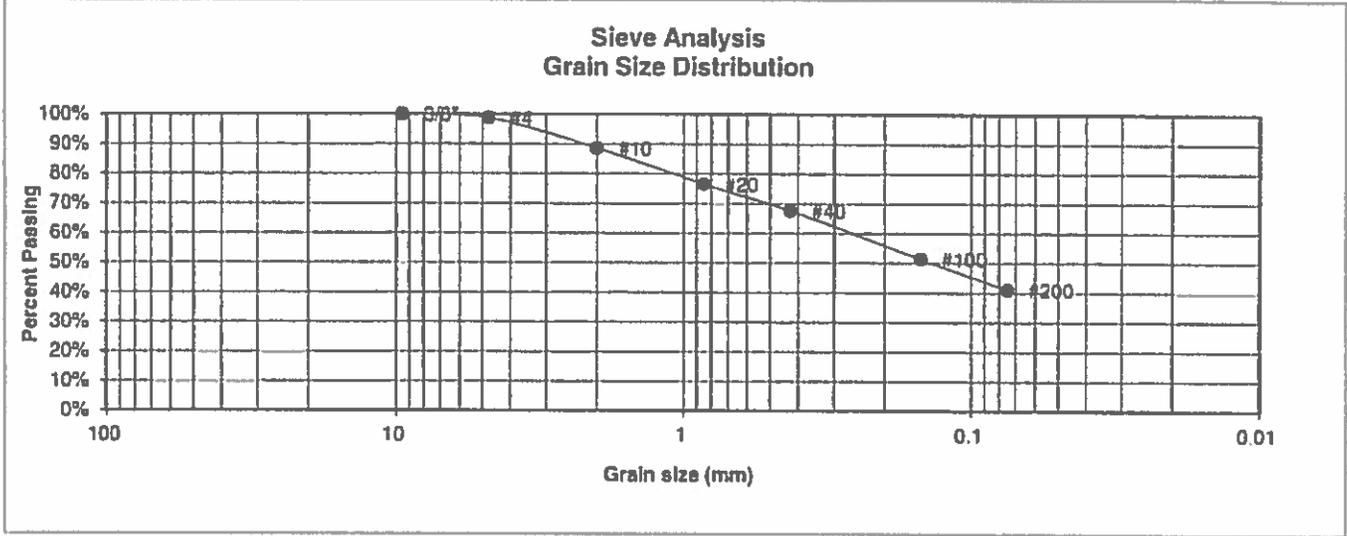
**LABORATORY TEST  
RESULTS**

<b>DRAWN:</b>	<b>DATE</b>	<b>CHECKED:</b> LLL	<b>DATE:</b> 6/5/17
---------------	-------------	------------------------	------------------------

JOB NO  
170651

FIG NO  
B-5

<b>UNIFIED CLASSIFICATION</b>	SC	<b>CLIENT</b>	LAND FIRST, INC.
<b>SOIL TYPE #</b>	2	<b>PROJECT</b>	BENT GRASS COMM., F-2
<b>TEST BORING #</b>	4	<b>JOB NO.</b>	170651
<b>DEPTH (FT)</b>	20	<b>TEST BY</b>	BL



<u>U.S. Sieve #</u>	<u>Percent Finer</u>	<u>Atterberg Limits</u>
3"		Plastic Limit
1 1/2"		Liquid Limit
3/4"		Plastic Index
1/2"		
3/8"	100.0%	
4	98.8%	<u>Swell</u>
10	88.6%	Moisture at start
20	76.6%	Moisture at finish
40	67.6%	Moisture increase
100	51.4%	Initial dry density (pcf)
200	41.1%	Swell (psf)



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

**LABORATORY TEST  
RESULTS**

<b>DRAWN:</b>	<b>DATE</b>	<b>CHECKED:</b>	<b>DATE</b>
		LLL	6/5/17

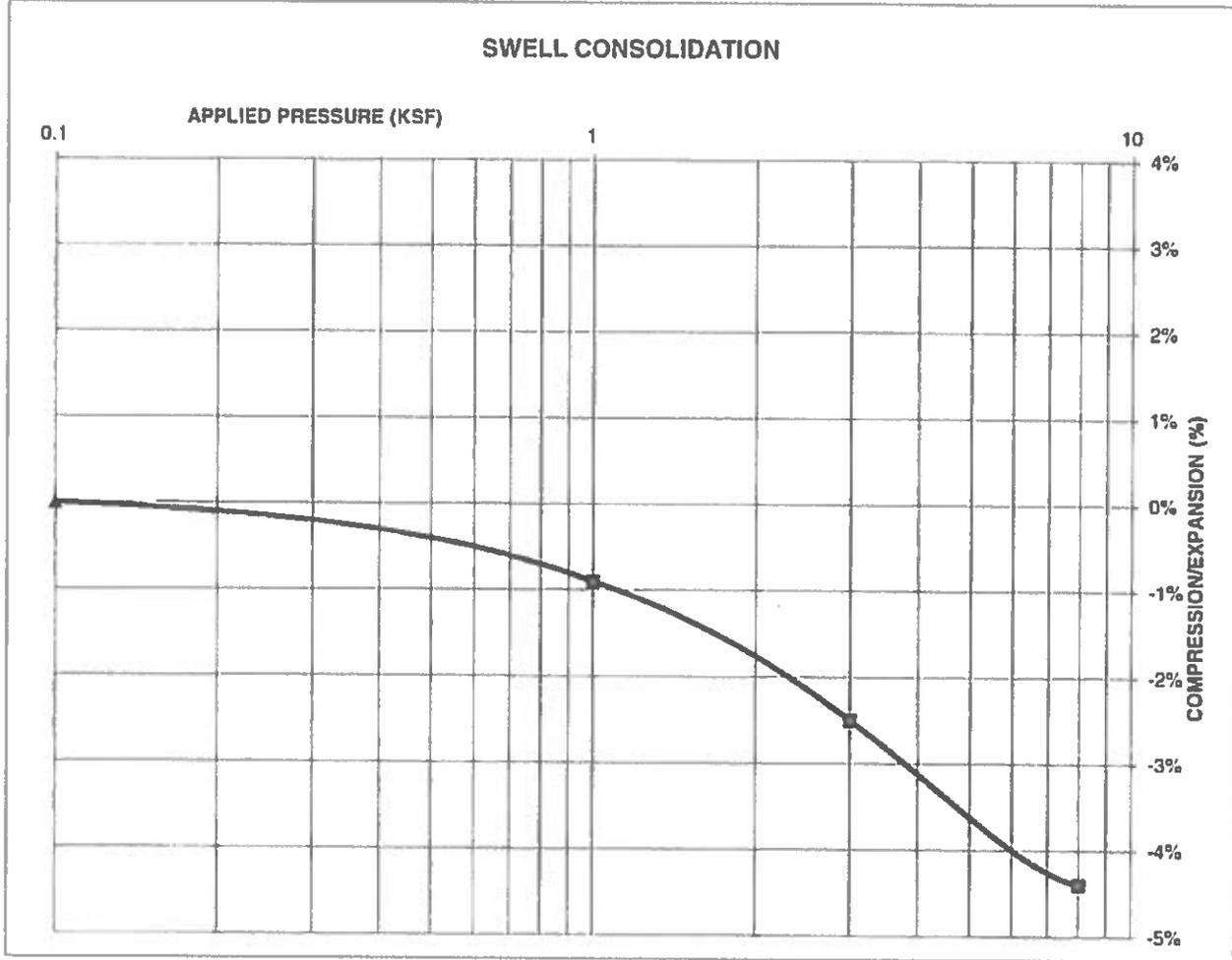
**JOB NO:**  
170651

**FIG NO:**  
B-6

**CONSOLIDATION TEST RESULTS**

TEST BORING #	2	DEPTH(ft)	5
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			123
NATURAL MOISTURE CONTENT			10.3%
SWELL/CONSOLIDATION (%)			0.0%

JOB NO. 170651  
 CLIENT LAND FIRST, INC.  
 PROJECT BENT GRASS COMM., F-2



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**ENGINEERING, INC.**

505 ELKTON DRIVE  
 COLORADO SPRINGS, COLORADO 80907

**SWELL CONSOLIDATION  
 TEST RESULTS**

DRAWN

DATE

CHECKED:  
 LLL

DATE  
 6/5/17

JOB NO  
 170651

FIG NO  
 B-7

## **APPENDIX C: Soil Survey Descriptions**

## El Paso County Area, Colorado

### 19—Columbine gravelly sandy loam, 0 to 3 percent slopes

#### Map Unit Setting

*National map unit symbol:* 367p  
*Elevation:* 6,500 to 7,300 feet  
*Mean annual precipitation:* 14 to 16 inches  
*Mean annual air temperature:* 46 to 50 degrees F  
*Frost-free period:* 125 to 145 days  
*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Columbine and similar soils:* 97 percent  
*Minor components:* 3 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Columbine

##### Setting

*Landform:* Fans, flood plains, fan terraces  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Alluvium

##### Typical profile

*A - 0 to 14 inches:* gravelly sandy loam  
*C - 14 to 60 inches:* very gravelly loamy sand

##### Properties and qualities

*Slope:* 0 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Very low  
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water capacity:* Very low (about 2.5 inches)

##### Interpretive groups

*Land capability classification (irrigated):* 4e  
*Land capability classification (nonirrigated):* 6e  
*Hydrologic Soil Group:* A  
*Ecological site:* R049XB215CO - Gravelly Foothill  
*Hydric soil rating:* No

#### Minor Components

##### Pleasant

*Percent of map unit:* 1 percent

*Landform: Depressions*  
*Hydric soil rating: Yes*

**Other soils**

*Percent of map unit: 1 percent*  
*Hydric soil rating: No*

**Fluvaquentic haplaquolls**

*Percent of map unit: 1 percent*  
*Landform: Swales*  
*Hydric soil rating: Yes*

## **Data Source Information**

Soil Survey Area: El Paso County Area, Colorado  
Survey Area Data: Version 18, Jun 5, 2020