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SOIL, GEOLOGY, AND GEOLOGIC HAZARD STUDY
HOMESTEAD AT STERLING RANCH FILING NO. 2
EL PASO COUNTY, COLORADO

Prepared for

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Attn: Chaz Collins

June 20, 2019

Respectfully Submitted,

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Entech Job No. 190935 Homestead
F:/AAProjects/2019/190935Homestead F2 Geohaz

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TABLE OF CONTENTS

1.0 SUMMARY

Project Location:

The project lies in a portion of the north half of Section 33, Township 12 South, Range 65 West of the 6th Principal Meridian. The site is located east of Vollmer Road and north of Woodmen Road in El Paso County, Colorado.

Project Description:

Total acreage involved in the project is approximately 29.6 acres. The proposed development is to consist of single-family residential development. Homestead at Sterling Ranch Filing 2 consists of 104 lots. The development will be serviced by Woodmen Hills Metropolitan District.

Scope of Report:

The report presents the results of our geologic investigation and treatment of engineering geologic hazard study. This report presents the results of our geologic reconnaissance, a review of available maps, aerial photographs and our conclusions with respect to the impacts of the geologic conditions on development.

Land Use and Engineering Geology:

The site was found to be suitable for development. Geologic conditions will impose some constraints on development. These include areas of artificial fill, potentially unstable slopes, potential expansive soils, floodplain, and seasonally shallow groundwater areas. Artificial fill is associated with recent overlot grading. The potentially unstable slopes and floodplains are associated with a drainage along the eastern portion of the site. Areas of seasonal shallow groundwater occur in detention ponds. Shallow bedrock will also be encountered on portions of the site. Site conditions will be discussed in greater detail in this report. All recommendations are subject to the limitations discussed in the report.

2.0 GENERAL SITE CONDITIONS AND PROJECT DESCRIPTION

The site is located in a portion of the north half of Section 33, Township 12 South, Range 65 West of the 6th Principal Meridian, in El Paso County, Colorado. The site is located east of Vollmer Road, approximately one mile north of Woodmen Road. The site is located south of proposed Briargate Parkway and east of the intersection of Volmer Road and Dines Boulevard. The location of the site is shown on the Vicinity Map, Figure 1.

The topography of the site is generally gently sloping to the south with some minor areas of moderate to steep slopes along Sand Creek, which flows in a southerly direction along the eastern boundary of the site. Minor flows of water were observed in Sand Creek at the time of this investigation. The area of the site is indicated on the USGS Map, Figure 2. Previous site uses have included grazing and pasture lands. Existing sand and gravel quarries lie to the east of the site, east of Sand Creek. The majority of the vegetation on site has been stripped during recent site grading with primarily low field grasses, weeds along the Sand Creek drainage.

Total acreage involved in the proposed development is approximately 29.6 acres. The proposed development is single-family residential. The development is to be serviced by Woodmen Hills Metropolitan District. The overall site plan for the entire Sterling Ranch Development, including Homestead Filing No. 2, is presented in Figure 3. The development plan for Homestead Filing No. 2 is presented in Figure 4. Site photographs, taken on June 13, 2019, are included in Appendix A. The approximate locations and directions of the photographs are indicated on Figure 4. It is our understanding there is on-going on-site grading and creek bank stabilization with drainage improvements and a regional trail corridor constructed in the area of the existing Sand Creek drainage along the eastern boundary of the site. The proposed grading is indicated on Figure 4.

3.0 SCOPE OF THE REPORT

The scope of this report will include the following:

- A geologic analysis of the site utilizing published geologic data, and subsurface soils information.
- Detailed site-specific mapping of major geographic and geologic features.
- Identification of geologic hazards and impacts on the proposed development.
- Recommended mitigation of geologic hazards where they affect development.

4.0 FIELD INVESTIGATION

Our field investigation consisted of the preparation of a geologic map of bedrock features and significant surficial deposits. The Natural Resources Conservation Service (Reference 1), previously the Soil Conservation Service (Reference 2) survey was reviewed to evaluate the site.

The positions of mappable units within the subject property are shown on the Geologic Map. Our mapping procedures involved field reconnaissance, measurements and interpretation. The same mapping procedures have also been utilized to produce the Engineering Geology Map which identifies pertinent geologic conditions affecting development.

Additionally, two (2) test borings were drilled by Entech Engineering, Inc. as a part of this investigation. The borings were drilled with a power driven continuous flight auger drill rig to 20 feet. Samples were obtained during drilling using the Standard Penetration Test, ASTM D-1586, utilizing a 2-inch O.D. Split Barrel Sampler and a California Sampler. Results of the penetration tests are shown on the drilling logs to the right of the sampling point. The location of the test borings is shown on the Test Boring Location Plan, Figure. The drilling logs are included in Appendix B.

Laboratory testing was performed to classify and determine the soils engineering characteristic. Laboratory tests included moisture content, ASTM D-2216, grain size analysis, ASTM D-422, and Atterberg Limits, ASTM D-4318. Swell tests included Swell/Consolidation Testing, ASTM D-4546. Results of the laboratory testing are included in Appendix C. A Summary of Laboratory Test Results is presented in Table 1.

Geologic Hazard Studies were previously performed by Entech Engineering, Inc. for the entire Sterling Ranch development, October 31, 2009 (Reference 3) and January 20, 2009 (Reference 4). One of the test borings from the previous investigations was located on the subject site (Homestead Filing No. 2). The location of the test boring is indicated on Figure 4. The Test Boring Log and Laboratory Test Results are included in Appendix D. Information from these reports was used in evaluating the site.

5.0 SOIL, GEOLOGY AND ENGINEERING GEOLOGY

5.1 General Geology

Physiographically, the site lies in the western portion of the Great Plains Physiographic Province. Approximately 10 miles to the west is a major structural feature known as Rampart Range Fault. This fault marks the boundary between the Great Plains Physiographic Province and the Southern Rocky Mountain Province. The site exists within the southern edge of a large structural feature known as the Denver Basin. Bedrock in the area tends to be gently dipping in a northeasterly direction (Reference 5). The rocks in the area of the site are sedimentary in nature, and typically Tertiary to Cretaceous in age. The bedrock underlying the site itself is the Dawson Formation. Overlying the Dawson Formation are unconsolidated deposits of artificial, residual, and alluvial soils. The site's stratigraphy will be discussed in more detail in Section 5.3.

5.2 Soil Survey

The Natural Resources Conservation Service (Reference 1), previously the Soil Conservation Service (Reference 2) has mapped one soil type on the site (Figure 5). In general, the soils consist of loamy sand. Soils are described as follows:

Soil Type	Description
71	Pring coarse sandy loam, 3-8% slopes: Dark grayish brown to brown coarse sandy loam. Permeability is rapid. Erosion hazard is moderate. Good potential for home sites.

Complete descriptions of the soils are presented in Appendix E (Reference 2). The soils have generally been described to have rapid permeabilities. Limitations to development are varied on the different soil types and include frost action potential. Possible hazards with soil erosion are present on the site. The erosion potential can be controlled with vegetation. The soils have been described to have moderate erosion hazards.

5.3 Site Stratigraphy

The Falcon NW Quadrangle Geologic Map showing the site is presented in Figure 6 (Reference 6). The Geology Map prepared for the site is presented in Figure 7. Four mappable units were identified on this site, which are described as follows:

- **Qaf** **Artificial Fill of Quaternary Age:** These are man-made fill deposits associated with overlot site grading. Some of the fill is associated with earthen embankments for detention ponds on-site.

- **Qal** **Recent Alluvium of Quaternary Age:** These are recent stream deposits that have been deposited along the main channel of Sand Creek. These materials consist of silty to clayey sands and sandy clays. Some of these alluviums may contain highly organic soils.

- **Qb** **Broadway Alluvium of Pleistocene Age:** These materials consist of stream terrace deposits. The Broadway Alluvium typically consists of silty to clayey gravelly sands. This deposit is usually highly stratified and may contain lenses of silt, clay or cobbles.

- **Tkd** **Dawson Formation of Tertiary to Cretaceous Age:** The Dawson formation typically consists of arkosic sandstone with interbedded fine-grained sandstone, siltstone and claystone. Overlying this formation is a variable layer of residual and/or colluvium soils. The residual soils were derived from the in-situ weathering of the bedrock materials on-site. The colluvium soils have been transported by the action of sheetwash and gravity. These soils consisted of silty to clayey sands and sandy clays.

The soils listed above were mapped from site-specific mapping of the site, the *Geologic Map of the Falcon NW Quadrangle* by Madole, 2003 (Reference 6), the *Reconnaissance Geologic Map of Colorado Springs and Vicinity, Colorado* by Scott and Wobus in 1973 (Reference 7), and *the Geologic Map of the Colorado Springs-Castle Rock Area Front Range Urban Corridor, Colorado*, by Trimble and Machette, 1979 (Reference 8). The test borings from the subsurface investigation by Entech Engineering, Inc. were also used in evaluating the site.

5.4 Soil Conditions

Three soil and rock types were encountered in the test borings drilled on the site. Type 1: silty sand (SM); Type 2: slightly silty to silty sandstone bedrock (SM-SW, SM); and Type 3: clayey, sandy siltstone bedrock (ML). Each material type was classified using the results of the laboratory testing and the Unified Soil Classification System (USCS). The bedrock encountered in the borings was classified as soil in that the upper bedrock zone could be penetrated using conventional soil drilling and sampling techniques.

Soil Type 1 classified as silty sand (SM). The sands were encountered in both of the test borings at the existing ground surface and extending to one to 4 feet below ground surface (bgs). Standard Penetration Testing on the sand resulted in a N-value of 22 blows per foot (bpf), indicating medium dense states. Water content and grain size testing resulted in a water

content of approximately 4 percent with approximately 13 percent of the soil size particle passing the No. 200 sieve. Atterberg limits testing resulted in non-plastic results.

Soil Type 2 was classified as slightly silty to silty sandstone bedrock (SM-SW, SM). The sandstone was encountered in both of the test borings, below Soil Type 1, at depths ranging from approximately one to 4 feet bgs and extending to depths ranging from 11 feet to the termination of the borings (20 feet). Standard Penetration Testing on the sandstone resulted in N-values greater than 50 bpf indicating very dense states. Water content and grain size testing resulted in water contents of 4 to 10 percent with approximately 10 percent of the soil size particles passing the No. 200 sieve. Atterberg limits testing resulted in non-plastic results.

Soil Type 3 was classified as clayey, sandy siltstone bedrock (ML). The siltstone was encountered in Test Boring No. 1A at 11 feet and extending to the termination of the boring (20 feet). Standard Penetration Testing on the siltstone resulted in N-values greater than 50 bpf, indicating hard consistencies. Water content and grain size testing resulted in water contents of 9 to 15 percent with approximately 88 percent of the soil size particles passing the No. 200 sieve. Atterberg limits testing resulted in a liquid limit of 33 and a plastic index of 9. Swell/Consolidation Testing of the siltstone resulted in a volume change of 2.4 percent, indicating moderate expansion potential.

Test Boring logs are included in Appendix B. A Summary of the Laboratory Test Results for each of the soil and rock types is presented in Table 1 and a presentation of the overall Laboratory Test Results is included in Appendix C.

5.5 Groundwater

Groundwater was not encountered in the test borings which were drilled to 20 feet. Fluctuations in the groundwater conditions may occur due to conditions such as variations in rainfall, precipitation infiltration and development of nearby areas. Areas of floodplains and areas of seasonal shallow groundwater have been identified on the site. These areas will be discussed in the following section.

6.0 ENGINEERING GEOLOGY - IDENTIFICATION AND MITIGATION OF GEOLOGIC HAZARDS

As mentioned previously, detailed mapping has been performed on this site to produce an Engineering Geology Map (Figure 7). This map shows the location of various geologic conditions of which the developers and planners should be cognizant during the planning, design and construction stages of the project. The hazards identified on this site include artificial fill, potentially unstable slopes, potentially expansive soils, floodplains, and seasonally shallow groundwater areas. The following hazards have been addressed:

Expansive Soils

Expansive soils were encountered in some of the test borings drilled on-site and as a part of the previous investigation (References 3 and 4). The site is classified in areas of low to moderate swell potential according to the *Map of Potentially Swelling Soil and Rock in the Front Range Urban Corridor, Colorado* by Hart, 1974 (Reference 9); however, highly expansive clays and claystone are typically encountered in the area. These areas are sporadic; therefore, none have been indicated on the map. Expansive clays and claystone, if encountered, can cause differential movement in the structure foundation.

Mitigation: Mitigation of expansive soils will require special foundation design. Overexcavation and replacement with non-expansive soils at a minimum 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557 is a suitable mitigation which is common in the area. Drilled piers are another option that is used in areas where highly expansive soils are encountered. Typical minimum pier depths are on the order of 25 feet or more and require penetration into the bedrock material a minimum of 4 to 6 feet, depending upon building loads. Floor slabs on expansive soils should be expected to experience movement. Overexcavation and replacement has been successful in minimizing slab movements. The use of structural floors can be considered for basement construction on highly expansive clays. Final recommendations should be determined after additional investigation of each building site.

Subsidence Area

Based on a review of a Subsidence Investigation Report for the Colorado Springs area by Dames and Moore, 1985 (Reference 10) and the mining report for the Colorado Springs coalfield (Reference 11), the site is not undermined. The closest underground mines in the area are 6 miles to the southwest and the site is not mapped within any potential subsidence zones.

Slope Stability and Landslide Hazard

The majority of the slopes on-site are gently sloping and do not exhibit any past or potential unstable slopes or landslides. Some of the steeper slopes along Sand Creek have been identified as potentially unstable slopes. The mitigation recommendation for these areas is as follows:

Potentially Unstable Slopes

Some of the steep slopes along the Sand Creek drainage have been identified as potentially unstable. Considerable care must be exercised in these areas not to create a condition which would tend to activate instability.

Mitigation: According to the grading plan shown on Figure 7, the majority of these areas are to be regraded. Building should be avoided on any remaining potentially unstable slopes unless stabilized. A setback of 20 feet from the crest of these slopes is recommended unless stabilized. Stabilization could involve regrading to slope angles no steeper than 3:1 or the use of engineer-designed retaining walls, tiebacks, or buttresses. Where retaining walls are not used, erosion protection may be necessary to prevent undercutting by the creek during periods of high water. It is our understanding the project will include drainage improvements and the construction of a regional trail along the Sand Creek drainage and stabilization of the slopes will be a part of the improvements. Specific slope stabilization recommendations are beyond the scope of this report.

Based on the prepared development plan it appears the potentially instable slopes can be regraded or avoided. These areas are minor and there is sufficient distance for proposed setbacks for any remaining slopes.

Debris Fans

Based on-site observations, debris fans were not observed in this area.

Groundwater and Floodplain Areas

Areas within the detention pond drainages have been identified as areas of seasonal shallow groundwater areas. The Sand Creek drainage has been mapped as a floodplain zone according to the FEMA Map No. 08041CO535G, Figure 8 (Reference 12). These areas are discussed as follows:

Floodplain: Construction is not anticipated within the main channel of the Sand Creek floodway. The Sand Creek drainage is to be preserved as open space according to the Overall Site Plan, Figure 3. The proposed lots are outside the floodplain zone. It is anticipated any proposed construction considered within the floodplain zone would involve drainage improvements and channelization of the floodplain. Development within the floodplain will require approval of the Drainage Plan prior to construction. Finished floor levels must be one foot above the floodplain level. Exact floodplain locations and drainage studies are beyond the scope of this report.

Seasonal Shallow Groundwater: In these areas, we would anticipate the potential for periodically high subsurface moisture conditions and possible frost heave potential, depending on the soil conditions. These areas are located within detention ponds and will be avoided by development. Areas of shallow groundwater may exhibit unstable subgrade conditions in terms of bearing support of construction equipment during overlot grading. Lots immediately adjacent to the detention ponds or the Sand Creek drainage may also experience higher subsurface moisture conditions during periods of higher flows.

Mitigation: In these locations, foundations subject to severe frost heave potential should penetrate sufficient depth so as to discourage the formation of ice lenses beneath foundations. At this location and elevation, a foundation depth for frost protection of 30 inches is recommended. In areas where high subsurface moisture conditions are anticipated periodically, a subsurface perimeter drain will be necessary to help prevent the intrusion of water into areas located below grade. A typical perimeter drain detail is presented in Figure 9. Structures should not block drainages. Swales should be created to intercept surface runoff and carry it safely around and away from structures. Groundwater was not encountered in the test borings drilled on the site. It is anticipated groundwater will not affect shallow foundations on the majority of the site.

Artificial Fill

Areas of artificial fill were observed in areas of the site. The majority of these areas are associated with recent overlot grading. Fill depths are variable, therefore, all regraded areas have been mapped as artificial fill. Some areas of artificial fill associated with detention ponds exist on-site.

Mitigation: Fill records should be obtained to determine if the fill was placed in a controlled manner. Where uncontrolled fill is encountered beneath foundations, mitigation will be necessary. Mitigation typically involves removal and recompaction at a minimum of 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557.

Faults

The closest fault is the Rampart Range Fault, located approximately 10 miles to the west. No faults are mapped on the site itself. Previously, Colorado was mapped entirely within Seismic Zone 1, a very low seismic risk. Additionally, the International Residential Code (IRC), 2003, currently places this area in Design Category B, also a low seismic risk. According to a report by the Colorado Geological Survey by Kirkman and Rogers, 1981, (Reference 13) this area should be designed for Zone 2 due to more recent data on the potential for movement in this area, and any resultant earthquakes.

Dipping Bedrock

The bedrock underlying the site is the Dawson Formation of Tertiary to Cretaceous Age. The bedrock in this area is gently dipping a northeasterly direction according to the *Geologic Structure Map of the Pueblo 1x2 Quadrangle, South-Central Colorado* (1978) (Reference 5). The bedrock encountered in the test borings did not exhibit steeply dipping characteristics; therefore mitigation is not necessary.

Radioactivity

Radon levels for the Colorado Geologic Survey in the Open-File have reported the area, Report No. 91-4 (Reference 14). Radon levels ranging from 0 to 20 pci/l have been measured in the area. Only two readings have been taken in the area. One reading was between 4 and 10 pci/l and the other was less than 4 pci/l. The minimal information from this report is not sufficient to determine if radon levels are higher for this site. An occurrence of radioactive minerals has been identified 4 miles northwest of the site (Reference 15). This occurrence is associated with a limonite deposit in the Dawson Formation. The

radioactivity hazard was researched by CTL/Thompson, Inc. for Wolf Ranch, west of the site (Reference 16). It was determined that the area lies within a zone that may have small deposits of low intensity radioactivity. No known occurrences exist on the site, however, radon gas originating in the bedrock underlying the site could migrate up into the upper soil profile.

Mitigation: The potential exists for radon gas to build up in areas of the site. Build-ups of radon gas can be mitigated by providing increased ventilation of basements and crawlspaces and sealing of joints. Specific requirements for mitigation should be based on-site specific testing after the site is constructed.

7.0 EROSION CONTROL

The soil types observed on the site are mildly to moderately susceptible to wind erosion, and moderately to highly susceptible to water erosion. A minor wind erosion and dust problem may be created for a short time during and immediately after construction. Should the problem be considered severe enough during this time, watering of the cut areas or the use of chemical palliative may be required to control dust. However, once construction has been completed, and vegetation reestablished, the potential for wind erosion should be considerably reduced.

With regard to water erosion, loosely compacted soils will be the most susceptible to water erosion, residually weathered soils and weathered bedrock materials become increasingly less susceptible to water erosion. For the typical soils observed on-site, allowable velocities or unvegetated and unlined earth channels would be on the order of 3 to 4 feet/second, depending upon the sediment load carried by the water. Permissible velocities may be increased through the use of vegetation to something on the order of 4 to 7 feet/second, depending upon the type of vegetation established. Should the anticipated velocities exceed these values, some form of channel lining material may be required to reduce erosion potential. These might consist of some of the synthetic channel lining materials on the market or conventional riprap.

In cases where ditch-lining materials are still insufficient to control erosion, small check dams or sediment traps may be required. The check dams will serve to reduce flow velocities, as well as provide small traps for containing sediment. The determination of the amount, location and placement of ditch linings, check dams and of the special erosion control features should be

performed by or in conjunction with the drainage engineer who is more familiar with the flow quantities and velocities.

Cut and fill slope areas will be subjected primarily to sheetwash and rill erosion. Unchecked rill erosion can eventually lead to concentrated flows of water and gully erosion. The best means to combat this type of erosion is, where possible, the adequate re-vegetation of cut and fill slopes. Cut and fill slopes having gradients more than three (3) horizontal to one (1) vertical become increasingly more difficult to re-vegetate successfully. Therefore, recommendations pertaining to the vegetation of the cut and fill slopes may require input from a qualified landscape architect and/or the Soil Conservation Service.

8.0 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 7), portions of the site are mapped as upland and floodplain deposits. According to the *Atlas of Sand, Gravel and Quarry Aggregate Resources, Colorado Front Range Counties* distributed by the Colorado Geological Survey (Reference 18), portions of the site are mapped as U3 – Upland deposits: sand, and V3: valley fill deposits: sand. According to the *Evaluation of Mineral and Mineral Fuel Potential* (Reference 19), tracts in the area of the site have been mapped as "Good" for industrial minerals. Quarries exist on the site and in the area of the site for sand and gravel, particularly in the Eolian Sand and Alluvial deposits. Based on the depth of bedrock encountered in the test borings, it appears the majority of the thicker deposits have been excavated from the site.

According to *the Evaluation of Mineral and Mineral Fuel Potential of El Paso County State Mineral Lands* (Reference 19), the tracts in the area of the site have been mapped as "Poor" for coal resources and "Little or no Potential" metallic mineral resources.

The site has been mapped as "Fair" for oil and gas resources (Reference 19). No oil or gas fields have been discovered in the area of the site. The sedimentary rocks in the area lack the essential elements for oil or gas.

9.0 RELEVANCE OF GEOLOGIC AND SITE CONDITIONS TO LAND USE PLANNING

The existing geologic and geotechnical conditions at the site will likely impose only minor constraints on the proposed development and construction. Avoidance or regrading can mitigate many hazards such as potentially unstable slopes; low lying floodplain areas and areas of seasonal shallow groundwater. Other constraints identified on the site such as expansive soils and artificial fill, can be mitigated through proper engineering design and construction.

The majority of the soils at typical foundation depths consist of sands, sandstone and claystone. Areas of shallow bedrock will be encountered on the site. Shallow sandstone will have higher bearing capacities. Excavation of the harder sandstone or claystone bedrock may be more difficult in some areas than others. Difficult excavation is anticipated in areas of shallow bedrock, particularly sandstone. Overlot grading and excavation for utility trenches and foundations will be affected by shallow bedrock. The use of track-mounted equipment will likely be required.

Expansive soils may be encountered in areas of this site. The expansive soils encountered in the test borings drilled on-site are sporadic; therefore, none have been indicated on the maps. Expansive soils, if encountered, will require special foundation design and/or overexcavation and replacement with non-expansive soil compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). Other options include drilled piers.

Areas of seasonal shallow groundwater have been mapped in the detention ponds on site. These areas will be avoided by structures, however, structures immediately adjacent to the detention ponds may experience higher water levels during periods of high moisture. Shallow groundwater areas may also affect utility installation. Geo-grids or shotrock may be necessary to stabilize excavation. In or adjacent to seasonal shallow groundwater areas, drains may be necessary to control seepage within the foundation zone. A typical perimeter drain detail is presented in Figure 9.

The floodplain areas of the Sand Creek drainage exist along the eastern boundary of the site. According to the Overall Site Plan, Figure 3, this area is to be preserved as open space. Should development be considered in the floodplain, channelization and drainage improvements would be necessary as well as raising building site grades above the floodplain level. According to the development plan, the lots are proposed outside the floodplain zone. Finished floor elevations must be a minimum of one foot above the floodplain level. Drains may be necessary for foundations immediately adjacent to the floodplain to help prevent the intrusion of water into areas below grade. Specific floodplain location and drainage studies are beyond the scope of this report.

Potentially unstable slopes exist along Sand Creek. According to the grading plan the majority of these areas are to be regraded. A minimum building setback of 20 feet is recommended from the crest of any remaining potentially unstable slopes unless site-specific investigation or slope stability analysis is performed. Another option is to stabilize the slopes. Potentially unstable slopes can be typically mitigated by regrading to angles no steeper than 3 horizontal to 1 vertical or by construction of engineer-designed retaining walls. Erosion protection may be necessary along these slopes to prevent erosion by the creek. It is our understanding there will be drainage improvements that will incorporate slope stabilization and the construction of a regional trail corridor along the Sand Creek drainage.

In summary, development of the site can be achieved if the items discussed above are mitigated. These items can be mitigated through proper design and construction or by avoidance. Specific recommendations should be made after additional investigation prior to construction.

10.0 CLOSURE

It is our opinion that the existing geologic engineering and geologic conditions will impose some constraints on development and construction of the site. The geologic hazards identified on the site can either be avoided by development or satisfactorily mitigated through proper engineering design and construction practices.

It should be pointed out that because of the nature of data obtained by random sampling of such variable and non-homogeneous 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. Discrepancies should be reported to Entech Engineering, Inc. soon after they are discovered so that the evaluation and recommendations presented can be reviewed and revised if necessary. Planning and design personnel should be made familiar with the contents of this report.

This report has been prepared for Morley – Bentley Investments, LLC for application to the proposed project in accordance with generally accepted geologic soil and engineering practices. No other warranty expressed or implied is made.

We trust this report has provided you with all the information you required. Should you require additional information, please do not hesitate to contact Entech Engineering, Inc.

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TABLE

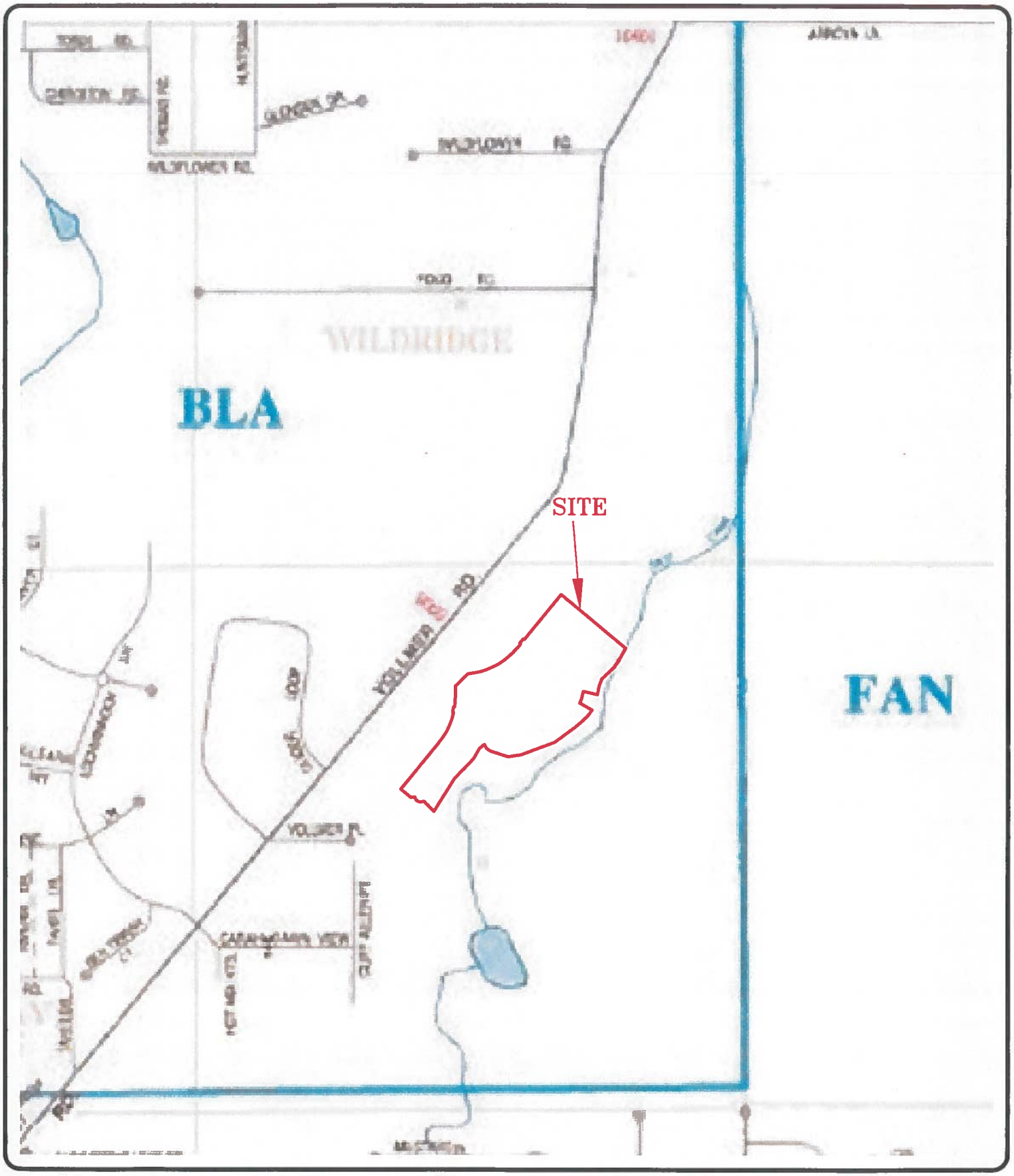
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT MORLEY-BENTLY INVESTMENTS
PROJECT STERLING RANCH, HOMESTEAD, FILING 2
JOB NO. 190935

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	1A	2-3			12.8	NV	NP				SM	SAND, SILTY
2	2A	10			9.9	NV	NP				SM-SW	SANDSTONE, SLIGHTLY SILTY
3	1A	15	14.8	117.5	88.2	33	9			2.4	ML	SILTSTONE, CLAYEY, SANDY

FIGURES



ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
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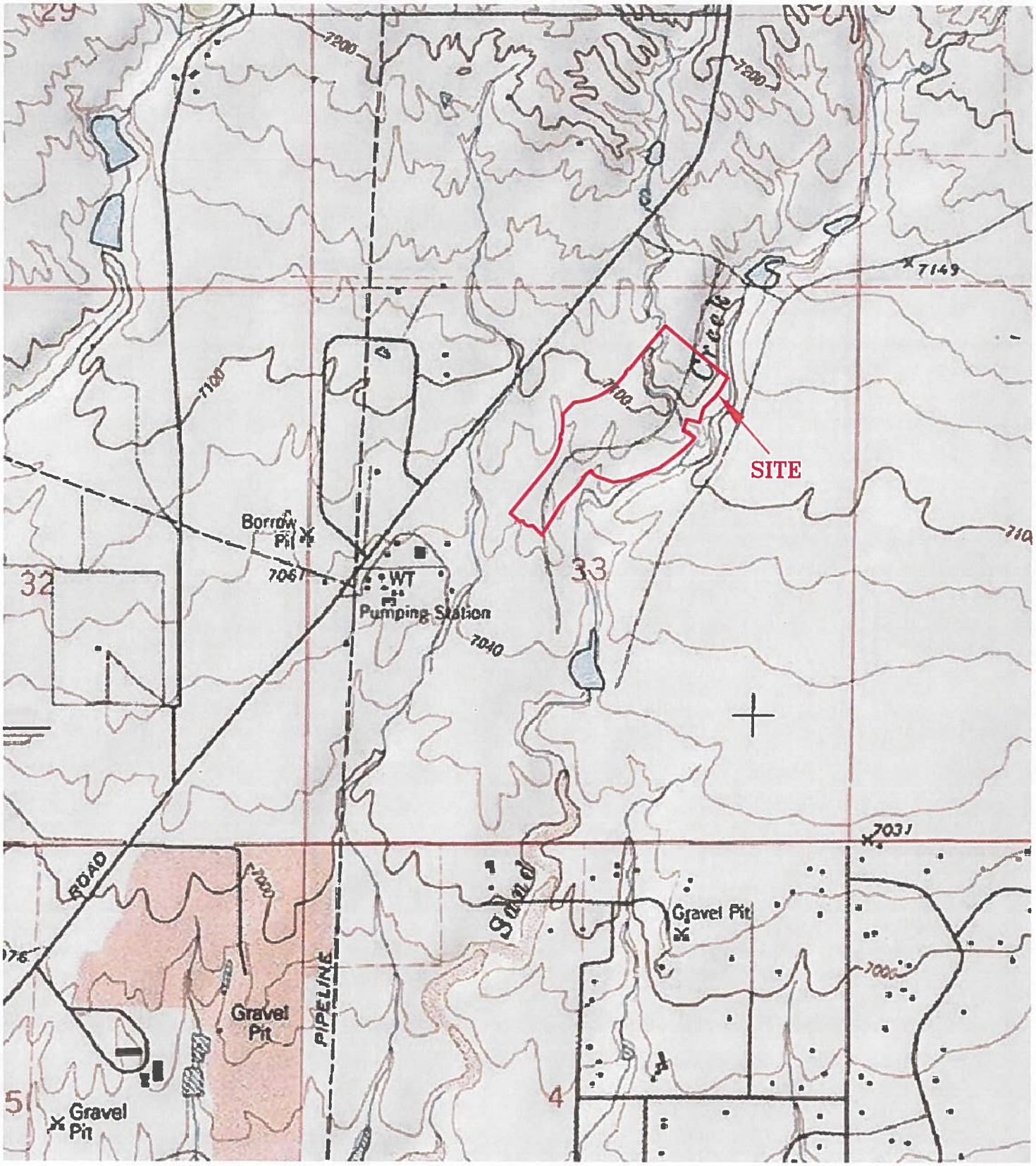
Vicinity Map
Homestead at Sterling Ranch F2
El Paso County, CO.
For: Morley-Bentley Investments, LLC

DRAWN:	DATE:	CHECKED:	DATE:
JAC	6/13/19		6/20/19

JOB NO.: 190935

FIG NO.: 1



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USGS Map
Homestead at Sterling Ranch F2
El Paso County, CO.
For: Morley-Bentley Investments, LLC

DRAWN:	DATE:	CHECKED:	DATE:
KAH	6/13/19		6/26/19

JOB NO.: 190935

FIG NO.: 2

38.5 ac

Homestead Filing
No. 3 Lots: 153
53.2 ac

Wetlands

Ponds

Detention 2 ac

Detention 2 ac

BRIARGATE PARKWAY

Commercial Lots
14.8 ac

Homestead Filing No. 2 (Classic)
Lots:104 Submitted 29.6 ac

Sterling Ranch Phase 1
Preliminary Plan Filing No. 1

Sterling Ranch Phase 3

Homestead Filing No. 1 (Classic)
Lots:72 Approved 19.5 ac

Sterling Ranch Phase 1
Preliminary Plan

VOLLMER ROAD

DINES BOULEVARD

WHEATLAND DRIVE
BEAVER BROOK DRIVE
HIAWATHA DRIVE
MILESTONE WAY
HIAWATHA WAY
CUT BANK DRIVE
RYEGATE WAY
SCOBY COURT
BEAVER BROOK DRIVE

55 LOTS

SCHOOL SITE

85 LOTS

Sterling Ranch
Future Phase
160.1 ac

Branding Iron Filing No. 2
(Challenger) Lots: 75
Conceptual Layout 18.8 ac

Branding Iron Filing No.
1 (Challenger) Lots: 51
Approved 10.5 ac

Sterling Ranch Phase 1
Filing No. 2 Lots: 49
Submitted 49.6 ac

Isolated Wetlands

Sterling Ranch
Phase 2 Preliminary
Plan Submitted
Lots: 50

LODGEPOLE WAY
MOSBY WAY
WHITE FISH WAY
SPRAGUE WAY
KINTLA CT

Sterling Ranch Phase 1
Preliminary Plan

Community
Park 22 ac

LOW GRASS DRIVE
7.4 ac

School Site
11.6 ac

STERLING RANCH ROAD

101 LOTS

Sterling Ranch Phase 3
73.7 ac

30 LOTS

MARKSHEFFEL ROAD

4.8 ac

7.4 ac

THOMAS DRIVE
MCKINLEY STREET
HOOVER DRIVE

Sterling Ranch Filing No. 3
(Richmond & Century) Lots: 66
Conceptual Layout 19.5 ac

Sterling Ranch Phase 2
Preliminary Plan Submitted
Lots: 162 87.9 ac

Copper Chase at Sterling
Ranch (Challenger) Lots: 134
Submitted 19.67 ac

5 ac

7.4 ac

N

OVERALL SITE PLAN
HOMESTEAD AT STERLING RANCH F2
EL PASO, COLORADO
FOR: MORLEY-BENTLY INVESTMENTS

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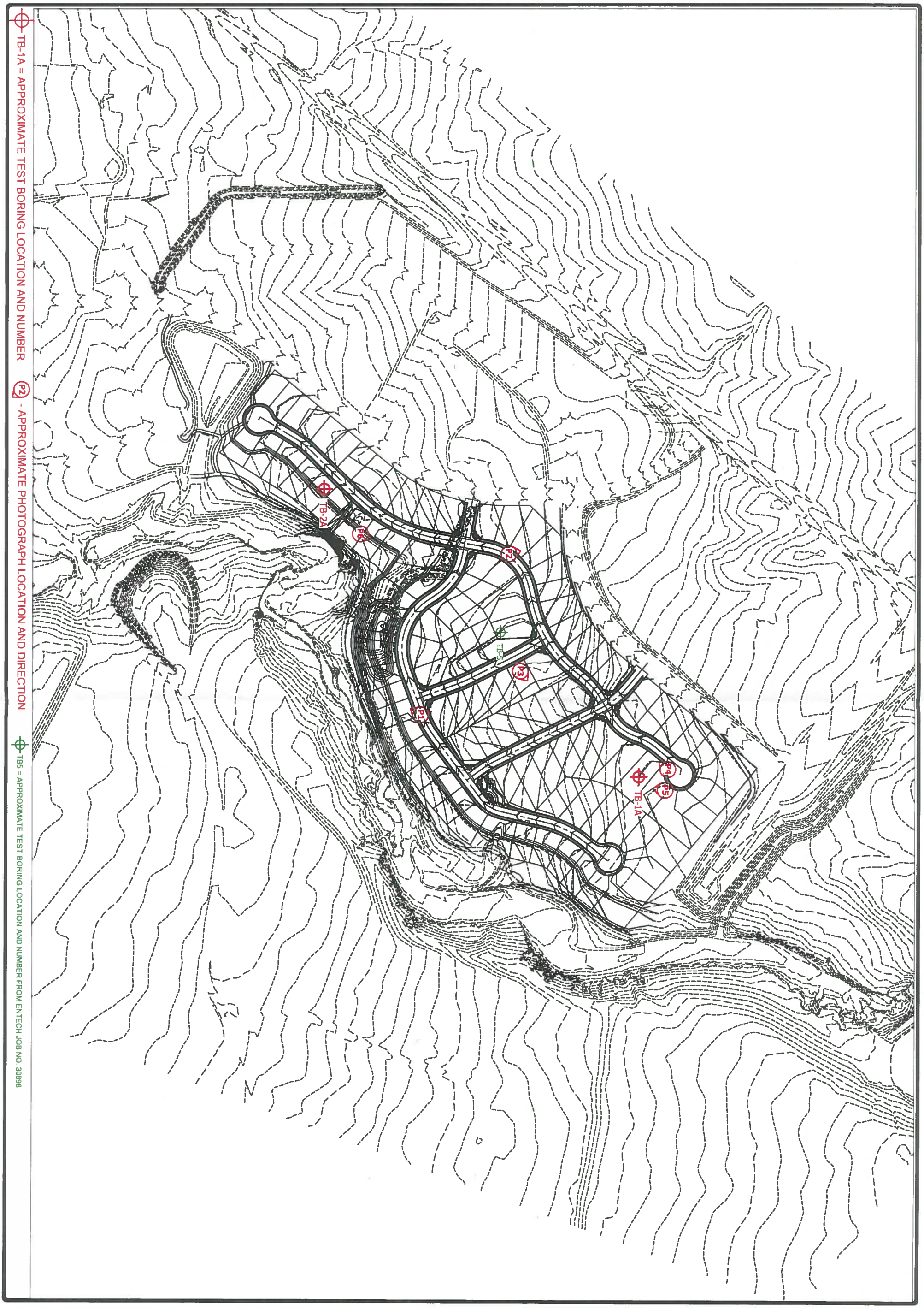
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

DRAWN	JAC
CHECKED	SC
DATE	06/15/19
SCALE	AS SHOWN
JOB NO.	190035
FIGURE No.	3

REVISION BY



DRAWN	JAC
CHECKED	SC
DATE	08/17/16
SCALE	AS SHOWN
JOB NO.	30898
SHEET NO.	4

SITE PLAN/TEST BORING
LOCATION MAP
HOMESTEAD @ STERLING RANCH F2
EL PASO, COLORADO
FOR: MORLEY-BENTLY INVESTMENTS

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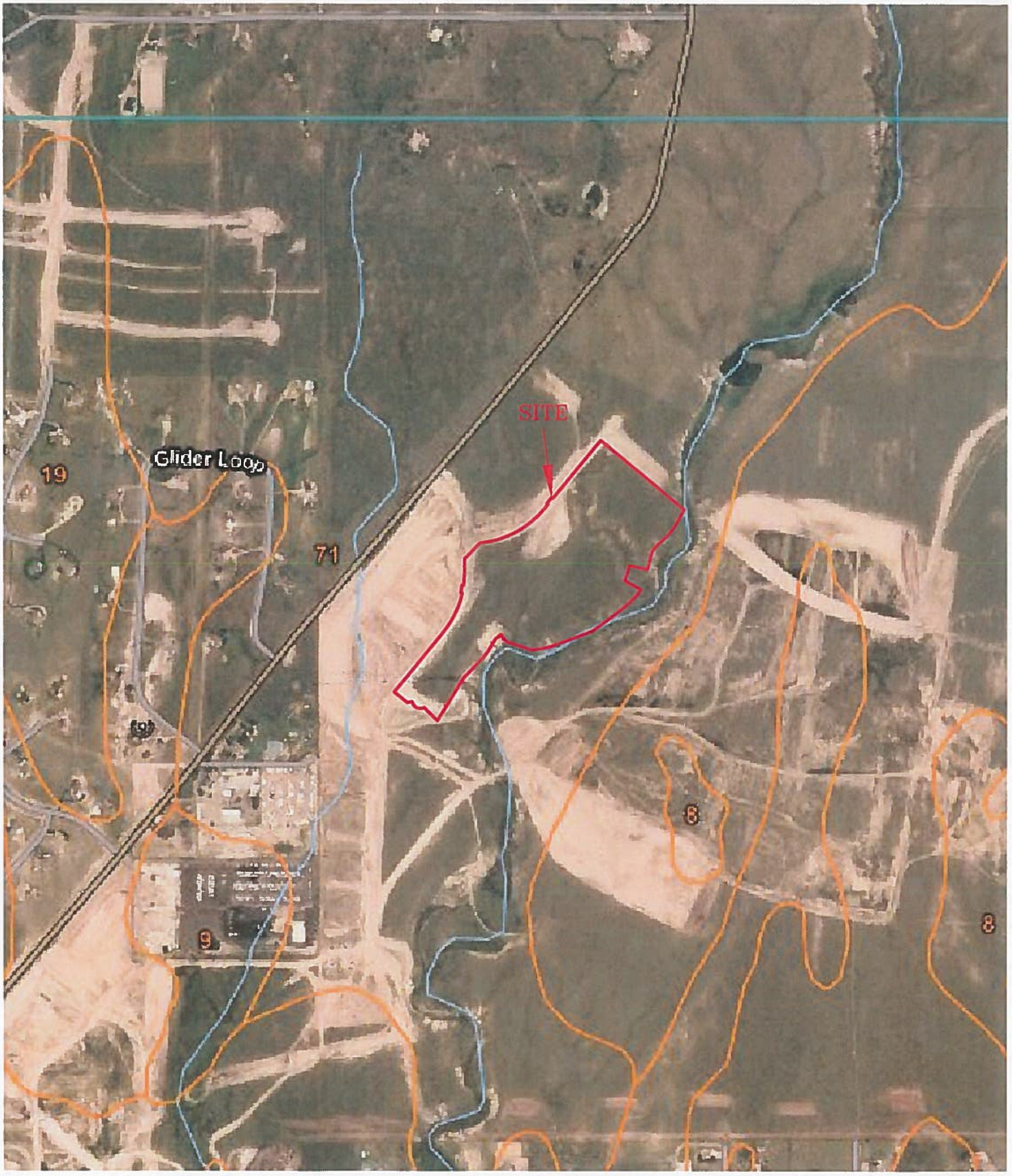
REVISION	BY



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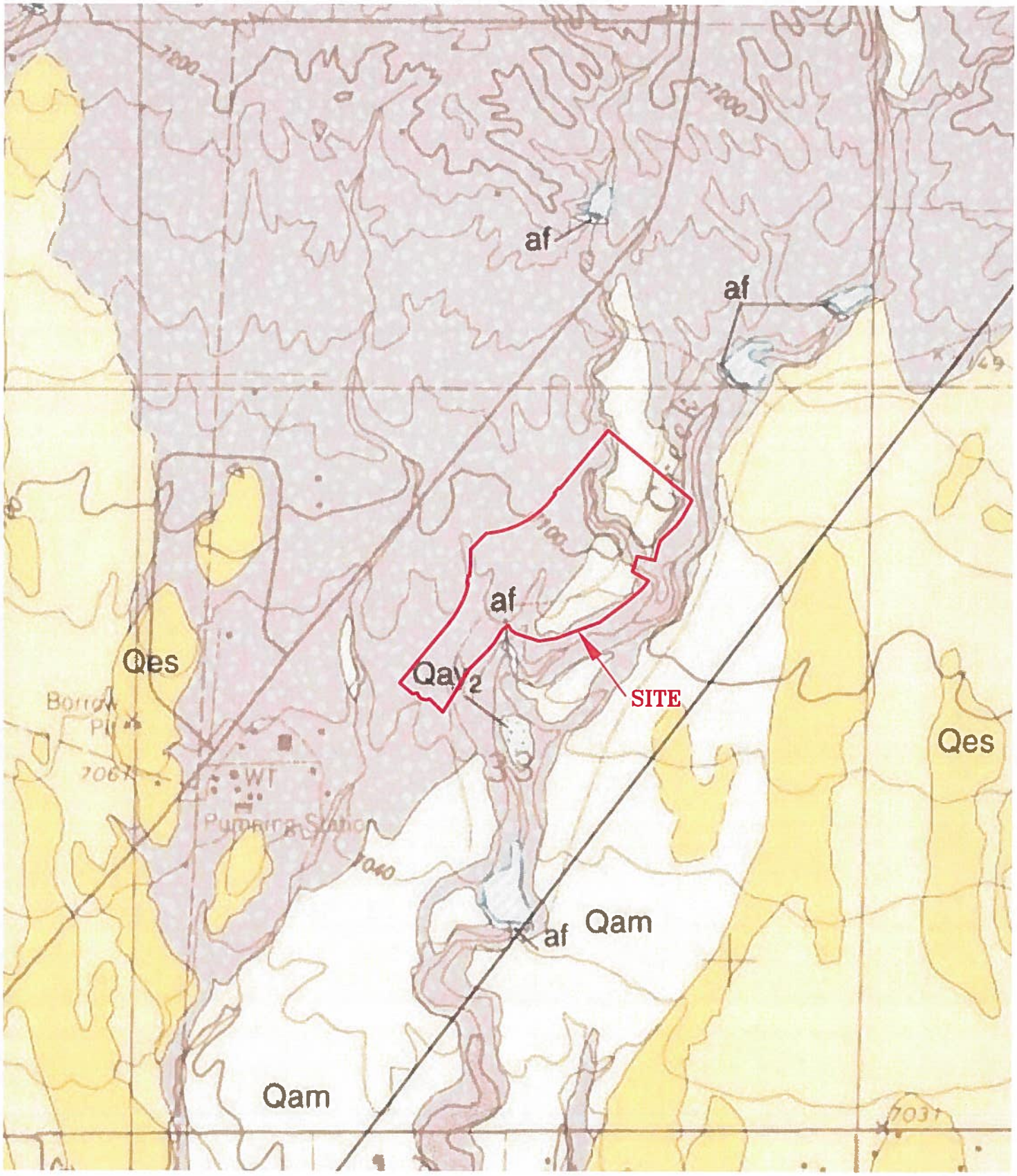
Soil Survey Map
Homestead at Sterling Ranch F2
El Paso County, CO.
For: Morley-Bentley Investments, LLC

DRAWN:	DATE:	CHECKED:	DATE:
JAC	6/13/19		6/20/19

JOB NO.: 190935

FIG NO.: 5



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Falcon NW Quadrangle Geology Map
Homestead at Sterling Ranch F2
El Paso County, CO.
For: Morley-Bentley Investments, LLC

DRAWN:	DATE:	CHECKED:	DATE:
JAC	6/13/19		6/20/19

JOB NO.: 190935

FIG NO.: 6

Legend:

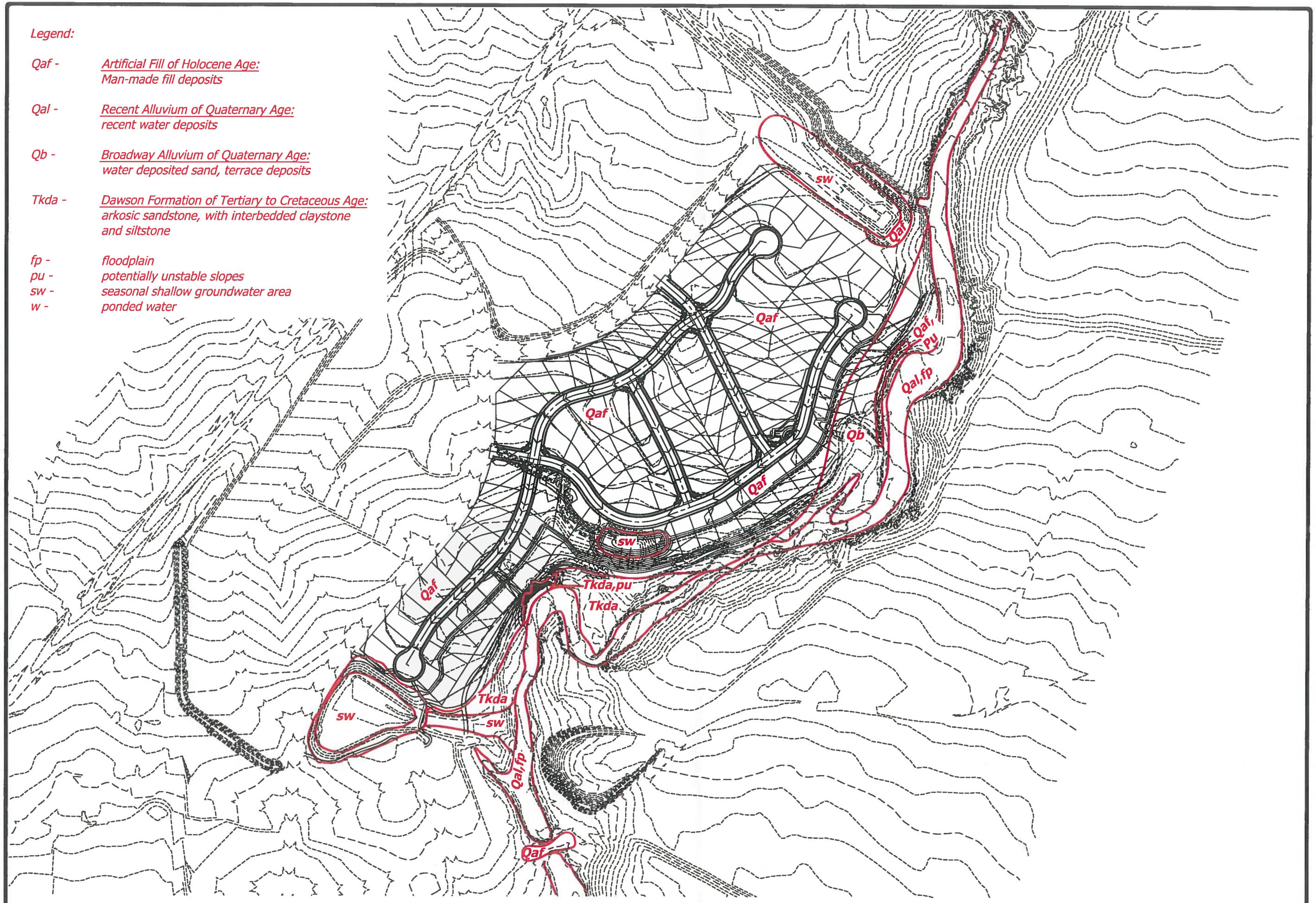
Qaf - *Artificial Fill of Holocene Age:*
Man-made fill deposits

Qal - *Recent Alluvium of Quaternary Age:*
recent water deposits

Qb - *Broadway Alluvium of Quaternary Age:*
water deposited sand, terrace deposits

Tkda - *Dawson Formation of Tertiary to Cretaceous Age:*
arkosic sandstone, with interbedded claystone and siltstone

fp - floodplain
pu - potentially unstable slopes
sw - seasonal shallow groundwater area
w - ponded water



REVISION	BY

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505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

GEOLOGY/ENGINEERING GEOLOGY MAP
HOMESTEAD AT
STERLING RANCH F2
EL PASO, COLORADO
FOR: MORLEY-BENTLY INVESTMENTS

DRAWN	JAC
CHECKED	SC
DATE	06/13/19
SCALE	1" = 300'
JOB NO.	190935
FIGURE No.	7

LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100–YEAR FLOOD

ZONE A No base flood elevations determined.

ZONE AE Base flood elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); base flood elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE A99 To be protected from 100–year flood by Federal flood protection system under construction; no base elevations determined.

ZONE V Coastal flood with velocity hazard (wave action); no base flood elevations determined.

ZONE VE Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X Areas of 500–year flood; areas of 100–year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 100–year flood.

OTHER AREAS

ZONE X Areas determined to be outside 500–year floodplain.

ZONE D Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS

Identified 1983 | Identified 1990 | Otherwise Protected Areas

Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

Flood Boundary

Floodway Boundary

Zone D Boundary

Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.

513 — Base Flood Elevation Line; Elevation in Feet. See Map Index for Elevation Datum.

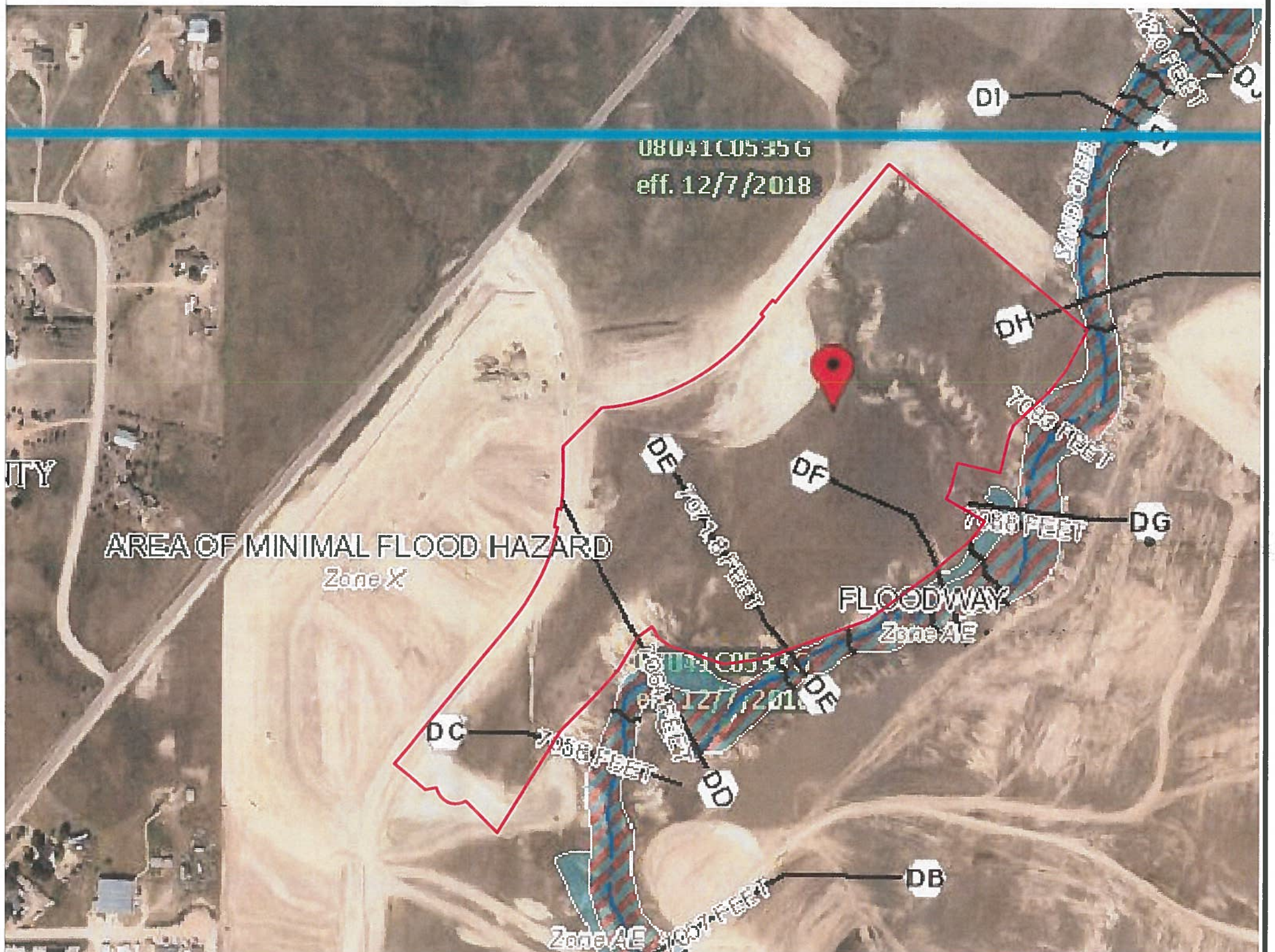
D — D — Cross Section Line

(EL 987) — Base Flood Elevation in Feet Where Uniform Within Zone. See Map Index for Elevation Datum.

RM7 — Elevation Reference Mark

M2 — River Mile

97°07'30", 32°22'30" — Horizontal Coordinates Based on North American Datum of 1927 (NAD 27) Projection.



REVISION	BY

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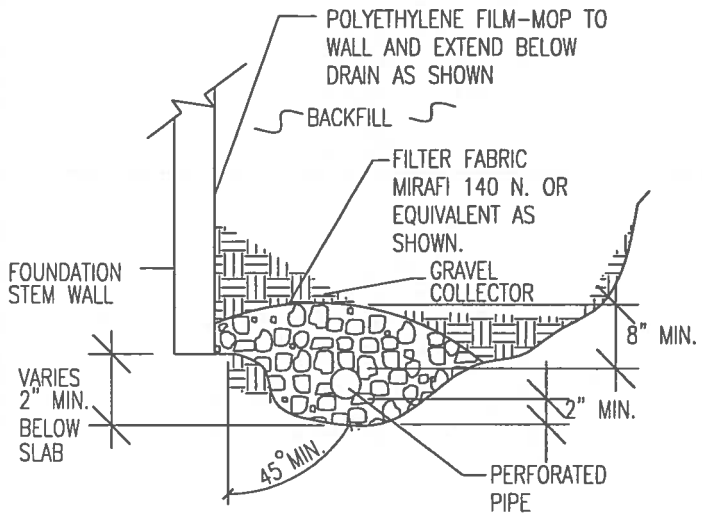
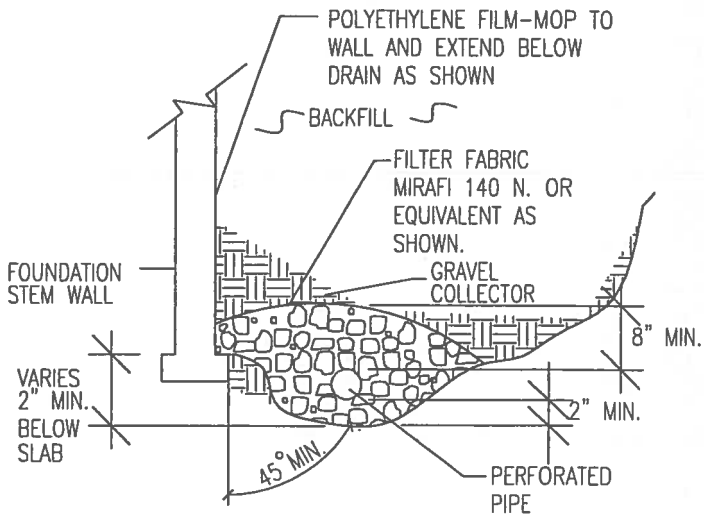
505 ELKTON DRIVE (719) 531-5599
COLORADO SPRINGS, CO. 80907

Floodplain Map
Homestead at Sterling Ranch F2
El Paso County, CO.
For: Morley–Bentley Investments, LLC

DRAWN	JAC
CHECKED	
DATE	6/13/19
SCALE	AS SHOWN
JOB NO.	190935
FIGURE No.	8





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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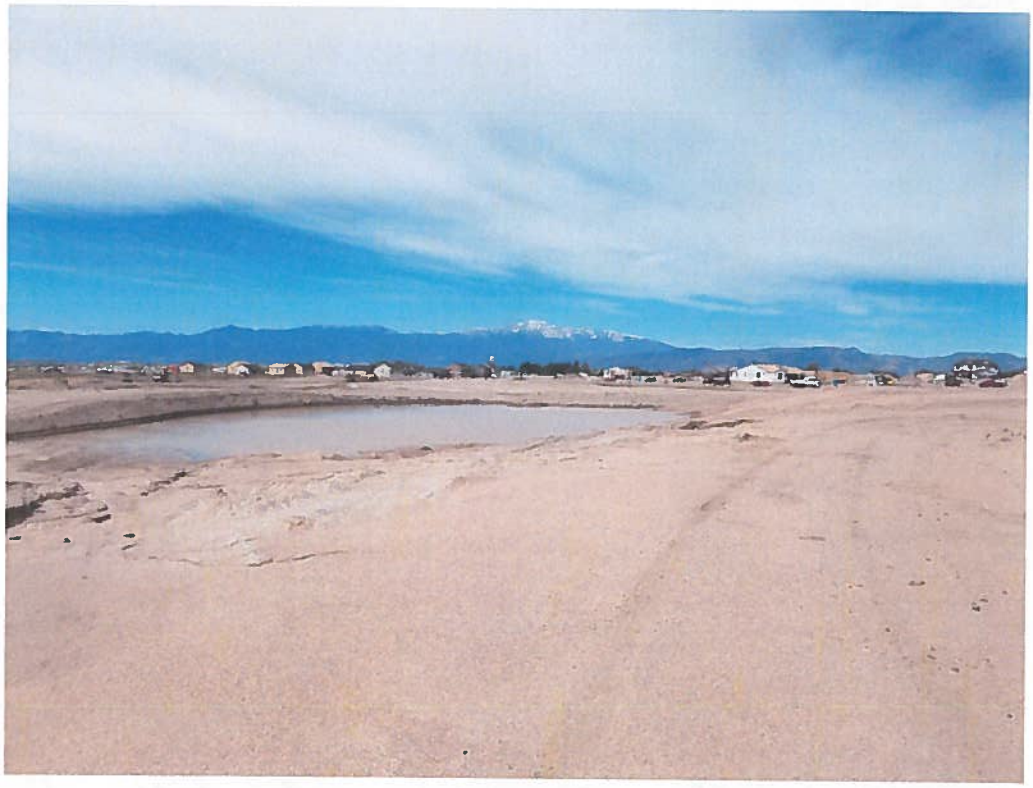
PERIMETER DRAIN DETAIL

DRAWN:	DATE: 6/20/19	DESIGNED: DS	CHECKED:

JOB NO.: 190935

FIG NO.: 9

APPENDIX A: Site Photographs



1

Looking west from the southeastern portion of the site.

June 13, 2019

2

Looking north from the western portion of the site.

June 13, 2019

Job No. 190935

3

Looking northeast from the central portion of the site.

June 13, 2019

4

Looking southwest from the northern portion of the site.

June 13, 2019

Job No. 190935

5

Looking south from the northern portion of the site.

June 13, 2019

6

Looking northeast from the southern portion of the site.

June 13, 2019

Job No. 190935

APPENDIX B: Test Boring Logs

TEST BORING NO. 1 A
DATE DRILLED 6/17/2019
Job # 190935

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 20', 6/17/19						
SAND, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST				22	3.5	1
SANDSTONE, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE, MOIST	5			50/10"	10.4	2
	10			50/8"	7.4	2
SILTSTONE, CLAYEY, SANDY, BLUE GRAY, HARD, MOIST	15			50/11"	15.2	3
	20			50/5"	9.2	3

TEST BORING NO. 2 A
DATE DRILLED 6/17/2019
CLIENT MORLEY-BENTLY INVESTMENTS
LOCATION STERLING RANCH, HOMESTEAD, F2

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 20', 6/17/19						1
SAND, SILTY, BROWN SANDSTONE, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST				50/9"	4.3	2
	5			B	7.8	2
	10			50/6"	8.8	2
	15			50/5"	7.4	2
B - BOUNCE	20			50/5"	8.0	2

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COLORADO SPRINGS, COLORADO 80907

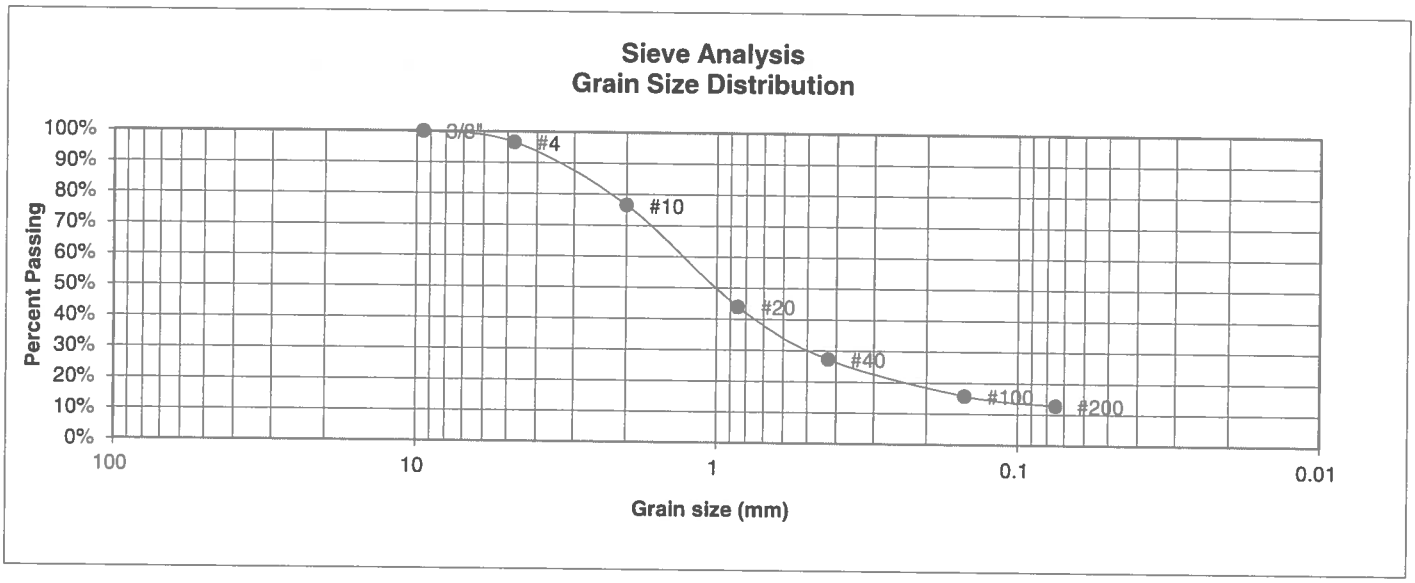
TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			6/20/19

JOB NO.: 190935
FIG NO.: B- 1

APPENDIX C: Laboratory Test Results

UNIFIED CLASSIFICATION	SM	CLIENT	MORLEY-BENTLY INVESTMENTS
SOIL TYPE #	1	PROJECT	STERLING RANCH
TEST BORING #	1A	JOB NO.	190935
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.6%
10	76.5%
20	44.0%
40	27.2%
100	15.8%
200	12.8%

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)

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COLORADO SPRINGS, COLORADO 80907

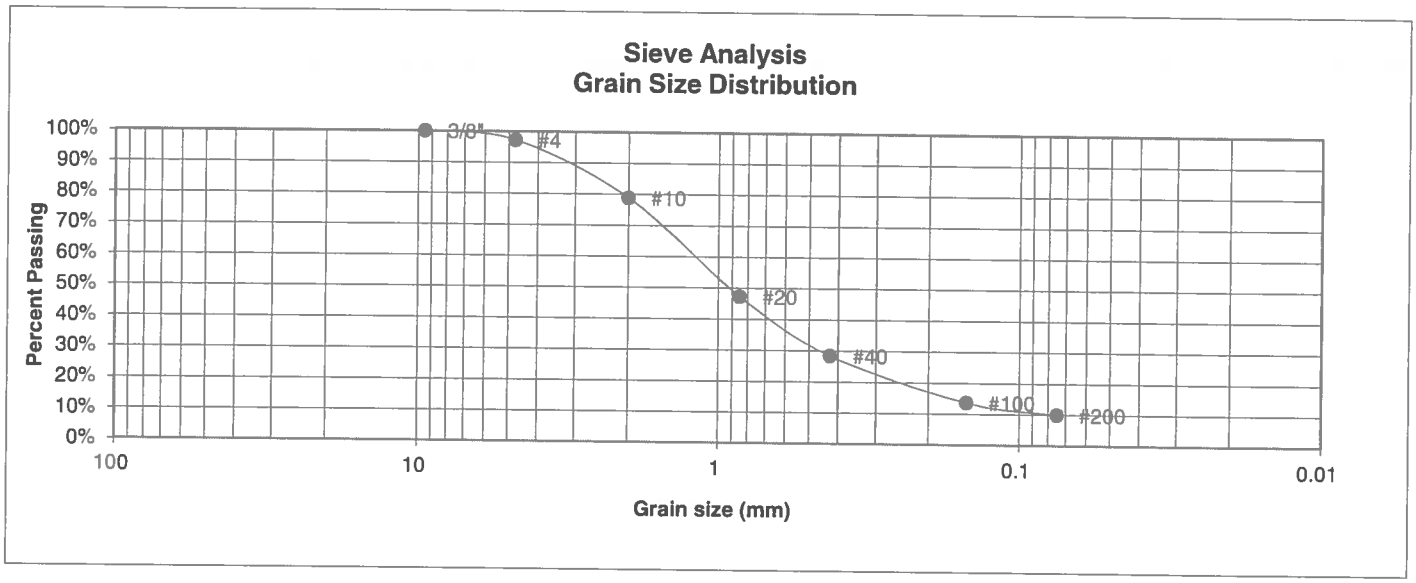
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 6/20/19

JOB NO.: 190935

FIG NO.: C-1

UNIFIED CLASSIFICATION	SM-SW	CLIENT	MORLEY-BENTLY INVESTMENTS
SOIL TYPE #	2	PROJECT	STERLING RANCH
TEST BORING #	2A	JOB NO.	190935
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.2%
10	78.9%
20	47.3%
40	28.4%
100	13.7%
200	9.9%

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)

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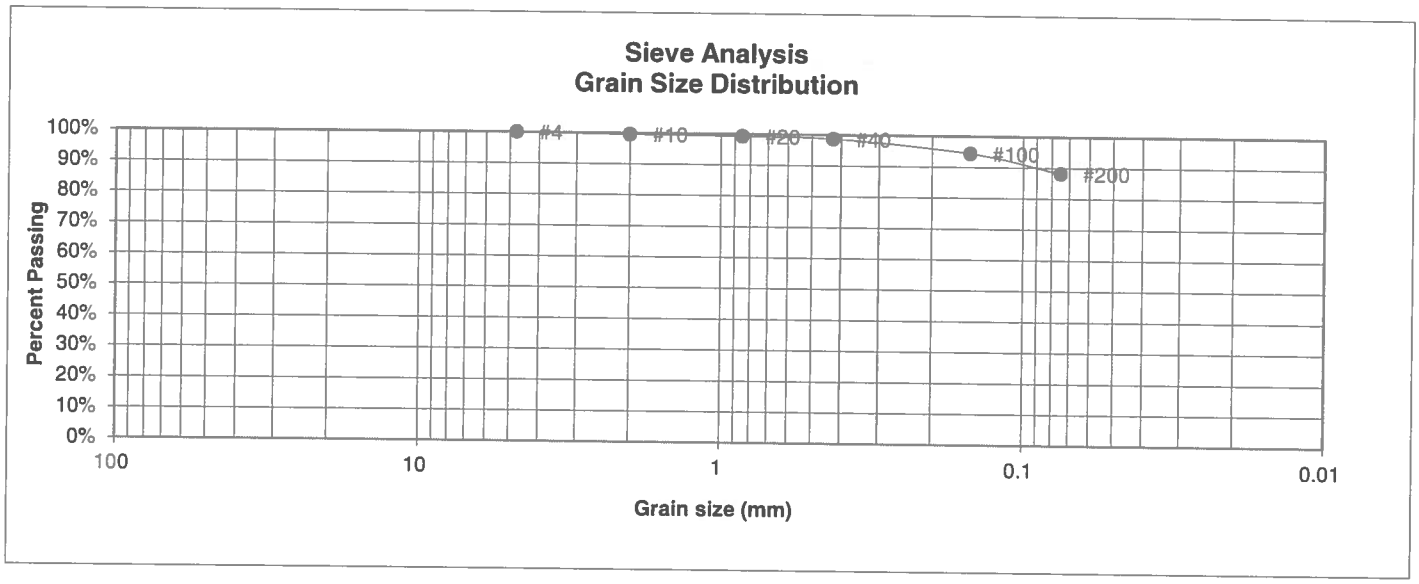
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			6/20/19

JOB NO.: 190935

FIG NO.: C-2

UNIFIED CLASSIFICATION	ML	CLIENT	MORLEY-BENTLY INVESTMENTS
SOIL TYPE #	3	PROJECT	STERLING RANCH
TEST BORING #	1A	JOB NO.	190935
DEPTH (FT)	15	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	99.6%
20	99.3%
40	98.7%
100	94.5%
200	88.2%

Atterberg Limits	
Plastic Limit	24
Liquid Limit	33
Plastic Index	9

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

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LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 6/20/19

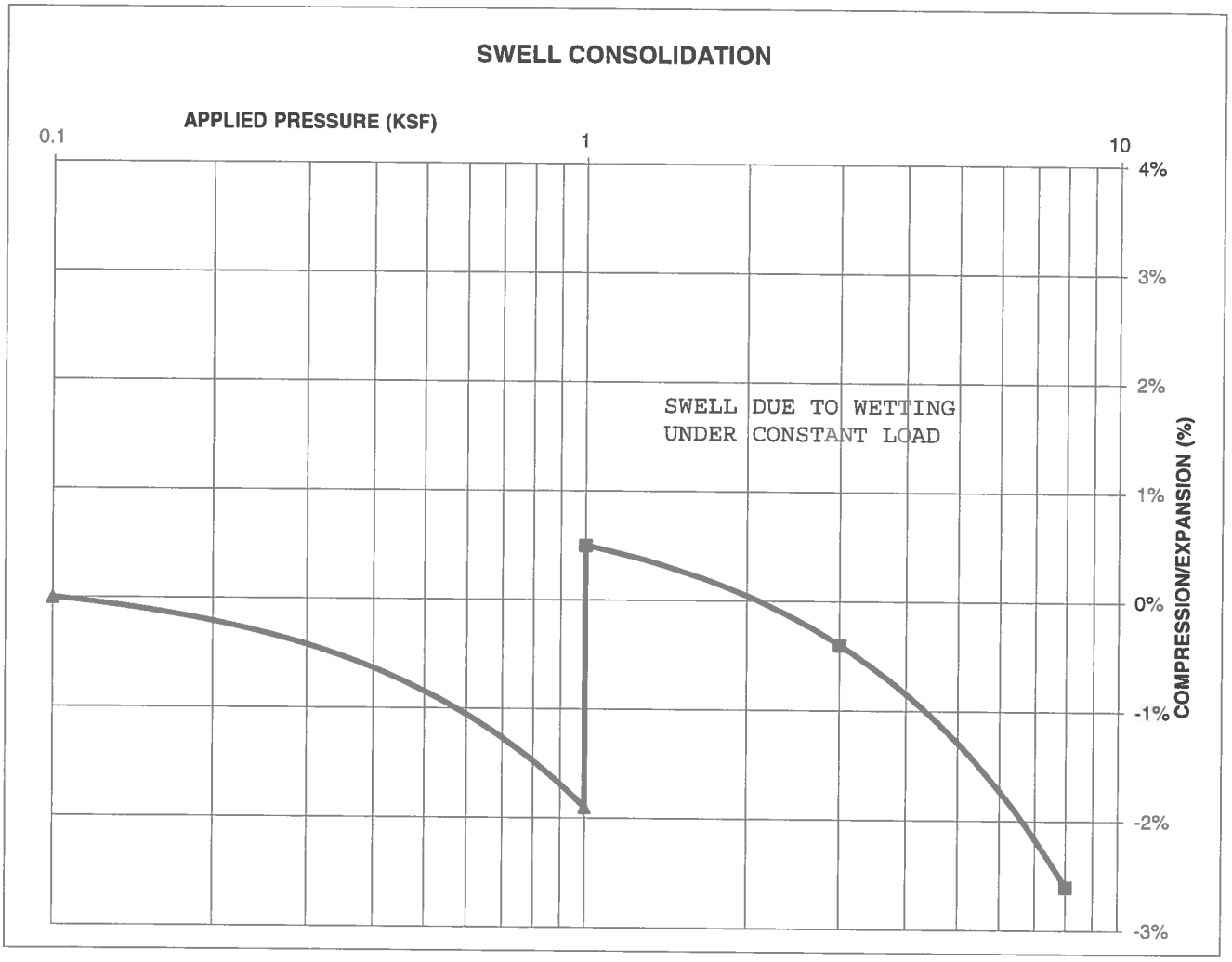
JOB NO.: 190935

FIG NO.: C-3

CONSOLIDATION TEST RESULTS

TEST BORING #	1A	DEPTH(ft)	15
DESCRIPTION	ML	SOIL TYPE	3
NATURAL UNIT DRY WEIGHT (PCF)			117
NATURAL MOISTURE CONTENT			14.8%
SWELL/CONSOLIDATION (%)			2.4%

JOB NO. 190935
CLIENT MORLEY-BENTLY INVESTMENTS
PROJECT STERLING RANCH



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COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			6/20/19

JOB NO.: 190935
FIG NO.: C-4

APPENDIX D: Test Boring Logs and Laboratory Test Results from Entech Job No. 30898

TEST BORING NO. 5
DATE DRILLED 8/16/2006
Job # 30898

REMARKS

DRY TO 15', 8/17/06

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			19	4.1	1	SAND, GRAVELLY, SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, MEDIUM DENSE, MOIST
5			27	11.1	1	SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST
			*	17.2	2	CLAY, SANDY, BROWN, MOIST
10			50 10"	18.6	4	CLAYSTONE, SANDY, GREEN BROWN, HARD, MOIST
15			50 6"	11.9	3	SANDSTONE, CLAYEY, FINE GRAINED, LIGHT BROWN, VERY DENSE, MOIST
20						

TEST BORING NO. 6
DATE DRILLED 8/16/2006
CLIENT MORLEY-BENTLEY INVESTMENTS
LOCATION STERLING RANCH RESIDENTIAL

REMARKS

DRY TO 15', 8/16/06
CAVED TO 13.5', 8/17/06, DRY

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			15	2.2	1	SAND, GRAVELLY, SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN TO TAN, MEDIUM DENSE, MOIST
5			16	2.6	1	
10			48	15.9	4	WEATHERED TO FORMATIONAL
			50 10"	15.6	4	CLAYSTONE, SANDY, GREEN BROWN, VERY STIFF TO HARD, MOIST
15			50 3"	10.1	3	SANDSTONE, SILTY, FINE TO COARSE GRAINED, BLUE GRAY, VERY DENSE, MOIST
20						

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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

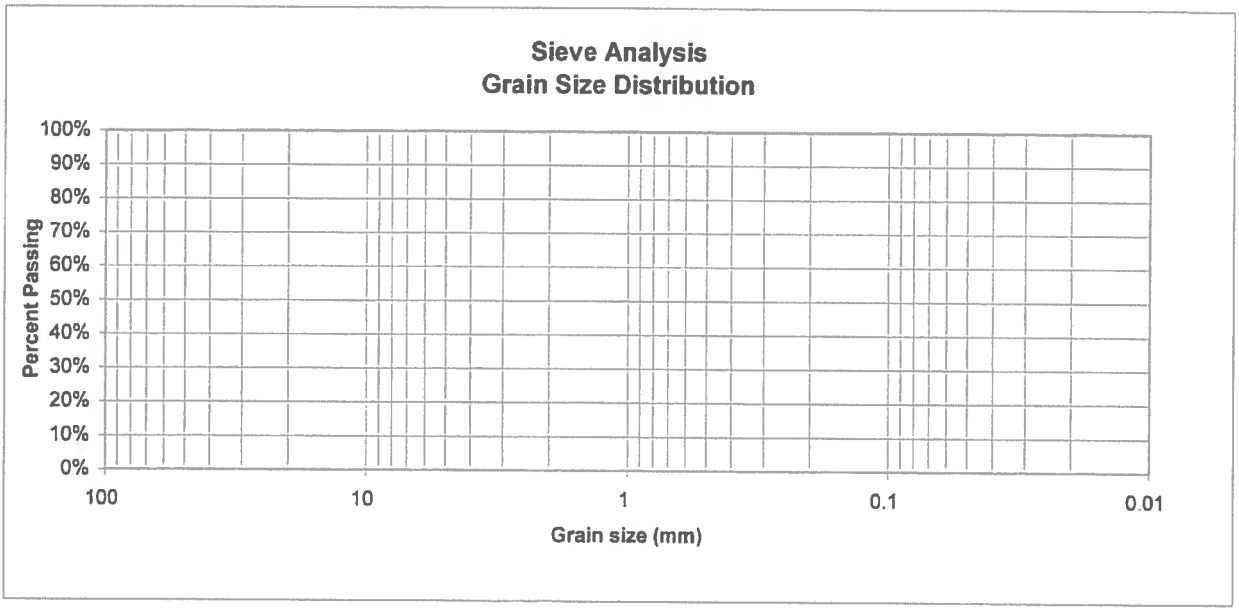
TEST BORING LOG

DRAWN	DATE	CHECKED	DATE
			12/30/06

JOB NO

FIG NO D-1

UNIFIED CLASSIFICATION	CL	CLIENT	MORLEY-BENTLEY INVESTMENTS
SOIL TYPE #	2	PROJECT	STERLING RANCH RESIDENTIAL
TEST BORING #	5	JOB NO.	30898
DEPTH (FT)	7	TEST BY	DG



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	
20	
40	
100	
200	

Atterberg Limits	
Plastic Limit	
Liquid Limit	
Plastic Index	
Swell	
Moisture at start	10.8%
Moisture at finish	23.4%
Moisture increase	12.6%
Initial dry density (pcf)	102
Swell (psf)	1085

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COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN	DATE	CHECKED	DATE
			12/30/06

JOB NO

FIG NO D-2

APPENDIX E: Soil Survey Descriptions

71—Pring coarse sandy loam, 3 to 8 percent slopes. This deep, noncalcareous, well drained soil formed in sandy sediment derived from arkosic sedimentary rock on valley side slopes and on uplands. Elevation ranges from 6,800 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The substratum is dark grayish brown coarse sandy loam about 10 inches thick over pale brown gravelly sandy loam that extends to a depth of 60 inches or more.

Included with this soil in mapping are small areas of Alamosa loam, 1 to 3 percent slopes, along drainageways; Cruckton sandy loam, 1 to 9 percent slopes; Peyton sandy loam, 1 to 5 percent slopes; Peyton sandy loam, 5 to 9 percent slopes; and Tomah-Crowfoot loamy sands, 3 to 8 percent slopes. In some places arkose beds of sandstone and shale are at a depth of 0 to 40 inches.

Permeability of this Pring soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the hazard of erosion is moderate.

Almost all areas of this soil are used as rangeland. Some areas previously cultivated have been reseeded to grass. This soil is also used for wildlife habitat and homesites.

This soil is well suited to the production of native vegetation suitable for grazing by cattle and sheep. Rangeland vegetation is mainly mountain muhly, little bluestem, needleandthread, Parry oatgrass, and junegrass.

Deferment of grazing in spring helps to maintain vigor and production of the cool-season bunchgrasses. Fencing and properly locating livestock watering facilities help to control grazing.

Windbreaks and environmental plantings generally are suited to this soil. The hazard of soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil is well suited for use as homesites. Erosion control practices are needed to control soil blowing and water erosion on construction sites where the ground cover has been removed. Capability subclass IVe.