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SOIL, GEOLOGY AND GEOLOGIC HAZARD STUDY BANNING LEWIS RANCH NORTH EL PASO COUNTY, COLORADO

Prepared for

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1.0 SUMMARY

Project Location:

The project lies in portions of Sections 2, 3, 10, and 11, Township 13 South, Range 65 West of the 6th Principal Meridian. The site is located north and south of Woodmen Road, east of Brule Road and west of Golden Sage Road, approximately one mile west of Falcon in El Paso County, Colorado. The site lies immediately north of the Banning Lewis Ranch Subdivision and the Colorado Springs city limits.

Project Description:

Total acreage involved in the project is approximately 807 acres. The proposed development primarily consists of residential with some commercial areas, schools, parks, and open space areas.

Scope of Report:

The report presents the results of our geologic investigation and treatment of engineering geologic hazard study for the sketch plan submitted. 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:

This site was found to be suitable for the proposed development. Geologic conditions will impose some constraints on development. These include areas of hydrocompaction, loose soils, potentially expansive soils, erosion, seasonal and potentially seasonal shallow groundwater areas, areas of ponded water, springs, floodplains, and artificial fill. 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 portions of Sections 2, 3, 10, and 11 of Township 13 South, Range 65 West of the 6th Principal Meridian, El Paso County, Colorado. The site is located north and south of Woodmen Road, east of Brule Road, and west of Golden Sage Road, immediately north of the Colorado Springs city limits, and approximately one mile west of Falcon, in El Paso County, Colorado. It is our understanding the site is to be annexed into the city of Colorado Springs. 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 moderate slopes along drainages that flow through the site. Drainages on-site flow in southerly directions. Only minor amounts of water were observed flowing in some of the drainages at the time of this investigation, however, some areas of ponded water were observed. The approximate boundaries of the site are indicated on the USGS Map, Figure 2. Previous site uses have included grazing and pasture land. Vegetation on site consists primarily of field grasses and weeds. Site photographs are included in Appendix A. The approximate locations and directions of the photographs are indicated on Figure 3.

Total acreage involved in the proposed development is approximately 807 acres. The proposed development is to consist of residential and commercial areas with schools, parks and open space areas. The area will be serviced by central water and sewer. The proposed Master Plan is presented in Figure 3A. A grading plan was not available at the time of this report.

3.0 SCOPE OF THE REPORT

The scope of this 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.

4.0 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 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, seven (7) test borings were drilled as a part of the preliminary subsurface soil investigation for the subdivision to determine general soil conditions. The borings were drilled with a power driven continuous flight auger drill rig to depths of 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 Map, Figure 3. 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/Consolidation Testing, ASTM D-4546, was conducted on select samples to evaluate the expansive/compressive characteristics of the soils. Results of the laboratory testing are included in Appendix C. A Summary of Laboratory Test Results is presented in Table 1.

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 13 miles to the west 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 the southern edge of a large structural feature known as the Denver Basin. Bedrock in the area tends to be gently dipping in a northerly direction (Reference 1). Bedrock in the area of the site is sedimentary in nature, and typically Tertiary to Cretaceous in age. The bedrock underlying the site itself is the Dawson Formation. Overlying the Dawson are unconsolidated deposits of artificial, residual, alluvial, and eolian soils. The site's stratigraphy will be discussed in more detail in Section 5.3.

5.2 Soil Conservation Service

The Natural Resource Conservation Service (Reference 2), previously the Soil Conservation Service (Reference 3) has mapped three soil types on the site (Figure 4). In general, the soils consist of loamy sand and gravelly sandy loam. Soils are described as follows:

Type	Description
8	Blakeland loamy sand, 1-9% slopes
9	Blakeland Complex, 1-9% slopes
19	Columbine gravelly sandy loam, 0-3% slopes

Complete descriptions of the soils are presented in Appendix D. The soils have generally been described to have rapid to very rapid permeabilities. The majority of the soils have been described by the Soil Conservation Service as good potential for urban development. Limitations include the hazard of flooding on some areas of Soil Types 9 and 19. Possible hazards with soil erosion are present on the site. The erosion potential can be controlled with vegetation. The majority of

the soils have been described to have slight to moderate erosion hazards. The soil blowing hazard is severe if vegetation is removed.

5.3 Site Stratigraphy

The Falcon NW Quadrangle Geology Map showing the site is presented in Figure 5 (Reference 4). The Geology Map prepared for the site is presented in Figure 6. Six mappable units were identified on this site, which are identified as follows:

- **Qaf** **Artificial Fill of Quaternary Age:** These are man-made fill deposits associated with earthen dams and erosion berms on-site.

- **Qal** **Recent Alluvium of Quaternary Age:** These are recent stream deposits in the drainages that exist on-site. These materials consist of silty sands and may contain lenses of silt, clay or gravel. Areas of organic soils will also be encountered.

- **Qam** **Middle Alluvium of Quaternary Age:** These materials consist of lower stream terrace deposits. The alluvium typically consists of silty to clayey gravelly sands. This deposit correlates with the Broadway Alluvium.

- **Qao_1** **Old Alluvium One of Quaternary Age:** This is a stream deposited material typically occurring as terrace deposits on portions of the site. The Old Alluvium One typically consists of brown silty to clayey sands and may contain some silt and clay lenses. This deposit likely correlates with the Louviers Alluvium.

- **Qes** **Eolian Sand of Quaternary Age:** These are deposits are fine to medium grained soil deposited by the action of the prevailing winds from the northwest. They typically occur as large dune deposits or narrow ridges. Additionally, low areas associated with blow-outs were observed. The eolian soil types are typically tan to brown in color and tend to have a very uniform or well-sorted gradation. These materials tend to have a relatively high permeability and low density.

- **TKda** **Dawson Arkose Formation of Tertiary to Cretaceous Age:** The bedrock underlying the site is the Dawson Formation. This formation consists of arkosic sandstone with interbedded lenses on fine grained sandstone, claystone or siltstone. Typically, it is buff to light brown and light gray in color. Overlying the Dawson is a variable layer of residual soil derived from the in-situ weathering of the bedrock materials.

The soils listed above were mapped from the *Geologic Map of the Falcon NW Quadrangle* by Madole in 2003 (Figure 5, Reference 4), the *Geologic Map of the Pueblo 1°x2° Quadrangle, South-Central* distributed by the US Geological Survey in 1978 (Reference 5) and site-specific mapping of the site. The test borings from the preliminary subsurface investigation were also used in evaluating the site. The test boring logs are included in Appendix B of this report.

5.4 Soil Conditions

The soils encountered in the test borings can be grouped into three general soil types. The soils were classified using the Unified Soil Classification System (USCS).

Soil Type 1 consists of slightly silty to silty and very clayey sand (SW-SM, SM, SC). The sands were encountered in the upper soil profile of all of the test borings at the surface and extending to depths ranging from 14 feet to the termination of the borings (20 feet). Standard penetration testing on the sands resulted in N-values of 10 to 36 blows per foot (bpf), indicating medium dense to dense states. Water content and grain size testing resulted in water contents of one to 13 percent with approximately 7 to 46 percent of the soil size particles passing the No. 200 sieve. Atterberg limits testing resulted in liquid limits of 41 to no value and plastic indexes of 22 to non-plastic. Swell/Consolidation Testing on the very clayey sands resulted in a volume change of 0.6 percent, indication low expansion potential.

Soil Type 2 consists of very sandy weathered to formational claystone bedrock (CL). The claystone was encountered in Test Boring Nos. 3 and 7 at depths of 14 feet below the surface and extending to the termination of the borings (20 feet). Standard Penetration Testing on the claystone resulted in N-values of 35 to greater than 50 bpf, indicating very stiff to hard consistencies. Water content and grain size testing resulted in water contents of 10 to 14 percent

with approximately 60 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 16. Swell/Consolidation Testing resulted in a volume change of 0.7 percent, indicating low to moderate expansion potential. Highly expansive claystone is common in the area.

Soil Type 3 consists of slightly silty to clayey sandstone (SW-SM, SC). The sandstone was encountered in Test Boring Nos. 5 and 6 at depths of 14 feet and extending to the termination of the borings (20 feet). Standard penetration testing on the sandstone resulted in N-values of 44 bpg to greater than 50 bpf, indicating dense to very dense states. Water content and grain size testing resulted in water contents of 9 to 11 percent with approximately 9 to 17 percent of the soil size particles passing the No. 200 sieve. Atterberg limits testing resulted in non-plastic results. Swell/Consolidation Testing resulted in a consolidation of 0.7 percent, indication low consolidation potential.

A Summary of Laboratory Results is presented in Table 1. Laboratory results are included in Appendix C. A summary of the depth to bedrock is included in Table 2.

5.5 Groundwater

Groundwater was encountered at depths ranging from 6 to 18 feet in five of the test borings. A table showing the depth to groundwater is presented in Table 2. Areas of seasonal and potentially seasonal groundwater, springs, and ponded water have been mapped on the site and are discussed in the following section.

Fluctuation in groundwater conditions may occur due to variations in rainfall and other factors not readily apparent at this time. Isolated sand layers within the variable soil profile, sometimes only a few feet in thickness and width, can carry water in the subsurface. Water may also flow on top of the sandstone. Contractors should be cognizant of the potential for the occurrence of such subsurface water features during construction on-site. Grading in areas of shallow water should be minimized.

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 6). 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 hydrocompaction, loose soils, erosion, artificial fill, potentially expansive soils, seasonal and potentially seasonal shallow groundwater areas, springs, and areas of ponded water. The following hazards have been addressed as a part of this investigation:

Expansive Soils

While the majority of the soils encountered in the test borings drilled on-site have low expansion potential, expansive clays and claystone are common in the area and may be encountered in the subsurface on this site. The expansive soils on-site are highly sporadic, therefore, none have been indicated on the map. Expansive clays and claystone, if encountered beneath foundations, can cause differential movement in the structure foundation. These occurrences should be identified and dealt with on an individual basis.

Mitigation: Should expansive soils be encountered beneath foundations, mitigation will be necessary. Mitigation of expansive soils will require special foundation design. Overexcavation and replacement with non-expansive soils at 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 on 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 should 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 the *Mining Report for the Colorado Springs Coal Field* (Reference 6), a Subsidence Investigation Report for the Colorado Springs area by Dames and Moore, 1985 (Reference 7), and the *Evaluation of Mineral and Mineral Fuel Potential of El Paso County* (Reference 8), the site is not undermined. The closest underground mines in the area are 8 miles to the south and southwest and the site is not mapped within any potential subsidence zones.

Slope Stability and Landslide Hazard

The slopes on-site are gently to moderately sloping and do not exhibit any past or potential unstable slopes or landslides. Grading plans were not available at the time of this investigation. Slopes should be no steeper than 3:1, if regraded unless specifically evaluated. All topsoil and organics should be removed prior to any regrading or fill placement. All new fill should be properly benched into native slopes and compacted at a minimum of 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557.

Rockfall Hazards

Based on our site observation, no rock outcrops or areas of rockfall hazard were observed on this site.

Areas of Erosion

These are areas that are undergoing erosion by water and sheetwash producing gullies and rill erosion.

Mitigation: Due to the nature of the soils on this site, virtually all the soils are subject to erosion by wind and water. Other minor areas of erosion were observed on site other than those mapped, particularly where some rill erosion has occurred. Areas of erosion can occur across the entire site, particularly if the soils are disturbed during construction. Vegetation reduces the potential for erosion. The areas identified where erosion is actually taking place may require check dams, regrading and revegetation using channel lining mats to anchor vegetation. Further recommendations for erosion control are discussed under Section 9.0 "Erosion Control" of this report. Recommendations pertaining to revegetation may require input from a qualified landscape architect and/or the Natural Resource Conservation Service (previously Soil Conservation Service).

Debris Fans

Based on site observations, debris fans were not observed in this area. Areas of recent sediment deposits were observed in some of the drainages on the site. The drainage areas are discussed below.

Groundwater and Drainage Areas

Groundwater was encountered in five of the test borings at depths ranging from 6 to 18 feet. Areas within the drainages on-site have been identified as seasonal and potentially seasonal shallow groundwater. Only minor areas with water flowing in the drainages were noted at the time of this investigation, however, areas of ponded water and some springs were observed. Blow-out areas within the Eolian Sand deposits were also observed. No areas of the site have been mapped as floodplain zones according to the FEMA Map No. 08041CO535G, Figure 7 (Reference 9). Exact floodplain location and drainage studies are beyond the scope of this report. Groundwater areas are discussed as follows:

- *Seasonal and Potentially 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. The majority of the areas mapped with this designation lie within drainages designated as open space and will be avoided by development. Where structures encroach on, or lie within these areas, the following mitigation is recommended:

Mitigation: In these locations, foundations in areas 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 8. Where shallow groundwater is encountered, additional drains, such as capillary breaks and/or interceptor drains may be necessary. Unstable conditions should be expected where excavations approach the groundwater level. The used of shot rock or geo-grids may be necessary to stabilize excavations. Additionally, swales should be created to intercept surface runoff and carry it safely around and away from structures. It is anticipated that the

drainages can be avoided or site grading will mitigate the drainages and raise foundations further above the groundwater level. The water table may be of sufficient depth to minimize the effects on buildings. Additional investigation is recommended after development and grading plans are finalized.

- *Areas of Ponded Water*

These are areas where there is standing water observed in drainages or ponded water behind earthen dams. The majority of these areas lie within the drainages designated as open space and will be avoided by construction. Where construction is proposed, the following mitigation is recommended:

Mitigation: The larger of the ponds lie behind earthen dams in the western portions of the site that are within areas designated as park and open space. Other areas where ponded water was observed are minor and can be avoided or regraded. All soft and organic soils should be removed prior to fill placement. Any drainage into these areas should be rerouted in a non-erosive manner where it does not create areas of ponded water around proposed structures. The same mitigation techniques for the seasonal shallow groundwater areas are recommended for these areas as well.

- *Springs*

Areas of seepage in the form of springs were observed on the site, particularly in the western portions of the site. These are areas where it appears groundwater flows perched through permeable sands and daylights on top of impermeable layers. These areas are mainly within designated as park and open space and will be avoided by development. Any regrading or development considered in these areas should follow the same mitigation techniques for the ponded water areas. Additional drains, as discussed under the seasonal shallow groundwater areas, may also be necessary.

- *Blow-outs*

These are low areas within the Eolian Sand deposits where the prevailing winds have blown out sands creating a low area or "blow-out" that could collect surface waters on a seasonal basis. These areas are in permeable sands that typically do not hold water. A review of historic aerial photographs and site observations indicate the majority of these areas do not exhibit signs of potentially seasonal shallow groundwater. One blow-out in the northwest

portion of the site is identified as a potentially seasonal shallow groundwater area. It is anticipated the majority of the blow-out areas would be regraded as a part of the development and grading plans. Any remaining low areas that have the potential for seasonal shallow groundwater should follow recommendations discussed under "Seasonal and Potentially Seasonal Shallow Groundwater" areas.

Artificial Fill

Areas of artificial fill were observed on the site. The majority of the fill is associated with earthen dams and erosion berms. The earthen dams lie within areas designated as open space or easements and will be avoided by construction. The majority of the erosion berms are shallow and may be penetrated by foundations or will likely be removed during site grading. Should any uncontrolled fill be encountered beneath foundations, removal and recompaction at 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557 will be required.

Hydrocompaction

Areas in which hydrocompaction have been identified are acceptable as building sites. In areas identified for this hazard classification, however, we anticipate a potential for settlement upon saturation of these surficial soils. The low density, uniform grain sized, windblown sand deposits are particularly susceptible to this type of phenomenon.

Mitigation: The potential for settlement is directly related to saturation of the soils below the foundation areas. Therefore, good surface and subsurface drainage is extremely critical in these areas in order to minimize the potential for saturation of these soils. The ground surface around all permanent structures should be positively sloped away from the structure to all points, and water must not be allowed to stand or pond anywhere on the site. We recommend that the ground surface within 10 feet of the structures be sloped away with a minimum gradient of five percent. If this is not possible on the upslope side of the structures, then a well-defined swale should be created to intercept the surface water and carry it quickly and safely around and away from the structures. Roof drains should be made to discharge well away from the structures and into areas of positive drainage. Where several structures are involved, the overall drainage design should be such that water directed away from one structure is not directed against an adjacent building. Planting and watering in the immediate vicinity of the structures, as well as general lawn irrigation, should be minimized.

Collapsible Soils

Areas of loose or potentially collapsible soils were encountered in some of the test borings drilled on-site. Should loose or collapsible soils be encountered beneath foundations, removal and recompaction with thorough moisture conditioning at 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557 will be necessary. Typically, the overexcavation extends to a depth of 2 to 3 feet. Specific recommendations should be made after additional investigation of each building site.

Faults

The closest fault is the Rampart Range Fault, located 13 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 Seismic Design Category B, also a low seismic risk. According to a report by the Colorado Geological Survey by Kirkman and Rogers, 1981, (Reference 10) 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 Dawson in this area is gently dipping a northerly direction according to the *Geologic Structure Map of the Pueblo 1x2 Quadrangle, South-Central Colorado* (1978) (Reference 1). The bedrock encountered in the test borings and observed on-site did not exhibit steeply dipping characteristics; therefore, mitigation is not necessary.

Shallow Bedrock

Bedrock was encountered at 14 feet in Test Boring No. 3. Bedrock was not encountered in the other borings which were drilled to 20 feet. A Summary of the Depth to Bedrock is included in Table 2. Shallow bedrock may be encountered in some areas of this site, particularly those mapped as TKda: Dawson Arkose Formation. Where shallow sandstone is encountered, higher allowable bearing capacities are anticipated. Shallow claystone may require mitigation for expansive soils. Excavations extending in the sandstone or claystone bedrock may be difficult requiring track excavators.

Radioactivity

Radon levels for the area have been reported by the Colorado Geologic Survey in the Open-File, Report No. 91-4 (Reference 11). Radon levels ranging from 0 to 20 pci/l have been measured in the area. The following is a table of radon levels in this area.

0<4 pci/l	50.00%
4<10 pci/l	50.00%
10<20 pci/l	0.00%
>20 pci/l	0.00%

Only two readings have been taken in the area. 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 approximately 7 miles northwest of the site (Reference 12). This occurrence is associated with a limonite deposit in the Dawson Formation. 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 13), 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 14), areas of the site are mapped as A3 – Alluvial fan: sand resource and E3/E4 – wind-deposited sand and probable aggregate resource. According to the *Evaluation of Mineral and Mineral Fuel Potential* (Reference 8), the area of the site has been mapped as "Good" for industrial minerals. The sands associated with the eolian and alluvial deposits are considered a sand resource. Considering the silty to clayey nature of much of these materials and abundance of similar

materials through the region and close proximity to developed land, 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 8), 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 13) 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 8). At this depth, mining the coal would not be economical at this time. No metallic mineral resources have been mapped on the site (Reference 8).

The site has been mapped as "Fair" for oil and gas resources (Reference 8). No oil or gas fields have been discovered in the area of the site. 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. Hydraulic fracturing is a new method that is being used to extract oil and gas from rocks that would not normally be productive. The area of the site has not been explored to determine If the rocks underlying the site would be commercially viable utilizing hydraulic fracturing. The practice of hydraulic fracturing has come under review due to concerns about environmental impacts, health and safety.

9.0 RELEVANCE OF GEOLOGIC AND SITE CONDITIONS TO LAND USE PLANNING

We understand that the development will be primarily residential with areas of commercial development, schools, parks, and open space areas. It is our opinion that the existing geologic and engineering geologic conditions will impose some constraints on the proposed development and construction. The most significant hazards associated with the site are those associated with the drainage areas and potential seasonal shallow groundwater conditions. These can be satisfactorily mitigated by either avoidance, regrading, or through proper engineering design, construction and drainage systems. Constraints identified on the site such as hydrocompaction,

collapsible soils, artificial fill, and expansive soils can also be mitigated through proper engineering design and construction.

The upper materials are typically at medium dense to dense states. The medium dense to dense granular soils encountered in the upper soil profiles of the test borings should provide good support for foundations. Loose soils, if encountered beneath foundations or slabs, will require removal and recompaction. Expansive soils, although sporadic, were encountered. Expansive clayey sandstone and claystone are common in the Dawson Formation, and may require mitigation. Foundations anticipated for the site are standard spread footings possibly in conjunction with overexcavation in areas of expansive soils or loose soils. Areas of artificial fill, if encountered beneath foundations will require penetration or recompaction. Areas containing arkosic sandstone will have high allowable bearing conditions. Expansive layers may also be encountered in the soil and bedrock on this site. Expansive soils, if encountered, will require special foundation design and/or overexcavation. These soils will not prohibit development.

Areas of hydrocompation have been identified on this site where there is the potential for settlement movements upon saturation of the surficial soils. Good surface and subsurface drainage is critical in these areas and the ground surface should be positively sloped away from structures at all points. Roof drains should be made to discharge well away from structures and planting and watering in the immediate vicinity of structures should be minimized.

Areas of seasonal and potentially seasonal shallow groundwater, ponded water, springs, and floodplains exist on this site. The floodplains, springs, and areas of ponded water are to be avoided by development and preserved as open space in drainage easements. Finished floor levels must be a minimum of one foot above the floodplain level. According to the site plan as shown on the Geology Map, Figure 6, some of the minor drainages can be avoided or filled which will mitigate the hazard. Blow-out areas also exist where surface waters could collect seasonally. The majority of these areas are in permeable sands that do not show signs of collecting and retaining moisture. It is anticipated these areas and some of the minor drainage swales would be regraded and filled during site development. Where structures encroach on areas of potential shallow groundwater or construction and regrading is proposed, drains may be necessary. Typical drain details are included in Figures 8 through 10. Exact floodplain locations and drainage studies are beyond the scope of this report.

Areas of perched groundwater may be encountered on this site in areas other than those mapped. Permeable sands exist on the site that may carry water in the subsurface perched on less permeable bedrock. Groundwater was encountered at depths ranging from 6 to 18 feet in five of the test borings drilled on the site. Site grading in areas of shallow water should be kept to a minium. Fluctuation in groundwater conditions may occur due to variations in rainfall, soil conditions and development of surrounding areas. Builders should be cognizant of the potential for the occurrence of subsurface water features during construction and deal with each individual problem as necessary at the time of construction. Subsurface drains and dewatering systems may be necessary in some areas where seepage and perched water occurs. Unstable conditions should be expected where excavations approach the groundwater level. Stabilization using geofabric or shot rock may be necessary.

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. Additional investigation is recommended as grading and development plans are prepared, 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. The report was prepared for the proposed master plan. Additional soils investigation is recommended as the development and grading plans are prepared to provide more detailed information on soil, groundwater and bedrock.

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 Norwood Development 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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TABLES

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT NORWOOD DEVELOPMENT
PROJECT BANNING LEWIS RANCH NORTH
JOB NO. 190723

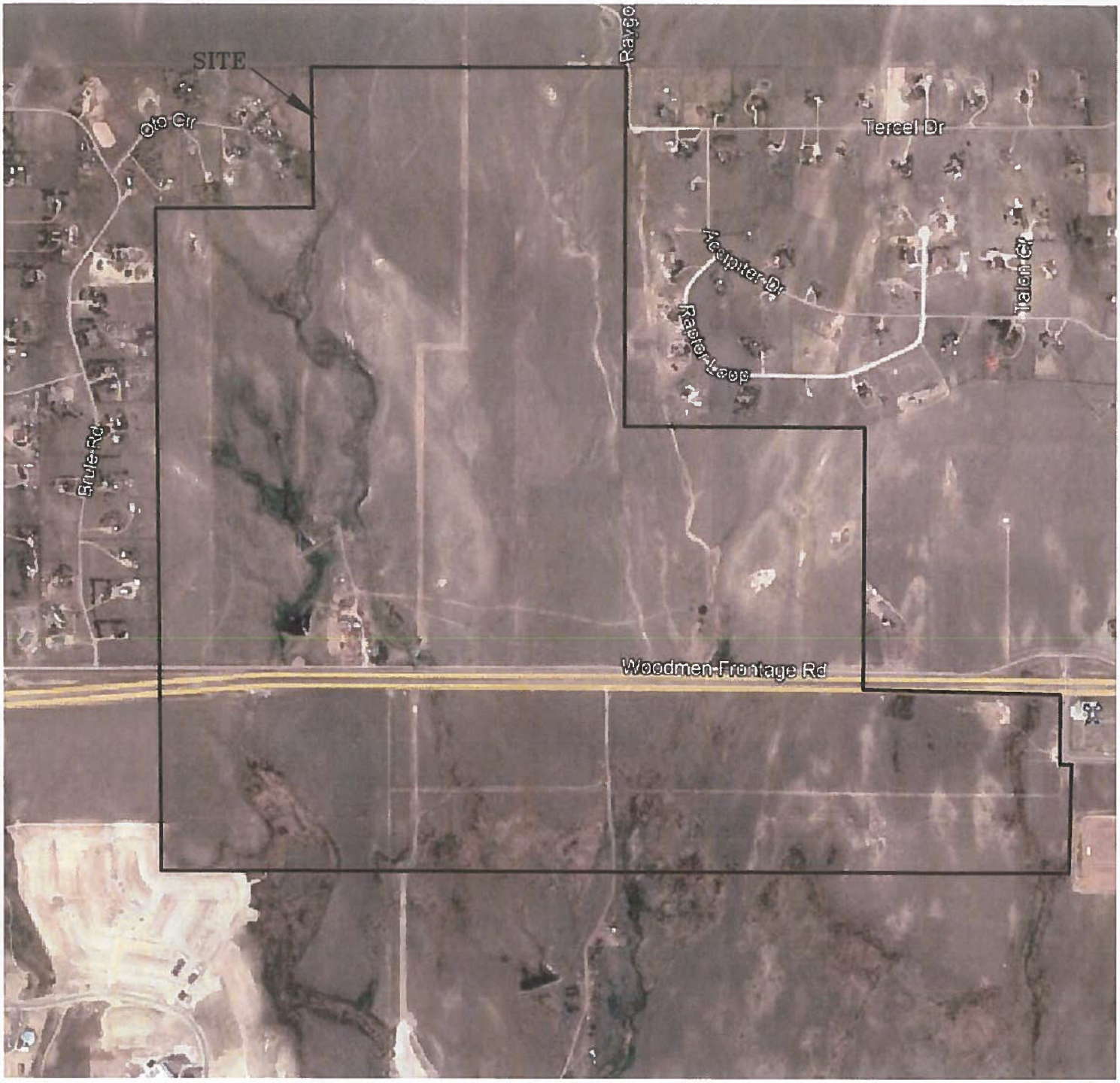
SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	FHA SWELL (PSF)	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	1	5			8.7	NV	NP				SM-SW	SAND, SILTY
1	2	2-3			20.9						SM	SAND, SILTY
1	3	10			20.0						SM	SAND, SLIGHTLY SILTY
1	4	5			7.2						SM-SW	SAND, SLIGHTLY SILTY
1	5	2-3			9.0	NV	NP				SM-SW	SAND, SLIGHTLY SILTY
1	7	5			6.3						SM-SW	SAND, SILTY
1	7	10	15.1	113.7	46.1	41	22			0.6	SC	SAND, VERY CLAYEY
2	3	20	9.7	127.2	60.1	33	16			0.7	CL	CLAYSTONE, VERY SANDY
3	5	20			8.5	NV	NP				SM-SW	SANDSTONE, SILTY
3	6	20	14.4	109.0	16.6					-0.7	SC	SANDSTONE, CLAYEY

Table 2: Summary of Depth to Bedrock and Groundwater

Test Boring No.	Depth to Bedrock (ft.)	Depth to Groundwater (ft.)
1	>20	18
2	>20	11
3	14*	6
4	>20	13.5
5	14	>20
6	14*	14
7	14	>20

* Weathered bedrock

FIGURES



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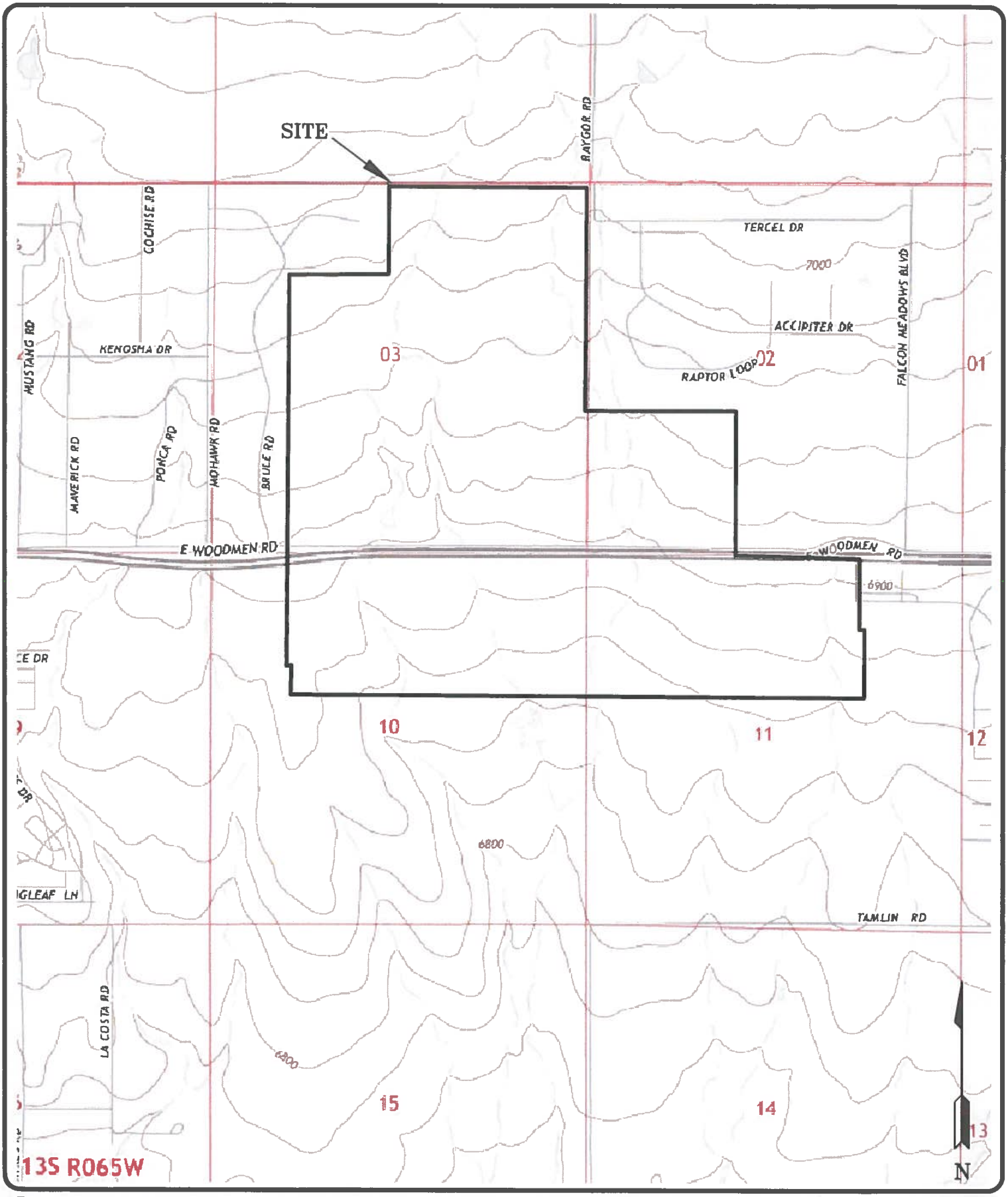
VICINITY MAP
BANNING LEWIS RANCH NORTH
EL PASO COUNTY, CO
FOR: NORWOOD DEVELOPMENT

DRAWN:	DATE:	CHECKED:	DATE:
LLL	5/14/19		5/24/19

JOB NO.: 190723

FIG NO.: 1



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USGS MAP
BANNING LEWIS RANCH NORTH
EL PASO COUNTY, CO
FOR: NORWOOD DEVELOPMENT

DRAWN:	DATE:	CHECKED:	DATE:
LLL	5/14/19		5/24/19

JOB NO.: 190723

FIG NO.: 2

SITE PLAN/TEST BORING LOCATION MAP
BANNING LEWIS RANCH NORTH
EL PASO COUNTY, CO
FOR: NORWOOD DEVELOPMENT

DRAWN: LLL
CHECKED:
DATE: 5/24/19
SCALE: AS SHOWN
JOB NO.: 197123
FRAME No.: 3

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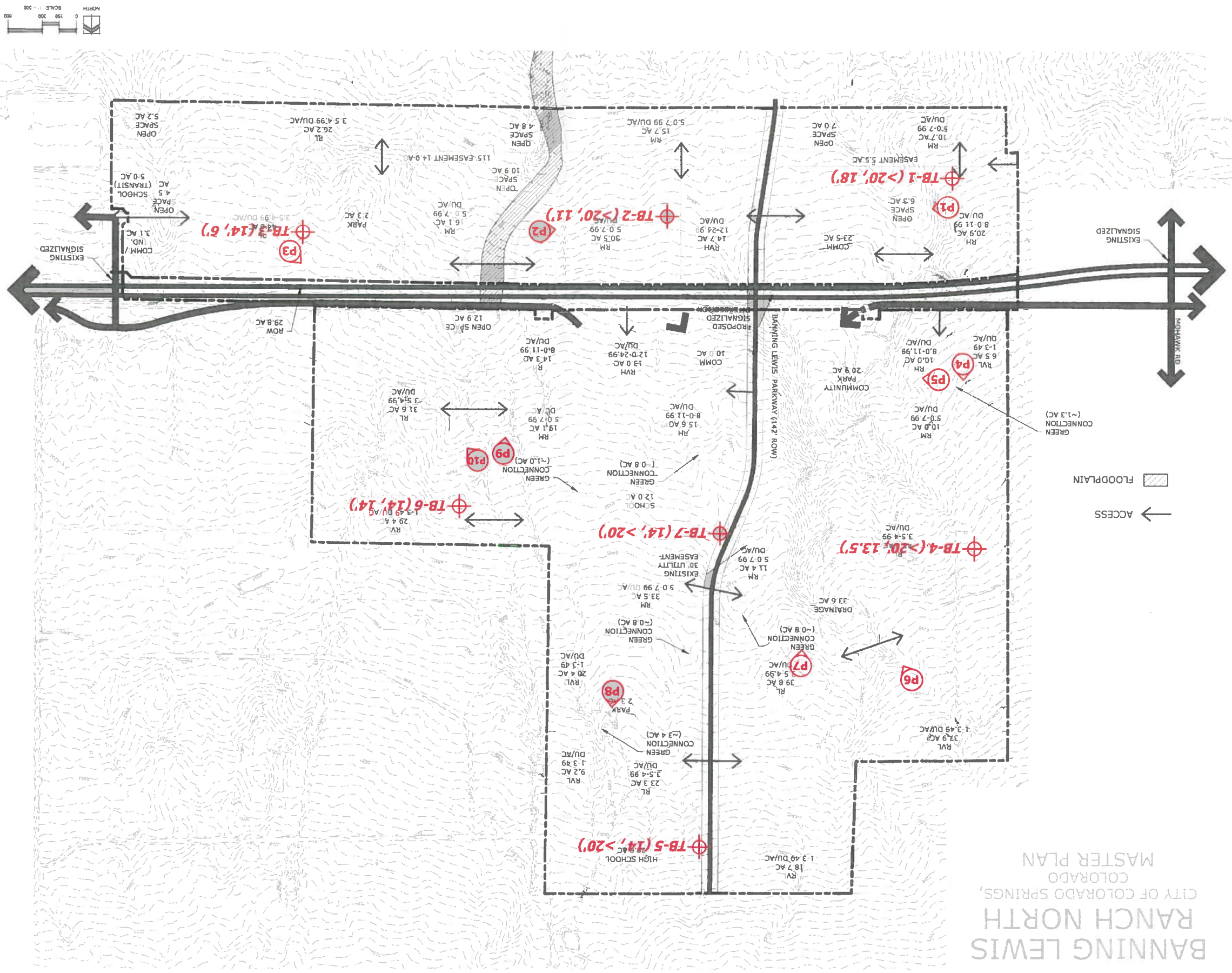
TB- APPROXIMATE TEST BORING LOCATION AND NUMBER
(DEPTH TO BEDROCK, GROUNDWATER)

P2 - APPROXIMATE PHOTOGRAPH LOCATION AND NUMBER

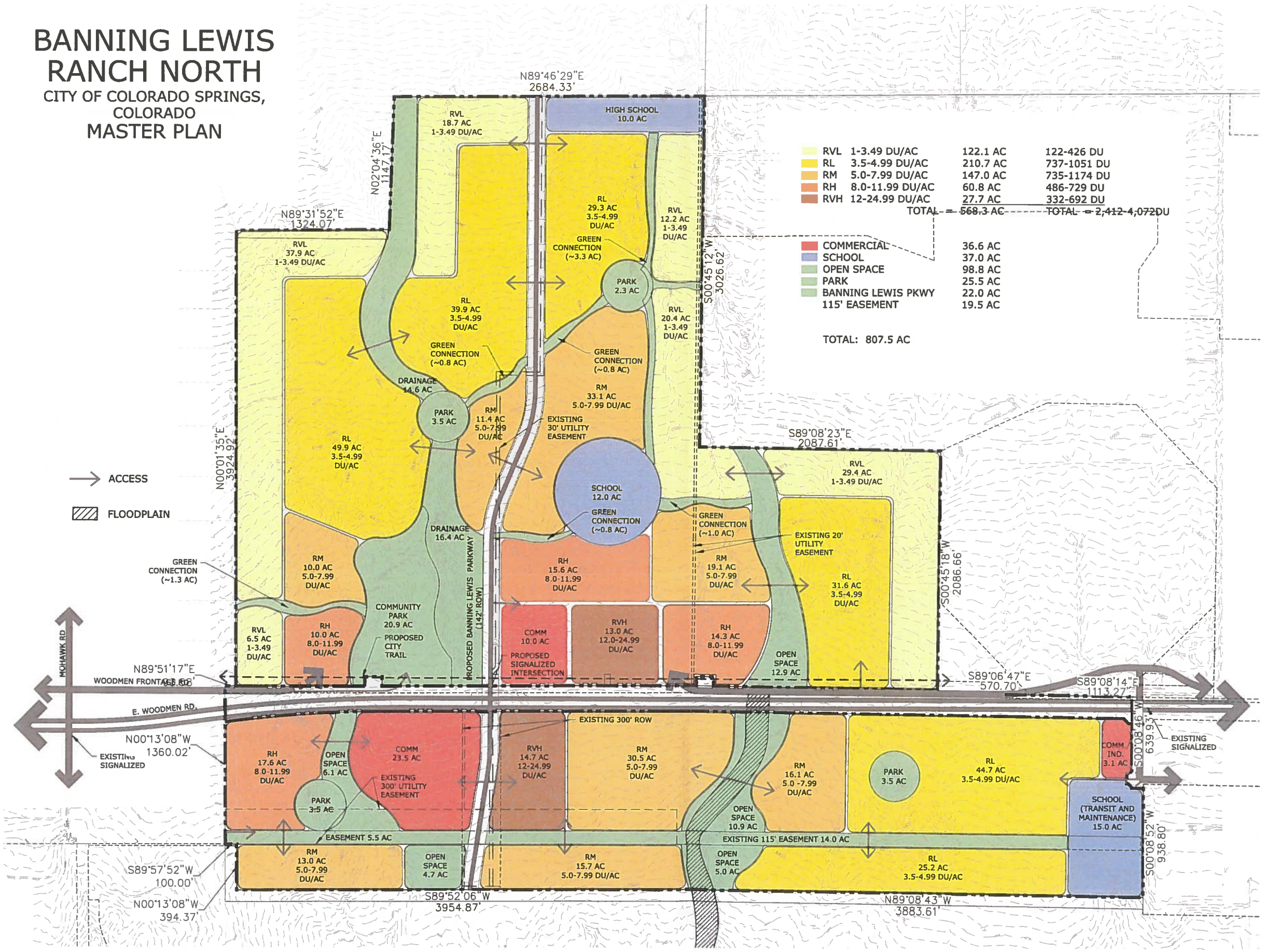


BANNING LEWIS RANCH NORTH
CITY OF COLORADO SPRINGS, COLORADO
MASTER PLAN

BANNING LEWIS RANCH NORTH

CITY OF COLORADO SPRINGS, COLORADO

MASTER PLAN



RVL	1-3.49 DU/AC	122.1 AC	122-426 DU
RL	3.5-4.99 DU/AC	210.7 AC	737-1051 DU
RM	5.0-7.99 DU/AC	147.0 AC	735-1174 DU
RH	8.0-11.99 DU/AC	60.8 AC	486-729 DU
RVH	12-24.99 DU/AC	27.7 AC	332-692 DU
		TOTAL = ~~568.3 AC~~	TOTAL = ~~2,412-4,072~~DU

COMMERCIAL	36.6 AC
SCHOOL	37.0 AC
OPEN SPACE	98.8 AC
PARK	25.5 AC
BANNING LEWIS PKWY	22.0 AC
115' EASEMENT	19.5 AC

TOTAL: 807.5 AC

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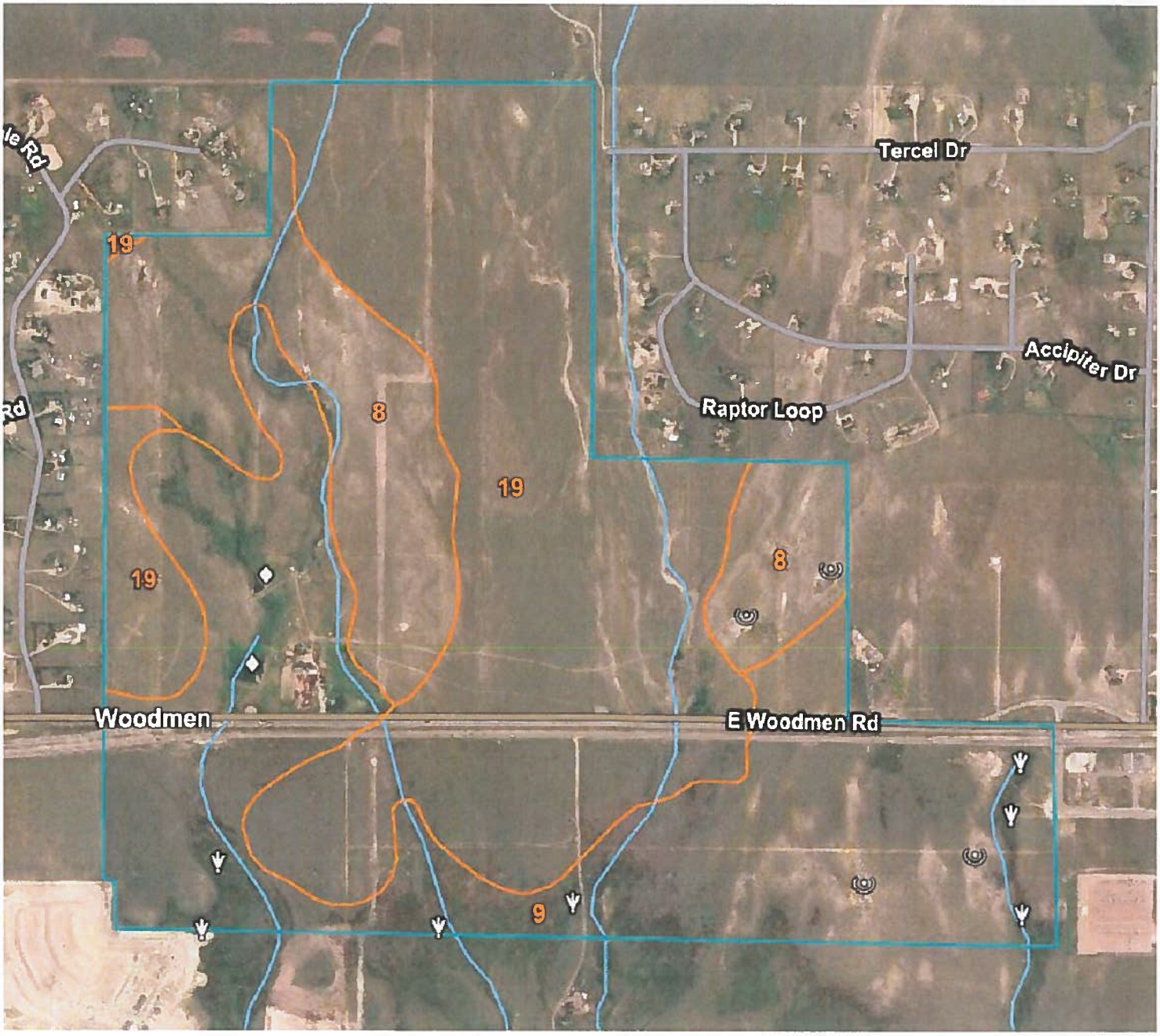
MASTER PLAN
BANNING LEWIS RANCH NORTH
EL PASO COUNTY, CO
FOR: NORWOOD DEVELOPMENT

DRAWN	LLL
CHECKED	
DATE	5/24/19
SCALE	AS SHOWN
JOB NO.	190723
FIGURE No.	3A



N

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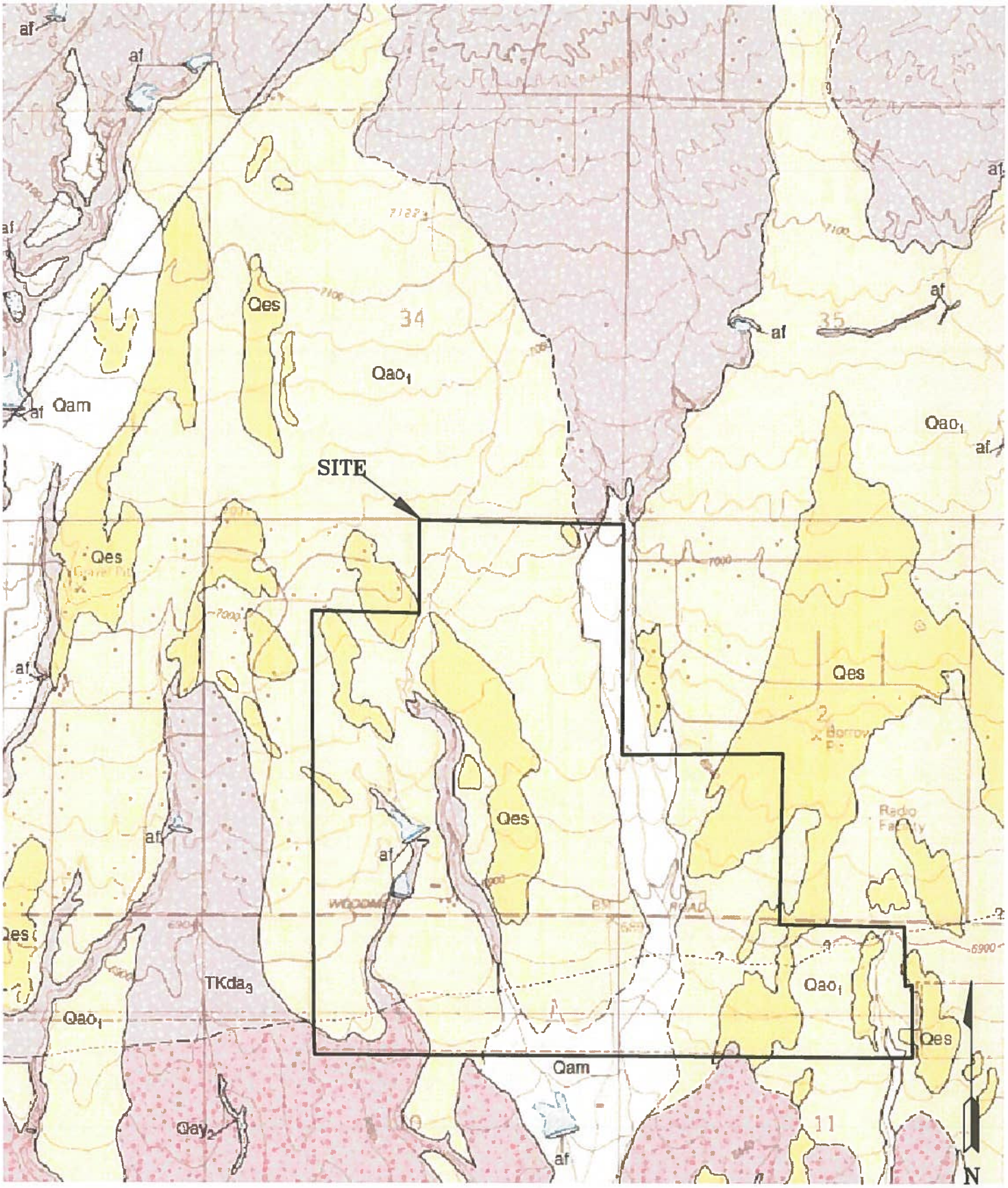
SOIL SURVEY MAP
BANNING LEWIS RANCH NORTH
EL PASO COUNTY, CO
FOR: NORWOOD DEVELOPMENT

DRAWN:	DATE:	CHECKED:	DATE:
LLL	5/14/19		5/24/19

JOB NO.: 190723

FIG NO.: 4



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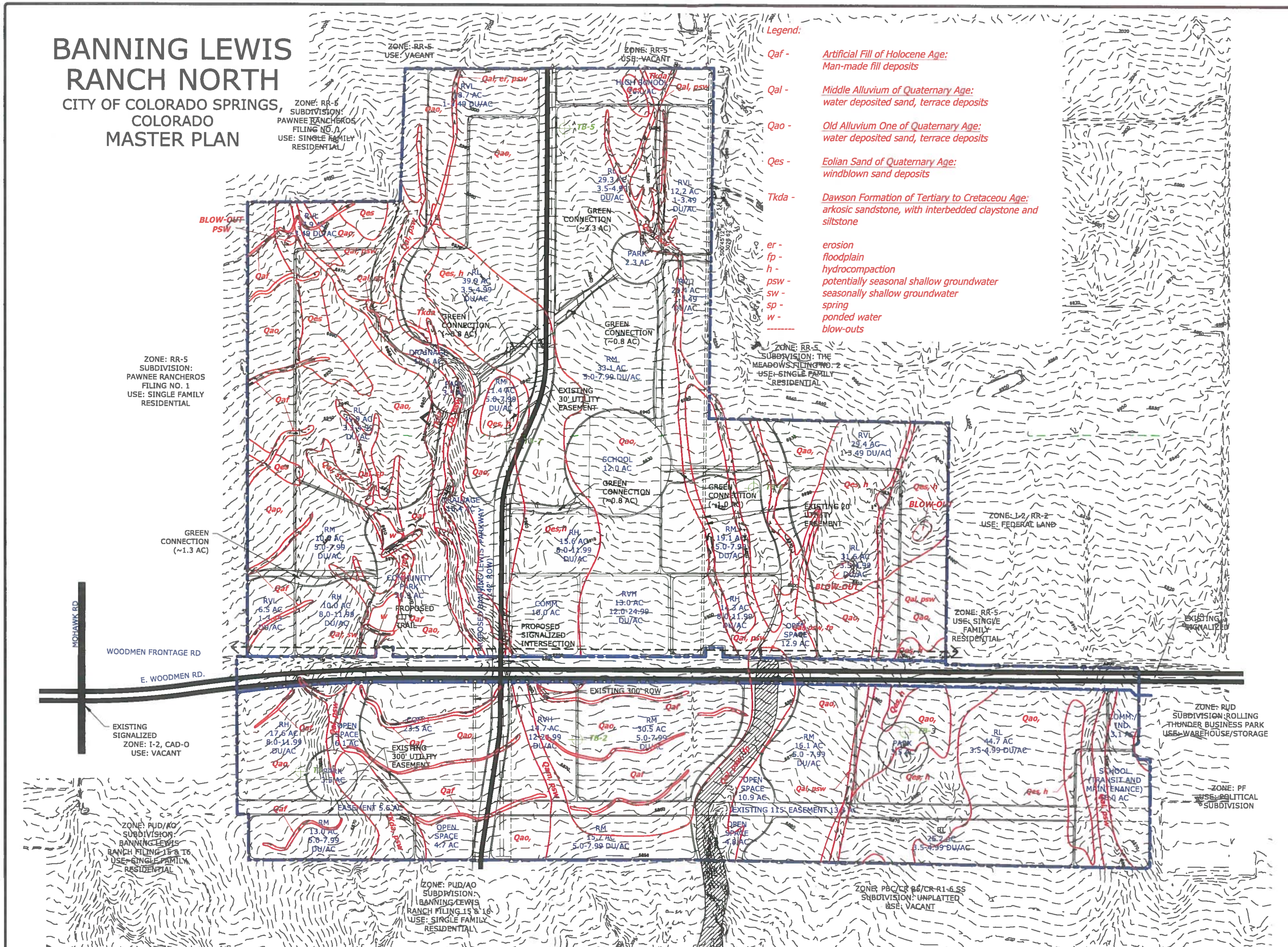
FALCON NW QUADRANGLE GEOLOGY MAP
BANNING LEWIS RANCH NORTH
EL PASO COUNTY, CO
FOR: NORWOOD DEVELOPMENT

DRAWN:	DATE:	CHECKED:	DATE:
LLL	5/14/19		5/24/19

JOB NO.: 190723

FIG NO.: 5



TB - INDICATES APPROXIMATE TEST BORING LOCATION AND NUMBER

REVISION | BY:

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GEOLOGY/ENGINEERING GEOLOGY MAP
BANNING LEWIS RANCH NORTH
COLORADO SPRINGS, CO
FOR: NORWOOD DEVELOPMENT

DRAWN BY: JAC
DESIGNED BY: LL
CHECKED BY:
DATE: 05/24/19
SCALE: AS SHOWN
JOB NO.: 190723
FIGURE NO.: 6

N

CITY OF COLORADO SPRINGS
080060

0.2mi

080041C0538G
eff. 12/7/2018

080041C0535G
eff. 12/7/2018

EL PASO COUNTY
080059

SITE

F
G
H

FLOODPLAIN MAP
BANNING LEWIS RANCH NORTH
EL PASO COUNTY, CO
FOR: NORWOOD DEVELOPMENT

DRAWN LLL
CHECKED
DATE 5/14/19
SCALE AS SHOWN
JOB NO. 190725
FIGURE No. 7

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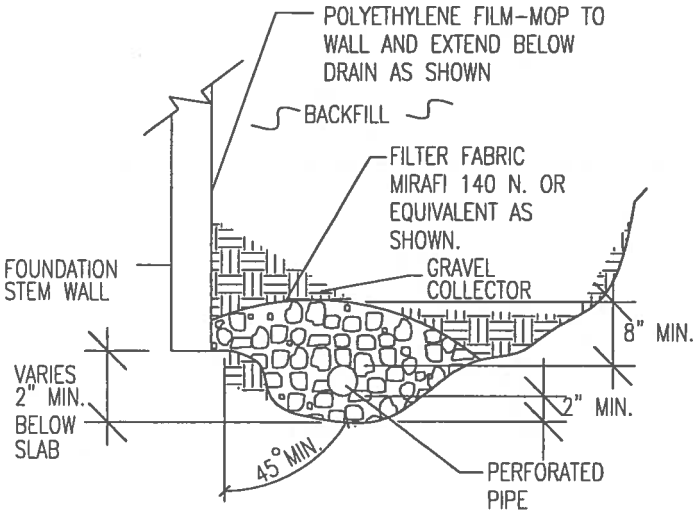
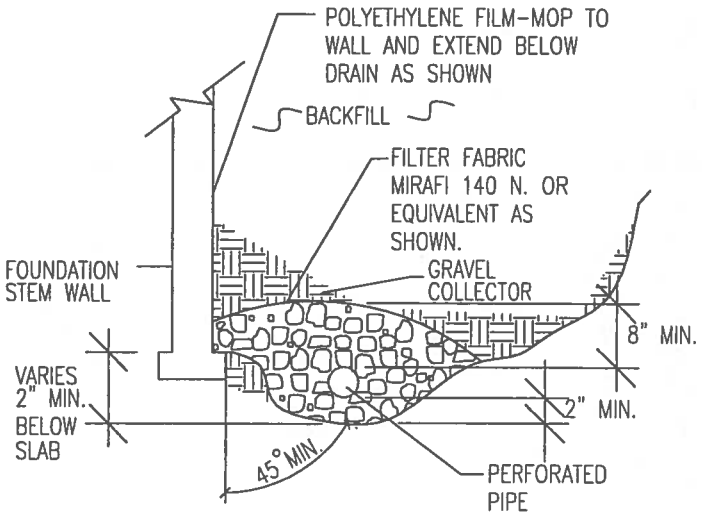
BY	REVISION





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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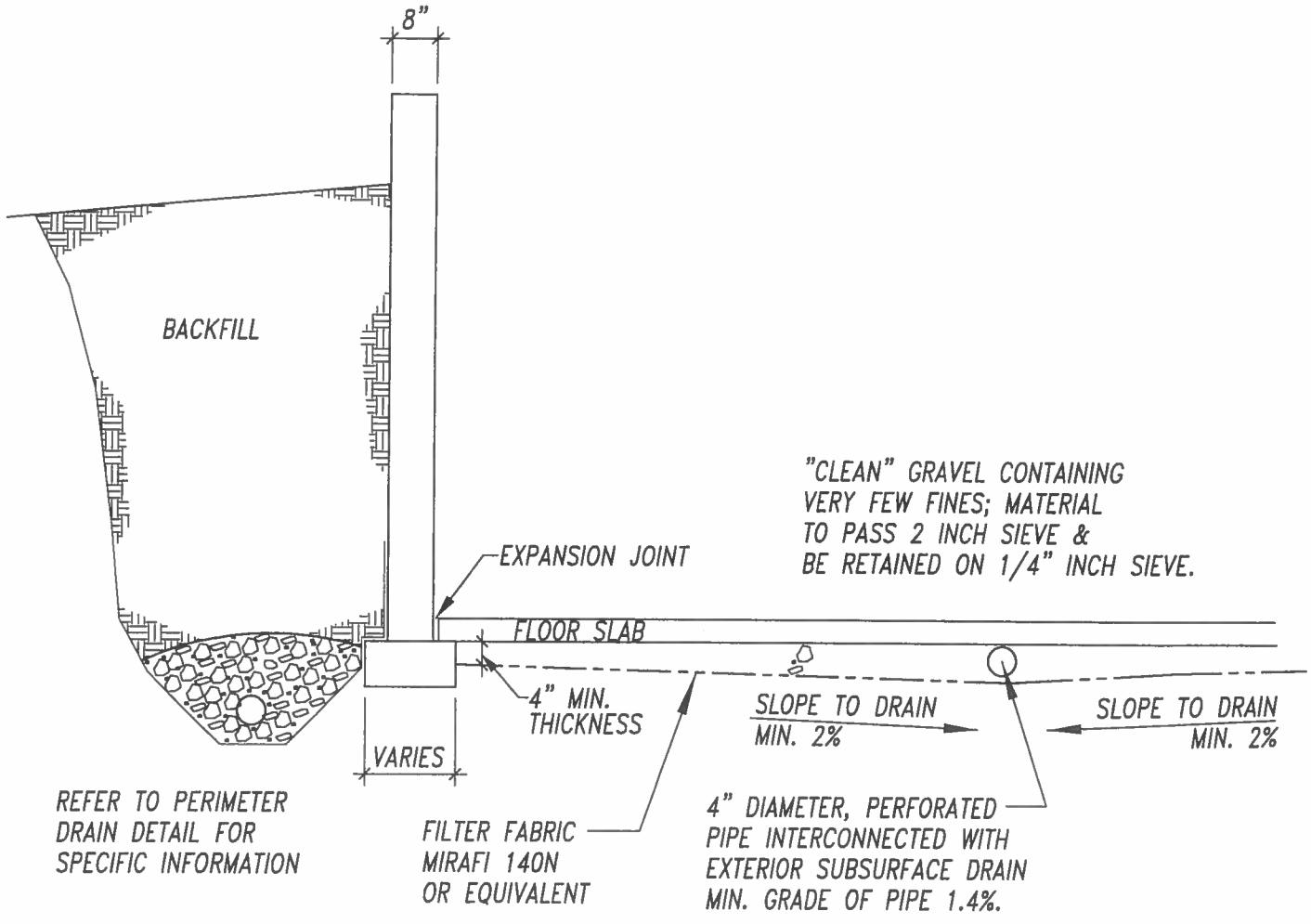
PERIMETER DRAIN DETAIL

DRAWN:	DATE: 5/15/17	DESIGNED: DS	CHECKED:

JOB NO.: 190723
FIG NO.: 8



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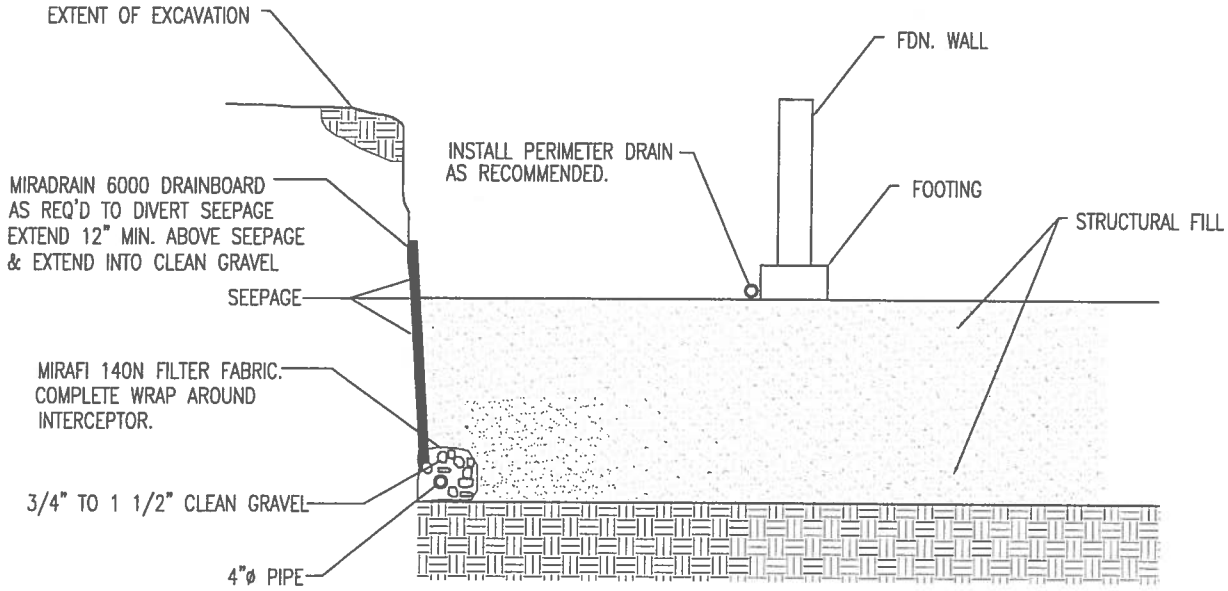
TYP. UNDERSLAB DRAINAGE
LAYER (CAPILLARY BREAK)

DRAWN:	DATE: 5/15/19	DESIGNED: DS	CHECKED:

JOB NO.: 190723
FIG NO.: 9



NOTE:
EXTEND INTERCEPTOR DRAIN TO DAYLIGHT

INTERCEPTOR DRAIN DETAIL

N.T.S.

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INTERCEPTOR DRAIN DETAIL			
DRAWN BY:	DATE DRAWN: 9/5/19		CHECKED:

JOB NO.: 190723
FIG. NO.: 10

APPENDIX A: Site Photographs

1

Looking east from southwest portion of the site.

May 7, 2019

2

Looking west from south-central portion of the site.

May 7, 2019

Job No. 190723

3

Looking west from southeast portion of the site.

May 7, 2019

4

Looking north from the western portion of the site.

May 7, 2019

Job No. 190723

5

Looking east from the western portion of the site.

May 7, 2019

6

Looking at spring in the southeast from the northwest portion of the site.

May 7, 2019

Job No. 190723

7

Looking south along drainage in north-central portion of the site.

May 7, 2019

8

Looking north along drainage in the northeastern potion of the site.

May 7, 2019

Job No. 190723

9

Looking south along drainage in the eastern portion of the site.

May 7, 2019

10

Looking southeast along drainage in the eastern portion of the site.

May 7, 2019

Job No. 190723

APPENDIX B: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 5/16/2019
Job # 190723

REMARKS

WATER @ 18', 6/11/19

SAND, SILTY TO SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE TO DENSE, DRY TO WET

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			11	1.4	1
5			23	6.5	1
10			27	3.4	1
15			26	4.3	1
20			36	11.7	1

TEST BORING NO. 2
DATE DRILLED 5/16/2019
CLIENT NORWOOD DEVELOPMENT
LOCATION BANNING LEWIS RANCH NORTH

REMARKS

WATER @ 11', 6/11/19

SAND, SILTY TO SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE TO DENSE, DRY TO WET

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			21	3.1	1
5			13	1.8	1
10			11	13.0	1
15			11	18.2	1
20			30	10.8	1

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COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
		L	6/17/19

JOB NO.: 190723
FIG NO.: B- 1

TEST BORING NO. 3
DATE DRILLED 5/16/2019
Job # 190723

REMARKS

WATER @ 6', 6/11/19

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			20	2.0	1	SAND, SILTY TO SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE TO DENSE, DRY TO WET
5			30	4.4	1	
10			14	13.0	1	
15			35	14.1	2	WEATHERED TO FORMATIONAL CLAYSTONE, VERY SANDY, GRAY BROWN, HARD, MOIST
20			50/7"	12.4	2	

TEST BORING NO. 4
DATE DRILLED 5/16/2019
CLIENT NORWOOD DEVELOPMENT
LOCATION BANNING LEWIS RANCH NORTH

REMARKS

WATER @ 13.5', 6/11/19

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			10	2.2	1	SAND, SILTY TO SLIGHTLY SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE TO DENSE, MOIST
5			20	1.8	1	
10			25	6.9	1	
15			26	13.1	1	
20			23	12.3	1	

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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			6/17/19

JOB NO.: 190723
FIG NO.: B- 2

TEST BORING NO. 5
DATE DRILLED 6/10/2019
Job # 190723

REMARKS

DRY TO 20', 6/11/19

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			14	2.2	1	SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, DRY TO MOIST
5			20	7.7	1	
10			26	7.3	1	
15			50/7"	10.7	3	SANDSTONE, SILTY, FINE GRAINED, GRAY BROWN, VERY DENSE, MOIST
20			50/7"	8.8	3	SANDSTONE, SLIGHLTY SILTY, FINE TO MEDIUM GRAINED, TAN, VERY DENSE, MOIST

TEST BORING NO. 6
DATE DRILLED 6/10/2019
CLIENT NORWOOD DEVELOPMENT
LOCATION BANNING LEWIS RANCH NORTH

REMARKS

WATER @ 14', 6/11/19

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			26	3.3	1	SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, DRY TO MOIST
5			17	2.2	1	
10			27	11.1	1	
15			44	8.7	3	WEATHERED TO FORMATIONAL SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, GRAY BROWN, DENSE TO VERY DENSE, MOIST
20			50/11"	10.5	3	

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			6/17/19

JOB NO.: 190723
FIG NO.: B- 3

TEST BORING NO. 7
DATE DRILLED 6/10/2019
Job # 190723

TEST BORING NO.
DATE DRILLED
CLIENT NORWOOD DEVELOPMENT
LOCATION BANNING LEWIS RANCH NORTH

REMARKS

DRY TO 20', 6/11/19

REMARKS

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	Description
			10	8.5	1	SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST
5			11	4.6	1	
10			20	13.4	1	SAND, VERY CLAYEY, FINE GRAINED, GRAY BROWN, MEDIUM DENSE, MOIST
15			50/11"	9.9	2	CLAYSTONE, VERY SANDY, GRAY BROWN, HARD, MOIST
20			50/11"	12.2	2	

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

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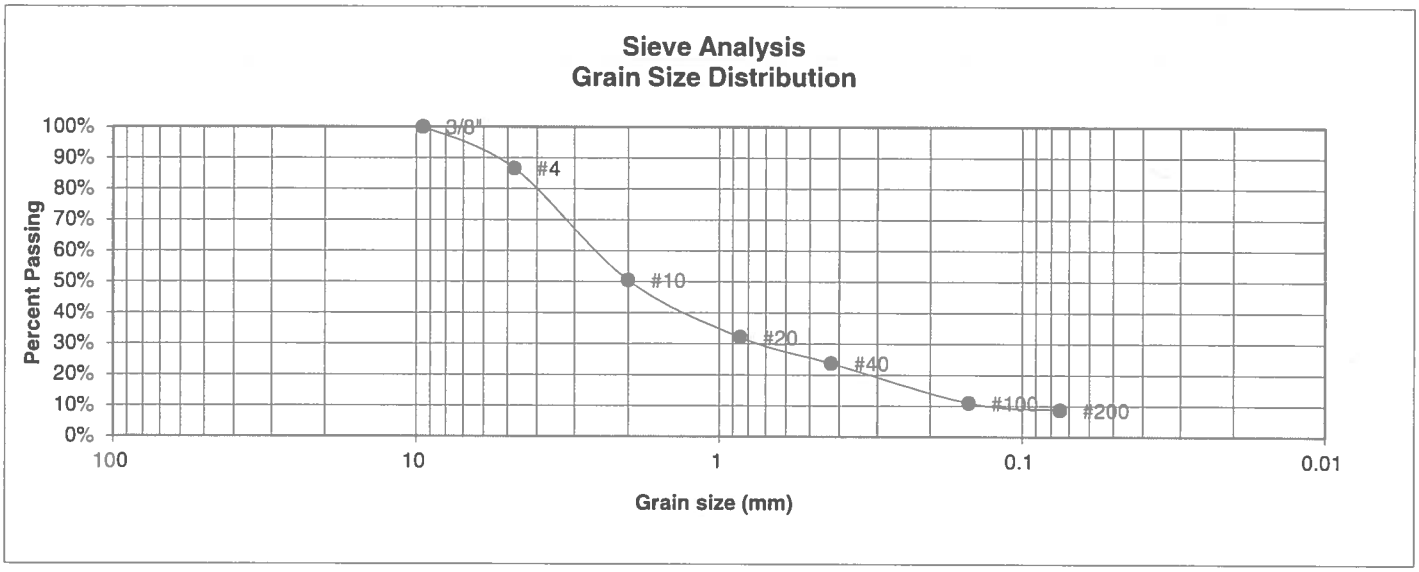
TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			6/17/19

JOB NO.: 190723
FIG NO.: B- 4

APPENDIX C: Laboratory Test Results

UNIFIED CLASSIFICATION	SM-SW	CLIENT	NORWOOD DEVELOPMENT
SOIL TYPE #	1	PROJECT	BANNING LEWIS RANCH NORTH
TEST BORING #	1	JOB NO.	190723
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	86.6%
10	50.5%
20	32.1%
40	23.7%
100	11.0%
200	8.7%

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

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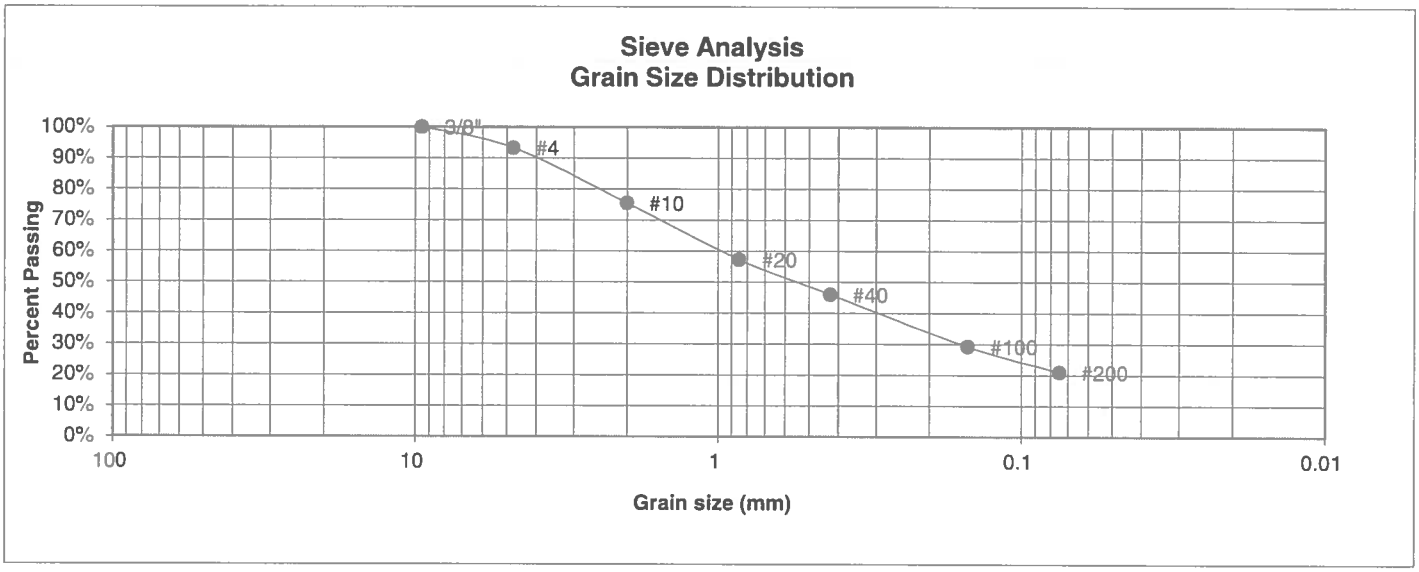
JOB NO.: 190723

FIG NO.: C-1

UNIFIED CLASSIFICATION	SM	CLIENT	NORWOOD DEVELOPMENT
SOIL TYPE #	1	PROJECT	BANNING LEWIS RANCH NORTH
TEST BORING #	2	JOB NO.	190723
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	93.3%
10	75.5%
20	57.3%
40	46.0%
100	29.3%
200	20.9%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

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

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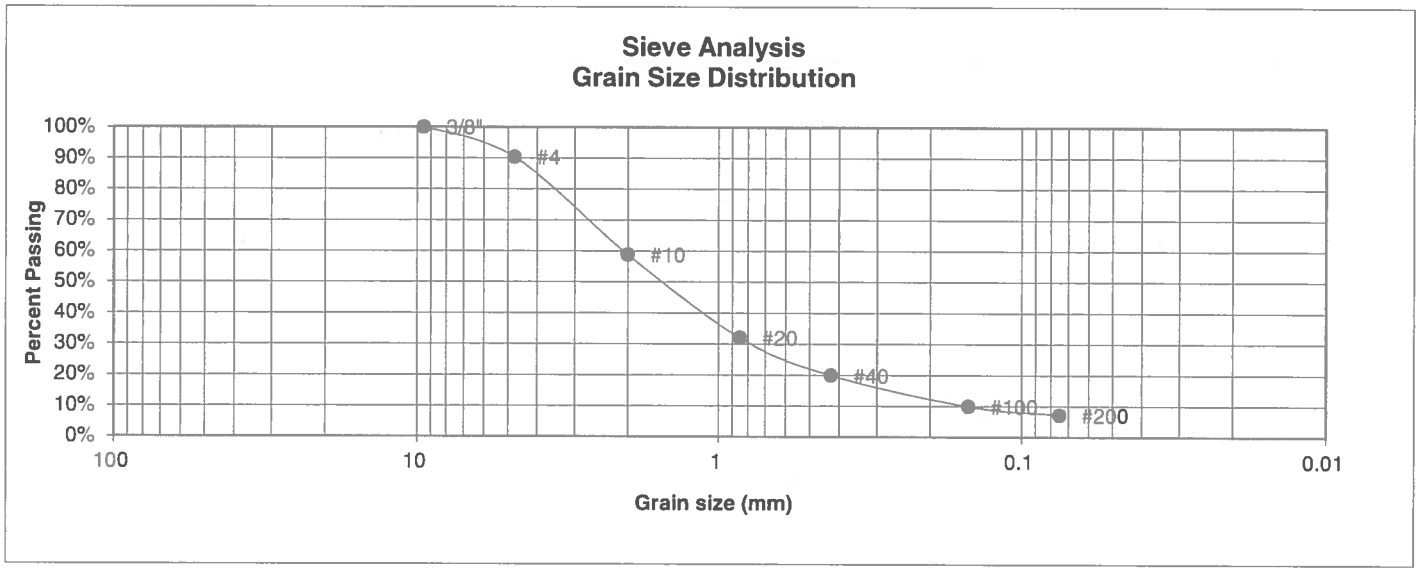
FIG NO.: C-2

UNIFIED CLASSIFICATION	SM-SW	CLIENT	NORWOOD DEVELOPMENT
SOIL TYPE #	1	PROJECT	BANNING LEWIS RANCH NORTH
TEST BORING #	4	JOB NO.	190723
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	90.3%
10	58.8%
20	32.0%
40	19.9%
100	9.9%
200	7.2%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

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

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LABORATORY TEST RESULTS

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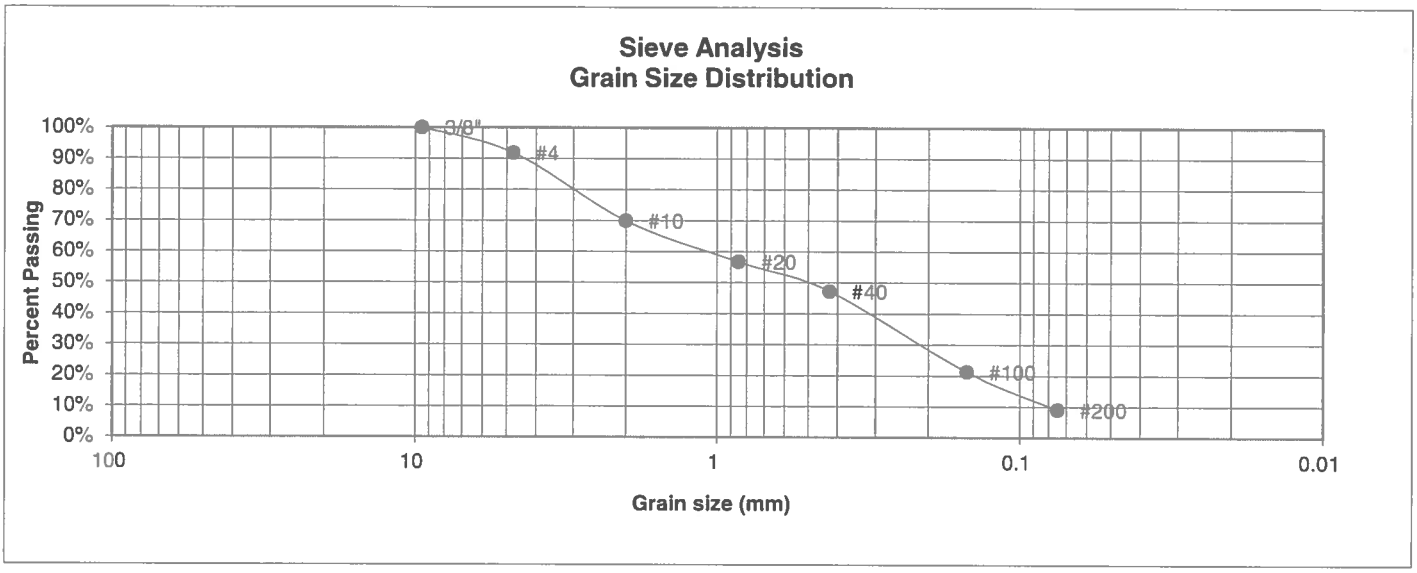
JOB NO.: 190723

FIG NO.: C-3

UNIFIED CLASSIFICATION	SM-SW	CLIENT	NORWOOD DEVELOPMENT
SOIL TYPE #	1	PROJECT	BANNING LEWIS RANCH NORTH
TEST BORING #	5	JOB NO.	190723
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	91.8%
10	69.9%
20	56.7%
40	47.2%
100	21.3%
200	9.0%

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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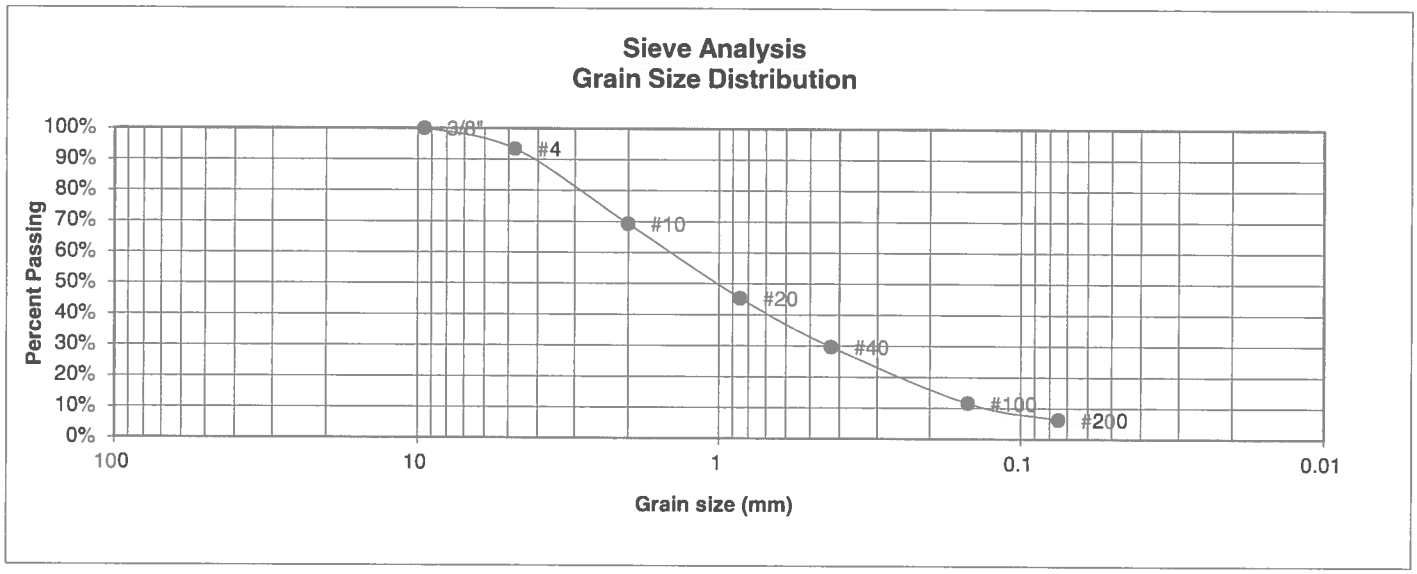
FIG NO.: C-4

UNIFIED CLASSIFICATION	SM-SW	CLIENT	NORWOOD DEVELOPMENT
SOIL TYPE #	1	PROJECT	BANNING LEWIS RANCH NORTH
TEST BORING #	7	JOB NO.	190723
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.4%
10	69.3%
20	45.4%
40	29.7%
100	11.6%
200	6.3%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

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

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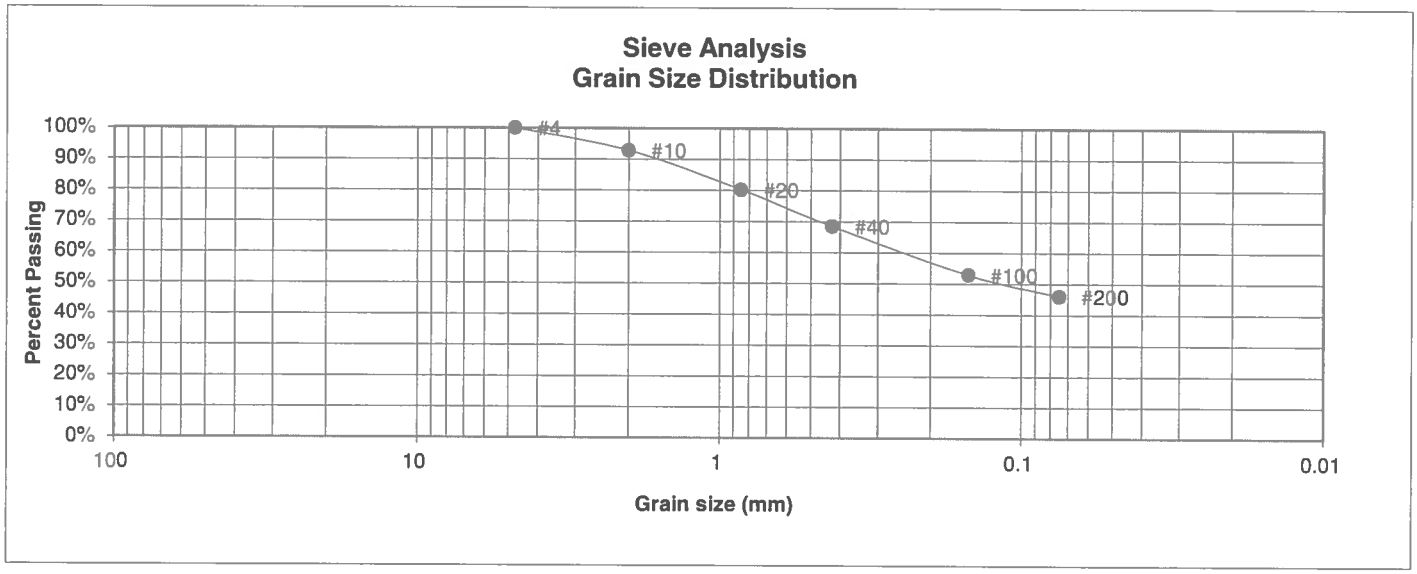
LABORATORY TEST RESULTS

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

JOB NO.: 190723

FIG NO.: C-5

UNIFIED CLASSIFICATION	SC	CLIENT	NORWOOD DEVELOPMENT
SOIL TYPE #	1	PROJECT	BANNING LEWIS RANCH NORTH
TEST BORING #	7	JOB NO.	190723
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	92.9%
20	80.2%
40	68.5%
100	52.9%
200	46.1%

Atterberg Limits	
Plastic Limit	19
Liquid Limit	41
Plastic Index	22

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

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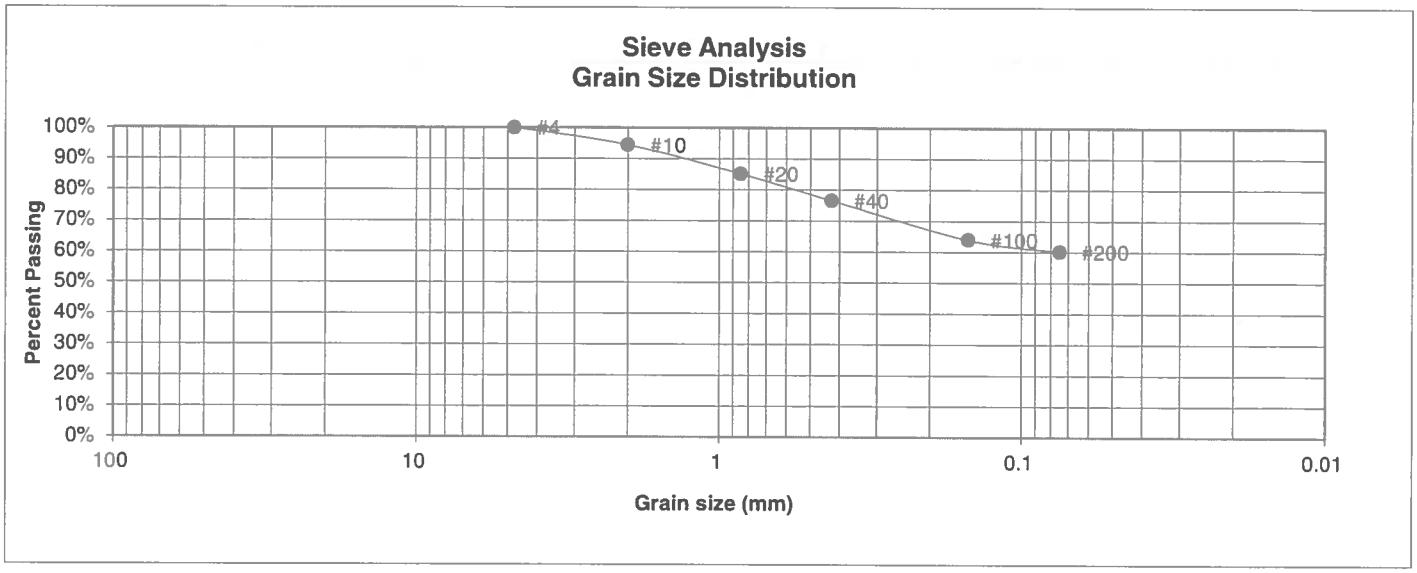
FIG NO.: C-6

UNIFIED CLASSIFICATION	CL	CLIENT	NORWOOD DEVELOPMENT
SOIL TYPE #	2	PROJECT	BANNING LEWIS RANCH NORTH
TEST BORING #	3	JOB NO.	190723
DEPTH (FT)	20	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	94.5%
20	85.2%
40	76.5%
100	64.0%
200	60.1%

Atterberg Limits	
Plastic Limit	17
Liquid Limit	33
Plastic Index	16

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

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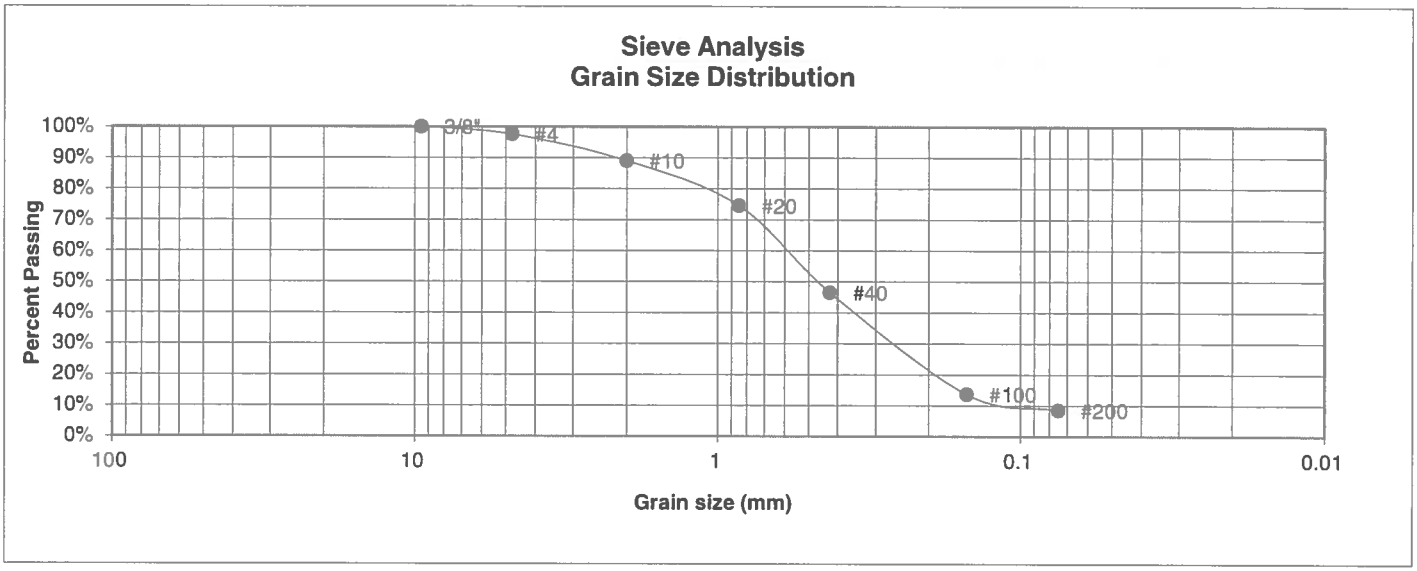
JOB NO.: 190723

FIG NO.: C-7

UNIFIED CLASSIFICATION	SM-SW	CLIENT	NORWOOD DEVELOPMENT
SOIL TYPE #	3	PROJECT	BANNING LEWIS RANCH NORTH
TEST BORING #	5	JOB NO.	190723
DEPTH (FT)	20	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.6%
10	89.1%
20	74.5%
40	46.5%
100	13.7%
200	8.5%

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

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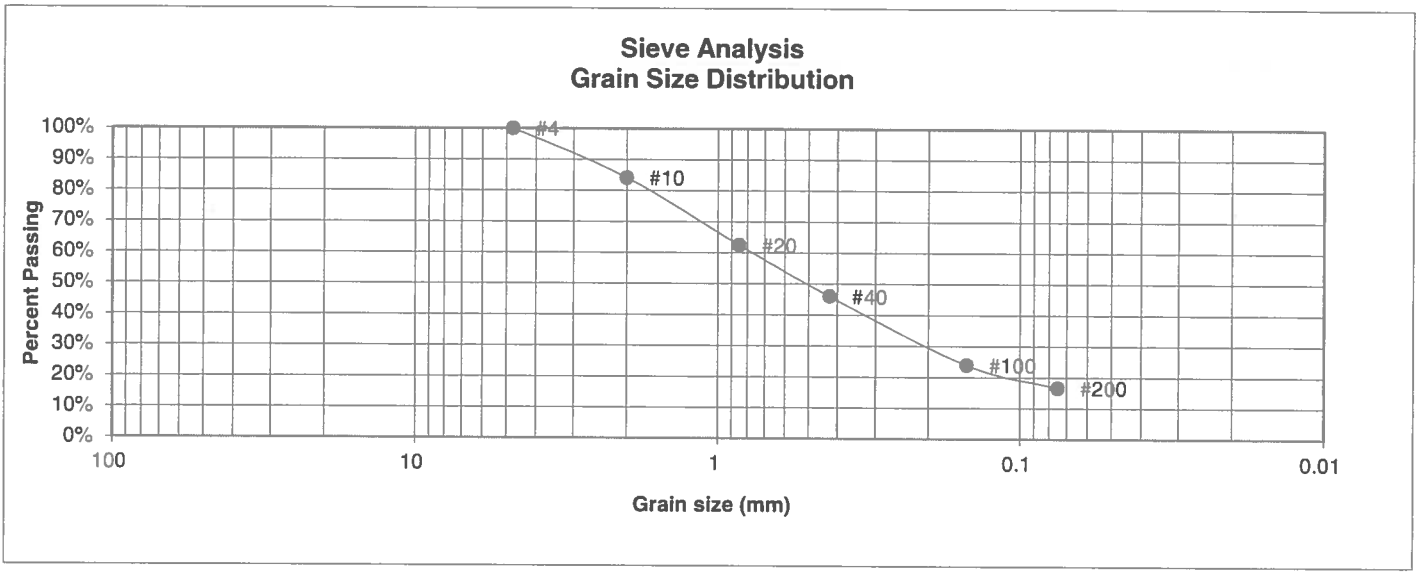
FIG NO.: C-8

UNIFIED CLASSIFICATION	SC	CLIENT	NORWOOD DEVELOPMENT
SOIL TYPE #	3	PROJECT	BANNING LEWIS RANCH NORTH
TEST BORING #	6	JOB NO.	190723
DEPTH (FT)	20	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	84.2%
20	62.5%
40	46.0%
100	23.9%
200	16.6%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

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:
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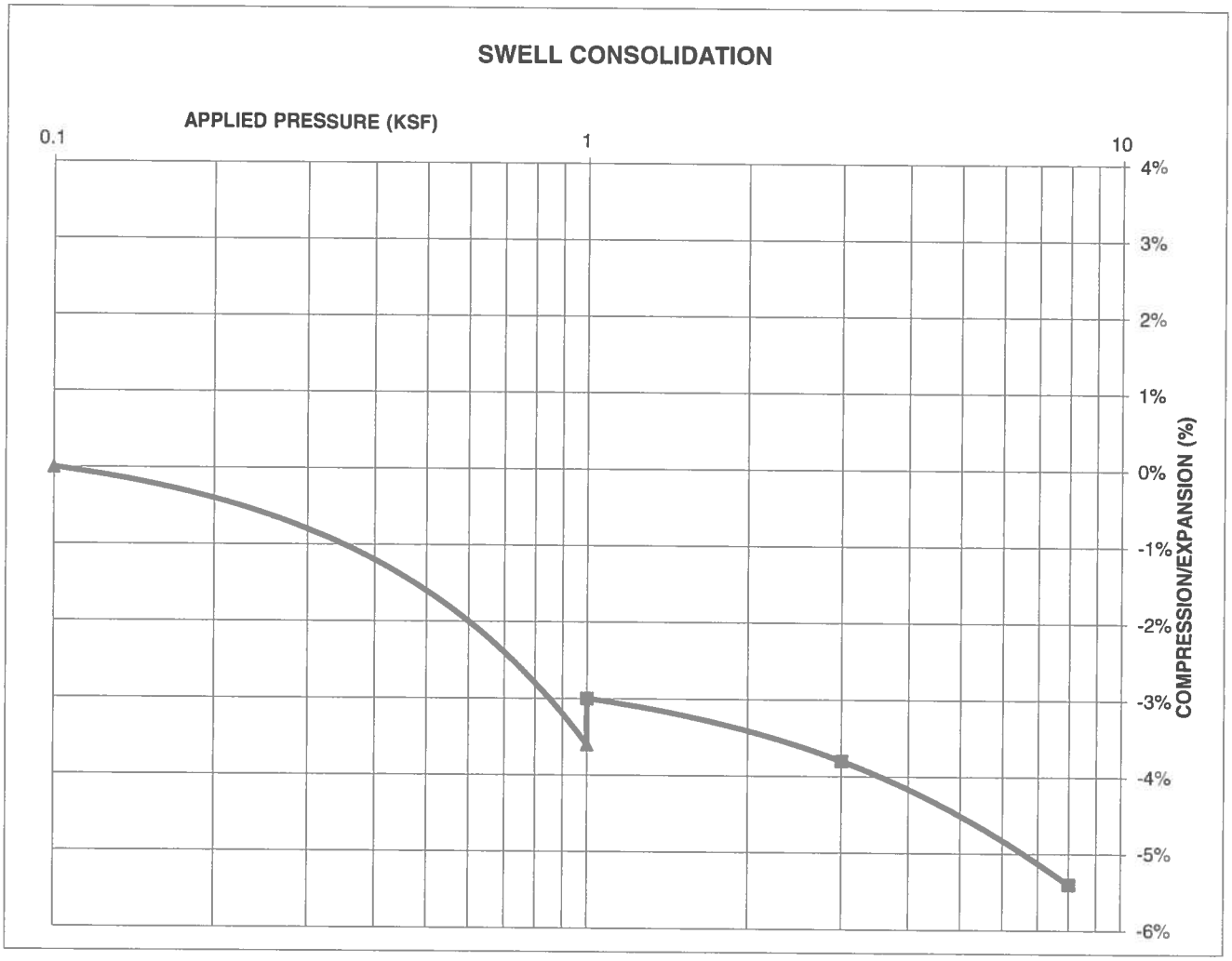
JOB NO.: 190723

FIG NO.: C-9

CONSOLIDATION TEST RESULTS

TEST BORING #	7	DEPTH(ft)	10
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			114
NATURAL MOISTURE CONTENT			15.1%
SWELL/CONSOLIDATION (%)			0.6%

JOB NO. 190723
CLIENT NORWOOD DEVELOPMENT
PROJECT BANNING LEWIS RANCH NORTH



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SWELL CONSOLIDATION
TEST RESULTS

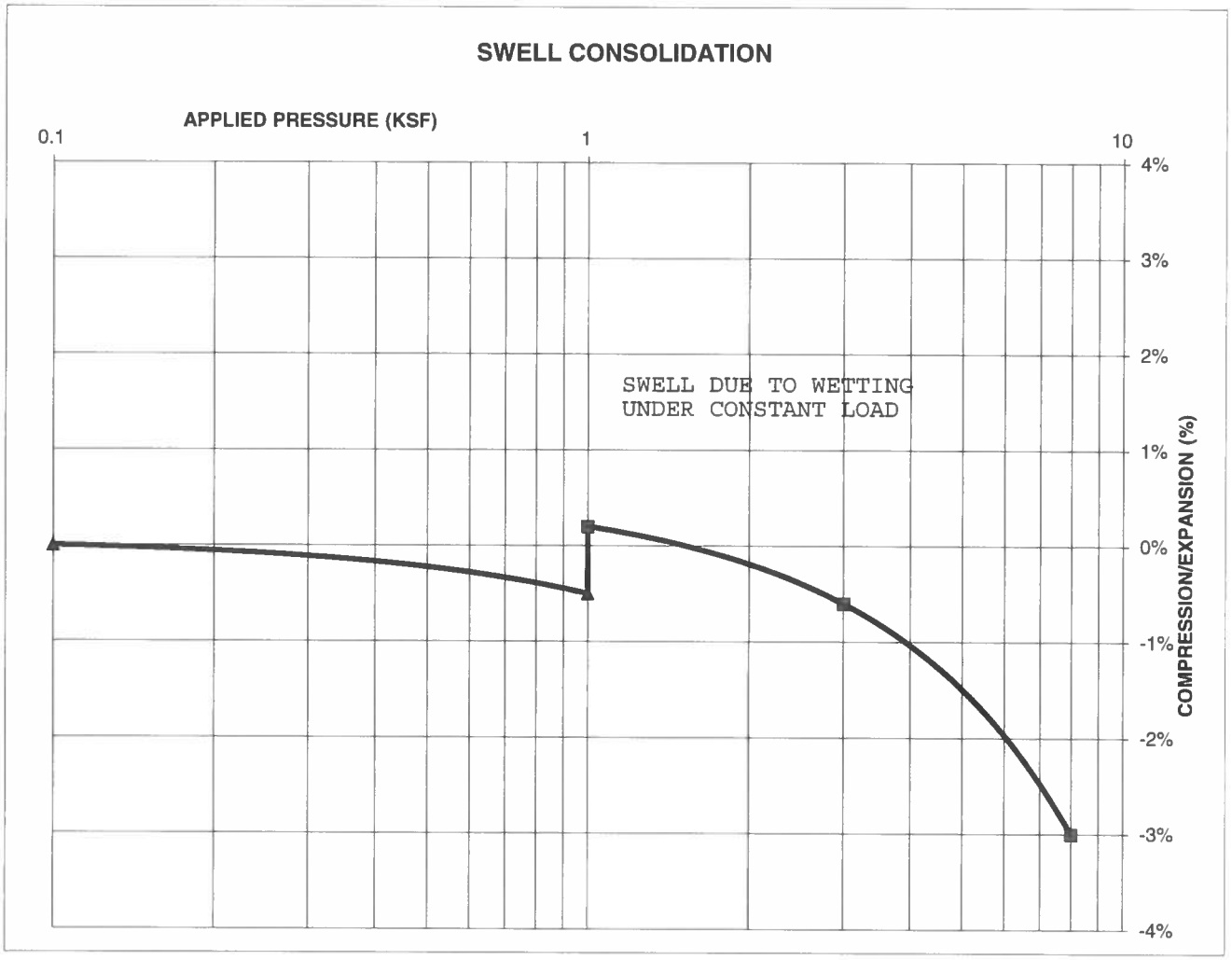
DRAWN:	DATE:	CHECKED:	DATE:
			6/13/19

JOB NO.: 190723
FIG NO.: C-10

CONSOLIDATION TEST RESULTS

TEST BORING #	3	DEPTH(ft)	20
DESCRIPTION	CL	SOIL TYPE	2
NATURAL UNIT DRY WEIGHT (PCF)			127
NATURAL MOISTURE CONTENT			9.7%
SWELL/CONSOLIDATION (%)			0.7%

JOB NO. 190723
CLIENT NORWOOD DEVELOPMENT
PROJECT BANNING LEWIS RANCH NORTH



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SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
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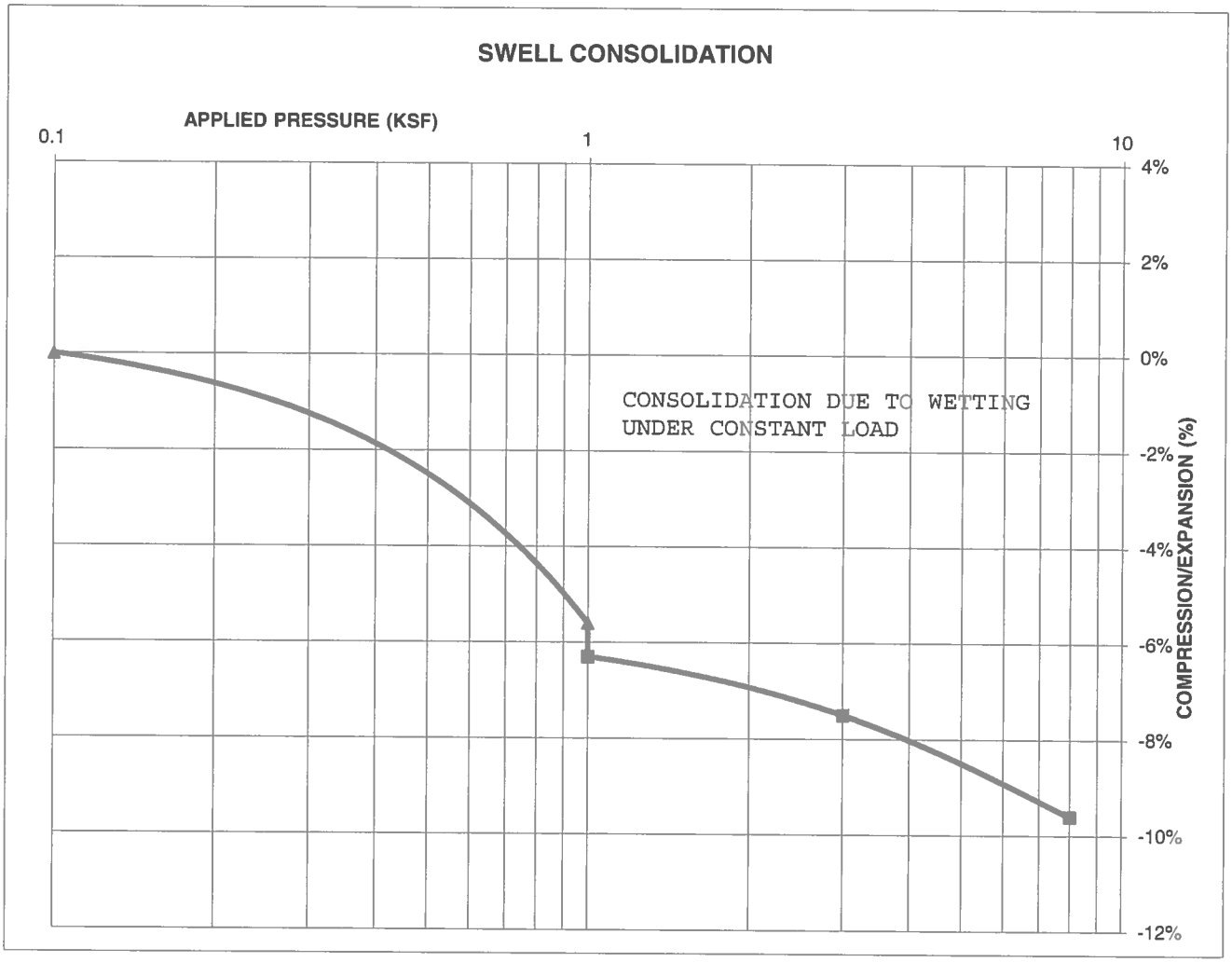
JOB NO.: 190723
FIG NO.: C-11

CONSOLIDATION TEST RESULTS

TEST BORING #	6	DEPTH(ft)	20
DESCRIPTION	SC	SOIL TYPE	3
NATURAL UNIT DRY WEIGHT (PCF)			109
NATURAL MOISTURE CONTENT			14.4%
SWELL/CONSOLIDATION (%)			-0.7%

JOB NO. 190723
CLIENT NORWOOD DEVELOPMENT
PROJECT BANNING LEWIS RANCH NORTH



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SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
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FIG NO.: C-12

APPENDIX D: Soil Survey Descriptions

8—Blakeland loamy sand, 1 to 9 percent slopes. This deep, somewhat excessively drained soil formed in alluvial and eolian material derived from arkosic sedimentary rock on uplands. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is dark grayish brown loamy sand about 11 inches thick. The substratum, to a depth of 27 inches, is brown loamy sand; it grades to pale brown sand that extends to a depth of 60 inches.

Included with this soil in mapping are small areas of Bresser sandy loam, 0 to 3 percent slopes; Bresser sandy loam, 3 to 5 percent slopes; Truckton sandy loam, 0 to 3 percent slopes; Truckton sandy loam, 3 to 9 percent slopes; and Stapleton sandy loam, 3 to 8 percent slopes. In some areas, mainly north of Colorado Springs in the Cottonwood Creek area, arkosic beds of sandstone and shale are at a depth of 0 to 40 inches.

Permeability of this Blakeland soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Organic matter content of the surface layer is medium. Surface runoff is slow, the hazard of erosion is moderate, and the hazard of soil blowing is severe.

Most areas of this soil are used for range, homesites, and wildlife habitat.

Native vegetation is dominantly western wheatgrass, side-oats grama, and needleandthread. This soil is best suited to deep-rooted grasses.

Proper range management is necessary to prevent excessive removal of plant cover from the soil. Interseeding improves the existing vegetation. Deferment of grazing in spring increases plant vigor and soil stability. Proper location of livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand and low available water capacity are the main limitations for the establishment of trees and shrubs. The soil is so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to wildlife habitat. It is best 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 has good potential for urban development. Soil blowing is a hazard if protective vegetation is removed. Special erosion control practices must be provided to minimize soil losses. Capability subclass VIe.

9—Blakeland complex, 1 to 9 percent slopes. This complex is on uplands, mostly in the Falcon area. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the frost-free period is about 135 days.

This complex is about 60 percent Blakeland loamy sand, about 30 percent Fluvaquentic Haplaquolls, and 10 percent other soils.

Included with these soils in mapping are areas of Columbine gravelly sandy loam, 0 to 3 percent slopes, Ellicott loamy coarse sand, 0 to 5 percent slopes, and Ustic Torrifluvents, loamy.

The Blakeland soil is in the more sloping areas. It is deep and somewhat excessively drained. It formed in sandy alluvium and eolian material derived from arkosic sedimentary rock. Typically, the surface layer is dark grayish brown loamy sand about 11 inches thick. The substratum, to a depth of 27 inches, is brown loamy sand; it grades to pale brown sand that extends to a depth of 60 inches or more.

Permeability of the Blakeland soil is rapid. The effective rooting depth is more than 60 inches. The available water capacity is moderate to low. Surface runoff is slow, and the hazard of erosion is moderate.

The Fluvaquentic Haplaquolls are in swale areas. They are deep, poorly drained soils. They formed in alluvium derived from arkosic sedimentary rock. Typically, the surface layer is brown. The texture is variable throughout. The water table is at a depth of 0 to 3 feet.

The Blakeland soil is well suited to deep-rooted grasses. Native vegetation is dominantly western wheatgrass, side-oats grama, and needleandthread. Rangeland vegetation on the Fluvaquentic Haplaquolls is dominantly tall grasses, including sand bluestem, switchgrass, prairie cordgrass, little bluestem, and sand reedgrass. Cattails and bulrushes are common in the swampy areas.

Proper range management is needed to prevent excess removal of plant cover from these soils. It is also needed to maintain the productive grasses. Interseeding improves the existing vegetation. Deferment of grazing during the growing season increases plant vigor and soil stability, and it helps to maintain and improve range condition. Proper location of livestock watering facilities helps to control grazing of animals.

Windbreaks and environmental plantings are fairly well suited to these soils. Blowing sand and low available water capacity are the main limitations to the establishment of trees and shrubs. The soils are so loose that trees need to be planted in shallow furrows and plant cover needs to be maintained between the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

The Blakeland soil is well suited to wildlife habitat. It is best 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. Wetland wildlife can be attracted to the Fluvaquentic Haplaquolls and the wetland habitat can be enhanced by several means. Shallow water developments can be created by digging or by blasting potholes to create open-water areas. Fencing to control livestock grazing is beneficial, and it allows wetland plants such as cattails, reed canarygrass, and rushes to grow. Control of unplanned burning and prevention of drainage that would remove water from the wetlands are good practices. Openland wildlife use the vegetation on these soils for nesting and escape cover. These shallow marsh areas are especially important for winter cover if natural vegetation is allowed to grow.

The Blakeland soil has good potential for homesites, roads, and streets. It needs to be protected from erosion when vegetation has been removed from building sites. The Fluvaquentic Haplaquolls have poor potential for homesites. Their main limitations for this use are the high water table and the hazard of flooding. Capability subclass VIe.

19—Columbine gravelly sandy loam, 0 to 3 percent slopes. This deep, well drained to excessively drained soil formed in coarse textured material on alluvial terraces and fans and on flood plains. Elevation ranges from 6,500 to 7,300 feet. The average annual precipitation is about 15 inches, the average annual air temperature is about 47 degrees F, and the average frost-free period is about 135 days.

Typically, the surface layer is grayish brown gravelly sandy loam about 14 inches thick. The underlying material is light yellowish brown very gravelly loamy sand.

Included with this soil in mapping are small areas of Stapleton sandy loam, 3 to 8 percent slopes; Blendon sandy loam, 0 to 3 percent slopes; Louviers silty clay loam, 3 to 18 percent slopes; and Fluvaquentic Haplaquolls, nearly level. In places the parent arkose beds of sandstone or shale are at a depth of 0 to 40 inches.

Permeability of this Columbine soil is very rapid. Effective rooting depth is 60 inches or more. Available water capacity is low to moderate. Surface runoff is slow, and the hazard of erosion is slight to moderate.

This soil is used mainly for grazing livestock and for wildlife habitat. It is also used for homesites.

Native vegetation is mainly western wheatgrass, sideoats grama, needleandthread, and little bluestem. The main shrub is true mountainmahogany.

Proper location of livestock watering facilities helps to control grazing.

Windbreaks and environmental plantings are fairly well suited to this soil. Blowing sand and low available water capacity are the principal limitations to the establishment of trees and shrubs. The soil is so loose that trees need to be planted in the rows. Supplemental irrigation may be needed to insure survival. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, and Siberian elm. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

Rangeland wildlife, such as pronghorn antelope, cottontail, coyote, and scaled quail, is best adapted to life on this droughty soil. Forage production is typically loam, and proper livestock grazing management is necessary if wildlife and livestock share the range. Livestock watering developments are also important and are used by various wildlife species.

The main limitation of this soil for urban development is a hazard of flooding in some areas. Care must be taken when locating septic tank absorption fields because of possible pollution as a result of the very rapid permeability of this soil. Capability subclass VIe.